ECONOMIC SCIENCE FOR RURAL DEVELOPMENT

Production and Co-operation in Agriculture

№ 34
Jelgava
2014

TIME SCHEDULE OF THE CONFERENCE

Preparation: October 2013 – 20 April 2014
Process: 24-25 April 2014

University of Economics, Prague	Czech Republic
Estonian University of Life Sciences	Estonia
BA School of Business	Latvia
Baltic International Academy	Latvia
Latvian State Institute of Agrarian Economics	Latvia
University of Latvia	Latvia
Latvia University of Agriculture	Latvia
Riga International School of Economics and Business Administration	Latvia
Latvian State Forest Research Institute "Silava"	Latvia
Institute for National Economy Research	Latvia
Riga Technical University	Latvia
Rezekne Higher Education Institution	Latvia
State Priekuli Plant Breeding Institute	Latvia
Ventspils University College	Latvia
Aleksandras Stulginskis University	Lithuania
Kaunas University of Technology	Lithuania
Vilnius University	Lithuania
Mykolas Romeris University	Lithuania
Lithuanian University of Health Sciences	Lithuania
Vilnius Gediminas Technical University	Lithuania
Szczecin University	Poland
University of Warmia and Mazury in Olsztyn	Poland
Warsaw University of Life Sciences	Poland
Poznan University of Economics	Poland
West Pomeranian University of Technology in Szczecin	Poland
University of Agriculture in Krakow	Poland
Institute of Agricultural and Food Economics - National Research Institute, Warsaw	Poland
Welfare Projects Academy of Sciences in Lodz	Poland
South Dakota State University	USA
Pennsylvania State University, State College	USA
Russian Academy of Sciences	Russia
Saratov State Socio-Economic University	Russia
Kazakh Economic University	Kazakhstan

ISSN 1691-3078
ISSN 2255-9930 on line

ISBN 978-9934-8466-1-8

Abstracted / Indexed: AGRIS, EBSCO
http://www.esaf.llu.lv/journals-and-proceedings
www.fao.org/agris/
http://search.ebscohost.com/login.aspx?authtype=ip,uid&profile=ehost&defaultdb=lbh
http://search.ebscohost.com/login.aspx?direct=true&db=a9h&jid=25AP&site=ehost-live

The Conference Committee

Professor **Baiba Rivza**	Latvia University of Agriculture **/Latvia/**
Professor **Irina Pilvere**	Latvia University of Agriculture **/Latvia/**
Professor **Barbara Freytag - Leyer**	Fulda University of Applied Sciences **/Germany/**
Professor **Bo Öhlmer**	Swedish University of Agricultural Sciences **/Sweden/**
Professor **Wim J.M. Heijman**	Wageningen University /the **Netherlands**/
Professor **Bartosz Mickiewicz**	West Pomeranian University of Technology **/Poland/**
Professor **Maria Parlinska**	Warsaw University of Life Sciences **/Poland/**
Professor **Alina Danilowska**	Warsaw University of Life Sciences **/Poland/**
Professor **Jacques Viaene**	University of Gent /**Belgium**/
Professor **Arild Sæther**	University of Agder **/Norway/**
Professor **Vilija Alekneviciene**	Aleksandras Stulginskis University **/Lithuania/**
Associate professor **Bruna Maria Zolin**	University of Venice **/Italy/**
Professor **Ingrida Jakusonoka**	Latvia University of Agriculture /**Latvia/**
Professor **Andra Zvirbule-Berzina**	Latvia University of Agriculture /**Latvia/**
Professor **Aina Dobele**	Latvia University of Agriculture /**Latvia/**
Professor **Modrite Pelse**	Latvia University of Agriculture /**Latvia**/
Associate professor **Gunita Mazure**	Latvia University of Agriculture /**Latvia**/
Associate professor **Inguna Leibus**	Latvia University of Agriculture /**Latvia**/
Associate professor **Aija Eglite**	Latvia University of Agriculture /**Latvia**/
Associate professor **Gunars Brazma**	Latvia University of Agriculture /**Latvia**/

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Editorial Board

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Reviewers

Every article included into the Proceedings was subjected to a scientific, including international review.

All reviewers were anonymous for the authors of the articles.

The following 76 reviewers from scientific and academic institutions of 7 countries (the Czech Republic, Estonia, Latvia, Lithuania, Russia, Poland, and the United States of America) have written 196 reviews.

Vilija Alekneviciene	Dr.oec., prof. (Aleksandras Stulginskis University, Lithuania)
Audrius Aleknavicius	Dr.,prof. (Aleksandras Stulginskis University, Lithuania)
Valentina Andrejeva	Dr.oec. (A/S Olainfarm, Latvia)
S.A.Andryuschenko	Dr.oec., prof. (IAgP RAS, Russia)
Anita Auzina	Dr.oec., assoc. prof. (Latvia University of Agriculture, Latvia)
James G. Beierlein	PhD, prof. (Pennsylvania State University, United States of America)
Dina Bite	Dr.sc.soc., assist. prof (Latvia University of Agriculture, Latvia)
Ligita Bite	Dr.oec., assist. prof. (Latvia University of Agriculture, Latvia)
Agnieszka Brelik	PhD. (West Pomeranian University of Life Sciences, Poland)
Akvile Cibinskiene	PhD , assoc. prof. (Kaunas University of Technology, Lithuania)
Cheslav Christauskas	Dr., assoc. prof. (Kaunas University of Technology, Lithuania)
Alina Danilowska	Dr.hab., assoc. prof. (Warsaw University of Life Sciences, Poland)
Ramunas Darulis	Dr.oec. (Mykolas Riomeris University, Lithuania)
Konstantins Didenko	Dr.oec., prof. (Riga Technical University, Latvia)
Aina Dobele	Dr.oec., prof. (Latvia University of Agriculture, Latvia)
Lasma Dobele	Dr.oec. (Latvia University of Agriculture, Latvia)
Aija Eglite	Dr.oec., assoc. prof. (Latvia University of Agriculture, Latvia)
Zbigniew Florianczyk	PhD , assist. prof. (Institute of Agricultural and Food Economics, Poland)
Gunta Grinberga-Zalite	Dr.oec., assist. prof. (Latvia University of Agriculture, Latvia)
Aleksander Grzelak	PhD , assoc. prof. (Poznan University of Economics, Poland)
Jan Gorecki,	Dr., prof. (Polish Academy of Sciences, Poland)
Wojciech Gotkiewicz	PhD, prof. (University of Warmia and Mazury in Olsztyn, Poland)
Sandra Gusta	Dr.oec. assist. prof. (University of Latvia, Latvia)
Joanna Henrik	PhD (West Pomeranian University of Life Science, Poland)
Ingrida Jakusonoka	Dr.oec., prof. (Latvia University of Agriculture, Latvia)
Inara Jurgena	Dr.oec., assoc. prof. (Latvia University of Agriculture, Latvia)
Stanislavs Keiss	Dr.oec., assoc. prof. (University College of Economics and Culture, Latvia)
Joanna Kisielinska	Dr. hab. (Warsaw University of Life Sciences, Poland)
Gediminas Kuliesis	Dr. (Lithuanian Institute of Agrarian Economic, Lithuania)
Vulfs Kozlinskis	Dr.hab.oec., prof. (Latvia University of Agriculture, Latvia)
Jakub Kraciuk	Dr. hab., assoc. prof. (WULS-SGGW, Poland)
Karlis Kreslins	PhD (Ventspils University College, Latvia)
Bogdan Klepacki	Dr hab., prof. (Warsaw University of Life Sciences, Poland)
Jakub Kraciuk	Dr.hab., assoc. prof. (WULS-SGGW, Poland)
Krystyna Kryzanowska	Dr., professor (Warsaw University of Life Sciences, Poland)
Jüri Krusealle	PhD, assoc. prof. (Estonian University of Life Sciences, Estonia)
Piotr Kulyk	PhD, assit. prof. (University of Zielona Gora, Poland)
Janis Kusis	Dr.hist., assoc. prof. (Latvia University of Agriculture, Latvia)
Inguna Leibus	Dr.oec., assoc. prof. (Latvia University of Agriculture, Latvia)
Sviesa Leitoniene	Dr., assoc. prof. (Kaunas University of Technology, Lithuania)
Gunita Mazure	Dr.oec., assoc. prof. (Latvia University of Agriculture, Latvia)
Joseph Mezera	Senior researcher, Csc, (Institute of Agricultural Economics and Information, Czech Republic)
Bartosz Mickiewicz	Dr hab., prof. (West Pomeranian University of Technology in Szsecin, Poland)
Tatjana Muravska	Dr.oec., prof. (University of Latvia, Latvia)
Aina Muska	Dr.oec., assoc. prof. (Latvia University of Agriculture, Latvia)
Kaspars Naglis-Liepa	Dr.oec. (Latvia University of Agriculture, Latvia)

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Publication Ethics and Malpractice Statement for the International Scientific Conference "Economic Science for Rural Development"

The conference and its proceedings are dedicated to topical themes of rural development, such as primary and secondary agricultural production and cooperation; integrated and sustainable development; finance and taxes; resources and sustainable consumption; home economics and other.

The Editorial Board is responsible for, among other, preventing publication malpractice. Unethical behaviour is unacceptable and the authors who submit articles to the Conference Proceedings affirm that the content of a manuscript is original. Furthermore, the authors' submission also implies that the material of the article was not published in any other publication; it is not and will not be presented for publication to any other publication; it does not contain statements which do not correspond to reality, or material which may infringe upon the intellectual property rights of another person or legal entity, and upon the conditions and requirements of sponsors or providers of financial support; all references used in the article are indicated and, to the extent the article incorporates text passages, figures, data or other material from the works of others, the undersigned has obtained any necessary permits as well as the authors undertake to indemnify and hold harmless the publisher of the proceedings and third parties from any damage or expense that may arise in the event of a breach of any of the guarantees.

Editors, authors, and reviewers, within the International Scientific Conference **"Economic Science for Rural Development"** are to be fully committed to good publication practice and accept the responsibility for fulfilling the following duties and responsibilities, as set by the *COPE Code of Conduct and Best Practice Guidelines for Journal Editors of the Committee on Publication Ethics* (COPE).

It is necessary to agree upon standards of expected ethical behaviour for all parties involved in the act of publishing: the author, the editor, the peer reviewer, and the publisher.

DUTIES OF EDITORS

Publication decisions

The Editorial Board is responsible for deciding which of the articles submitted to the Conference Proceedings should be published. The Editorial Board may be guided by the policies of ethics and constrained by such legal requirements as shall then be in force regarding libel, copyright infringement and plagiarism. The editor may confer with other editors or reviewers in making this decision.

Fair play

An editor at any time evaluate manuscripts for their intellectual content without regard to the nature of the authors or the host institution including race, gender, sexual orientation, religious belief, ethnic origin, citizenship, or political philosophy of the authors.

Confidentiality

The editor and any editorial staff must not disclose any information about a submitted manuscript to anyone other than the corresponding author, reviewers, potential reviewers, other editorial advisers, and the publisher, as appropriate.

Disclosure and conflicts of interest

Unpublished materials disclosed in a submitted manuscript must not be used in an editor's own research without the express written consent of the author.

DUTIES OF REVIEWERS

Contribution to editorial decisions

Peer review assists the editor in making editorial decisions and through the editorial communications with the author may also assist the author in improving the paper.

Promptness

Any selected referee who feels unqualified to review the research reported in a manuscript or knows that its prompt review will be impossible should notify the editor and excuse himself from the review process.

Confidentiality

Any manuscripts received for review must be treated as confidential documents. They must not be shown to or discussed with others except as authorised by the editor.

Standards of objectivity

Reviews should be conducted objectively. Personal criticism of the author is inappropriate. Referees should express their views clearly with supporting arguments.

Acknowledgement of sources

Reviewers should identify relevant published work that has not been cited by the authors. Any statement that an observation, derivation, or argument had been previously reported should be accompanied by the relevant citation. A reviewer should also call to the editor's attention any substantial similarity or overlap between the manuscript under consideration and any other published paper of which they have personal knowledge.

Disclosure and conflict of interest

Privileged information or ideas obtained through peer review must be kept confidential and not used for personal advantage. Reviewers should not consider manuscripts in which they have conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors, companies, or institutions connected to the papers.

DUTIES OF AUTHORS

Reporting standards

The authors of reports of original research should present an accurate account of the work performed as well as an objective discussion of its significance. Underlying data should be represented accurately in the paper. A paper should contain sufficient detail and references to permit others to replicate the work. Fraudulent or knowingly inaccurate statements constitute unethical behaviour and are unacceptable.

Data access and retention

The authors are asked to provide the raw data in connection with a paper for editorial review, and should be prepared to provide public access to such data (consistent with the ALPSP-STM Statement on Data and Databases), if practicable, and should in any event be prepared to retain such data for a reasonable time after publication.

Originality and plagiarism

The authors should ensure that they have written entirely original works, and if the authors have used the work and/or words of others that this has been appropriately cited or quoted.

Multiple, redundant or concurrent publication

An author should not in general publish manuscripts describing essentially the same research in more than one journal or primary publication. Submitting the same manuscript to more than one journal concurrently constitutes unethical publishing behaviour and is unacceptable.

Acknowledgement of sources

Proper acknowledgment of the work of others must always be given. The authors should cite publications that have been influential in determining the nature of the reported work.

Authorship of the paper

Authorship should be limited to those who have made a significant contribution to the conception, design, execution, or interpretation of the reported study. All those who have made significant contributions should be listed as co-authors. Where there are others who have participated in certain substantive aspects of the research project, they should be acknowledged or listed as contributors.

The corresponding author should ensure that all appropriate co-authors and no inappropriate co-authors are included on the paper, and that all co-authors have seen and approved the final version of the paper and have agreed to its submission for publication.

Hazards and human or animal subjects

If the work involves chemicals, procedures or equipment that have any unusual hazards inherent in their use, the author must clearly identify these in the manuscript.

Disclosure and conflicts of interest

All authors should disclose in their manuscript any financial or other substantive conflict of interest that might be construed to influence the results or interpretation of their manuscript. All sources of financial support for the project should be disclosed.

Fundamental errors in published works

When an author discovers a significant error or inaccuracy in his/her own published work, it is the author's obligation to promptly notify the editor or publisher and cooperate with the editor to retract or correct the paper.

Editorial Board

Foreword

Every year the Faculty of Economics and Social Development, Latvia University of Agriculture holds the international scientific conference "Economic Science for Rural Development" and publishes internationally reviewed papers of scientific researches, which are presented at the conference. **This year** researchers from various European countries representing not only the science of economics in the diversity of its sub-branches have contributed to the conference; they have expanded their studies engaging colleagues from social and other sciences, thus, confirming inter-disciplinary and multi-dimensional development of the contemporary science. The conference is dedicated to topical themes of rural development; hence, the research results are published in 4 successive volumes (No 33, No 34, No 35, and No 36). The first volume of scientific conference proceedings was published in 2000.

The following topical themes have been chosen for the conference:

- Production and Co-operation in Agriculture
- Integrated and Sustainable Regional Development
- Finance and Taxes
- Marketing and Sustainable Consumption
- Rural Development and Entrepreneurship
- Home Economics
- New Dimensions in the Development of Society

Professors, doctors of science, associate professors, assistant professors, PhD students, and other researchers from the following higher education, research institutions, and professional organisations participate at the International Scientific Conference held on 24-25 April 2014 and present their results of scientific research:

University of Economics, Prague	Czech Republic
Estonian University of Life Sciences	Estonia
BA School of Business	Latvia
Baltic International Academy	Latvia
Latvian State Institute of Agrarian Economics	Latvia
University of Latvia	Latvia
Latvia University of Agriculture	Latvia
Riga International School of Economics and Business Administration	Latvia
Latvian State Forest Research Institute "Silava"	Latvia
Institute for National Economy Research	Latvia
Riga Technical University	Latvia
Rezekne Higher Education Institution	Latvia
State Priekuli Plant Breeding Institute	Latvia
Ventspils University College	Latvia
Aleksandras Stulginskis University	Lithuania
Kaunas University of Technology	Lithuania
Vilnius University	Lithuania
Mykolas Romeris University	Lithuania
Lithuanian University of Health Sciences	Lithuania
Vilnius Gediminas Technical University	Lithuania
Szczecin University	Poland
University of Warmia and Mazury in Olsztyn	Poland
Warsaw University of Life Sciences	Poland
Poznan University of Economics	Poland
West Pomeranian University of Technology in Szczecin	Poland
University of Agriculture in Krakow	Poland
Institute of Agricultural and Food Economics - National Research Institute, Warsaw	Poland
Welfare Projects Academy of Sciences in Lodz	Poland
South Dakota State University	USA

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Pennsylvania State University, State College	USA
Russian Academy of Sciences	Russia
Saratov State Socio-Economic University	Russia
Kazakh Economic University	Kazakhstan

The comprehensive reviewing of submitted scientific articles has been performed on international and inter-university level to ensure that only high-level scientific and methodological research results, meeting the requirements of international standards, are presented at the conference.
Every submitted manuscript has been reviewed by one reviewer from the author's native country or university, while the other reviewer came from another country or university. The third reviewer was chosen in the case of conflicting reviews. All reviewers were anonymous for the authors of the articles, and the reviewers presented blind reviews. Every author received the reviewers' objections or recommendations. After receiving the improved (final) version of the manuscript and the author's comments, the Editorial Board of the conference evaluated each article.
All the papers of the international scientific conference "Economic Science for Rural Development" are arranged into the following four thematic volumes:

No 33 Finance and Taxes
New Dimensions in the Development of Society

No 34 Production and Cooperation in Agriculture

No 35 Marketing and Sustainable Consumption
Rural Development and Entrepreneurship
Home Economics

No 36 Integrated and Sustainable Regional Development

The publishing of the Proceedings before the conference promotes exchange of opinions, discussions, and collaboration of economic scientists on the international level. The research results included into the Proceedings are available worldwide to any interested person.

The Conference Proceedings are indexed in ISI Web of Knowledge, AGRIS, CAB Abstracts and EBSCOHost Academic Search Complete databases.

The Conference Committee and Editorial Board are open to comments and recommendations for the development of future conference proceedings and organisation of international scientific conferences.

We would like to thank all the authors, reviewers, members of the Programme Committee and the Editorial Board as well as supporting staff for their contribution organising the conference.

On behalf of the conference organisers
Ingrida Jakusonoka
Professor of Faculty of Economics and Social Development
Latvia University of Agriculture

Contents

Janusz Majewski	ECONOMIC VALUE OF POLLINATION OF MAJOR CROPS IN POLAND IN 2012	14
Inese Biuksane	PROBLEMS OF FISHERY IN LATVIAN PORTS AND ITS DEVELOPMENT PERSPECTIVES	22
Jindrich Spicka	PRODUCTION EFFICIENCY OF MIXED FARMING IN THE EU REGIONS	31
Agnese Krievina, Ligita Melece	SUPPORT TO BIOENERGY AND ITS IMPACT ON COMPETITIVENESS OF LATVIAN AGRIBUSINESS	40
Marta Smigla	ECONOMIC DETERMINANTS OF MILK PRODUCTION IN REGIONS OF THE EUROPEAN UNION WITH MEDIUM SMALL MILK FARMS IN 2009 COMPARED WITH THE SITUATION IN 2004	50
Liga Proskina, Sallija Cerina	INVESTIGATIONS ON APPLE POMACE USED IN RED DEER NUTRITION	59
Tomas Balezentis	ANALYSING THE DETERMINANTS OF LITHUANIAN FAMILY FARM PERFORMANCE: A DOUBLE BOOTSTRAP INFERENCE	66
Irena Krisciukaitiene, Tomas Balezentis, Alvydas Balezentis	AN INPUT-SPECIFIC ANALYSIS OF THE COST EFFICIENCY ON LITHUANIAN FAMILY FARMS	75
Katarzyna Boratynska, Emilia Wloczewska	ECONOMIC PROBLEMS OF POLISH MEAT SECTOR DEVELOPMENT - A COMPARATIVE STUDY	83
Asta Saboniene, Jurate Pridotkiene	CHANGES IN LITHUANIAN FLAX INDUSTRY EXPORTS	92
Antoni Miciewicz, Bartosz Mickiewicz	CHANGE OF THE POSITION OF POLISH AGRICULTURE IN RELATION WITH THE EUROPEAN UNION IN LIGHT OF THE AGRICULTURAL CENSUSES OF 2002 AND 2010	101
Adam Pawlewicz	IMPORTANCE OF HORIZONTAL INTEGRATION IN ORGANIC FARMING	112

Petra Stamfestova	BUSINESS PERFORMANCE MANAGEMENT IN FOOD COMPANIES IN THE CZECH REPUBLIC WITH EMPHASIS ON NON-FINANCIAL ASPECTS OF BUSINESS	121
Reet Põldaru, Jüri Roots	ASSESSING THE PERFORMANCE OF MILK PRODUCER IN ESTONIAN FARMS USING PCA-DEA APPROACH	127
Evaldas Serva, Vlada Vitunskiene	SHIFTS IN PATTERN OF SPECIALISATION OF LITHUANIA'S AGRI-FOOD PRODUCTS EXPORT	135
Andrzej Czyzewski, Katarzyna Smedzik-Ambrozy	INPUT-OUTPUT MODEL IN ASSESSMENT OF EFFECTIVENESS OF AGRICULTURAL SECTOR – THEORETICAL PREREQUISITES AND PRACTICAL IMPLICATIONS	145
Armands Veveris	INVESTMENT SUPPORT AND ITS IMPACT ON THE ECONOMIC RESULTS OF RURAL FARMS OF DIFFERENT GROUPS	154
Ivars Ozolins	CHARACTERISTICS OF SHEEP FARMING SECTOR AND ITS DEVELOPMENT IN LATVIA	163
Kaspars Naglis-Liepa, Modrite Pelse	BIOGAS PRODUCTION FROM AGRICULTURAL RAW MATERIALS	172
Ligita Melece, Peteris Lakovskis	LAND USE CHANGES AND BIOENERGY IN LATVIA	180
Kristine Polacenko, Veronika Bugina	DEVELOPMENT OF COOPERATION IN DAIRY FARMING	189

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

ECONOMIC VALUE OF POLLINATION OF MAJOR CROPS IN POLAND IN 2012

Janusz Majewski[1], PhD
Department of Agricultural Economics and International Economic Relations,
Warsaw University of Life Sciences

Abstract. Bees are the single most important species of pollinators in Poland. They are responsible for 90-95% of pollination carried out by insects. Their importance has been growing due to the wild pollinators' population being reduced by humans. In Poland, over 1.28 million beehives were in operation in 2012. This number only satisfies 53% of the minimum pollination needs of major entomophilous plants at the peak of their flowering. This also affects the yield of the plants and a decline in the quality of the crop.

The yield values obtained by pollination and losses resulting from the low number of pollinators for selected crops have been estimated in the paper. The major entomophilous plants flowering at approximately the same time included rape and agrimony, apple, pear, plum, sweet and sour cherry orchards as well as currant and gooseberry. The plantation yield obtained in Poland in 2012 owing to the pollination by bees is valued at EUR 825.1 million, and losses resultant from too low number of pollinators are estimated at EUR 728.5 million.

Key words: Poland, pollination, economic effects of pollination.
JEL code: Q57

Introduction

Beekeeping is an important sector of agriculture. Bees provide their products to humans, the most important of which is honey. Apart from that pollen, propolis, royal jelly, beeswax and bee venom are also obtained from bees. On the contrary, apiculture plays the role of service providers of sorts in the pollination of plants, including domesticated plants. Pollination is the chief advantage derived from the breeding of bees. It is estimated that, by pollinating plants, these insects contribute benefits to the economy which are from ten to even a hundred times greater than the value of their products (Prabucki, 1998). It is estimated that the production of approximately one third of food produced globally is directly or indirectly dependent on plant pollination by bees (Gojmerac, 1983).

In Poland's geographical zone, approximately 78% of all plant species are pollinated by insects; such plants are referred to as entomophilous plants (Prabucki, 1998). Domesticated plants are among them. In Poland, there are about 60 species of cultivated plants dependent on pollination, mainly performed by bees (Banaszak, 1987). In economic terms, rape and agrimony, fruit plants and shrubs, most perennial permanent stock as well as buckwheat belong to the most important entomophilous plants cultivated in Poland. Pollinators also play an important role in the production of vegetable seeds, herbs, and flowers.

The most important role in insect pollination is played by *Apidae*, including honeybees, which account for approximately 90-95% of the pollination by insects (Bornus, 1982).

[1] Corresponding author. Tel. +48 225934112
e-mail: Janusz_Majewski@sggw.pl

The importance of honeybees in the pollination of plants is increasing. This is caused, *inter alia*, by (Majewski, 2011):

- changes in the production technology;
- large areas of monocultures hindering the access of pollinators living in the wild to plants;
- limiting the area of non-farming land;
- environmental pollution;
- improper use of plant protection products.

The predominant role of bees in the pollination of entomophilous plants in Poland indicates the need to investigate the economic value of pollination. The purpose of this article is to determine the number of bee colonies needed for the pollination of major entomophilous crops in Poland in 2012. An attempt has also been made to determine the value of the harvest obtained owing to the pollination as well as the estimated losses resulting from an insufficient number of pollinators as compared with the needs. The study included the following plants: rape and agrimony, fruit plants, including apple trees, pear trees, plum trees, sweet and sour cherries trees as well as shrubs and perennial permanent stock, which included strawberries, raspberries, currants, and gooseberries.

The study used data from the Central Statistical Office in Warsaw, Apiculture Department in Pulawy of the Institute of Horticulture in Skierniewice (formerly the Institute of Pomology and Floriculture), the National Bank of Poland and the Polish Ministry of Agriculture and Rural Development as well as literature. Statistical data were used among other things to indicate the size of major cultivations of entomophilous plants in Poland and to determine the value of the harvest obtained owing by pollination. The impact of bees on the size of the crops was determined based on the literature.

In determining the economic value of pollination, it was assumed that bees pollinate plants flowering approximately at the same time to an equal degree. This assumption was also used in the estimation of the yield obtained from crops without pollination and with full pollination. The economic value of pollination was estimated as the value of the crop obtained owing to pollinators (the difference between the actual value of the crop and the potential value of the crop without accounting for pollination). In turn, a loss resulting from an insufficient number of pollinators was established as the difference between the achievable value of the harvest in the case of full pollination and the actual value of the harvest.

Research results and discussion

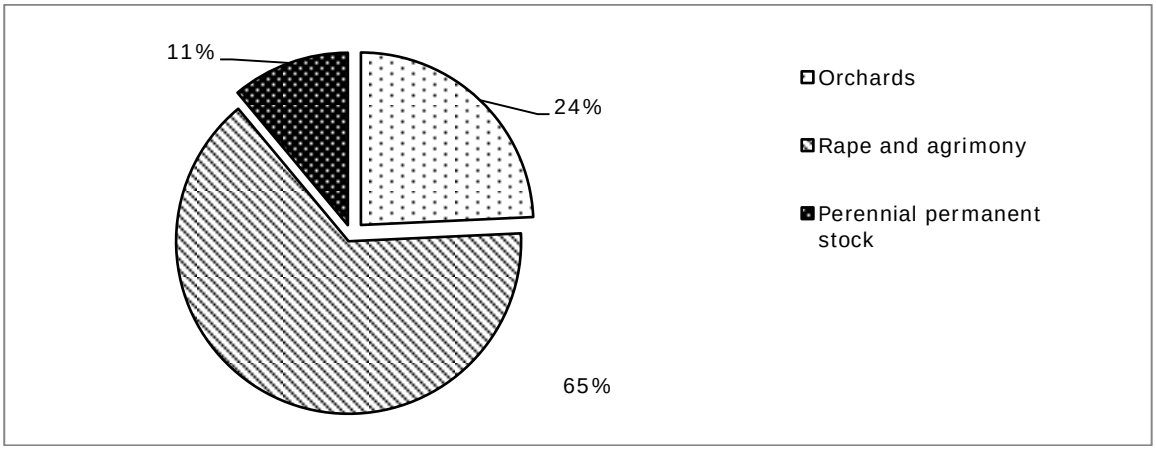
Pollinating needs of domesticated plants in Poland

Pollination is a necessary process for the obtaining of fruit or seed yield. In the case of entomophilous plants, pollination is carried out by insects. An absence or a small number of pollinators decreases the size of the crop obtained and reduces their quality. Also in the case of self-pollinated plants, the presence of pollinators increases the size and the quality of crops.

The principal role of bees in the pollination of plants results from a number of premises. Firstly, these insects live in swarms ranging from several to tens of thousands of individuals which enables a significant area of crop pollination. Secondly, in bees the whole colony overwinters, rather than fertilised mother only, as it is in other insects. As a result, as early as at the onset of spring, bees are capable of pollinating a significant number of plants. Thirdly, these insects can be transported to plantations, depending on the needs connected with their pollination. Another favourable feature of using bees to

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

pollinate is their so-called floral fidelity. It consists in that during its flight a bee only visits flowers one plant species. Importantly, this also results in a possibility of obtaining bee products which in the case of Poland are the main source of revenue earned by beekeepers.



Source: author's construction based on Produkcja upraw rolnych i ogrodniczych (Production of Agricultural and Horticultural Crops in 2012), 2013, GUS Warszawa

Fig. 1. **The structure of major entomophilous plants in Poland in terms of cultivation area in 2012**

The main crops that require pollination by insects in Poland are rape and agrimony, fruit plants and shrubs, and perennial permanent stock. The arable land area used for the cultivation of rape and agrimony represented two thirds; whereas, orchards, nearly a quarter of farmland where entomophilous plants are cultivated (Figure 1). The area covered by these crops has increased by 36% since 2000, resulting in increased pollination needs by over 30%. This was due to an increase in the cultivation area of rape and agrimony by over 60% and an increase in apple orchard area by 18%. The cultivation area of raspberries has grown by 125% and that of currants by 33%. In the case of other plants, over the same period, the cultivation area has decreased by a percentage ranging from less than 5% for sweet cherry orchards to almost 50% in the case of gooseberry plantations.

Table 1

Dates of major entomophilous domesticated plants flowering and the number of hives needed for the pollination of 1 ha of plantation area

Type of crop	Flowering period	Number of colonies to pollinate1 ha		
		Minimum*	Average	Maximum
Apple trees	5.05 - 20.05	3	4	6
Pear trees	5.05 - 15.05	3	4	6
Plum trees	20.04 - 20.05	4	5	8
Sour cherry trees	1.05 - 15.05	4	5	8
Sweet cherry trees	25.04 - 5.05	4	5	8
Rape and agrimony	25.04 - 15.05	2	3.5	6
Strawberries	10.05 - 5.06	1	1.5	2
Raspberries	25.05 - 25.06	2	3.5	6
Currants	25.04 - 10.05	2	3.5	6
Gooseberries	20.04 - 5.05	2	3.5	6

* - Minimum - means the number of hives needed to pollinate the plants calculated on the basis of the minimum recommendations provided in the literature; Average - calculations were performed taking into account the average of the most frequently indicated intervals; Maximum - the highest value provided in the literature was applied.

Source: author's calculations based on Prabucki, 1998

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

A different number of pollinators is required for the pollination of individual plants. There are different indications in the literature as to the required number of colonies for a good pollination of the planted area. The most common values are displayed in Table 1. It is obvious that an increase in the number of bees is bound to lead to a better pollination of plantations, but the efficiency of additional colonies will be decreasing.

Table 2

The number of colonies needed for the pollination of selected crops in Poland in 2012

Type of crop	The pollination needs to the min/ave/maximum extent	Number of hives (in thousand)
Orchards	Minimum*	875
	Average	1145
	Maximum	1751
Rape and agrimony	Minimum	1441
	Average	2521
	Maximum	4322
Fruit shrubs and perennial permanent stock	Minimum	199
	Average	337
	Maximum	551
Total	Minimum	2515
	Average	4004
	Maximum	6623
Plants with a similar flowering period	Minimum	2412
	Average	3834
	Maximum	6359

* - Explanation as in Table 1

Source: author's calculations

The greatest demand for the pollination of domesticated plants in Poland occurs from April 25th to mid-May. It is the period when the major entomophilous domesticated plants bloom, namely, rape and agrimony, fruit plants and currants as well as gooseberries. They represent over 90% of the entomophilous plants investigated. These plants "compete" with each other for pollinators, as the number of bee colonies in Poland, which amounted to more than 1.28 million hives in 2012 (Semkiw, 2012), does not meet the pollination needs of those crops (Table 2).

The literature data on the number of colonies needed for the pollination of selected domesticated plants are diverse. Therefore, the number of hives needed for the pollination of such plants was determined for the three options set out in Table 1. In each scenario, the number of colonies in Poland in 2012 was too small for a full pollination of flowering plants investigated in a comparable period. In the minimum sufficiency scenario, the number of colonies was only sufficient for the pollination of 53% of the areas where the plants studied are grown. In the two other variants, this percentage amounted to 33% (the average scenario) and 20% (the maximum scenario).

The largest share in the pollination needs was claimed by rape and agrimony plantations. Depending on the variant adopted, the share of these crops ranged from 60 to 68 per cent of the pollination needs for plants flowering at that time. This is due to a large area covered by these crops. The number of bees in Poland is insufficient even for a minimum pollination of the entire area where rape and agrimony are grown. Orchards are responsible for a significant proportion of the pollination needs for plants flowering roughly at the same time. This proportion varies, depending on the scenario, in the range of 28-36%. The share of currants and gooseberries represented approximately 4% of the pollination needs for plants flowering roughly at the same time, irrespective of the variant.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The importance of pollination for selected crops

Pollination is a procedure which enables an increase in the yield potential of fruit or seeds. It also results in enhancing the crop quality. Pollination does not guarantee obtaining high yields, since between the pollination of plants and harvesting there may be situations such as frost and hail which cause yield losses. However, other procedures such as fertilisation, plant protection, irrigation etc., are applied to ensure the maximum utilisation of the plants' yield potential.

Table 3

The effect of pollination on the yield of selected crops

Plant species	The effect of pollination on yield (in%) per	
	ISiK *	Morse and Calderone 2000; Losey 2006
Apple trees	85	100
Pear trees	90	70
Plum trees	40	70
Sour cherry trees	60	90
Sweet cherry trees	95	90
Rape and agrimony	30	90
Currants	85	-
Gooseberries	70	-
Strawberries	85	20
Raspberries	70	90

* - data from the Institute of Pomology and Floriculture (ISiK). Plant Protection Scheme Safe for Bees (in Polish). Retrieved: http://www.opisik.pulawy.pl, Access: 15.04.2010

Source: ISiK 2010; Morse and Calderone, 2000; Losey, 2006

The effect of pollination is varied on the size of the crop yield. The results of studies on the impact of pollination on crop yields vary significantly (Gallai et al., 2009). This is evidenced by the results presented in Table 3. The differences in the effect of pollination on yield range from 5 to 60 percentage points.

The average yield and the number of colonies in 2012, the estimated yields achievable in the absence of pollination and in the case of full pollination of these plants were determined based on the data from the Institute of Pomology and Floriculture (presently the Institute of Horticulture) regarding the size of the effect of pollination on the crop yield of domesticated plants.

Table 4

The average yield of major entomophilous domesticated plants and estimated yields of these plants with pollination and without pollination in 2012

Plant species	Average yield (in t / ha)	Yields without pollinators (in t / ha)	Yields with pollinators (in t / ha)
Apple trees	14.78	4.04	26.94
Pear trees	5.95	1.14	11.4
Plum trees	5.31	4.05	6.74
Sour cherry trees	5.2	3.05	7.63
Sweet cherry trees	3.54	0.36	7.14
Rape and agrimony	2.59	2.16	3.08
Currants	4.35	1.19	7.93
Gooseberry	5.25	2.51	8.36

Source: author's calculations

The largest difference in the yields estimated was observed in plants with the highest impact of pollination, i.e. sweet cherry orchards, pear and apple orchards as well as strawberries (Table 4). These differences may result from differences related with the plant species studied, differences in the weather or from methodological differences in the conducted research projects.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The estimated value of pollination of selected crops in Poland in 2012

Estimating the value of pollination of plants is a complicated issue. In order to determine it, the following methods are frequently used:

market method;

cost methods (replacement cost, restoration cost, cost of preventing damage);

product value method as obtained owing to pollination.

Estimating the value of pollination by using the market method consists in determining the market price of pollination services. The market price of pollination services, which equals the value of pollination, is determined by juxtaposing the supply side represented by beekeepers with the demand side represented by entomophilous crop owners. In Poland, there is no market for plant pollination services; on the contrary, beekeepers often pay for the opportunity of placing beehives on plantations, mostly rapeseed plantations. Therefore, it can be indicated that the value of pollination in Poland amounts to zero.

In assessing the value of pollination methods one can distinguish the replacement cost method or the restoration cost method as well as the cost of preventing damage method. The costs that would have to be incurred to replace pollination are determined in the replacement cost method. An alternative solution for pollination by insects is the so-called mechanical pollination performed by humans. Such a method of pollination can be encountered in China, in the province of Maoxian (Mburu et al., 2006) where the bees have died out as a result of poisoning and people were compelled to take over. For example, it takes between 45 to 90 minutes for a human to pollinate one apple or pear tree. For the pollination of one hectare of such plants a single individual would require from 150 to over 300 days (Allsopp et al., 2011). The value of pollination as determined by this method would amount to the cost of employing people to perform the pollination. One should also take into account the costs involved in the preparation of the workstation. In turn, the cost of preventing damage method determines the costs associated with the prevention of incurring losses due to the lack or limitation of the number of pollinators.

The value of pollination for crops is most frequently determined by establishing the value of the products obtained by pollination. The yield obtained owing to pollinators is determined as the difference between the yields of the plants subject to pollination and those that have not been pollinated. The resultant amount is subsequently multiplied by the market price of the product. The calculation should also include the costs connected with the renting of hives for pollination. The difficulty in determining the value of pollination in this approach stems from the varied data on the effect of pollinators on crop yields. In the present study, the method of products obtained by pollination was applied to estimate the economic value of pollination of selected crops. The amounts are provided in PLN as well as in Euro (Table 5).

The largest differences in yields obtainable per hectare between pollinated and unpollinated plantations were established in the case of sweet cherry orchards: over PLN 41 thousand (EUR 9.8 thousand)[2]. For the most significant entomophilous crops, from the point of view of the Polish economy, i.e. rape and agrimony as well as apple orchards, the differences amounted to EUR 438 and EUR 3997 respectively.

[2] The amount in EUR was calculated based on the average FX rate of PLN in 2012, estimated on the basis of the National Bank of Poland's data at the level of PLN 4.185

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 5

Estimated value of the pollination of selected crops and losses arising from an insufficient number of pollinators in Poland in 2012

Plant species	Difference between the yield of the plantation with and without pollination		The value of plant pollination by bees		The value of pollination by bees given full pollination		Losses resulting from the insufficient number of pollinators	
	in PLN/ha	in EUR/ha	in million PLN	in million EUR	in million PLN	in million EUR	in million PLN	in million EUR
Apple trees	16729	3997	1729.6	413.3	3256.8	778.2	1527.2	364.9
Pear trees	20934	5002	120.9	28.9	227.7	54.4	106.8	25.5
Plum trees	4494	1074	46.1	11.0	86.8	20.7	40.7	9.7
Sour cherry trees	15693	3750	281.1	67.2	529.3	126.5	248.2	59.3
Sweet cherry trees	41095	9820	253.4	60.5	477.1	114.0	223.7	53.5
Rape and agrimony	1831	438	700.4	167.4	1318.9	315.1	618.5	147.8
Currants	12067	2883	286.5	68.5	539.5	128.9	253	60.5
Gooseberry	21187	5063	35.0	8.4	65.8	15.7	30.8	7.4
Total	-	-	3453.0	825.1	6501.9	1553.6	3048.9	728.5

Source: author's calculations

The estimated value of the pollination of selected crops in 2012 amounted to over EUR 825 million. Half of this amount was the value of the pollination of apple orchards; whereas, rape and agrimony as well as other fruit plants each represented ca. 20% of the total. The value of the pollination of currants and gooseberries equalled less than 10% of the estimated amount.

As for the number of colonies that would have ensured a full pollination in 2012, the value of the pollination of plants encompassed by the present study would have amounted to EUR 1.55 billion. The losses incurred as a result of the absence of bee colonies to ensure a full pollination of crops were estimated at EUR 728.5 million (Table 5).

Summary and conclusions

Pollination is the most important task of bees, frequently underestimated by people. The economic effects obtained owing to pollination exceed the value of apicultural products by a multiple. This results from an increase in crop yields and an enhancement of crop quality.

The estimated crop value of major entomophilous plants in Poland in 2012, obtained by pollination, amounted to more than EUR 825 million. The value of the crops obtained by the pollination of apple orchards was estimated at more than EUR 413 million; for rape and agrimony it was estimated at more than EUR 167 million, EUR 68 million for currant, EUR 67 million for sour cherry orchards, and EUR 60 million sweet cherry orchards. These amounts confirm the significance of pollination of crops by insects. The number of bee colonies is too small to pollinate all the entomophilous plant cultivations which gives rise to losses. In 2012, the crop losses for major entomophilous plants resultant from too small number of pollinators amounted to EUR 728 million.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The conclusions of the study and recommendations are as follows:

1. The growing importance of bees as pollinators of plants should be included in the national agricultural policy as well as the European Union's policy, and adequate support should be provided to beekeepers. This is even more evident by the fact that the effects of pollination by bees are consumed by plantation owners.
2. The limited knowledge on the role of pollinators in crop yielding results in a lack of willingness to use the services of pollinators.
3. The diverse impact of pollination on crop yields of entomophilous plants hinder the correct estimation of yields obtained by pollination by insects. It is, thereby, necessary to continue research in this scope.
4. Research on determining the economic value of pollination should be continued, particularly, on the role of pollinators in improving the crop quality of entomophilous plants and in the natural environment. It is advisable to develop new methods or to refine existing ones for estimating the economic value of pollination.

Bibliography

1. Allsopp, M.H., de Lange, W., Veldtman, R. (2011). Valuing Insect Pollination Services with Cost of Replacement, PloS ONE, 3(9). Retrieved: http://www.plosone.org/article/info% 3Adoi%2F10.1371%2Fjournal.pone.0003128. Access: 16.02.2011.
2. Banaszak, J. (1987). *Pszczoly i zapylanie roslin (Bees and Plant's Pollination)*. PWRiL, Warszawa.
3. Bornus, L. (1982). *ABC mistrza ogrodnika – pszczelarstwo (ABC of Master Gardener – Beekeeping)*. Wydawnictwo Spoldzielcze, Warszawa.
4. Gallai, M., Salles, J.M., Settele, J., Vaissiere, B.E. (2009). Economic Valuation of the Vulnerability of World Agriculture Confronted with Pollinator Decline. *Ecological Economics*, Volume 68, Issue 3, pp. 810-821.
5. Gojmerac, W.L. (1983). *Bee Beekeeping Honey and Pollination*. AVI Publishing Company INC., Westport Connecticut.
6. Losey, J.E. (2006). The Economic Value of Ecological Services Provided by Insects. BioScience, 56(4). 311. Retrieved:http://www.bioone.org/doi/pdf/10.1641/0006-3568%282006%2956%5B311%3ATEVOES% 5D2.0.CO%3B2. Access: 20.10.2012.
7. Mburu, J., Hein, L.G., Gemmill, B., Collette, L. (2006). *Economic Valuation of Pollination Services: Review of Methods*. Food and Agriculure Organization of the United Nations, Roma.
8. Majewski, J. (2011). Wartosc zapylania upraw w wojewodztwie mazowieckim; proba szacunku *(Value of Plant Pollination in the Mazovia Province; an Attempt of Estimate)*. *Zeszyty Naukowe SGGW w Warszawie Problemy Rolnictwa Swiatowego*, Volume 11 (XXVI), Issue 1, pp. 112-120.
9. Morse, R.A., Calderone, N.W. (2000). The Value of Honey Bees as Pollinators of US Crops in 2000. Retrieved: http://www.beeculture.com/content/PollinationReprint07.pdf. Access: 25.04.2012.
10. Ochrona roslin bezpieczna dla pszczol *(Plant Protection Scheme Safe for Bees)*. (2010). Instytut Sadownictwa i Kwiaciarstwa w Skierniewicach Oddział Pszczelnictwa w Pulawach. Retrieved: http://www.opisik.pulawy.pl. Access: 15.04.2010.
11. Prabucki, J. (editor) (1998). *Pszczelnictwo (Beekeeping)*. Wydawnictwo Promocyjne Albatros, Szczecin;
12. Produkcja upraw rolnych i ogrodniczych *(Production of Agricultural and Horticultural Crops in 2012)*. (2013). GUS Warszawa.
13. Semkiw, P. (2012). Sektor pszczelarski w Polsce w 2012 r. *(Beekeeping Sector in Poland in 2012).* Retrieved: http://www.opisik.pulawy.pl/pdf/SP2012.pdf. Access: 5.10.2013.
14. Skup i ceny produktow rolnych w 2012 r. *(Procurement and Prices of Agricultural Products in 2012).* (2013). GUS Warszawa.

PROBLEMS OF FISHERY IN LATVIAN PORTS AND ITS DEVELOPMENT PERSPECTIVES

Inese Biuksane, PhD student of Riga Technical University[1]

Abstract. The research deals with the identification and analysis of the factors influencing fishing development at the ports of Latvia, aimed at discovering the prospects of fishing development and types of European Maritime and Fisheries Fund support for the next planning period from 2014 to 2020. Various research methods were applied to achieve the research aim. The obtained results show that several variable factors influence the volume of unloaded fish at Latvian ports, and consequently, the prospects of fishing development at the ports of Latvia are unclear. Therefore, fishing limits and fishermen diversification, further investments into the fishing development at Latvian ports should be made taking into account the number of enterprises.

Key words: cohesion policy, fisheries sector, Latvian ports.

JEL code: O13

Introduction

One of the main problems the fishing industry faces globally is that there are too many fishing boats and ships for too little fish resources (The European Commission, 2012). Fish stocks have high natural productivity but it is not unlimited. If people catch more fish than the natural surplus of the stock, the future production potential reduces (The European Commission, 2012) which may have a global impact on the environment and the fisheries sector as a whole. In order to prevent running out of fish reserves of the EU Member States, including Latvia, it is necessary to implement a range of measures to ensure sustainable fishing within the framework of the Common Fisheries Policy.

The overall objective of the reformed Common Fisheries Policy is to make fishing sustainable - environmentally, economically, and socially. The new policy will bring fish stocks back to sustainable levels and will stop wasteful fishing practices. It will provide the EU citizens with a stable, secure, and healthy food supply for a long term. It seeks to bring new prosperity to the fishing sector, create new opportunities for jobs and growth in coastal areas, and put an end to dependence on subsidies. The EU financial assistance through the proposed European Maritime and Fisheries Fund (hereinafter − EMFF) will be available to support the sustainability objectives of the new policy (The European Commission, 2013).

Research hypothesis − several variable social and economic, political and environmental factors influence fishing development at Latvian ports.

Research aim − to analyse fishing development and factors influencing it at Latvian ports to discover the future prospects of fishing at the ports' areas and kinds of the EMFF support for the next planning period. Well-planned investments and their efficient use for fishing development at Latvian ports would facilitate not only the development of the sector but also would advance the social and economic development of seaports and whole regions.

Research tasks:

1) to acquaint the activity of Latvian ports and fishing development at the ports;

[1] Corresponding author. Tel.: +371 29566569; fax: +371 67541789
E-mail address: inese.biuksane@inbox.lv

2) to identify the factors influencing fishing development at Latvian ports;

3) to define the necessary types of support for the next planning period.

Research object – fishing development at Latvian ports.

The research includes the statistical data on the fish caught in the Baltic Sea and the Gulf of Riga and unloaded at the area of Latvian ports, constituting on average 92% of total amount of unloaded fish (The Institute of Food Safety, Animal Health and Environment "BIOR", 2013). The research does not deal with the analysis of statistical data regarding the amounts of unloaded fish outside Latvian ports.

Methods used within the research: descriptive, document, and statistical analysis method.

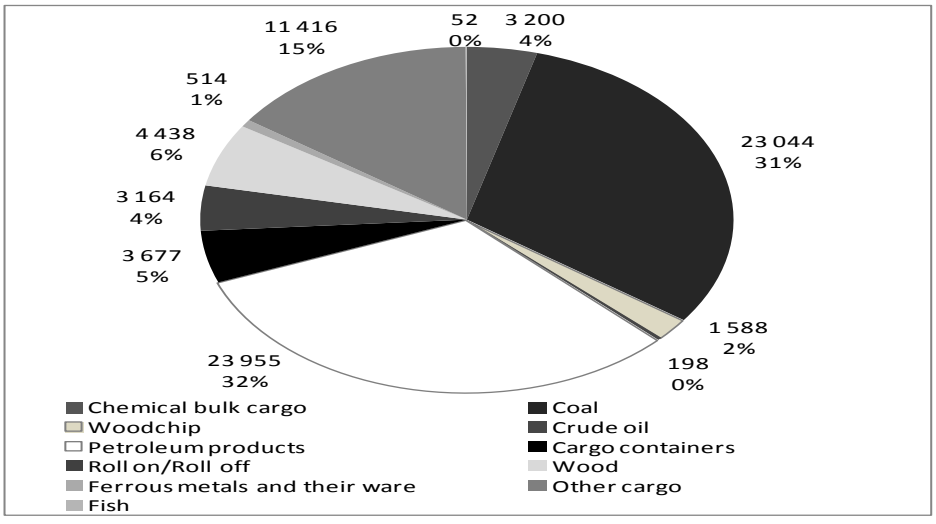
Novelty – this is the first broad summary and analysis of the information on fishing development at Latvian ports and the factors influencing it.

Fisheries' development at Latvian ports

In Latvia, there are ten ports: three of them are large ports (Riga, Ventspils, and Liepaja) and seven - smaller ports (Skulte, Mersrags, Salacgriva, Pavilosta, Roja, Engure, and Lielupe), located along the whole Latvian sea border.

One can see a gradual growth of the Latvian ports' activity. During the period from 2004 to 2012, the turnover of cargo at Latvian ports grew by 32%: from 56 780 thousand tonnes in 2004 up to 75 188 thousand tonnes in 2012 per year (Latvian ports, 2013).

The total cargo turnover in 2012 mostly consisted of transportation of petroleum products (32%), coal and wood (31% un 6% respectively): woodchip, cargo containers, chemical bulk cargo, RO-RO cargo, ferrous metals and their ware, as well as transportation of crude oil (31%) and the unloaded fish (only 0.1%) (Figure 1).



Source: author's calculations based on the Ministry of Transport of the Republic of Latvia (2013); The Institute of Food Safety, Animal Health and Environment "BIOR" (2013)

Fig 1. **Cargo turnover typical of Latvian ports in 2012 (thousand tonnes, %)**

The large ports mostly deal with processing of transit cargoes, while the small ports having local importance mostly are engaged in shipping timber and accepting fishing products; in summer season, they also act as ports for yachts (Ministry of Transport of the Republic of Latvia, 2004).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

All the ports in Latvia are used for the fishing needs, except Lielupe port which is closed for cargo service.

On the one hand, the impact of fishing on the development of Latvian ports is not strong, since the amounts of fish unloaded at areas of the ports do not constitute a significant proportion (Table 1). However, the only turnover of cargoes is fish at Engure and Pavilosta ports, and consequently, the impact of fishing on these ports is big.

Table 1

The amount of the unloaded fish at large and small Latvian ports and other cargoes' turnover from 2008 – 2012 (thousand tonnes, %)

Name of port	2008		2009		2010		2011		2012	
	fish	other	fish	other	fish	other	fish	other	fish	other
TURNOVER (THOUSAND TONNES)										
Pavilosta	4.4	-	3.3	-	2.9	-	2.5	-	1.9	-
Skulte	0.8	450.1	1.8	497.1	2.5	647.1	2.2	687.4	2.3	587.4
Roja	11.3	21.3	10.0	14.4	8.0	38.0	11.2	46.4	9.1	31.3
Mersrags	3.9	496.6	4.7	389.0	4.7	398.6	3.3	431.7	3.3	440.6
Riga	2.2	29 564.4	1.6	29 715.2	2.1	30 466.9	2.0	34 070.8	2.6	36 046.1
Liepaja	19.2	4 187.7	15.1	4 381.3	12.5	4 383.7	11.3	4 856.8	12.7	7 431.3
Salacgriva	2.5	333.5	2.2	318.4	1.1	381.6	1.1	277.4	0.8	284.5
Engure	0.2	-	0.1	-	0.3	-	0.4	-	0.1	-
Ventspils	36.1	28 570.0	27.9	26 640.0	26.6	24 815.0	19.5	28 452.0	19.5	30 346.0
Large ports	**57.5**	**62 322.1**	**44.6**	**60 736.5**	**41.3**	**59 665.6**	**32.9**	**67 379.6**	**34.8**	**73 823.4**
Small ports	**23.2**	**1 301.5**	**22.2**	**1 218.9**	**19.5**	**1 465.3**	**20.7**	**1 442.9**	**17.6**	**1 343.8**
Total:	**80.7**	**63 623.6**	**66.8**	**61 955.4**	**60.8**	**61 130.9**	**53.6**	**68 822.5**	**52.4**	**75 167.2**
PROPORTION (%)										
Pavilosta	100.00	-	100.00	-	100.00	-	100.00	-	100.00	-
Skulte	0.19	99.81	0.37	99.63	0.39	99.61	0.32	99.68	0.40	99.60
Roja	34.74	65.26	41.04	58.96	17.39	82.61	19.40	80.60	22.57	77.43
Mersrags	0.79	99.21	1.20	98.80	1.16	98.84	0.77	99.23	0.75	99.25
Riga	0.01	99.99	0.01	99.99	0.01	99.99	0.01	99.99	0.01	99.99
Liepaja	0.46	99.54	0.34	99.66	0.28	99.72	0.23	99.77	0.17	99.83
Salacgriva	0.74	99.26	0.70	99.30	0.28	99.72	0.39	99.61	0.28	99.72
Engure	100.00	-	100.00	-	100.00	-	100.00	-	100.00	-
Ventspils	0.13	99.87	0.10	99.90	0.11	99.89	0.07	99.93	0.06	99.94
Large ports	**0.09**	**99.91**	**0.07**	**99.93**	**0.07**	**99.93**	**0.05**	**99.95**	**0.05**	**99.95**
Small ports	**1.75**	**98.25**	**1.79**	**98.21**	**1.32**	**98.68**	**1.41**	**98.59**	**1.29**	**98.71**
Total:	**0.13**	**99.87**	**0.11**	**99.89**	**0.10**	**99.90**	**0.08**	**99.92**	**0.07**	**99.93**

Source: author's calculations based on Latvian ports (2013); The Institute of Food Safety, Animal Health and Environment "BIOR" (2013)

On the other hand, the existence of the fishing sector and its development is impossible without Latvian ports, their infrastructure and services. Latvian ports offer infrastructure suitable for the needs of fishermen and services for fishing ships (including those for fish unloading and storing) and their maintenance. In addition, there are processing and trade companies located near the ports for mobile sales. In addition, the inhabitants of the local county/civil parish and demand from abroad facilitate the consumption of the caught fish.

Within the last eight years, there have been significant changes in the structure of fish unloading amounts at Latvian ports (Table 2). From 2005 to 2012, the proportion of fish unloading reduced at the Freeport of Ventspils (from 41.4% to 37.2%), at Pavilosta port (from 6.9% to 3.7%), Liepaja port (from 27% to 24.2%), Salacgriva port (from 4.4% to 1.5%), and Engure port (from 1.6% to 0.1%). On the contrary, the proportion of unloaded fish gradually increased at Skulte port (from 1.1% to 4.5%), at the Freeport of Riga (from 2.3% to 5%), and Mersrags port (from 4.2% to 6.4%).The proportion of the

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

unloaded fish significantly increased at Roja port (increase of 6 percentage points) where it increased from 11.2% to 17.4%.

The most constant proportion varies at the level of 41.4% to 37.2% (coefficient of variation Vσ = 7%) – at the Freeport of Ventspils. In 2005, the proportion of the unloaded fish was one fourth of the total amount of the unloaded fish at the port; whereas, in 2012 – already one third of the total amount of the unloaded fish, indicating that fish unloading has concentrated at the Freeport of Ventspils already since 2005.

Basing on the data analysis, it is evident that the fish unloading amounts at the ports of Roja, Skulte, Riga, and Mersrags tend to grow. However, the tendency is negative at the other ports – the amounts of unloaded fish decrease. Only the Freeport of Ventspils has had the smallest fluctuations of unloaded fish volumes, indicating that unloading dominates at this port.

Table 2

Structure of unloaded fish amounts at Latvian ports from 2005 – 2012 (%)

Name of port	2005	2006	2007	2008	2009	2010	2011	2012	Percent points	Coefficient of Variation - Vσ	Rank	
											Place in 2005	Place in 2005
Ventspils	41.4	43.3	40.3	44.7	41.8	43.8	36.5	37.2	-4	7	1	1
Skulte	1.1	1.5	1.1	1.0	2.7	4.2	4.1	4.5	3	60	9	6
Roja	11.2	10.9	12.4	14.1	15.0	13.2	20.8	17.4	6	24	3	3
Pavilosta	6.9	5.2	5.4	5.4	4.9	4.8	4.7	3.7	-3	18	4	7
Mersrags	4.2	3.7	4.1	4.9	7.1	7.7	6.2	6.4	2	28	6	4
Riga	2.3	3.9	2.6	2.8	2.4	3.5	3.8	5.0	3	28	7	5
Liepajas	27.0	26.1	28.1	23.8	22.6	20.6	21.2	24.2	-3	11	2	2
Salacgriva	4.4	4.3	4.7	3.1	3.4	1.8	2.0	1.5	-3	40	5	8
Engure	1.6	1.3	1.3	0.2	0.1	0.5	0.7	0.1	-2	82	8	9
Large ports	**71**	**73**	**71**	**71**	**67**	**68**	**61**	**66**	**-4**	**5**	**-**	**-**
Small ports	**29**	**27**	**29**	**29**	**33**	**32**	**39**	**34**	**4**	**12**	**-**	**-**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**-**	**-**	**-**	**-**

Source: author's calculations based on the Institute of Food Safety, Animal Health and Environment "BIOR" (2013)

At the Freeport of Ventspils, mostly sprat (59%) are unloaded, at Liepaja port – codfish (84%) and salmon (56%), and at Roja port – smelt (84%) and Baltic herring (39%). A big proportion (64%) of the other fish species is unloaded at Liepaja port. The fish unloaded at the rest of ports constitute a minor proportion (Table 3).

Table 3

Average proportion of the unloaded fish species at Latvian ports from 2005 – 2012 (%)

Name of port	Fish species name					
	Sprat	Salmon	Cod	Herring	Smelt	Other
Engure	0.2	-	-	2	0.2	-
Liepaja	29	56	84	3	-	64
Mersrags	1	-	-	16	11	0.1
Pavilosta	7	24	0.4	1	-	4
Riga	0.2	-	-	11	3	0.01
Roja	3	-	0.01	39	84	2
Salacgriva	1	-	-	10	1	0.0002
Skulte	0.3	-	-	8	1	-
Ventspils	59	20	16	9	0.1	30
Total:	**100**	**100**	**100**	**100**	**100**	**100**

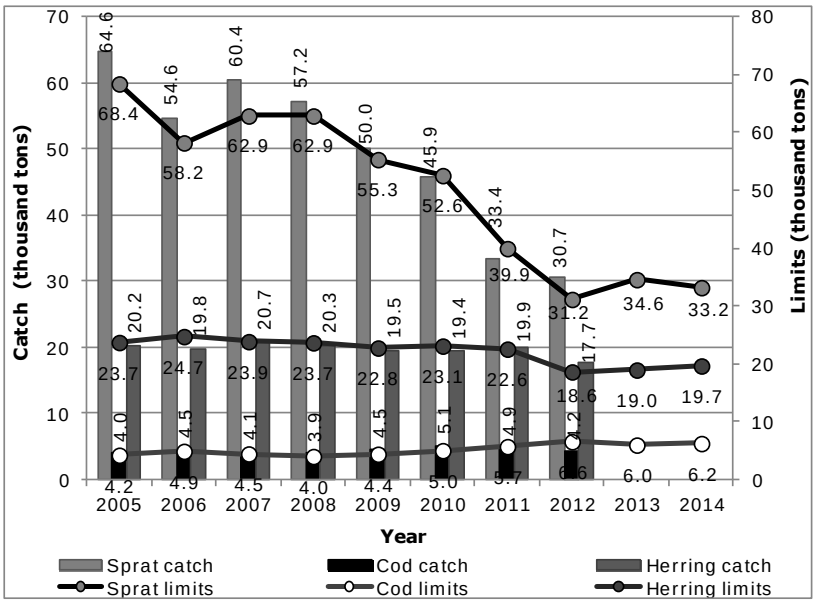
Source: author's calculations based on the Institute of Food Safety, Animal Health and Environment "BIOR" (2013)

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

An important factor, influencing the volume of fish unloaded at Latvian ports, is the distance from a fishing place to the closest port where to unload the caught fish. Taking into account the fact that sprats are generally caught in the Baltic Sea and the closest unloading places are Ventspils and Liepaja ports, naturally, the biggest unloaded amounts take place exactly at these ports. Similar is the situation with other fish species and ports.

The amount of catches of commercially significant and internationally regulated species depends on the quota annually allocated to Latvia (Figure 2), which in their turn depends on the fish present in the stock. The fishing opportunities available to Latvia in the Baltic Sea are distributed individually for each fishing merchant, allowing mutual exchange and transferring of these fishing opportunities, resulting in more efficient use of the resources accessible to Latvia. However, due to the fluctuations of stocks and the changes in fishing opportunities annually allocated at the level of the EU, the fishing companies cannot fully plan their future actions.

Available fishing opportunities vary from year to year and already several years there has been a decrease of the common opportunities of fishing available to Latvia - from 96.4 thousand tonnes (in 2005) to 59.1 thousand tonnes (in 2014).



Source: author's calculations based on the Institute of Food Safety, Animal Health and Environment "BIOR" (2013); Ministry of Agriculture of the Republic of Latvia (2013)

Fig. 2. Fishing limits and amounts of catches from 2005 – 2014 (thousand tonnes)

Note: Salmon:	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Limits (thousand pieces):	59.5	59.5	56.5	48.0	40.8	38.7	33.0	16.2	14.3	14.0
Catch (thousand pieces):	5.1	3.2	4.4	1.4	2.3	1.1	1.2	1.5	-	-
Catch (tonnes):	24.7	13.8	21.3	4.8	8.7	3.6	4.4	4.9	-	-

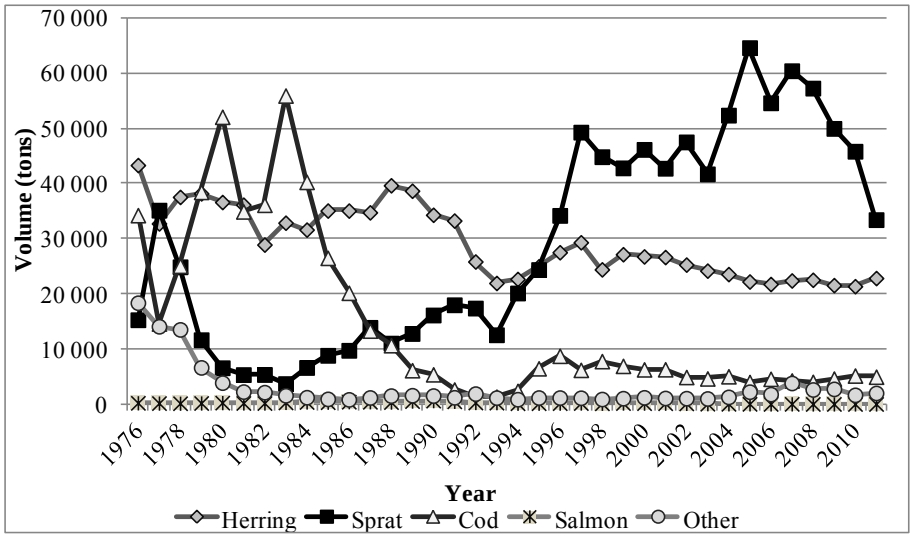
The data analysis shows that the fishing quotas are not fully used. The main obstacles for the utmost use of quotas are:

- fishes periodically disperse due to the hydrometeorological conditions and do not form industrial concentrations, consequently, it is not gainful for the fishermen to go fishing due to the small catches;

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

- unsuitable seasonal weather (strong wind, ice etc.) impeding fishing or making it impossible;
- salmon quota is not reached, since the drift-net fishing is forbidden and hook fishing is not developed well enough (salmon is caught by stationary fishing tools).

The EU quotas allocated for fishing vary depending on the amounts of fish present in stock, which in their turn depend on the productivity of the generations of the corresponding fish species and the supply with nourishment available to them (Figure 3).



Source: author's calculations based on The Institute of Food Safety, Animal Health and Environment "BIOR" (2013)

Fig. 3. Latvian catches in the Baltic Sea and the Gulf of Riga by species from 1976 – 2011, tonnes

During the period from 1976 to 2011, cod has been the most changing and unpredictable fish species (variation coefficient Vσ = 106%). Its amount varies from 1 250 tonnes (in 1992) up to 55 956 tonnes (in 1983).

The second most changeable fish species is salmon (variation coefficient Vσ = 81%); its amount varies from 4 tonnes (in 2010) even up to 607 tonnes (in 1990).

The third most fluctuating fish species is sprat (variation coefficient Vσ = 65%), the amount of which varies from 3 695 tonnes (in 2003) up to 64 646 tonnes (in 2005).

In turn, the fourth least fluctuating fish species is Baltic herring (variation coefficient Vσ = 22%), the amount of which varies from 21 365 tonnes (in 2010) even up to 43 342 tonnes (in 1976).

Fluctuations of the rest fish species are also important (variation coefficient Vσ = 139%), their amounts vary from 833 tonnes (in 1986) up to 18 368 tonnes (1976).

Analysing the amounts of the fish catches within the past decade, one can see significant changes in catches of cod: the amounts of cod catches stabilised (variation coefficient Vσ = 9%) in the period from 2002 to 2011 having a positive impact on the cod quotas and the unloaded fish amounts at Latvian ports. As a result of cod population stabilisation, the largest amounts of unloaded cod were at Liepaja port (on average 84% of total unloaded cod at Latvian ports), wherewith, the amounts of unloaded fish at this port to a great extent depend on the cod population fluctuations and the cod quotas established by the EU.

Within the last 10 years the Baltic herring catches were the most stable (variation coefficient Vσ = 5%); its biggest unloaded amounts were at Roja port (on average 39% of total unloaded volumes of

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Baltic herring at Latvian ports). Swift changes in Baltic herring population and the Baltic herring quota established by the EU may considerably influence the volumes of unloaded fish at Roja port.

In contrast, the amounts of sprat, salmon and other fish species catches within the past decade have not considerably stabilised (variation coefficient Vσ: 18%, 121%, and 43% respectively), thus, causing problems to plan quota and predict fish unloading amounts at the Freeport of Ventspils (amounts of unloaded sprat constitute on average 59% of total unloaded sprat at Latvian ports) and at Liepaja port (amounts of unloaded salmon and other fish species constitute correspondingly 59% and 64% of total unloaded amount of the species at Latvian ports).

Taking into account that it is complicated to predict changes in fish population depending on the productivity of the generations of the corresponding fish species and the supply with nourishment available to them, it is hard to predict the unloaded fish amounts at Latvian ports.

Moreover, meteorological conditions have a significant impact on the amounts of unloaded fish at Latvian ports. During the cold winter months (especially in January and February), the Gulf of Riga often freezes up, consequently, the ports located at the coast of the Gulf of Riga (ports of Riga, Salacgriva, Skulte, Engure, Mersrags, and Roja) become unavailable to fishermen. The only ports that do not freeze up in the cold winter months are Ventspils, Liepaja, and Pavilosta ports. Hence, at the time when the Gulf of Riga is frozen up and a great part of Latvia's ports is unavailable to fishermen, in order to sell the caught fish products, they unload the fish at the ports of Ventspils and Liepaja (much less at Pavilosta port), as a result of what, the unloaded fish amounts at the other port areas decrease.

Purchasing price plays the decisive role in the amounts of unloaded fish. In general, the fish purchasing prices at Latvian ports are similar and they do not influence unloading amounts. However, fish purchasing price has a great importance at the international level – if the price offered abroad is higher and more gainful than the one offered at Latvian ports, fishermen will gladly sell their fish abroad, consequently, the volume of fish unloaded at Latvian ports decreases. The biggest amounts of unloaded fish of late years (2009-2012) were registered in Nekso (Denmark), Vladislavovo (Poland), and Karlskrona (Sweden) (The Institute of Food Safety, Animal Health and Environment "BIOR", 2013).

The amounts of unloaded fish at Latvian ports are also influenced by the concentration of the fishing fleet. As a result of the fleet balancing measures, the number of fishing ships in the fishing sector has decreased by 20% since 2004, consequently, providing fishing ships a freer access to Latvian ports and facilitating an increase in average catch per ship (Ministry of Agriculture of the Republic of Latvia, 2013). Latvian big ports, with maximum draught at 9.5-15.0 m (Liepaja port, 2013; Freeport of Riga, 2013; Freeport of Ventspils, 2013), mostly are attended by fishing ships having a big carrying capacity. In their turn, the small ports of Latvia, with maximum draught at 2.2–6.5 m (Mersrags port, 2013; Pavilosta, 2013; Roja port, 2008; Salacgriva port, 2013; Skulte port, 2012), do not receive and service fishing ships with big carrying capacity, since the draught of these ports does not allow it. Therefore, the small ports of Latvia provide service for the fishing ships with small carrying capacity.

Furthermore, reserves of the caught fish appear when fish are caught but they are not sold because of inadequate purchasing prices or too big and unpredicted amounts of catch. Specific fishing equipment is needed (freezing, storing, and other equipment) to ensure and keep the high quality of the caught fish in a long term. Not only availability of various services but also infrastructure (wharves, breakwaters, driveways etc.) and its quality influence the amounts of unloaded fish at Latvian ports. From 2007 to 2013, eight Latvian ports received investments in the amount of LVL 13.94 million aimed at the fishing

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

development (Rural Support Service, 2013) to ensure various service and improve infrastructure. The author has researched the impact of financing on the fishing development at Latvian ports and reflected it in her previous publications (Project Report "Return on Investment of the 3rd Prior Direction Activities No 301 "Measures of Joint Action" and No 303 "Investments into the Fishing Ports and Fish Unloading Places").

All-in-all it is evident that the volumes of unloaded fish at Latvian ports are influenced by several variable factors: amount of fish in stock, peculiarities of fish distribution and industrial concentration formation, distance from fishing places and location of a port, fish purchasing price on the market, fleet concentration, meteorological weather, infrastructure and services available at ports, as a result it is complicated to predict fishing development at Latvian ports. Consequently, the EMFF support within the next planning period should be allocated to fishing development at all the Latvian ports, emphasising as a priority projects involving a greater number of fishing enterprises with bigger total limit of haul as well as the projects involving fishermen with a diversified fishing approach (those who do both the sea and coastal fishing).

Conclusions, proposals, recommendation

1. In Latvia, there are ten ports: three of them are large ports (Riga, Ventspils, and Liepaja) and seven smaller ports (Skulte, Mersrags, Salacgriva, Pavilosta, Roja, Engure, and Lielupe). Nine of the ports are related with fishing (Lielupe port is closed for cargo service). During the period from 2005 to 2012, the amount of the unloaded fish at Latvian ports has decreased from 80.7 thousand tonnes in 2005 to 52.4 thousand tonnes in 2012. The biggest amounts of unloaded fish took place at large Latvian ports (61-73%), and the smallest amounts – at small Latvian ports (27-39%).

2. Taking into account that the volume of the unloaded fish does not form a significant proportion of the common turnover of ports, fishing influence on the Latvian ports' development is not very strong. As an exception can be mentioned the port of Engure as well as Pavilosta port where the only turnover of cargoes consists of fish, consequently, fishing has a great impact on these ports. In turn, the existence of fishing sector and its development without Latvian ports is not possible. Latvian ports provide infrastructure corresponding to the fishermen's needs, services and processing, and trade enterprises are located nearby, ensuring unloading, storing and further sales of the caught fish.

3. Several variable factors (amount of fish in stock, peculiarities of fish distribution and industrial concentration formation, distance from fishing places and location of a port, fish purchasing price in the market, fleet concentration, meteorological weather, infrastructure and services available at ports) influence the volume of unloaded fish at the Latvian ports, making it difficult to predict the fishing development; consequently, the future prospects of fishing at Latvian ports are unclear. Therefore, the EMFF support within the next planning period should be allocated to fishing development at all Latvian ports, providing support to the projects involving a greater number of fishing companies having bigger total limit of haul as well as the ones involving fishermen with the diversified fishing approach.

Bibliography

1. Freeport of Riga (2013). Facts and Figures. Retrieved: http://www.rop.lv/lv/par-ostu/fakti-un-skaitli.html. Access: 21.11.2013.

2. Freeport of Ventspils (2013). Free Port Today. Retrieved: http://www.portofventspils.lv/lv/brivosta_sodien/. Access: 22.11.2013.
3. Latvian ports: Freeport of Riga, Freeport of Ventspils, Ports of Pavilosta, Liepaja, Skulte, Mersrags, Salacgriva, Roja and Engure (2013). Turnover of the Types of Cargoes from 2004 to 2012.
4. Liepaja Port (2013). History. Retrieved: http://www.liepaja-sez.lv/lv/liepajas-osta/vesture/. Access: 21.11.2013.
5. Mersrags Port (2013). Port Services. Retrieved: http://www.mersragsport.lv/?cat=39&lang=lv. Access: 23.11.2013.
6. Ministry of Agriculture of the Republic of Latvia (2013). The Limits of Fishing from 2005 – 2012.
7. Ministry of Agriculture of the Republic of Latvia (2013). The Operational Programme for Fisheries Development 2014-2020 (project). Retrieved: https://www.zm.gov.lv/public/ck/files/ZA_EJZF_Ricibas_programma.pdf. Access: 08.12.2013.
8. Ministry of Transport of the Republic of Latvia (2004). Ports. Retrieved: http://www.transport.lv/?sadala=107. Access: 12.11.2013.
9. Ministry of Transport of the Republic of Latvia (2013). Turnover of Cargoes at the Latvian Ports in 2012.
10. Pavilosta (2013). The Fishing Pier. Retrieved: http://pavilostaport.lv/?page_id=88. Access: 21.11.2013.
11. Roja Port (2008). Port of Technical Options. Retrieved: http://www.rojaport.lv/index.php?p=627&lang=201. Access: 21.11.2013.
12. Rural Support Service (2013). The Ones who Received the Support and the Confirmed Projects on the 20/03/2013 under the Activity No 303 "Investments in Fishing Ports and Places of Fish Unloading" of the 3rd Prior Area (axis) "Measures of Common Interest" of the Operational Programme "For Implementation of the European Fisheries Fund Support in Latvia for 2007-2013".
13. Salacgriva Port (2013). Commercial Port. Retrieved: http://www.salacgrivaport.lv/tirdzniecibas-osta/. Access: 21.11.2013.
14. Skulte Port (2012). Port. Retrieved: http://www.skulteport.lv/lv/osta. Access: 22.11.2013.
15. The European Commission (2013). Memo. Retrieved: http://europa.eu/rapid/press-release_MEMO-13-1125_en.htm. Access: 20.11.2013.
16. The European Commission (2012). A Fleet for the Future. Retrieved: http://ec.europa.eu/fisheries/documentation/publications/cfp_brochure/fleet_lv.pdf. Access: 16.11.2013.
17. The European Commission (2012). Fishing Rules. Retrieved: http://ec.europa.eu/fisheries/cfp/fishing_rules/index_lv.htm. Access: 16.11.2013.
18. The Institute of Food Safety, Animal Health and Environment "BIOR" (2013). *Latvian Fisheries 2012th.* Riga: The Institute of Food Safety, Animal Health and Environment "BIOR", p. 206.
19. The Institute of Food Safety, Animal Health and Environment "BIOR" (2013). Latvian Fisheries Integrated Control and Information System: Unloaded Fish at Latvian Ports and other Unloading Places from 2005-2012.

PRODUCTION EFFICIENCY OF MIXED FARMING IN THE EU REGIONS

Jindrich Spicka[1], PhD [+]

[1] University of Economics, Prague, Czech Republic

Abstract. The paper aims at evaluation of the production efficiency and its determinants of mixed crop and livestock farming among the 103 FADN EU regions in 2010. The DEA method with variable returns to scale (DEAVRS) reveals efficient and inefficient FADN regions including the scale efficiency. Decreasing returns to scale are typical for regions with largest farms on average. In the next step, the two-sample t-test determines differences between efficient and inefficient regions. The economic and structural indicators from the FADN standard results are used to detect significant factors of production efficiency. The research reveals substitution between labour and capital/contract work inputs. Substitution of labour by capital or contract work significantly increases income indicator Farm Net Value Added per AWU. The substitution effect, measured by proposed LC_{sub} indicator, explains 71% of FNVA/AWU variability. The significant economic determinants of production efficiency in mixed type of farming are crop output per hectare, livestock output per livestock unit, productivity of material, energy, capital, and contract work. Agricultural enterprises in inefficient regions have more extensive structure and produce more non-commodity output (public goods) because of higher rural development subsides.

Key words: agriculture, productivity, income, efficiency, regions.

JEL code: O13, D24

Introduction

The production efficiency is one of the key prerequisites for the competitiveness of enterprises in every business. The assessment of production efficiency in agriculture is limited by the weather conditions and by large variability of farms not only within the Member States but also among the EU regions. Nevertheless, the identification of production efficiency and its main determinants can reveal the weaker regions and show ways how to improve their farming performance.

The aim of the paper is to evaluate the production efficiency of mixed type of farming among the FADN EU regions and to determine which structural and economic factors significantly affect the farming performance. Production efficiency of other types of farming will be considered in the future research. The mixed type farming has been very important part of the Czech agriculture for a long time. The structure of today's Czech agriculture is rooted in its history. Family farms are not as important as in the Western states of the European Union. The bigger part of the agricultural area (about 70%) is used by large holdings of legal persons. There were 6 245 farms with combined crop and livestock production in 2010, out of 22 864 agricultural holdings. The Czech farms with mixed production are large with 454.6 ha of utilized agricultural area on average in 2010.

Many researchers consider the agricultural production efficiency so far. Jurica et al. (2004), Jelinek (2006), Medonos (2006), Davidova - Latruffe (2007), Boudny et al. (2011), and Cechura (2010, 2012) concern the technical efficiency in the Czech conventional farming. Mala (2011) aims at the efficiency of Czech organic farming and its determinants. Cechura (2012) identifies the key factors determining the

[+] Corresponding author. Tel.: + 420 224 09 8650
E-mail address: jindrich.spicka@vse.cz.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

efficiency of input use and the total factor productivity (TFP) development. He concludes that the developments in the individual branches are characterised by idiosyncratic factors as well as the systemic effect, especially in the animal production. The most important factors which determine both technical efficiency and TFP are those connected with institutional and economic changes, in particular, a dramatic increase in the imports of meat and increasing subsidies.

Blazejczyk-Majka, Kala, and Maciejewski (2012) use the FADN data to find out whether a higher specialisation and a bigger economic size class of farms determine a higher technical efficiency at the same scale for the farms from the new and old countries of the EU. Results recorded for mixed farms in relation with the pure technical efficiency indicate a bigger efficiency of the farms from the "old" EU regions (EU-15) in comparison with the farms from the "new" regions, except for the biggest farms.

Hussien (2011) calculates the production efficiency of the mixed crop-livestock farmers in two districts of the North-eastern Ethiopia. He concludes that the production efficiency of mixed crop-livestock farming is determined by farm size, livestock ownership, labour availability, off/non-farm income participation, total household assets, total household consumption expenditure, and improved technology adoption.

Material and methods

The FADN RICA provides structural and economic data. Complete data for 2010 are available in 103 EU regions. The analysis focuses on mixed crop and livestock type of farming (code 80 in TF14 FADN grouping) which comprises farms with prevailing combined field crops-grazing livestock and various crops and livestock type of farming. The FADN uses special weighting system. The individual weight is equal to the ratio between the numbers of holdings, of the same classification cell (FADN region x type of farming x economic size class), in the population and in the sample.

Analysis of economic efficiency of mixed farming respects the view of efficiency in utilisation of production factors (Coelli et al, 1998; Fried, Lovell, Schmidt, 2008). The Data Envelopment Analysis method (DEA) is applied to determine the level of the production efficiency of farms. Production unit is efficient when there is no any other unit maintaining the same level of outputs with lower level of inputs, respectively, when there is no any other unit achieving the higher level of outputs with the same level of inputs. Units with the highest efficiency are located on the efficient frontier. The purpose of the DEA method is to construct a non-parametric envelopment frontier over the data points such that all observed points lie on or below the production frontier. The technical efficiency (TE) estimates vary between 0 (0%) and 1 (100%). The model assumes variable returns to scale. The issue of returns to scale concerns what happens to units' outputs when they change the amount of inputs that they are using to produce their outputs. Under the assumption of variable returns to scale a unit found to be inefficient has its efficiency measured relative to other units in the data-set of a similar scale size only. The results distinguish among increasing, constant (effective) and decreasing returns to scale.

Six inputs and two outputs per weighted average farm are used for efficiency calculation:

- outputs: crop output, livestock output (EUR);
- land input (utilized agricultural area in ha);
- labour input (actual working time in hours per year);
- material costs (seeds and plants, fertilisers, crop protection, other crop specific costs, feed for grazing livestock, feed for pigs & poultry, other livestock specific costs in EUR);
- energy costs (motor fuels and lubricants, electricity, heating fuels in EUR);

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

- capital costs (depreciation, rent paid, interest paid, machinery & building current costs, taxes and other charges on land and buildings in EUR);
- contract work (costs linked to work carried out by contractors and to the hire of machinery in EUR).

The technical efficiency (TE) score divides the sample into two groups − efficient with TE = 1.0 and inefficient with TE < 1.0. The statistical procedure tests the differences of structural and economic indicators between the two groups. The Farm Net Value Added (FNVA) per AWU (Annual Work Unit) represents the main income indicator in agriculture. According to the FADN definition, the FNVA is the remuneration to the fixed factors of production (work, land, and capital), whether they be external or family factors. As a result, holdings can be compared irrespective of their family/non-family nature of the factors of production employed. Since it covers costs on external factors, it is convenient for comparison of the different farm structures within the EU-27. The economic indicators also include modified FNVA per AWU which is defined as the remuneration to paid and unpaid work only.

Statistical procedures for assessment of differences between efficient and inefficient groups are selected depending on the features of the two groups. The skewness, kurtosis and omnibus normality are tested. Since the choice of appropriate statistical tests varies by the normality and variance assumptions of the sample, some researchers recommend against using a preliminary test on variances. If the two sample sizes are approximately equal, the equal-variance t-test can be used (Ott, 1984). The results of DEA indicate 53 efficient regions and 50 inefficient regions, so the prerequisite for equal-variance t-test is fulfilled.

The two-sample t-test compares the distribution between two groups − inefficient regions (μ_1) and efficient regions (μ_2). The null and alternative hypotheses are: H_0: mean μ_1 = mean μ_2, H_A: mean μ_1 > mean μ_2 (Diff > 0) or mean μ_1 < mean μ_2 (Diff < 0). So, the one-sided test of hypotheses is applied depending on the subjective assumptions about the efficiency determinants. The statistical analysis is processed automatically by the software NCSS 9.

Research results and discussion

Results in Table 1 confirm the theoretical assumption about returns to scale. As the business grows, a company initially increases the scale efficiency. The scale efficiency gradually decreases after achieving the optimum size.

Table 1

Distribution of the returns to scale

Indicator	Inefficient regions	Efficient regions	Total	Average UAA (ha)	Average economic size (ESU*)
Number of regions with decreasing returns to scale	5	4	9	466.21	586.77
Number of regions with efficient returns to scale	0	32	32	76.55	140.60
Number of regions with increasing returns to scale	45	17	62	60.49	61.41
Total	50	53	103	100.93	131.92

Note: * ESU (Economic Size Unit) = 1 ESU is 1 000 EUR of standard output

Source: author's calculations based on the FADN data

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 2

Differences in economic indicators

Indicator	Unit	Inefficient regions (μ_1), N = 50	Efficient regions (μ_2), N = 53	H_0 ($\mu_1 - \mu_2$)	T-Stat.	P-value	Sig.
Utilized agricultural area	ha/farm	108.730	93.570	Diff > 0	0.483	0.3150	-
	SD	151.230	166.140				
Economic size	ESU/farm	113.846	148.962	Diff > 0	-0.843	0.7993	-
	SD	151.487	255.312				
Labour input (hours per year)	hours/farm	4 714.718	5 000.894	Diff < 0	-0.220	0.4134	-
	SD	6 566.059	6 656.931				
Crop output	EUR/ha	640.540	1 023.057	Diff < 0	-4.331	0.0000	***
	SD	249.597	575.430				
Livestock output	EUR/LU	855.180	1 030.226	Diff < 0	-2.968	0.0019	***
	SD	253.906	336.234				
Other production in Total input	%	6.560	5.024	Diff > 0	1.352	0.0897	*
	SD	5.284	6.188				
Total output per Total input	EUR/EUR	1.000	1.274	Diff < 0	-5.402	0.0000	***
	SD	0.155	0.327				
Total intermediate consumption per Total. O.	EUR/EUR	0.704	0.565	Diff > 0	6.115	0.0000	***
	SD	0.111	0.121				
Total output per Working hour	EUR/hour	25.411	27.837	Diff < 0	-0.521	0.3016	-
	SD	19.902	26.612				
Total output per Material costs	EUR/EUR	2.323	2.982	Diff < 0	-4.243	0.0000	***
	SD	0.507	0.981				
Total output per Energy costs	EUR/EUR	10.857	15.802	Diff < 0	-4.999	0.0000	***
	SD	4.032	5.794				
Total output per Capital costs	EUR/EUR	3.155	4.417	Diff < 0	-2.983	0.0018	***
	SD	1.339	2.693				
Total output per Contract work	EUR/EUR	24.043	41.932	Diff < 0	-1.954	0.0268	**
	SD	12.984	63.487				
Total current subsidies per Total output	EUR/EUR	0.328	0.206	Diff > 0	5.118	0.0000	***
	SD	0.123	0.119				
Total current subsidies per hectare	EUR/ha	350.851	348.654	Diff > 0	0.066	0.4738	-
	SD	144.216	189.733				
Rural development subsidies* per Total output	EUR/EUR	0.066	0.030	Diff > 0	3.059	0.0014	***
	SD	0.075	0.040				
Rural development subsidies* per hectare	EUR/ha	73.066	46.526	Diff > 0	1.813	0.0364	**
	SD	88.592	57.558				

Note: * Rural development subsidies = environmental subsidies + LFA payments + other RD subsidies

Source: author's calculations based on the FADN data

The regions with larger farms on average - the Czech Republic, Slovakia, regions in the former East Germany (Brandenburg, Sachsen, Sachsen-Anhalt, Thueringen), two regions in France (Lorraine, Pays de

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

la Loire), and England-East region in the United Kingdom - have decreasing returns to scale. It means that output increases by less than that proportional change in inputs.

All regions with efficient returns to scale are fully technically effective (TE = 1.0). The optimum-sized regions are in the "old" EU Member States - in France, Germany, Italy, Belgium, the Netherlands, Denmark, Greece, Spain, and Portugal. The optimal average size of farms in the "new" Member States are in Lithuania, Bulgaria (Severen tsentralen), and Romania (Bucuresti-Ilfov).

Table 2 contains economic indicators and the results of two-sample t-test. The economic indicators cover input and output variables including current subsidies.

The average size of farms between efficient and inefficient regions does not significantly differ. The average economic size is higher in efficient regions; whereas, they use less agricultural area on average. It is caused by higher livestock production in efficient regions. Regarding the production, the test proves that the efficient regions have significantly higher crop output per hectare and livestock output per livestock unit. The inefficient regions partially compensate the lower agricultural production by higher other output. The more efficient input-output ratio of efficient regions has positive impact on the significantly favourable share of intermediate consumption to total output. It means that efficient regions spend less material costs and overhead costs per one unit of output.

The hypotheses about partial factor productivity verify if the efficient regions have higher productivity of all production factors than inefficient units. Table3 shows that efficient regions have significantly higher total output per material, energy costs, capital costs, and contracting work than inefficient regions. On the contrary, the labour productivity is not significantly higher in the efficient regions. Table 3 hides explanation.

Table 3

Pearson correlation among input variables

	Land	Labour	Material	Energy	Capital	Contracting
Land	1	0.919414	0.942122	0.954030	0.913687	0.888472
Labour	0.919414	1	0.877458	0.928609	0.806775	0.799524
Material	0.942122	0.877458	1	0.981944	0.978041	0.926834
Energy	0.954030	0.928609	0.981944	1	0.945268	0.884427
Capital	0.913687	0.806775	0.978041	0.945268	1	0.947080
Contracting	0.888472	0.799524	0.926834	0.884427	0.947080	1

Note: All correlation coefficients are statistically significant at α = 0.01

Source: author's calculations based on the FADN data

The correlation matrix in Table 3 indicates lower correlation between contract work and labour, and between capital costs and labour. The reason why the labour productivity is not significantly higher in the efficient regions is capital-labour substitution or contract work-labour substitution. The analysis reveals that the substitution between capital/contract work and labour significantly affects the key income indicator FNVA per AWU. The substitution between capital / contract work can be quantified as follows:

$$LC_{sub} = \frac{TO/LI}{TO/(CC+CW)} \text{ , where} \quad (1)$$

LC_{sub} is substitution between capital/contract work, TO is total output, LI denotes labour input (actual working time in hours per year), CC denotes capital costs (depreciation, rent paid, interest paid,

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

machinery and building current costs, taxes and other charges on land and buildings) and CW means contract work (costs linked to work carried out by contractors and to the hire of machinery). The Spearman's rank correlation coefficient between labour productivity (numerator) and capital/contract work productivity (denominator) is -0.6560 (p-value = 0.0000).

The higher is the indicator, the more labour is substituted either by capital or by contract work. Regions in the Western and Northern Europe have highest LC_{sub} indicator, so they use more capital or contract work. In 1st/top quartile of LC_{sub} there are regions in Denmark, France, Sweden, Finland, the Netherlands, Germany, Belgium, and the United Kingdom. On the contrary, regions in the Central, Southern and Eastern Europe have the lowest LC_{sub} indicator. Therefore, they use more labour forces on farm. In 4th/bottom quartile of LC_{sub} there are regions in Poland, Lithuania, Spain, Bulgaria, Greece, Cyprus, Romania, and Portugal. Table 4 contains results of linear regression analysis between FNVA/AWU (in thousand EUR) as dependent variable y and indicator LC_{sub} as independent variable x. The LC_{sub} indicator can be used as valuable determinant of farm income level for mixed type of farming because it explains a variability of FNVA per AWU by more than 70 %.

Table 4

Regression between income indicator FNVA/AWU ('000 EUR) and LC_{sub}

Regression	Adj. R^2	p-value	Standard error	White test LM (p-value)
y = 9.73537 + 1.13677x	0.711826	0.0000	8.67504	2.9032 (0.234195)

Note: the presence of heteroskedasticity has not been proven

Source: author's calculations based on the FADN data

Table 5 presents the differences in income indicators. The differences in FNVA per AWU and modified FNVA per AWU do not differ between efficient and inefficient regions because the indicators represent only the labour productivity. Alternatively, the technical efficiency allows for input/labour substitution. The FNVA and modified FNVA per hectare significantly differ between efficient and inefficient unit because land cannot be so easily substituted as labour.

Table 5

Differences in income indicators

Indicator	Unit	Inefficient regions (μ_1) N = 50	Efficient regions (μ_2) N = 53	H0 ($\mu_1 - \mu_2$)	T-Stat.	P-value	Sig.
Farm net value added (FNVA) per AWU	EUR/AWU	20 580.1	24 592.4	Diff < 0	-1.263	0.1048	-
	SD	13 248.4	18 409.1				
Farm net value added (FNVA) per hectare	EUR/ha	497.4	1 022.6	Diff < 0	-5.284	0.0000	***
	SD	218.7	669.7				
Modified FNVA per AWU	EUR/AWU	15 474.7	18 654.6	Diff < 0	-1.450	0.0751	*
	SD	9 748.6	12 277.2				
Modified FNVA per hectare	EUR/ha	400.4	880.6	Diff < 0	-4.956	0.0000	***
	SD	199.0	657.2				
LC_{sub} indicator	x	11.7	11.1	Diff < 0	0.248	0.5975	-
	SD	10.6	13.3				

Source: author's calculations based on the FADN data

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 6 provides information on the structural determinants of production efficiency in the EU regions.

Table 6

Differences in structural indicators

Indicator	Unit	Inefficient regions (μ_1) N = 50	Efficient regions (μ_2) N = 53	H_0 ($\mu_1 - \mu_2$)	T-Stat.	P-value	Sig.
Cereals in UAA	%	44.949	45.712	Diff < 0	-0.289	0.3868	-
	SD	10.798	15.485				
Other field crops in UAA	%	11.553	10.769	Diff < 0	0.521	0.6983	-
	SD	6.266	8.724				
Forage crops in UAA	%	36.617	32.265	Diff > 0	1.782	0.0389	**
	SD	11.871	12.855				
Setaside land per Total agricultural area	%	3.616	3.558	Diff > 0	0.059	0.4767	-
	SD	5.409	4.752				
Dairy cows per Total LU	%	14.449	19.268	Diff < 0	-1.788	0.0384	**
	SD	11.486	15.452				
Other cattle per Total LU	%	58.329	55.025	Diff > 0	0.652	0.2579	-
	SD	25.971	25.414				
Pigs per Total LU	%	22.926	17.015	Diff > 0	1.437	0.0769	*
	SD	22.471	19.230				
Poultry per Total LU	%	3.464	7.587	Diff < 0	-2.367	0.0099	***
	SD	6.120	10.785				
Number of LU per 100 hectares	LU/100 ha	60.261	82.881	Diff < 0	-2.701	0.0041	***
	SD	23.743	54.538				
Stocking density	LU/ha f.c.	1.126	1.913	Diff < 0	-3.088	0.0013	***
	SD	0.427	1.752				
Debt ratio	%	16.480	14.136	Diff > 0	0.728	0.2343	-
	SD	15.138	17.402				
Share of hired labour	%	22.231	21.280	Diff > 0	0.210	0.4171	-
	SD	21.814	24.027				
Share of rented UAA	%	59.779	57.437	Diff > 0	0.472	0.3189	-
	SD	23.527	26.610				

Source: author's calculations based on the FADN data

The efficiency of mixed type of farms depends on the share of forage crops in total utilized agricultural area. The higher share of forage crops including pastures and meadows means less intensive farming. Moreover, efficient regions have higher share of dairy cows per total livestock units. The stocking density per hectare of feed crops and the number of livestock units per 100 hectares are significantly higher in efficient regions. Efficient regions also have significantly higher share of granivores than inefficient regions. It confirms the assumption about production inefficiency of extensive farming.

The share of hired external factors does not significantly differ between efficient and inefficient regions. The use of external capital, hired labour and rented utilized agricultural area is slightly higher in inefficient regions but not significantly.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Conclusions

The aim of the paper is to evaluate the production efficiency of mixed type of farming among the FADN EU regions and to determine which structural and economic factors significantly affect the farming performance. The analysis of 103 EU regions with available data on mixed crop and livestock farming is processed by DEA method and t-test of statistical hypotheses. The research reveals some significant determinants of regional production efficiency and income level:

- The theoretical assumptions about scale efficiency are verified. Decreasing returns to scale are typical for regions with largest farms on average, such as the Czech Republic, Slovakia, regions in the former East Germany, two regions in France and England-East region in the United Kingdom.
- Crop output per hectare and livestock output per livestock unit are the key output determinants of production efficiency. On the input side, the efficient regions have higher land productivity, material and energy productivity, capital productivity, and productivity of contract work than inefficient regions.
- The labour productivity is not a key determinant of production efficiency. The analysis identifies substitution between land and capital/contract work. The proposed indicator LC_{sub}, as the share of labour productivity to capital/contract work productivity, significantly determines the FNVA per AWU in mixed type of farming.
- The current subsidies per hectare do not significantly differ between efficient and inefficient regions. Nevertheless, the subsidies on rural development are higher per total output as well as per hectare in inefficient regions. The inefficient regions provide more public goods for rural development which are generally produced with higher costs and/or lower production.
- The farming intensity significantly affects the production efficiency. Mixed farming with higher stocking density, higher share of dairy cows and granivores as well as farms with lower share of forage crops in total utilized agricultural area are more efficient.

Acknowledgements

The support of the paper came from the internal research project of the University of Economics, Prague "Measuring the Economic Efficiency in the Agri-food Sector Using Productivity Indices", project No MF/F3/4/2013.

Bibliography

1. Blazejczyk-Majka, L., Kala, R., Maciejewski, K. (2012). Productivity and Efficiency of Large and Small Field Crop Farms and Mixed Farms of the Old and New EU Regions. *Agricultural Economics – Czech*, Volume 58, Issue 2, pp. 61–71. ISSN 0139-570X.
2. Boudny, J., Janotova, B., Medonos, T. (2011). Analyza efektivnich a mene efektivnich podniku (Analysis of Efficient and Inefficient Farms). *Bulletin of the Institute of Agricultural Economics and Information*, Prague, No 7/2011.
3. Cechura, L. (2010). Estimation of Technical Efficiency in Czech Agriculture with Respect to Firm Heterogeneity. *Agricultural Economics – Czech*, Volume 56, Issue 4, pp. 36–44. ISSN 0139-570X.
4. Cechura, L. (2012). Technical Efficiency and Total Factor Productivity in Czech Agriculture. *Agricultural Economics – Czech*, Volume 58, Issue 4, pp. 147-156. ISSN 0139-570X.
5. Coelli, T., Prasada, R. D. S., Battese, G. E. (1998). *An Introduction to Efficiency and Productivity Analysis*. Boston: Kluwer Academic Publishers, 296 p. ISBN 978-0-79-238060-3.

6. Davidova, D., Latruffe, L. (2007). Relationships between Technical Efficiency and Financial Management for Czech Republic Farms. *Journal of Agricultural Economics*, Volume 58, Issue 2, pp. 269–288. ISSN 1477-9552.

7. Fried, H. O., Lovell, C. A. Knox, Schmidt, Shelton S. (2008). *The Measurement of Productive Efficiency and Productivity Growth*. 656 p. Oxford: Oxford University Press. ISBN 978-0-19-518352-8.

8. Hussien, H. B. (2011). Performance of Mixed Crop-Livestock Production System: The Data Envelopment Approach. *Livestock Research for Rural Development*, Volume 23, Issue 9. ISSN 0121-3784 Retreived: http://www.lrrd.org/lrrd23/9/besh23200.htm

9. Jelinek, L. (2006). *Relation between Technical Efficiency and Technological Change in Milk Production*. Dissertation, PEF CZU. Prague.

10. Jurica, A., Medonos, T., Jelinek, L. (2004). Structural Changes and Efficiency in Czech Agriculture in the Pre-Accession Period. *Agricultural Economics – Czech*, Volume 50, Issue 3, pp. 130–138. ISSN 0139-570X.

11. Mala, Z. (2011). Efficiency Analysis of Czech Organic Farming. *E a M: Ekonomie a Management*, Volume 14, Issue 1, 2011, pp. 14-28. ISSN 1212-3609.

12. Medonos, T. (2006). *Investment Activity and Financial Constraints of Czech Agricultural Companies*. Dissertation, PEF CZU. Prague.

13. Ott, L. (1984). *An Introduction to Statistical Methods and Data Analysis*. 2nd edition. Wadsworth: Belmont, Calif.

SUPPORT TO BIOENERGY AND ITS IMPACT ON COMPETITIVENESS OF LATVIAN AGRIBUSINESS

Agnese Krievina[1], Dr.oec.[+]; **Ligita Melece**[1], Dr.oec.

[1]Latvian State Institute of Agrarian Economics

Abstract. The paper deals with the analysis of bioenergy support instruments in Latvia, with an objective to evaluate the direct impact of the bioenergy support on energy costs and the overall competitive position of Latvian agribusiness. In Latvia, the generation support for electricity from biomass is provided as feed-in tariffs; biofuels are supported by mandatory blending requirement. The support has stimulated a rapid increase in the production of electricity from biogas and transport biofuels in Latvia. At the same time, energy support contributes to the larger share of energy costs and increases the total costs; though, the support alone does not explain a higher share of energy costs in Latvian agribusiness compared with other countries.

Key words: bioenergy, support instruments, agribusiness, energy costs.

JEL code: Q42, M21

Introduction

The analysis of production costs shows that energy costs in Latvian agribusiness are among the highest in the EU, being also above the Baltic level. The share of energy costs accounts for about 15% of the production value in Latvian agriculture and 5% of the production value in manufacture of food products and beverages. The same indicators stand for 11% and 3% in Lithuania and 11% and 4% in Estonia. Consequently, higher energy costs have larger burden on the total costs, potentially reducing the profit margin of the producers.

Latvia as many EU countries supports energy production from renewable sources to fulfil the mandatory targets towards renewable energy sources (RES). Traditionally, Latvia has had a high share of renewable energy in its total energy balance which has been ensured by hydro energy and wood biomass. In the recent years, there has also been a rapid expansion in electricity generated from biogas and biofuels which has facilitated the increase of the charge of public service obligation (PSO). Among other aspects, support to bioenergy resulting in higher energy prices has a direct implication on agribusiness competitiveness.

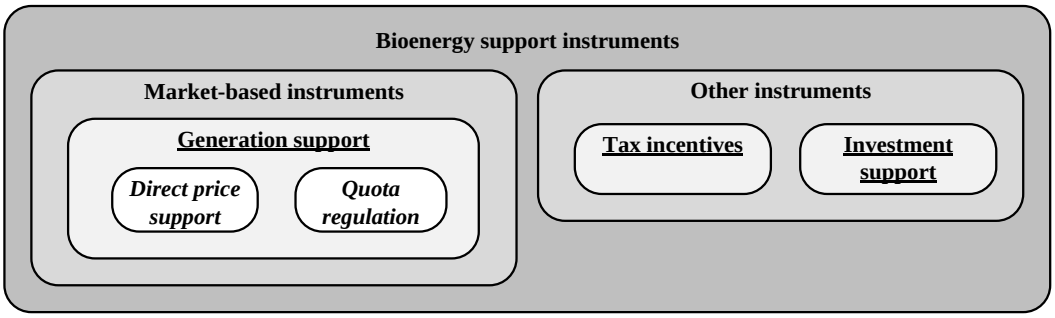
Therefore, the aim of this paper is to evaluate the direct impact of the bioenergy support on energy costs and the overall competitive position of Latvian agribusiness. According to the aim, several tasks were set: 1) to analyse bioenergy support instruments applied in Latvia (also to compare them with the support mechanism in other EU countries); 2) to explore different impacts of bioenergy support; 3) to evaluate the impact of electricity feed-in tariffs and mandatory biofuel blending requirement on the energy costs and the total costs of Latvian agribusiness.

The paper employs the term bioenergy to refer to the energy derived from biomass. The main sources of biomass are: wood; agricultural and forestry waste; municipal and industrial waste; fumes from landfills; field crops; and energy crop cultivations (REW, 2013; Söderberg et al., 2012). Considering the

[+] Tel.: +371 67167913; fax: +371 67541789
E-mail address: agnese@lvaei.lv

aim and limitedness of the paper, only biomass use for electricity and transport biofuels is studied, with most attention paid to the generation support.

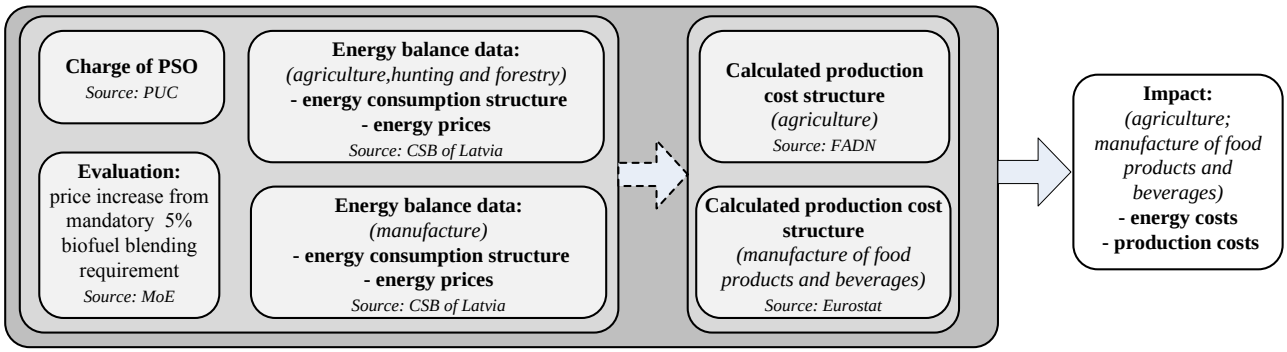
The research papers dedicated to the studies of RES policies classify support into various ways. Policy instruments can be generally distinguished between direct and indirect instruments - aiming at the immediate stimulation of renewable energy or focusing on improving long-term framework conditions (Kitzing et al., 2012, Haas et al., 2010; Harmelink et al., 2004). More importantly, policies may support investment in capacity or directly subsidise energy generation, thus, they may be classified as investment focused or generation based (Jenner et al., 2012; Haas et al., 2010). Further, support granted to investments or generation may address either the price or the quantity produced, so it can be also classified as price-driven or quantity-driven (Jenner et al., 2012; Verbruggen et al., 2012; Haas et al, 2010; delRio, 2010). Another approach is to classify support instruments as market-based instruments and others (delRio, 2010). These classifications are mostly used in respect to the electricity generation from RES, though similar classification can be applied also for other RES. Support classifications used in this paper are shown in Figure 1.



Source: authors' construction modified from delRio, 2010; Jenner et al., 2012

Fig. 1. **Classification of bioenergy support instruments**

The data on the charge of the PSO for RES as well as data on the total cost structure and the remaining profit of Latvian agricultural farms and food and beverage producing enterprises were used in order to evaluate the direct impact of electricity feed-in tariffs and mandatory blending requirement on the energy costs and total costs of Latvian agribusiness. The price increase due to the mandatory biofuel blending requirement was calculated using evaluation of the Ministry of Economics (2013). The charge of the PSO and higher price arising from the mandatory biofuel blending requirement was transferred to the energy costs of Latvian agribusiness enterprises, considering the structure of their energy consumption and the respective energy prices.



Source: authors' construction

Fig. 2. **Scheme of the calculations implemented and data used in the bioenergy support impact evaluation**

The scheme of the calculations implemented and data used is depicted in Figure 2.

Research results and discussion

1. Bioenergy support instruments in Latvia

The world is facing some major challenges today – hunger and increasing demand for food along with growing energy demand on the one hand and energy scarcity, coupled with environmental concerns over emissions of greenhouse gases (GHG) on the other hand (Söderberg, 2012; Jäger-Waldau et al., 2011; Demirbas, 2009; Escobar et al., 2008). Renewable energies are believed to be the solution to energy challenges as there is abundant supply worldwide and within the EU, and they do not face safety concerns like nuclear energy (Jäger-Waldau et al., 2011). They are associated with lowering emissions of GHG and so can also help solve environmental challenge (Söderberg, 2012). This has led to growing worldwide interests in renewable energy and associated support policies.

For Europe, the European Commission (EC) has set mandatory targets for the share of energy from RES by 2020, with a view to foster compliance with international agreements on GHG reductions, promote energy security, foster technological development and innovation of new energy sources and to provide opportunities for employment and regional development for rural areas in Europe and developing world (2009/28/EC; Söderberg, 2012). The action plan towards RES promotion in Latvia (2010) states the following main rationales: sustainable development, preservation of environmental quality and contribution to the GHG reduction, increase in Latvian energy self-sufficiency, sustainable use of Latvian natural resources, and social economic benefits from the use of RES.

The RES are viewed by policy makers of many countries as a key to reducing reliance on foreign oil and, thus, enhancing energy security, lowering GHG emissions and meeting rural development goals (Sorda et al., 2010; Kaditi, 2008; Koh et al., 2008). As regards bioenergy and its support policies, it should be noted that there are number of ways in which biomass differs from other RES: it is equally suitable to be used for heat, electricity and transport; it can be used at desired time (no seasonality attached); it is a limited resource with costs attached; the geographical and social implications of bioenergy can be much wider than for other forms of RES due to the supply chain aspect (Verbruggen et al., 2012; Thornley et al., 2008).

1.1 Support to electricity from biomass

In order to reach the binding target of 40% RES in energy (2009/28/EC), Latvia has set that electricity from RES has to reach 60% of electricity consumption in 2020 (MoE, 2010). Starting from 2010, electricity from biogas should comprise 7.93% of total electricity consumption and electricity from biomass (possible also with fossil fuels) - 4.97% (both further referred as electricity from biomass). Certain measures have been introduced to implement the targets.

In Latvia, eligible electricity produced from biomass is purchased by the public energy buyer (the JSC "Latvenergo") through **feed-in tariffs**. The tariffs are differentiated according to the installed capacity (smaller plants receive higher tariff) and depend on gas prices. The support is provided for eligible plants for the period of 10 years, after which reduction is applied. No tenders for new plants are organised from 2011 to 2016 due to the need to evaluate the present support impact and decide on new measures.

Table 1

Electricity from biomass production and support indicators in Latvia in 2008-2012

Indicator	2008	2009	2010	2011	2012
Electricity produced, GWh	**45**	**48**	**66**	**120**	**288**
Electricity purchased (*feed-in tariff*), GWh	**32**	**37**	**51**	**110**	**272**
Supported plants (*feed-in tariff*)	**7**	**8**	**17**	**36**	**55**
Share in electricity consumption, %	**0.6**	**0.7**	**0.9**	**1.7**	**3.6**

Source: based on MoE public data of support recipients and the CSB of Latvia public database

Feed-in tariffs provided for electricity from biomass are generous – in 2012, they exceeded the market price by 19.2 EUR/100 kWh on average, and the public burden of the support totalled EUR 39.7 million (EUR 14.8 million in 2011). There has been a rapid increase in the bio electricity in Latvia since 2011 (Table 1) considering the high tariffs coupled with the possibility to apply also for investment support for electricity that is produced from biomass of agricultural and forestry origin from 2010 (almost all plants eligible for feed-in tariffs used investment support as well. Though, its share is still below the target. A subsidised energy tax levied on the revenues from the electricity sales has been introduced since 2014 to reduce the impact of feed-in tariffs on electricity prices.

Table 2

Overview of bioelectricity support instruments in the EU countries (as of December, 2013)

Country	Direct price support		Quota regulation	Tax incentives		Investment support
	feed-in tariff	premium		reduced excise tax	reduced other taxes	
Austria	**x**	**-**	**-**	**-**	**-**	**-**
Belgium	-	-	**x**	-	-	**x**
Bulgaria	**x**	**-**	**-**	**-**	**-**	**x**
Cyprus	**-**	**x**	**-**	**-**	**-**	**-**
Czech Republic	**x**	**x**	**-**	**-**	**-**	**x**
Denmark	-	**x**	**-**	**-**	**x**	**x**
Estonia	-	**x**	**-**	**-**	**-**	**x**
Finland	**x**	**-**	**-**	**-**	**-**	**x**
France	**x**	**-**	**-**	**-**	**x**	**-**
Germany	**x**	**x**	**-**	**-**	**-**	**x**
Greece	**x**	**-**	**-**	**-**	**-**	**-**
Hungary	**x**	**-**	**-**	**-**	**-**	**x**
Italy	**x**	**x**	**x**	**-**	**x**	**-**
Ireland	**x**	**-**	**-**	**-**	**x**	**-**
Latvia	**x**	**-**	**-**	**-**	**x**	**x**
Lithuania	**x**	**-**	**-**	**x**	**-**	**x**
Luxembourg	**x**	**-**	**-**	**-**	**-**	**x**
Malta	**-**	**-**	**-**	**-**	**-**	**-**
Netherlands	**-**	**x**	**-**	**-**	**x**	**-**
Poland	**-**	**-**	**x**	**-**	**x**	**-**
Portugal	**x**	**-**	**-**	**-**	**-**	**-**
Romania	**-**	**-**	**x**	**-**	**-**	**x**
Slovakia	**x**	**-**	**-**	**x**	**-**	**x**
Slovenia	**x**	**x**	**-**	**-**	**-**	**x**
Spain	**x**	**x**	-	-	-	-
Sweden	-	**-**	**x**	**-**	**-**	**-**
United Kingdom	**x**	**-**	**x**	**-**	**x**	**x**

Source: authors' summary based on the RES LEGAL Europe portal; MS RES progress reports, 2011

Electricity from RES is also **exempt from electricity tax** in Latvia which is paid by electricity producer. It has been possible to apply for **investment support** in Latvia as part of the RDP 2007-2013

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

(electricity produced from biomass of agricultural and forestry origin), the Cohesion fund 2007-2013 (development of CHP plants using RES) as well as the state Climate Change Financial Instrument.

Overview of the bioelectricity support instruments in other EU countries is summarised in Table 2. Almost all countries use direct price support – mostly feed-in tariffs and rarer premiums. In some countries, there is a possibility to choose between selling electricity to public buyer or selling on the market and receiving a bonus on top of the selling price. Quota regulation exists in Poland, Sweden, Belgium, and Romania which obligates certain share of produced, sold or used electricity to be green and it is regulated with a certificate system. Italy and the United Kingdom use quotas along with the price support mechanisms.

In some countries, tax incentives are also used to promote bio energy which depending on the country include exemption from excise, energy, CO_2, consumption or real estate tax as well as reduction of the taxable base of income tax by RES investments. In about half of the countries, investment support is provided for bio electricity production and consumption.

1.2 Support to transport biofuels

Several support measures were introduced in Latvia to reach the targets of biofuels in transport - 5.75% by 2010 (2003/30/EC) and 10% by 2020 (2009/28/EC).

During the period of 2005-2010, producers of biofuel in Latvia received **support per litre of eligible biofuel produced** (i.e. bioethanol and biodiesel) which compensated the difference between the retail price of fossil fuels and the average production costs of biofuels. In total, support of EUR 95.8 million was paid to the sector during the whole period (the total budget was planned at EUR 27 million). At the support programme planning stage, it was considered that the compensation for biofuels could diminish over the period due to the growing fossil fuel prices, though in reality the support rate in 2010 was almost two times the 2005 level.

From the analysis of the biofuel production figures in Table 3, it can be concluded that the support facilitated biofuel production in Latvia and it mainly took place in the framework of the support quota. The volume of produced biofuels in 2010 was close to the quota amount set in order to reach the biofuel target in transport consumption; though, the actual consumption of biofuels in transport was below the target because of large biofuel exports. After the cessation of the support measure, production of bioethanol has considerably decreased in Latvia, though, the produced volumes of biodiesel have grown.

Table 3

Biofuel production and support indicators in Latvia in 2005-2012

Indicator	2005	2006	2007	2008	2009	2010	2011	2012
Produced amount, thou.t	2.1	11.7	20.7	39.7	58.5	58.3	55.9	92.1
- bioethanol	-	5.0	11.6	11.6	13.5	14.8	2.0	1.6
- biodiesel	2.1	6.7	9.1	28.1	45.0	43.4	53.9	90.5
Support quota, thou.t	20.0	29.0	39.0	50.0	62.0	63.2	-	-
Supported amount, thou.t	2.3	14.3	25.4	38.9	45.4	49.3	-	-
Share in transport consumption, %	0.26	0.22	0.14	0.17	0.48	2.60	4.00	n.d.

Source: based on MoE, 2013 and the CSB of Latvia database

The mandatory **4.5-5% biofuel blending requirement** has been introduced in Latvia since October, 2009. The share of biofuels in transport has notably increased only after the introduction of this measure. Therefore, the increase of the blending requirement to 7% has been proposed to reach target of the year 2020.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

In Latvia, **reduced excise tax rates** are applied for biofuel blends (except with 5% biofuel blending), pure biofuels are exempt from the tax. Excise tax exemption is also applied to diesel used in agriculture, though, it does not stimulate biofuel use by the sector.

Table 4

Overview of biofuel support instruments in the EU countries (as of December, 2013)

Country	Direct price support	Quota regulation	Tax incentives		Investment support
			reduced excise tax	reduced other taxes	
Austria	-	x	-	x	-
Belgium	-	x	x	-	-
Bulgaria	-	x	x	-	-
Cyprus	-	-	-	-	x
Czech Republic	-	x	-	x	-
Denmark	x	x	-	x	-
Estonia	-	-	-	-	x
Finland	-	x	x	-	-
France	-	x	-	x	-
Germany	-	x	-	x	-
Greece	-	x	-	-	-
Hungary	-	x	x	-	-
Italy	-	x	-	-	-
Ireland	-	x	-	-	-
Latvia	-	x	x	-	-
Lithuania	x*	x	x	x	x
Luxembourg	-	x	-	-	-
Malta	-	-	x	-	-
Netherlands	-	x	-	x	-
Poland	-	x	-	-	-
Portugal	-	x	-	x	-
Romania	-	x	-	-	-
Slovakia	-	x	x	-	-
Slovenia	-	x	x	-	-
Spain	-	x	-	-	-
Sweden	-	-	-	x	-
United Kingdom	-	x	-	-	-

*compensations for the costs of acquisition of raw material

Source: authors' summary based on the RES LEGAL Europe portal; MS RES progress reports, 2011

The summary of the main biofuel support instruments implemented in other EU countries is presented in Table 4. Most countries support biofuels through quota regulation measures – either by setting mandatory biofuel blending requirement or quota which obligates certain amount of total sales to be covered by biofuels (fines applied in case of noncompliance). Only in Lithuania biofuel producers receive direct support as compensation for bought raw material as well as Denmark provides premium for seller for biogas use in transport. No generation support is provided in Estonia, Sweden, Malta, and Cyprus. Some countries apply reduced excise tax rates and exemptions regarding pollution and consumption taxes for biofuels. There is practically no investment support provided to biofuels in the EU countries.

2. General bioenergy support impacts

Despite the RES potential triggering support policies, political and public support for bioenergy, especially for biofuels, has become controversial due to some negative effects of large scale production. Recently, there has been large criticism towards biofuels in respect of food security. They have been blamed for raising food prices - causing land use conflicts and such contributing to tightening of food supplies (Levidow, 2012; Wunder et al., 2012; Ninni, 2010; Kaditi et al., 2008; Koh et al., 2008). Furthermore, biofuels cause competition also for water (Kaditi et al., 2008; Koh et al., 2008; Charles et

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

al. 2007). All this has the most implication for the poor, especially in the developing world, which is predominantly agrarian and where food accounts for the most part of spending. Although, higher food prices potentially mean higher farm income, there is a question of these incomes being shared equitably (Escobar et al., 2008; Charles et al. 2007).

Biofuels have also raised a lot of environmental concerns. They are blamed for deforestation, threatening biodiversity (being monocultures), and resource degradation (soil erosion, chemical-intensive cultivation) (Levidow, 2012; Kaditi et al., 2008; Kohl et al., 2008). Due to land clearing practices and the energy consumed by the whole supply chain, their contribution to GHG emission reduction is questioned (Levidow, 2012; Kaditi et al., 2008; Bomb et al., 2006). The EC has introduced sustainability criteria towards bioenergy eligible for reaching 2020 targets to mitigate adverse impacts of biofuels.

Furthermore, there is also a question of the costs for reaching the policy targets. Support has stimulated worldwide rise in bioenergy production, including Europe (Klessmann et al., 2011; Ninni, 2010; Escobar, 2008; Elghali et al., 2007) and as seen before – also Latvia. Though, biofuels and RES electricity are considered to be an expensive option, often with negligible or without any of the alleged positive impacts on climate change and energy security (Frondel et al., 2010; Bomb et al., 2006). It has been highlighted that cost-competitive manufacture which highly depends on biomass feedstock at low costs, remains a key issue (Jäger-Waldau et al., 2011; Sorda et al., 2010). The EC states that cost-effective measures should be used to reach the binding targets; though, in Latvia the support has been costly, presenting high additional costs for final consumers. Direct impact of bioenergy support on Latvian agribusiness is examined further.

3. Direct impact of bioenergy support on the costs of Latvian agribusiness

The price of energy is one of the factors which determines the energy costs and, thus, influences the total production costs of manufacturers. Although, energy prices in Latvia are still slightly below the EU average, they are not low in the Baltic context. According to the data of 2013 (Table 5), the average diesel prices in the Baltic States were almost at the same level; gas prices in Latvia were about 12% higher than in Estonia but 14% lower than in Lithuania; and electricity prices in Estonia were about 30% lower than in other Baltic States. This shows that Latvian producers do not have resource price advantages in the Baltic context; though, cheaper electricity prices give competitive advantage to Estonia. Part of the differences in the prices of electricity can be explained by different support levels in the countries.

Table 5

Energy prices in the Baltic States in 2012 (all taxes included)

Indicators	Latvia	Lithuania	Estonia
Gas (industrial consumers), EUR/GJ	13.39	15.49	11.93
Electricity (industrial consumers), EUR/100 kWh	13.44	13.84	9.81
- PSO charge*, EUR/100 kWh (*of electricity price, %)*	3.25 (*24%)*	3.29 (*24%)*	1.04 (*11%)*
Diesel, EUR/l	1.37	1.33	1.37

*charge of 2013 for electricity purchased in 2012

Source: DG Energy, 2013; authors' calculations based on the PUC, 2013; NCCPE, 2013; ELERING, 2013

The costs of the public buyer arising from the purchase of electricity generated from the RES are proportionally distributed among the end users in Latvia. The total charge of the public service obligation (PSO) in Latvia in 2013 was set at 2.689 euro cents/kWh without VAT (electricity from combined heat and power (CHP) and RES). Majority of the charge of the PSO forms the CHP electricity (presently generated mainly from gas), electricity from the RES accounted for 0.797 euro cents/kWh. More than half

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

of the total electricity generated from the RES comes from biogas plants; the public service obligation for bioenergy was 0.563 euro cents/kWh (resulting in about 5-6% price increase in agribusiness).

The renewable energy charge is also applied to end consumers in Lithuania and Estonia. Consumers of electricity in Lithuania are charged the PSO charge similar to Latvia − Lithuanians pay 2.72 euro cents/kWh but the charge of the PSO in Estonia is much lower − 0.87 euro cents/kWh. Further, the mandatory 5% biofuel blending requirement in Latvia is estimated to increase diesel price by 1.17 euro cents/l and petrol price − by 0.57 euro cents/l without VAT (resulting in about 1% price increase in agribusiness). The mandatory biofuel blending requirement in Lithuania is 7%, while Estonia does not use any biofuel generation support.

Table 6

Impact of energy support on the production costs of Latvian agribusiness

Indicator	Increase in agriculture, %		Increase in food and beverages, %	
	Energy costs	Total costs	Energy costs	Total costs
Feed-in tariffs	+2.8	+0.3	+14.0	+0.6
- RES	+0.8	+0.1	+3.8	+0.2
- bioenergy	+0.6	+0.1	+2.6	+0.1
Mandatory 5% biofuel blending	+0.9	+0.1	+0.1	+0.0
Total	+3.7	+0.4	+14.1	+0.6

Source: authors' calculations based on the Eurostat, CSB of Latvia, FADN database, PUC, 2013; MoE, 2013

Considering the high share of energy costs in Latvian agribusiness, evaluation was made to determine the impact of feed-in tariffs and mandatory biofuel blending requirement on the energy costs and the total costs in Latvia. According to the obtained results (Table 6), the larger impact of electricity support on energy costs is seen in manufacture of food products and beverages − electricity feed-in tariffs increase energy costs of Latvian food processing enterprises by about 14% which further slightly raise the total production costs by about 0.6%. The impact of feed-in tariffs on energy costs and total costs in agriculture is smaller (+2.8% and +0.3%) due to the lower share of electricity in the total sector energy consumption. It is evaluated that energy costs in agriculture increase by 0.6%, while in manufacture of food products and beverages − by 2.6% due to the feed-in tariffs of electricity from biomass. Mandatory 5% biofuel blending requirement has small effect on energy costs in food processing, while the energy costs in agriculture are further increased by 0.9% due to larger share of diesel and petrol consumption in the total energy balance. According to the results, energy support contributes to the larger share of energy costs of Latvian agribusiness which also raise the share of total costs, yet it alone does not explain the higher share of energy costs in Latvian agribusiness.

Conclusions

1. In Latvia, bioenergy is promoted through generation support, tax incentives and investment support mechanisms. Generation support for bioelectricity is provided as feed-in tariffs; biofuels are supported by mandatory blending requirement. The main bioenergy support instruments in Latvia are similar to the support applied in other EU countries.
2. The support to bioenergy has stimulated a rapid increase in the production of electricity from biogas and transport biofuels in Latvia; though, the targets for bioenergy in total electricity and transport consumption have not been met up to now.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

3. The generation support for RES (including bioenergy), and especially feed-in tariffs have high burden on consumers in Latvia. At the same time, energy prices in Latvia are high in the Baltic context, contributing to the higher share of energy costs of Latvian agribusiness.
4. Energy costs in manufacture of food products in Latvia are by about 14.1% higher (+2.7% due to bioenergy) and in agriculture − by 3.7% higher (+1.5% due to bioenergy) due to feed-in tariffs and mandatory blending requirement, Though, the generation support alone does not explain the higher share of energy costs in Latvia.
5. Bioenergy presents potential for solving energy, environment and rural challenges; though, presently used biomass has attracted criticism in respect to food security, threats to environment as well as it is costly. Utilisation of waste material and second-generation bionergy could present new possibilities in overcoming some of its main shortcomings.

Bibliography

1. Bomb, C., Cormick K., M., Deurwaarder, E., Kaberger, T. (2006). Biofuels for Transport in Europe: Lessons from Germany and the UK. *Energy Policy*, Volume 35, pp. 2256−2267.
2. Charles, M., B., Ryana, R., Ryan, N., Oloruntoba, R. (2007). Public Policy and Biofuels: The Way Forward? Energy Policy, Volume 35, pp. 5737−5746.
3. delRı´o, P. (2010). Analysing the Interactions between Renewable Energy Promotion and Energy Efficiency Support Schemes: The Impact of Different Instruments and Design Elements. *Energy Policy*, Volume 38, pp. 4978−4989.
4. Demirbas, A. (2009). Political, Economic and Environmental Impacts of Biofuels: A review. *Applied Energy*, Volume 86, pp. S108−S117.
5. DG Energy (2013). EU Energy in Figures. Retrieved: http://ec.europa.eu/energy/observatory/statistics/statistics_en.htm. Access. 03.11.2013.
6. ELERING (2013). Renewable Electricity Charges for Consumers in Estonia. Retrieved: http://elering.ee/renewable-energy-charges/. Access. 01.11.2013.
7. Elghalia, L., Clifta, R., Sinclaira, P., Panoutsou, C., Bauen, A. (2007). Developing a Sustainability Framework for the Assessment of Bioenergy Systems. *Energy Policy*, Volume 35, pp. 6075−6083.
8. Escobar J., C., Lora, E., S., Venturini, O., J., Yanez, E., E., Castillo, E., F., Almazan, O. (2008). Biofuels: Environment, Technology and Food Security. *Renewable and Sustainable Energy Reviews,* Volume 13, pp. 1275−1287.
9. Frondel, M., Ritter, N., Schmidt, C., M., Vance, C. (2010). Economic Impacts from the Promotion of Renewable Energy Technologies: The German Experience. Energy Policy, Volume 39, pp. 4048−4056.
10. Haasa, R., Panzera, C., Rescha, G., Ragwitzb, M., Reecec, G., Held, A. (2010). A Historical Review of Promotion Strategies for Electricity from Renewable Energy Sources in EU Countries. *Renewable and Sustainable Energy Reviews*, Volume 15, pp. 1003-1034.
11. Harmelinka, M., Voogta, M., Cremer, C. (2004). Analysing the Effectiveness of Renewable Energy Supporting Policies in the European Union. *Energy Policy*, Volume 34, pp. 343-351.
12. Jäger-Waldau, A., Szabo, M., Scarlat, N., Monforti-Ferrario, F. (2011). Renewable Electricity in Europe. *Renewable and Sustainable Energy Reviews*, Volume 15, pp. 3703−3716.
13. Jenner, S., Groba, F., Indvik, J. (2012). Assessing the Strength and Effectiveness of Renewable Electricity Feed-in Tariffs in European Union Countries. *Energy Policy*, Volume 52, pp. 385-401.
14. Kaditi, E., A. (2008). Bio-energy Policies in a Global Context. Journal of Cleaner Production, Volume 17, pp. S4−S8.
15. Kitzing, L.,Mitchell, C., Morthorst, P., E. (2012). Renewable Energy Policies in Europe: Converging or Diverging? *Energy Policy*, Volume 51, pp. 192-201.
16. Klessmann, C., Held, A., Rathmann, M., Ragwitz, M. (2011). Status and Perspectives of Renewable Energy Policy and Deployment in the European Union—What is Needed to Reach the 2020 Targets? *Energy Policy*, Volume 39, pp. 7637−7657.
17. Koh, L., P., Ghazoul, J. (2008). Biofuels, Biodiversity, and People: Understanding the Conflicts and Finding Opportunities. Biological Conservation, Volume 141, pp. 2450 −2460.

18. Levidow,. L. (2012). EU Criteria for Sustainable Biofuels: Accounting for Carbon, Depoliticising Plunder. Geoforum, Volume 44, pp. 211−223.
19. Ministry of Economics (MoE). (2013). Informative Report on the Situation in Biofuel Production (in Latvian). Retrieved: http://www.mk.gov.lv/lv/mk/tap/?pid=40248005. Access. 02.11.2013.
20. MoE (2012). Informative Report on Support Mechanisms to Support Mechanisms of Electricity generated form RES (in Latvian). Retrieved: www.mk.gov.lv/doc/2005/EMInf_180712_AEREnergija.1672.doc. Access. 02.11.2013.
21. MoE (2010). The Action Plan towards RES Promotion in Latvia (in Latvian). Retrieved: http://www.mk.gov.lv/lv/mk/tap/?pid=40187012. Access. 02.11.2013.
22. MS RES Progress Reports. (2011). Retrieved: http://ec.europa.eu/energy/renewables/reports/2011_en.htm. Access. 08.11.2013.
23. National Control Commission for Prices and Energy (NCCPE). (2013). Public Service Obligations (PSO) in the Electricity Sector of Lithuania. Retrieved: http://www.regula.lt/en/activities/electricity/tariffs/viap_prices.php. Access. 01.11.2013.
24. Ninni, A. (2010). Policies to Support Biofuels in Europe: The Changing Landscape of Instruments. *AgBioForum*, Volume 13(2), pp. 131-141.
25. PUC (Public Utilities Commission). (2013). About PSO Components (in Latvian). Retrieved: http://www2.sprk.lv/?sadala=764&id=16183. Access. 01.11.2013.
26. Renewable Energy World (REW). (2013). Bioenergy. Retrieved: http://www.renewableenergyworld.com/rea/tech/bioenergy. Access. 09.11.2013.
27. Söderberg, C., Eckerberg, K. (2012). Rising Policy Conflicts in Europe over Bioenergy and Forestry. *Forest Policy and Economics*, Volume 33, pp. 112-119.
28. Sorda, G., Banse, M., Kemfert, C. (2010). An Overview of Biofuel Policies across the World. Energy Policy, Volume 38, pp. 6977−6988.
29. Thornley, P., Cooper, D. (2008). The Effectiveness of Policy Instruments in Promoting Bioenergy. *Biomass and Bioenergy*, Volume 32, pp. 903 − 913.
30. Verbruggen, A., Lauber, V. (2012). Assessing the Performance of Renewable Electricity Support Instruments. *Energy Policy*, Volume 45, pp. 635-633.
31. Wunder, S., Kaphengst, T., Timeus K., Berzins, K. (2012). Impact of EU Bioenergy Policy on Developing Countries. Retrieved: http://www.ecologic.eu/sites/files/project/2013/2610_21_bioenergy_lot_21.pdf. Access 10.11.2013.

ECONOMIC DETERMINANTS OF MILK PRODUCTION IN REGIONS OF THE EUROPEAN UNION WITH MEDIUM SMALL MILK FARMS IN 2009 COMPARED WITH THE SITUATION IN 2004

Marta Smigla[1], MA, PhD student [+]

[1]Poznan University of Economics, Poland

Abstract. The aim of the paper was to determine the diversity and factors that decided on the variation of milk production in the EU macro-regions with medium small milk farms in 2009 compared with the situation in 2004. The typology of the regions was based on the results of a cluster analysis. The research whether milk production is determined mostly by pricing, institutional, or resource factors will enable to recognise the reasons for the diversity of the EU milk market and determine the implications of this diversity for the dairy sector in Poland. Basing on the results of factor analysis, the author has identified the factors that have a decisive influence on the economic adjustments in medium small dairy farms in 2009 compared with the situation in 2004. The explanation of the research problem will also show which European macro-regions have developed most, and which worsened their competitive position in 2009 compared with 2004.

Keywords: cluster analysis, factor analysis, milk production, regions of the European Union.

JEL code: Q1, R1

Introduction

The European Union is characterised by diversity in many ways. Agriculture is one of the first mentioned among them (Matuszczak A., 2012). In addition to the diversity of soil conditions, climate and natural resources which are independent on the will of man (Grzelak A., Stepien S, 2010), there are also differences in the level of production and economic indicators of farms (Brelik A., 2010). These factors largely decide on the multi-million assistance for individual countries under the common agricultural policy (Smedzik K., 2013). Thus, it seems interesting to analyse differences in terms of the production and economic results in the regional scope, in particular, in the context of reforms involving quota system abolition. The statement, in which countries will be the most serious deterioration in the competitiveness of farms, appears to be insufficient due to the relatively big spatial differentiation of domestic production in the countries of the European Union. Therefore, the main objective of the paper is to determine the diversity and the factors deciding on the variation of milk production in the EU macro-regions with medium small milk farms in 2009 compared with the situation in 2004. In case of milk production, the scale of production plays an important role in shaping the differences in economic indicators (Stepien S., 2007, Baer-Nawrocka A. et al., 2012).This is confirmed by the research on the dependence of the herd size on income from the management of farms specialised in dairy cows conducted by R. Sass which shows that the economic situation of households focused on milk production is conditioned by its scale (Sass R., 2007). Larger scale of production provides higher household incomes, higher productivity, and

[+] Corresponding author. Tel.: + 48618543017; fax: + 48618543017
E-mail address: marta.smigla@ue.poznan.pl

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

profitability of land and higher work fee (Grzelak A., 2013). Therefore, the author decided to perform a cluster analysis. The typology was based on four characteristics from the FADN (Farm Accountancy Data Network) field of observation, describing the examined farms, i.e. the economic strength measured in ESU, agricultural area, the number of dairy cows, and average annual milk yield. Grouping of farms was performed by using a hierarchical method, agglomeration process, and the Ward method. This procedure detailed five groups of regions where dairy farms are characterised by similar features. It was considered that in the resulting clusters the production should be dependent on similar features. To check it, it was decided to carry out a factor analysis within each group in a dynamic form for two periods - 2004 and 2009. These periods were chosen because of the enlargement of the European Union in 2004 and due to the structure of the FADN database (annual results are the average of five contiguous years) and report delays (the latest possible closing year was 2009).This study concerns the 4th typological group, in which there are three out of four Polish macro-regions as well as Latvia. In the following analysis, there are 17 Euro-regions of medium small dairy farms for 2009 and 16 for 2004 (in the region of Languedoc-Roussillon in 2004, due to the insufficient number of households in the sample, in accordance with the principle of secrecy, publication of averaged results was not possible). The performed research (on the basis of cluster and factor analysis) will try to answer the following questions:

- which factors determined milk production in the EU macro-regions with medium small milk farms in 2009;
- how the determinants of milk production in the EU macro-regions with medium small milk farms in 2009 changed compared with the situation in 2004;
- which regions improved and which worsened their competitive positions among all the regions surveyed;
- what was the situation of Polish macro-regions on the background of all the regions surveyed.

The research was conducted using the data from the Farm Accounting Data Network. The author used the data grouped by the region and the type of farming (TF8) - dairy cows. Among the existing (the average annual results for 2009) 150 European macro-regions 94 were selected in the years 2007-2011, which performed the required number (15) of farms with the economic size allowing for their inclusion in the FADN accounting (due to the low number of households in the sample, in accordance with the principle of secrecy, the publication of averaged results was not possible). Economic size that enables the inclusion in the FADN methodology is different for individual Member States. In general, the study included the data from 487,480 households out of 25 Member States (excluding Cyprus and Greece, where due to the low number of households in the sample, the publication of averaged results was not possible in accordance with the principle of secrecy).

Research results and discussion

1. Specialisation in milk production in the European Union. Typology of regions

As a result of the cluster analysis, there were five internally homogeneous groups of regions obtained of the 94 analysed regions. These clusters contain the regions with dairy farms that are similar in economic size ESU, alike surface of arable land used, a similar number of dairy cows and cows' average annual milk yield. In this way, groups of the regions with dairy farms were established as:

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

- very large – typological group I (an average of 159.08 ESU, with the largest area of agricultural land (143.60 ha), the biggest number of cows (more than 100 cows per farm) and the highest annual milk production of cows - almost 8134 kg);
- large - typological group II (average 88.94 ESU, a relatively large area of agricultural land (77.36 ha) and the number of dairy cows (66.17 pcs) with milk yield at an average of about 7050 kg per year);
- medium large - typological group III (average 59.09 ESU, having almost 62 ha of farmland and an average of slightly more than 44 cows with an average milk yield of about 6170 kg per year);
- medium small - typological group IV (average 38.16 ESU, the agricultural area of 50 hectares, an average of about 35 dairy cows with milk yield at 4891 kg per year);
- small - typological group V (average 4.54 ESU, relatively least area - just about 10 ha, an average of only about 10 cows with the lowest milk yield - at an average of about 3592 kg per year).

Among the clusters of the regions with very large farms (typological group I), large (typological group II) and medium large (typological group III), relatively richer regions of the EU-15 countries prevailed. However, among the group of the regions with medium small farms (typological group IV) and small (typological group V) regions of the EU-10 strongly dominated. In the case of the regions with medium small farms (typological group IV), the author decided on the need to produce average results also with the exception of Slovakia which significantly overstated the economic size (more than 3 ESU for the group), the agricultural area (over 42 hectares for the whole group), and the number of dairy cows (almost 6 cows per farm).

Slovakia, however, could not be assigned to the groups of the regions with very large (group I), large (group II) or medium large farms (group III) due to the low milk yield of cows, characteristic for post-socialist countries remaining in a poor condition of the agricultural economies. These relations are confirmed by research of many scientists. The structure of agriculture in various countries of the European Union is largely a result of historical events taking place over many years (Majchrzak A., 2013,). According to W. Poczta, A. Sadowski, and J. Sredzinska "structural change (...) took a different course in the Eastern and Western parts of the European Union. The countries of the Central and Central-Eastern Europe such as the Czech Republic, Slovakia, Hungary, and the Baltic States, have been subjected to the post-war process of collectivisation, which led directly to the formation of large, big scale companies. After a period of structural change, their position depended on the adopted path of country privatisation" (Poczta W., Sadowski A., Sredzinska J., 2008; Czyzewski B., 2007). The concentration processes were enforced by market situation in the countries of the Western Europe.

2. Identification of factors determining milk production in the regions of the European Union with medium small milk farms in 2009 compared with 2004

These studies are intended to provide economic adjustments of dairy farms from the typological group IV after the enlargement of the European Union in 2004. To show the changes in the affecting the development of the medium small dairy farms in the regions of the European Union, the author used factor analysis in a dynamic form for two periods (2004 and 2009). The starting point was to create a matrix of observation which is taken from the FADN set of indicators that illustrate various features of

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

dairy farms in the regional context in 2004 and 2009.The correlation analysis of the variables revealed that there were significant associations between them characterised by a high complexity. The author used the method of clustering based on the criterion of maximum correlation to extract the basic features of interdependent systems. Economic adjustments after the accession to the European Union were determined by 16 features for 2009 and 15 features for 2004. There were three independent factors isolated in the case of the analysed sample of dairy farms. These factors explain more than 80% of the common variation for each of the analysis (Table 1). It was considered that such a high percentage of use of the common variation allows basing the analysis only on these three factors. The solution used for further analysis is obtained by a raw version of the Varimax analytical method.

Table 1

Factorial solution for 2004 and 2009

Factor	Eigen value of the correlation matrix		Participation in the use of variation (in%)			
			common		cumulative	
	2004	2009	2004	2009	2004	2009
F_1	7.49	7.71	46.83	45.36	46.83	45.36
F_2	3.42	3.49	21.35	20.55	68.18	65.91
F_3	3.51	2.99	21.96	17.65	90.14	83.56

Source: author's calculations based on http://ec.europa.eu/agriculture/rica/database/database_en.cfm

There was a decline in the share of all three factors in the overall variability of the resource in 2009 compared with 2004. The decrease in the share of the factor in the use of variation is equivalent to a reduction in its weight and uniformity. As the leading factor man can consider the first (F1), because it explains the most of common variation of the test resource. Presented in terms of the relevance of features, its design consists of basic data, specifying the availability of factors of production in medium small dairy farms.

3. Availability of production factors (F1)

The structure of features forming factor F1 and their weights indicate that the availability of production factors in medium small dairy farms in the Euro-regions was mainly conditioned by the total labour inputs, total utilized agricultural area, and the average farm capital. It is worth noting that the impact of total cost on the availability of factors of production was maintained during the period at a relatively constant level. However, the negative impact of net investment should be noted, and hence, changes in net worth which proved to be strong destimulants of factors of production availability. However, their impact value has decreased in 2009 compared with 2004. Therefore, it can be concluded that there have not been done such large investments which could significantly affect the budget of households (Table 2). In 2009, subsidies to total livestock production have become more important to the availability of factors of production, while there has been a decrease of the importance of total assets and net worth. That may suggest that despite the previously held investment and modernisation of dairy farms, they are not able to cope without the intervention on the EU milk market. In 2009, the number of dairy cows had a large impact on the availability of factors of production in the medium small dairy farms also which may indicate awareness of the existing in milk production economies of scale and the related need to increase the herd to improve its competitive situation in the perspective of the abolition of milk quota in 2015.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 2

Availability of production factors on the medium small milk farms in the regions of the European Union in 2004 and 2009 (structure factor F1)

No	Feature	Factorial load	
		2004	2009
1.	Total labour input	0.983248	0.976991
2.	Total utilised agricultural area	0.968428	0.992050
3.	Total inputs	0.958497	0.963817
4.	Total assets	0.952116	0.477895
5.	Net worth	0.956051	0.399839
6.	Change in net worth	-0.879852	-0.667971
7.	Average farm capital	0.987879	0.851007
8.	Net investments	-0.971505	-0.541969
9.	Milk cows	-	0.891805
10.	Total subsidies on livestock	-0.016023	0.975950

Source: author's study based on http://ec.europa.eu/agriculture/rica/database/database_en.cfm

The construction of a comparative scale was based on arranging the regions ranging from those with the greatest availability of factors of production ending with the worst ones for 2009. As it turned out, the greatest availability of production factors in 2009 was recorded in Slovakia, Spanish Balearic Islands, and French regions of Languedoc-Roussillion, Auvergne and Limousin.

Table 3

Position of the regions of the European Union in terms of availability of production factors in 2004 and 2009

Region	2004	No.	2009	No.
(0810) Slovakia	3.692600	1	3.810800	1
(0540) Baleares	0.031482	3	0.183100	2
(0201) Languedoc-Roussillon	-	-	0.045055	3
(0193) Auvergne	-0.320277	8	-0.022989	4
(0184) Limousin	-0.312222	7	-0.049619	5
(0770) Latvia	-0.355008	11	-0.205693	6
(0795) Mazowsze and Podlasie	-0.374463	15	-0.208428	7
(0133) Haute-Normandie	-0.405402	16	-0.226290	8
(0775) Lithuania	-0.364280	13	-0.254493	9
(0820) Slovenia	-0.298434	6	-0.266178	10
(0291) Lazio	0.135170	2	-0.279582	11
0785) Pomorze and Mazury	-0.358191	12	-0.312599	12
(0380) Ireland	-0.051680	5	-0.386004	13
(0192) Rhones-Alpes	-0.349735	10	-0.403101	14
(0790)Wielkopolska and Slask	-0.365232	14	-0.437720	15
(0765) Eszak-Alfod	-0.325414	9	-0.467100	16
(0780) Malta	0.021087	4	-0.519158	17

Source: author's calculations based on http://ec.europa.eu/agriculture/rica/database/database_en.cfm

The worst value was obtained in Malta and Hungarian Eszak-Alfod. Positive for Poland seems to be a shift of Mazowsze and Podlasieregion from the 15th position occupied in 2004 on the high 7th place. The regions of Pomorze and Mazury (12th position) and Wielkopolska and Slask (14th, 15th) remained in a relatively constant position. Lower values for these regions can be explained by large investments associated with the ongoing modernisation of farms. Among the regions that improved their availability of production factors, to a large extent by the concentration of production and the improvement of the financial situation of households in those areas, one can mention French Haute-Normandie, Latvia,

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Mazowsze and Podlasie, and Lithuania. The largest relative declines were recorded in Italian Lazio, Malta, HungarianEszak-Alfod, and Ireland (Table 3).

4. Market (price- cost) relations (F2)

The second factor (F2) explained 21.35% of the common resource variation in 2004. In 2009, this share decreased slightly and accounted for 20.55%. It is represented by the variables of the price-cost relations in medium small milk farms in Euro-regions in 2004 and 2009, among which the net value added per fully employed person and total net income of the family farm have the greatest impact (Table 4). The construction of F2 illustrates that investment in later years had a negative impact on price-cost relations in medium small milk farms in Euro-regions which is closely associated with the reduction of the impact of subsidies for livestock production. However, it is worth noting that during the period, the balance of VAT (excluding VAT on investment) remained at a relatively constant level.

Table 4

Price-cost relations on the medium small dairy farms in the Euro-regions 2004 and 2009 (structure factor F2)

No	Feature	Factorial load	
		2004	2009
1.	VAT balance (excluding on investment)	0.616951	0.652349
2.	Farm Net Value Added / AWU	0.956878	0.932400
3.	Farm Net Income / FWU	0.947341	0.967014
4.	Subsidies on livestock	0.822003	-0.076048
5.	Net investment	0.104797	-0.615099

Source: author's calculations based on http://ec.europa.eu/agriculture/rica/database/database_en.cfm

The majority of the regions are below the average (Table 5). It may indicate high diversity and strong, differing from the rest of the field, position of just the four regions of the leading edge.

Table 5

Position of regions of the European Union with medium small milk farms according to price-cost relations in 2004 and 2009

Region	2004	No.	2009	No.
(0540) Baleares	2.883509	1	2.786748	1
(0291) Lazio	0.838030	3	1.942401	2
(0380) Ireland	1.404919	2	1.102456	3
(0780) Malta	0.252474	4	0.199414	4
(0193) Auvergne	-0.309122	9	-0.222693	5
(0184) Limousin	-0.048698	7	-0.234795	6
(0810) Slovakia	-0.499912	10	-0.255329	7
(0201) Languedoc-Roussillon	-	-	-0.320129	8
(0192) Rhones-Alpes	0.087124	6	-0.345223	9
(0795) Mazowsze and Podlasie	-0.929940	16	-0.457350	10
0785) Pomorze and Mazury	-0.843681	14	-0.459526	11
(0790) Wielkopolska and Slask	-0.858615	15	-0.475502	12
(0775) Lithuania	-0.689438	13	-0.511750	13
(0770) Latvia	-0.601976	11	-0.590842	14
(0820) Slovenia	-0.629406	12	-0.662750	15
(0765) Eszak-Alfold	-0.170686	8	-0.746515	16
(0133) Haute-Normandie	0.115417	5	-0.748614	17

Source: author's calculations based on http://ec.europa.eu/agriculture/rica/database/database_en.cfm

It should be noted that there are households from the regions of the new Member States under the average which proves their backwardness and low competitive position relative to the countries EU-15. The best price-cost relations throughout the period occurred in Spanish Balearic Islands, in Italian Lazio,

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Ireland, and Malta. Polish regions are characterised by similar price-cost relations and all improved their competitive positions relative to 2004 among the surveyed regions with medium small milk farms. Relatively, the worst market relations occurred in French Haute-Normandie, Hungarian Eszak-Alfold, Slovenia, and Latvia. Among the regions that have improved their price-cost relations lead Polish regions, in particular, Mazowsze and Podlasie which moved up six places compared with 2004. The largest relative decreases were recorded in French Haute-Normandie and Hungarian Eszak-Alfold.

5. External financing the milk production (F3)

The third factor, in turn, explains 21.96% and 17.65% respectively of the common variation for 2004 and 2009. After analysing the components of this factor, it was decided that it contained features that could be defined as external financing in the medium small dairy farms in the regions of the EU in 2004 and 2009. In 2004, total liabilities and long- and medium-term loans associated with carried out during this period large investments for the modernisation forced by the need of adaptation to the EU standards were the most significant to the external financing of production. In 2009, when the investment activity of households within the study group slightly expired, the short-term loans covering farms' operating expenses were the most important.

Table 6

External financing of milk production on the medium small dairy farms in the Euro-regions in 2004 and 2009 (structure factor F3)

No	Feature	Factorial load	
		2004	**2009**
2.	Total liabilities	0.975647	0.668068
3.	Long & medium-term loans	0.970652	0.669541
4.	Short-term loans	0.901808	0.776104

Source: author's calculations based on http://ec.europa.eu/agriculture/rica/database/database_en.cfm

Table 7

Position of the regions of the European Union with medium small milk farms according to external financing (F3) in 2004 and 2009

Region	2004	No.	2009	No.
(0780) Malta	-0.28699	8	1.96977	1
(0133) Haute-Normandie	1.84735	1	1.81899	2
(0380) Ireland	0.01652	6	1.60948	3
(0192) Rhones-Alpes	1.68265	2	0.88789	4
(0810) Slovakia	0.24589	5	0.30369	5
(0184) Limousin	1.43808	3	0.29988	6
(0193) Auvergne	1.17268	4	-0.14495	7
(0790) Wielkopolska and Slask	-0.73892	14	-0.27702	8
(0765) Eszak-Alfod	-0.00642	7	-0.29055	9
(0291) Lazio	-1.37693	16	-0.50167	10
(0201) Languedoc-Roussillon	-	-	-0.57241	11
(0785) Pomorze and Mazury	-0.72117	13	-0.59250	12
(0820) Slovenia	-0.49165	9	-0.72255	13
(0540) Baleares	-0.62132	11	-0.80407	14
(0770) Latvia	-0.61991	10	-0.96736	15
(0795) Mazowsze and Podlasie	-0.84057	15	-1.00459	16
(0775) Lithuania	-0.69929	12	-1.01202	17

Source: author's calculations based on http://ec.europa.eu/agriculture/rica/database/database_en.cfm

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The largest external financing of production in medium small farms in Euro-regions was recorded in Malta, in French region of Haute-Normandie, Rhones-Alpes, Limousin, Ireland, and Slovakia. The smallest external financing occurred in the less prosperous regions of the new Member States – Lithuania, Latvia, and Mazowsze and Podlasie which are based on good natural conditions for milk production, favouring extensive production of high quality raw material. During the period under review, the impact of external funding on average economic condition of small farms has increased the most in Malta, Wielkopolska and Slask, and Italian Lazio. It could be related with the investments carried out in the period, modernisation of farms, and scaling up production.

Conclusions

1. Milk production in the medium small dairy farms in 2004-2009 was determined mostly by resource factors, and then, on similar level, price–cost relations and external financing of production.
2. All the three factors had slightly less impact on the variation of milk production in medium small farms in the EU macro-regions in 2009 compared with the situation in 2004.
3. The availability of factors of production on the medium small dairy farms in the Euro-regions was mainly conditioned by the total labour inputs, total utilized agricultural area, and the average farm capital. The impact of total cost on the availability of production factors maintained at a relatively constant level. In 2009, the subsidies to total livestock production became more important to the availability of production factors, while there has been a decrease of the importance of total assets and net worth. That may suggest that despite the previously held investment and modernisation of dairy farms, they are not able to cope without the intervention on the EU milk market. In 2009, a large impact on the availability of factors of production in the medium small dairy farms also had a number of dairy cows, which may indicate to awareness of the existing in milk production economies of scale and the related need to increase the herd to improve its competitive situation in the perspective of the abolition of milk quota in 2015.
4. In 2004 and 2009, the greatest impact on the price-cost relations in the medium small milk farms in Euro-regions was caused by net value added per fully employed person and total net income of the family farm. Investment in later years had a negative impact on price-cost relations on the medium small milk farms in Euro-regions, what is closely associated with a reduction of the impact of subsidies for livestock production. However, during the period, the balance of VAT (excluding VAT on investment) remained at a relatively constant level.
5. In 2004, total liabilities and long- and medium-term loans associated with large investments used for the modernisation during this period forced by the need of adaptation to the EU standards were the most significant to the external financing of production. In 2009, when the investment activity of households within the study group slightly expired, short-term loans covering farms operating expenses were the most important.
6. Positive for Poland seems to be a shift of Mazowsze and Podlasie region from the 15th position occupied in 2004 to the high 7th place in terms of the availability of production factors. It could happen largely due to the relative high concentration of production and the improvement of the financial situation of households. All Polish regions are characterised by similar price - cost relations and all improved their competitive positions compared with 2004 among the regions with the medium small farms. The biggest impact of external financing in medium small dairy farms in Poland

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

was recorded in the region of Wielkopolska and Slask which is closely related with the intensive production model there. The smallest impact of external financing was recorded in Mazowsze and Podlasie region where the natural conditions were conducive to extensive production. One can, thereby, conclude that the Polish regions have strengthened their competitive position against the others in the tested group.

7. The cluster analysis shows that there is a considerable internal diversity of dairy farms in the EU countries which confirms the need to study the problem on a regional scale.

However, one should be aware of the fact that the data used in the above analysis relate to the selected FADN farms. The economic situation of dairy farms that do not meet the eligibility requirements for the FADN in perspective abolition of milk quota may not allow them to withstand competition from larger manufacturers.

Bibliography

1. Baer-Nawrocka, A., Grochowska, R., Kiryluk-Dryjska, E, Seremak Bulge, J., Szajner, P. *Swiatowy rynek mleka i jego wplyw na polskie mleczarstwo po zniesieniu kwot mlecznych (World Milk Market and It's Influence on PolishDairyafterQuotaAbolition),*IERiGZ, Warszawa 2012, pp. 9-11.
2. Brelik, A. (2010). Zrownowazonyrozwojspoleczno-gospodarczy a rozwojturystyki (Sustainable Socio-economic Development and the Development of Tourism). *Roczniki Ekonomiczne Kujawsko –Pomorskiej SzkolyWyzszej w Bydgoszczy* 3 (2010) Bydgoszcz, pp. 153-162.
3. Czyzewski, B. (2007). Instytucje w tworzeniu struktur agrobiznesu (Institutions in Creating Structures of Agribusiness), *Uniwersalia polityki rolnej w gospodarce rynkowej ujeciemakro i mikroekonomiczne*. Red. A. Czyzewski. Wyd. AE, Poznan, pp. 57-98.
4. Grzelak, A. (2013). Reproduction Processes in Agriculture in Poland Considering Production Types of Farms (in the Light of the Data from Agricultural Accounting System FADN), *"Economic Science for Rural Development"*, No 32, pp. 184-189.
5. Grzelak, A., Stepien, S. (2010). Konsekwencje zmian klimatycznych dla rolnictwa - wybrane problemy (The Consequences of Climate Change for Agriculture - Selected Problems), *Agroekonomia w warunkach rynkowych: problemy i wyzwania* - Poznan: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu (UEP), pp. 46-58.
6. Majchrzak, A. (2013). Diversity of Agrarian Structures in the EU Member States – Dynamic Approach [in] *Rural Development and Entrepreneurship Marketing and Sustainable Consumption;* No 32 - Jelgava: Rural Development and Food, pp. 19-25.
7. Matuszczak, A. (2012). Podobienstwa i roznice w rozwoju regionow rolnych UE-25 – probaokresleniaczynnikowprowzrostowych (Similarities and Differences in the Development of the Agricultural Regions of the EU -25 - an Attempt to Identify the Pro-growth Factors, K. Pajak, T. Rozanski (red.), *Determinanty rozwoju regionow w Europie; Spoleczenstwo, gospodarka, turystyka,* Wyd. Poli Druk Poznan, Pila, p. 156.
8. Sass, R. (2007). Wielkosc stada a dochod z zarzadzania w gospodarstwach wyspecjalizowanych w chowie bydla mlecznego (Stock Size and Income from the Management in Farms Specialised in Dairy Cattle), *Roczniki nauk rolniczych*, Seria G, T. 93, z.2, Warszawa.
9. Poczta, W., Sadowski, A., Sredzinska J. (2008). Rola gospodarstw wielkotowarowych w rolnictwie Unii Europejskiej (The Role of Big Freight Households in Agriculture of the European Union), *Roczniki Nauk Rolniczych.* Seria G, t. 95, z. 1, p. 42.
10. Smedzik, K. (2013). Impact of Direct Payments on Sustainability of Farms in Poland - Simulation Based on the Example of FADN Farms from Wielkopolska and Slask Region,[in] *Production and Cooperation in Agriculture Finance and Taxes*; No 30 - Jelgava: Rural Development and Food, pp. 81-86.

INVESTIGATIONS ON APPLE POMACE USED IN RED DEER NUTRITION

Liga Proskina[1], Dr.oec.; **Sallija Cerina**[2], Dr.oec.
[1]Faculty of Economics and Social Development, Latvia University of Agriculture
[2]State Priekuli Plant Breeding Institute

Abstract. Animal nutrition is directly related with the need to maintain the animal's physiological functions and health, thereby, ensuring a certain level of productivity. However, the quality of food of animal origin is closely related with proper animal nutrition and the choice of feed. It is known that feeding apple pomace to food-producing animals contributes to the functions of their digestive system and increases the level of their productivity. Currently in Latvia, there are only a few studies on the efficiency of use of apple pomace as a feed rich in fibres and natural bioactive substances in livestock farming. Accordingly, the research aim is to determine the efficiency of use of apple pomace in the red deer feed ration in a winter period. The research found that it was efficient to use apple pomace as a valuable source of natural vitamins and minerals available in Latvia in the nutrition of red deer, thus, turning apple pomace into a valuable raw material for the production of high-quality and healthy meat. The daily consumption of feed per red deer in the experimental group amounted to 8.5 kg, i.e. 0.5 kg or 6.25% less than that of feed per red deer in the control group, while the cost of feed for the experimental group decreased by 1.5%. The carcass weight (by 2.49 kg or 4.07% on average) and the amount of muscle tissue (by 8.06%; $p<0.05$) in the experimental group were greater than in the control group. Feeding apple pomace resulted in higher quality meat − the contents of omega-3 and omega-6 fatty acids increased by 5.20% and 10.62% respectively compared with the control group.

Key words: deer farming.

JEL code: O13

Introduction

Deer farming is a new and non-traditional industry in Latvia, thus, one can assume that economically efficient feed of domestic origin for deer farming has not been sufficiently researched. Animal nutrition is actually directly related with the need to maintain the animal's physiological functions and health, thereby, ensuring a certain level of productivity. However, the quality of food of animal origin is closely related with proper animal nutrition and the choice of feed. It has to be emphasised that quite a few research on the possibilities to raise the quality of meat by using various feeds is available.

Foreign authors (Abdollahzadeh et al., 2010; Alibes et al., 1984; Rust, Buskirk, 2008) point that feeding apple pomace to ruminant animals contributes to the functions of their digestive system and increases the level of their productivity. In Latvia, 20 000-30 000 t of apples on average, depending on apple varieties and yields, are annually produced, of which a great deal is processed into juice. In total, up to 5 000 t of apple pomace or by-products of apple juice production are produced after processing 18 000-20 000 t of apples. Presently no research on the efficiency of use of apple pomace as a feed rich

[1] Corresponding author. Tel.:+371 28206624
E-mail address: liigaproskina@inbox.lv

in fibres and natural bioactive substances for livestock farming has been conducted in Latvia. It indicates that it is necessary to examine the possibility to feed apple pomace to agricultural animals in Latvia for the purpose of raising the quality of products and the efficiency of production.

The research aim is to determine the efficiency of use of apple pomace in the red deer feed ration in a winter period. To achieve the aim, the following research tasks were set:

1) to determine the changes in the cost of feed and in the productivity of animals due to feeding apple pomace;
2) to examine the effect of feeding apple pomace to red deer on the quality of products.

Research results and discussion

Research materials and methods

A feeding experiment on red deer (*Cervus elaphus*) raised in a fenced territory was conducted on a deer farm "Saulstari" Ltd in the winter period from January to April 2012 to determine the efficiency of use of apple pomace in the feed ration for red deer. The experiment involved two red deer groups of analogous age and physiological condition: the control group (*n=11)* and the experimental group (*n=11*). The red deer of both groups were fed with the same feed in terms of dry matter, crude protein, and energy value; in the feed ration for the experimental group, the daily haylage portion was replaced with a portion of apple pomace. In the control group, each animal was daily fed with 7.0 kg of haylage and 1.0 kg of rolled grain (oats) and barley grains. In the experimental group, each animal received 6.5 kg of haylage, 1.0 kg of rolled grain (oats), and 1.0 kg of apple pomace.

Table 1

Feed value of apple pomace (as a percentage of dry matter)

Indicators	Apple pomace	Haylage	± compared with haylage
Dry matter, %	14.80	30.08	-15.28
Crude protein	3.86	8.00	-4.41
Crude nitrogen	0.62	2.77	-2.15
Crude fibre	16.14	39.87	-23.73
Crude fats	0.28	3.42	-3.14
Crude ash	2.76	7.31	-4.55
Non-nitrogen extracts	77.02	22.06	+54.96
Calcium	0.34	0.78	-0.44
Phosphorous	3.74	2.10	+1.64
Carotenoids, mg kg^{-1}	72.84	54.98	+17.86
ADF, %	26.84	45.07	-18.23
NEL MJ kg^{-1}	6.56	5.07	+1.49
NDF, %	36.97	69.89	-32.92

Source: authors' calculations based on the feeding experiment

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The feed value of apple pomace and that of haylage was compared before starting the experiment to determine the necessary amount of apple pomace in the deer feed ration (Table 1).

Since red deer are ruminants, the feed value of apple pomace was evaluated according to feed quality criteria for ruminants, and the data obtained were compared with haylage characteristics. Apple pomace contains less dry matter, crude protein, crude fibre, crude fats, crude ash, and calcium compared with haylage. Yet, a positive fact is that apple pomace contains higher levels of carotenoids (by 17.86 mg kg^{-1}) and phosphorous (by 1.64%) compared with haylage (Table 1). In the winter feed ration for red deer, the contents of carotenoids and phosphorus are not sufficient; thus, their deficit might be offset by apple pomace. In the winter period, especially carotenoids (to stabilise the antioxidative system) and phosphorus (for the formation of antlers) have to be taken in with feed by the organism of red deer.

The quality of feed for ruminants, including red deer, is characterised by the contents of NDF and ADF in the feed. The size of NDF fraction determines the fibrosity of a feed and, indirectly, the animal's ability to consume this feed; thus, directly affecting the animal's productivity (Ositis, 2004). According to the test data, apple pomace is not as fibrous as haylage. The content of NDF in apple pomace was 36.97, i.e. 32.92% lower than in haylage (69.89%) (Table 1). The ADF fraction relates with the digestibility of a feed's organic component as well as the feed value of the feed. The smaller is the ADF fraction, the higher is the digestibility of a feed. The ADF fraction in apple pomace was 26.84% which was 18.23% smaller than in haylage. Adding apple pomace to the feed ration of red deer supplies 1.49% more energy (NEL MJ kg^{-1}) to the organism of red deer.

The proportions of muscle tissue in the carcases of red deer from the control and experimental groups were ascertained and compared at the end of the experimental period to determine the effect of feeding apple pomace to red deer on their productivity.

Changes in the cost of feed and in the productivity of animals

The feed chosen for feeding animals is a significant production factor which, to a great extent, affects the economic performance of a farm as well as the quality of products (meat) produced.

Table 2

Daily consumption and cost of feed and crude protein per red deer

Indicator	Group 1 – control *(n=10)*	Group 2 – experimental *(n=10)*	Changes compared with the control group	
			absolute value	%
Feed:				
haylage, kg	7.00	6.50	-0.5	-7.14
rolled grain, kg	1.00	1.00	0	0
apple pomace, kg	-	1.00	1	100.00
Feed in total, kg	8.00	8.50	0.5	6.25
Feed costs*:				
haylage, LVL	0.133	0.124	-0.009	-6.77
rolled grain, LVL	0.134	0.134	0.000	0
apple pomace, LVL	-	0.005	0.005	100.00
Feed in total, LVL	0.267	0.263	-0.004	-1.50
Cost of 1 kg of crude protein of feed, LVL	0.81	0.82	-0.012	-1.50

Source: authors' calculations based on the feeding experiment

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The basic feed for deer raised in captivity, just like for all ruminants, is coarse and juicy feeds: hay, haylage, and silage in the winter period; whereas, it is pasture grass in the summer period. These feeds contain crude fibre which serves as the main sources of energy and protein after being processed in the animal's rumen. Apple pomace can replace only a certain amount of haylage in the diet of deer. For the experimental group, 1.0 kg of apple pomace, in terms of feed value, replaced 0.5 kg of haylage.

Adding apple pomace to the feed ration of red deer increased the real consumption of feed by 0.5 kg, while the costs of this feed for the experimental group decreased by 1.5% (Table 2). Since crude protein comprises an insignificant share of apple pomace, the costs of 1 kg of crude protein do not considerably differ in the feed ration between the control and experimental groups. In total, the daily consumption of feed per red deer in the experimental group was equal to 8.5 kg, i.e. 0.5 kg or 6.25% less than that in the control group.

The proportions of muscle tissue in the carcases of red deer from the control and experimental groups were ascertained and compared at the end of the experimental period to determine the effect of feeding apple pomace to red deer on their productivity (Table 3).

Table 3

Red deer carcass weight (kg), the proportion (%) and ratio of carcass components

Group	Carcass weight, kg ±SD	Muscle tissue		Bone tissue		Ratio of muscle to bone tissue
		%	kg ±SD	%	kg ±SD	
Group 1, control *(n=11)*	61.16 ±4.92	58.20	35.60 ±3.55	32.05	19.60 ±1.74	1.81
Group 2, experimental *(n=11)*	63.65 ±5.37	60.43	38.46 ±3.89	29.60	18.84 ±1.56	2.04
Changes compared with the control group, absolute value	2.49	2.23	2.86	-2.45	-0.76	+0.23
Changes compared with the control group, %	4.07	-	8.06	-	-3.88	-

Source: authors' calculations based on the feeding experiment

The research findings show that adding apple pomace to the feed ration of red deer in the winter period led to an increase in the proportion of muscle tissue in the carcass. It has to be emphasised that the amount of muscle tissue in the carcases of red deer from the experimental group was considerably greater (by 8.06%) ($p=0.007<\alpha=0.05$) than in those from the control group and, accordingly, the proportion of bone tissue was lower. Therefore, the ratio of muscle tissue to bone tissue was higher in the carcases of red deer from the experimental group (2.04), i.e. 0.23 greater than in those from the control group. On the whole, the average weight of carcass from the experimental group was 2.49 kg or 4.07% greater than that from the control group. At the end of the feeding experiment, after comparing the indicators for the experimental and control groups, one can conclude that the economic efficiency is confirmed not only by a lower cost of feed but also an increase in the productivity of animals, as the carcass weight and the proportion of muscle tissue increased.

Changes in the quality of products

One of the key tasks set in the performance improvement programme of the meat production and processing industries of Latvia is "to provide the country's population with quality products from raw

materials produced by domestic producers". In food production, the term quality is defined as a set of product characteristics that is based on the ability of these characteristics to satisfy the needs of consumers (Karklina et al., 1998) and that is a mandatory requirement for every type of products (Jemeljanovs, 2002). The quality of products is equally viewed as one of the basic elements of economic development for producing competitive products (Mihejeva, 1999), as the technological processes of production, processing, and sales form the market demand and supply conditions for final products.

The development of the food industry in Latvia, just like that of the food industry in the world, is affected by changes in the consumer demand for food products. The increasing concerns of consumers about their health contribute to an increase in the demand for healthy food (Vaarst, Hovi, 2004). For this reason, the key goal of food industry is not only to achieve self-sufficiency in food production but also to raise the quality of products. Metabolism processes in the human organism are closely related with the everyday consumption of food products and their quality. It has to be stressed that feeding apple pomace to red deer improved the functional characteristics of this meat compared with the control group, i.e. improving the qualitative indicators of meat.

Feeding apple pomace to red deer led to an increase in the amounts of human health friendly omega-3 fatty acids by 11.28% and omega-6 fatty acids by 15.13% in the total amount of lipids compared with the control group. These fatty acids are not synthesised in the human organism and have to be taken in with food. The research conducted in Latvia concludes that the everyday food products consumed by Latvia's population contain insufficient amounts of unsaturated fatty acids, vitamins, and micro and macro elements (National Food Consumption…, 2009). On the climatic conditions of Latvia, meat is a source of nutrients which provides the human organism with necessary microelements, fatty acids, amino acids, and energy. The contents and amount ratios of saturated, monounsaturated, and polyunsaturated fatty acids in meat significantly determine the nutritional value of meat and the consumption of it in the diet of humans as well as considerably affect human health (Antipova et al., 2001; Ramins et al., 2002; Zarins, Neimane, 2009).

Quality and human health friendly meat is characterised by a low content of saturated fatty acids; whereas, the contents of monounsaturated and polyunsaturated fatty acids as well as the ratio of omega-6 and omega-3 fatty acids are higher (Zarins, Neimane, 2009). From the producer perspective, the interest in enhancing the composition of taffy acids in meat is mainly based on the need to find a way how to produce healthier or higher quality meat, i.e. meat with a higher ratio of polyunsaturated fatty acids, and to supply to the market products with greater contents of human health friendly fatty acids, minerals etc.

The muscle tissue of red deer from the experimental group had a 17.31% lower content of saturated fatty acids and a 15.82% higher content of polyunsaturated fatty acids compared with the control group (Table 4).

After examining the profile of polyunsaturated fatty acids in the muscle tissue, one has to note that feeding apple pomace to red deer increased the contents of omega-3 (by 5.20%) and omega-6 (by 10.62%) fatty acids in their muscle tissue compared with the control group. Such increases in the contents of omega-3 and omega-6 fatty acids are very positive for the health of consumers. Compared with other food products, the muscle tissue of red deer had an optimal amount ratio of omega-6 to omega-3 fatty acids which was 3.31:1 for the control group and 2.64:1 for the experimental group.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 4

Effect of apple pomace on the content of fatty acids in red deer muscle tissue, %

Indicator	Group 1 – control	Group 2 – experimental	Changes compared with the control group
Saturated fatty acids	50.02	32.71	-17.31
Unsaturated fatty acids: monounsaturated fatty acids	26.45	16.16	-10.29
polyunsaturated fatty acids	20.11	35.93	+15.82
Omega–3 fatty acids, in total	4.66	9.86	+5.20
Omega–6 fatty acids, in total	15.45	26.07	+10.62
Σ omega–6 : Σ omega–3	3.31:1	2.64:1	-0.67

Source: authors' calculations based on the feeding experiment

The World Health Organisation (WHO) considers that in ideal food, the ratio of omega-6 to omega-3 fatty acids is within a range from 1:1 to 4:1 (WHO, 2003). The lower is the ratio of fatty acids, the greater is physiological utility and functional activity of fatty acids in the human organism; thereby, feeding apple pomace to red deer leads to producing higher quality meat.

Conclusions

1. It is efficient to use apple pomace as a valuable source of natural vitamins and minerals available in Latvia in the nutrition of red deer, thus, turning apple pomace into a valuable raw material for the production of high-quality and healthy meat.
2. The daily consumption of feed per red deer in the experimental group amounted to 8.5 kg, i.e. 0.5 kg or 6.25% less than that of feed per red deer in the control group, while the cost of feed for the experimental group decreased by 1.5%.
3. The carcass weight (by 2.49 kg or 4.07% on average) and the amount of muscle tissue (by 8.06%; $p<0.05$) in the experimental group were greater than in the control group.
4. Feeding apple pomace resulted in higher quality meat – the contents of fatty acids omega-3 and omega-6 increased by 5.20% and 10.62% respectively compared with the control group.

Bibliography

1. Abdollahzadeh, F., Pirmohammadi, R., Fatehi F., Bernousi, I. (2010). Effect of Feeding Ensiled Mixed Tomato and Apple Pomace on Performance of Holstein Dairy Cows. *Slovak Journal of Animal Science*, Vol. 43, pp.31-35.
2. Alibes, X., Munoz, F., Rodriguez, J. (1984). Feeding Value of Apple Pomace Silage for Sheep. *Animal Feed Science and Technology*, Vol. 11, Iss. 3, pp.189-197.
3. Jemeljanovs, A. (2002). Interrelations among Agroecological, Biological, and Chemical risk Factors and their Effects on the Quality and Market Value of Animal Products (in Latvian). *LLU Proceedings*: Jelgava. No 6 (301), pp 1-14.
4. Karklina, D., Duma, M., Kaulins, U. (1998). The Consumer and the Quality of Food Products (in Latvian). *LLU Proceedings*, No 17 (294), Jelgava, pp. 42-47.
5. *National Food Consumption Pattern in Latvia and the Balance of Agricultural Products* (in Latvian). (2009). FVS National Diagnostic Centre and the FVS Food Centre. Retrieved: http://www.pvd.gov.lv/lat/augj_izvlne/iedzvotjiem_un_uzmjiem/ptjumi_un_apskati/ptjums_quotlatvijas_nacionlais. Access: 28 July 2010.
6. Mihejeva, L. (1999). Technological and Organisational Quality Management as the First Basic Prerequisite for Competitiveness (in Latvian). *Scientific Fundamentals of the Agriculture of Latvia. Monograph*. Riga, pp. 11,5.

7. Ositis, U. (2004). Animal Nutrition from a Complex Perspective (in Latvian). Ozolnieki: Latvian Agricultural Advisory and Training Centre, p. 363.

8. Ramins, E., Kaugers, R., Stira, A. (2002). Quality Criteria for the Long Muscle of the Back (M Longissimus Dorsi) for Pork Used as Food in Latvia (in Latvian). *Veterinary Medicine Proceedings*. Jelgava: LLU, VMF, p. 320.

9. Rust, S., Buskirk, D. (2008). Feeding Apples or Apple Pomace in Cattle Diets. *Cattle Call*, Vol. 13, Iss. 4, pp. 2-3.

10. Vaarst, M., Hovi, M. (2004). Organic Livestock Production and Food Quality: a Review of Current Status and Future Challenges. *Proceedings of the 2nd SAFO Workshop*. Witzenhausen, Germany, 25-27 March 2004, pp. 7−15.

11. WHO (2003). Population Nutrient Intake Goals for Preventing Diet − Related Chronic Diseases. *Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation.* World Health Organization Technical report series, 916. Genova, pp. 54−60.

12. Zarins, Z., Neimane, L. (2009). *Nutrition*. Riga, LU Publishing House, p. 100, pp. 237-238.

13. Antipova, L.V., Glomorovfa, I.A., Rogov, A.I. (2001). *Research Methods for Meat and Meat Products*. Moscow: Kolos, p. 570.

ANALYSING THE DETERMINANTS OF LITHUANIAN FAMILY FARM PERFORMANCE: A DOUBLE BOOTSTRAP INFERENCE

Tomas Balezentis[+]
Lithuanian Institute of Agrarian Economics
Vilnius University

Abstract. The efficiency analysis often involves the second stage analysis which enables to identify certain drivers of efficiency. However, suchlike inference is problematic due to the nature of the frontier measures. This paper employed the double bootstrap procedure (Simar, Wilson, 2007) to analyse the determinants of the efficiency on Lithuanian family farms. The double bootstrap method was employed to estimate the efficiency scores by the means of the data envelopment analysis and to regress them on the explanatory variables. The analysis was based on the farm-level data from the Farm Accountancy Data Network. Specifically, the second stage analysis included the variables of time, farm size, asset input, specialisation, and subsidy rate. The results did indicate that the period of 2004−2009 was generally associated with an increase in efficiency. Furthermore, larger farms appeared to be more efficient. Even though, livestock farming has been declining in Lithuania, the findings of the paper implied that the latter type of farming exhibited higher efficiency in general.

Key words: family farms, efficiency, Lithuania, frontier, double bootstrap.

JEL code: C24, C44, C61, Q12.

Introduction

Efficiency analysis is often followed by the second-stage analysis to estimate the impact of certain efficiency determinants. Suchlike inference might be useful for understanding the underlying trends of efficiency and, thus, reasonable policy making. The second-stage analysis can be based on various techniques (Hoff, 2007; Bogetoft, Otto, 2011).

Initially, the ordinary least squares (OLS) regression was considered as a primal tool for post-efficiency analysis. The latter method is attractive in that its coefficients are easy to interpret. However, it is obvious that efficiency scores are bounded to certain intervals which depend on both the type and the orientation of the distance functions. Consequently, the censored regression (tobit model) emerged as a remedy. Later on, however, Simar and Wilson (2007) argued that the censored regression models suffered from certain drawbacks. First, the underlying data generating process does not generate censored variables. Indeed, it is the finite sampling that causes efficiency estimates concentrated around unity. Second, censored model's errors are serially correlated. Therefore, they suggested using truncated regression alongside bootstrapping (Efron, Tibshirani, 1993) in order to avoid the serial correlation. The proposed methodology is, thus, referred to as the double bootstrapping.

[+] Corresponding author. Tel.: + 370 5 262 10 78; fax: +370 5 261 45 24
E-mail address: tomas@laei.lt

The double bootstrap procedure was implemented in analyses dedicated for various economic sectors (Assaf, Agbola, 2011; Alexander et al., 2010; Afonso, Aubyn, 2006). Though, there are few examples of application of the double bootstrap methodology for the studies of agricultural efficiency. Latruffe et al. (2008) analysed the performance of the Czech farms, both private and corporate ones. Balcombe et al. (2008) employed the double bootstrap methodology to identify the determinants of efficiency in Bangladesh rice farming. Olson and Vu (2009) utilised single and double bootstrap procedures to analyse farm household efficiency.

The Lithuanian agricultural sector was analysed by the means of the bootstrapped Data Envelopment Analysis (DEA) by Balezentis and Krisciukaitiene (2012); however, no second stage analysis was implemented. Therefore, there is a need for further analysis of the drivers of efficiency on the Lithuanian family farms. Indeed, suchlike analyses might help improve the agricultural policy. This paper, thus, aims at identifying the factors of (in)efficiency amongst the Lithuanian family farms. The research object is Lithuanian family farms reporting to the Farm Accountancy Data Network.

This paper employed the double bootstrap methodology (Simar, Wilson, 2007) to examine the factors of efficiency on Lithuanian family farms. The sample of 200 family farms over 6 years (1200 observation in total) was used to establish a production frontier and conduct the second stage regression. The FEAR package was applied for the analysis (Wilson, 2008).

Preliminaries for the double bootstrap

This section presents the methodology of the double bootstrap (Simar, Wilson, 2007). First, the technology set and the DEA estimator are discussed. Second, the truncated regression is presented. Third, the unifying algorithm of the double bootstrap is presented.

Productive technology and efficiency measures. The activity analysis defines the production technology with respect to inputs represented by a $(1\times p)$ vector $x\in\Re_+^p$, and outputs represented by a $(1\times q)$ vector $y\in\Re_+^q$. Furthermore, a $(1\times r)$ vector $z\in\Re_+^r$ comprises the environmental variables. The technology set, *T*, consists of all feasible production plans:

$$T=\left\{(x,y)\in\Re_+^{p+q}\mid x \text{ can produce } y\right\}. \tag{1}$$

Then, the output-oriented Farrell (1957) measure of efficiency for an arbitrary point, (x_0,y_0), is defined as:

$$\delta_0=\delta(x_0,y_0\mid T)\equiv\sup\left\{\delta\mid(x_0,\delta_0 y_0)\in T,\delta>0\right\}. \tag{2}$$

Indeed, the underlying technology set usually remains unknown and the analysis is based on its approximation determined by a set of observations, $S_K=\left\{(x_k,y_k,z_k)\right\}_{k=1}^K$, where k is the index of the decision making units (DMUs). Under assumptions of free disposability and convexity, T is given by

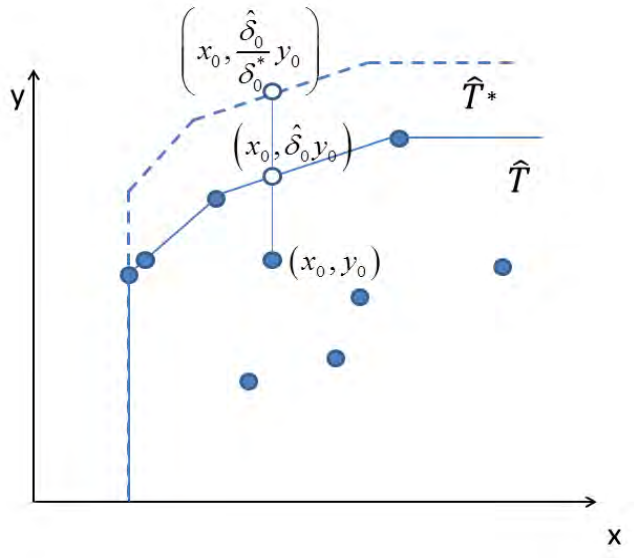
$$\hat{T}=\left\{(x,y)\in\Re_+^{p+q}\;\middle|\;\begin{array}{l}\sum_{k=1}^K\lambda_k x_{i,k}\le x_i,\sum_{k=1}^K\lambda_k y_{j,k}\ge y,\sum_{k=1}^K\lambda_k=1,\\ i=1,2,...,p,\ j=1,2,...,q,k=1,2,...,K\end{array}\right\}. \tag{3}$$

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Therefore, the Farrell's output-oriented measure of efficiency can be estimated by employing the following linear program:

$$\hat{\delta}_0 = \max\left\{\delta > 0 \middle| \sum_{k=1}^{K}\lambda_k x_{i,k} \le x_{i,0}, \sum_{k=1}^{K}\lambda_k y_{j,k} \ge \delta y_{i,0}, \sum_{k=1}^{K}\lambda_k = 1, \; i=1,2,...,p,\; j=1,2,...,q, k=1,2,...,K\right\}, \quad (4)$$

where δ_0 becomes greater than unity as an arbitrary observation, (x_0, y_0), is located further from the efficiency frontier. Fig. 1 presents a graphical interpretation of the model given by Eq. 4. The solid line there denotes an approximation, $\hat{T}$, of the true production possibility set, *T*. Note that the true production possibility set remains unknown and, thus, is approximated by the bootstrap frontiers denoted by the dashed line in Figure 1. An arbitrary observation, (x_0, y_0), is projected onto the efficiency frontier by keeping the output-mix fixed at the point $(x_0, \delta_0 y_0)$. This is a radial movement in an output space from the point of origin through an observation towards the frontier.



Source: author' s construction

Fig. 1. An output-oriented DEA model

The obtained efficiency measures can be further analysed in the second stage analysis. Obviously, the two directions emerge: (i) the true production frontier needs to be estimated; and (ii) the efficiency scores need to be related with the environmental variables. The bootstrap procedure tackles the former issue; whereas, the truncated regression is employed for the latter one.

Truncated regression. The regression model can be given as

$$\vartheta_k = z_k\beta + \varepsilon_k, \quad (5)$$

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

where β is a $(r \times 1)$ vector of parameters associated with respective environmental variables, $\varepsilon_k \sim N\left(0, \sigma_\varepsilon^2\right)$ is independently distributed for all $k = 1, 2, \ldots, K$. The variable ϑ_k is said to be truncated at c_k in case one can observe $\theta_k = \vartheta_k$ for all $\vartheta_k \geq c_k$, albeit observe nothing otherwise (Simar, Wilson, 2007).

The truncated regression can be estimated via the maximal likelihood method. Specifically, if ϑ_k are assumed to be distributed under the normal distribution with left-truncation at c_k, the vector of parameters, β, for Eq. 5 can be estimated by maximising the following likelihood function:

$$L = \prod_{k=1}^{K} \frac{1}{\sigma_\varepsilon} \phi\left(\frac{\theta_k - z_k\beta}{\sigma_\varepsilon}\right)\left[1 - \Phi\left(\frac{c_k - z_k\beta}{\sigma_\varepsilon}\right)\right]^{-1}, \quad (6)$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the standard normal density and distribution functions, respectively.

In the framework of the output-oriented efficiency analysis, one has a left-truncation at unity. Therefore, the determinants of efficiency are analysed by employing the following model:

$$\hat{\delta}_k = z_k\beta + \varepsilon_k \geq 1, \quad (7)$$

where $\hat{\delta}_k$ is an estimate of δ_k (cf. Eq. 4).

An algorithm for the double bootstrap. Simar and Wilson (2007) proposed the two methods for double bootstrapping. In this paper, the author will present and employ Algorithm No 2. The algorithm involves the two main stages: 1) the true production frontier is estimated by the means of output correction; and 2) the truncated regression is estimated to relate the efficiency measures with the explanatory variables, z_k. Indeed, the point $\left(x_0, \hat{\delta}_0 y_0 / \delta_0^*\right)$ in Figure 1 depicts the bootstrap bundle of inputs and the corrected (stimulated) outputs. Note that thanks to the nature of the DEA, the underlying frontier can be shifted upwards with respect to the originally observed one but never inwards.

Algorithm #2 in Simar and Wilson (2007) proceeds as follows:

1. Estimate the Farrell efficiency scores, $\hat{\delta}_k = \delta\left(x_k, y_k \mid \hat{T}\right), \forall k = 1, 2, \ldots, K$, with respect to the observed data set, S_K, by employing Eq. 4.
2. Use the truncated regression of $\hat{\delta}_k > 1$ on z_k (Eq. 7) to obtain the estimates $\hat{\beta}$ and $\hat{\sigma}_\varepsilon$ of β and σ_ε, respectively.
3. Loop over steps 3.1–3.4 L_1 times to obtain K sets of bootstrap estimates, $B_k = \left\{\hat{\delta}_{kb}^*\right\}_{b=1}^{L_1}$:

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

3.1. For each $k=1,2,\ldots,K$, draw ε_k from the distribution $N\left(0,\hat{\sigma}_\varepsilon^2\right)$ with left-truncation[1] at $\left(1-z_k\hat{\beta}\right)$.

3.2. For each $k=1,2,\ldots,K$, compute $\delta_k^*=z_k\hat{\beta}+\varepsilon_k$, where ε_k has been drawn in Step 3.1.

3.3. Set $x_k^*=x_k$ and $y_k^*=\hat{\delta}_k y_k/\delta_k^*$ for all $k=1,2,\ldots,K$.

3.4. Estimate the bootstrap efficiency scores, $\hat{\delta}_k^*=\delta\left(x_k,y_k\,|\,\hat{T}^*\right),\forall k=1,2,...,K$, with $\hat{T}^*$ being defined by replacing the original input-output vectors in Eq. 3 with the corrected ones obtained in Step 3.3, i.e. Eq. 4 is modified by changing the left hand sides of inequalities in restrictions[2].

4. For each $k=1,2,\ldots,K$, compute the bias-corrected estimates of the efficiency scores, $\hat{\hat{\delta}}_k$, by employing the bootstrap replications, B_k, along with the original estimates, $\hat{\delta}_k$: $\hat{\hat{\delta}}_k=\hat{\delta}_k-bias\left(\hat{\delta}_k\right)=\hat{\delta}_k-\left(\frac{1}{L_1}\sum_{b=1}^{L_1}\hat{\delta}_{kb}^*-\hat{\delta}_k\right)$.

5. The bias-corrected efficiency scores, $\hat{\hat{\delta}}_k$, are regressed on z_k (cf. Eq. 7) to obtain the estimates of parameters $\left(\hat{\hat{\beta}},\hat{\hat{\sigma}}_\varepsilon\right)$.

6. Loop over Steps 6.1–6.3 L_2 times to obtain a set of bootstrap estimates $C=\left\{\left(\hat{\hat{\beta}}^*,\hat{\hat{\sigma}}_\varepsilon^*\right)_b\right\}_{b=1}^{L_2}$:

6.1. For each $k=1,2,\ldots,K$, draw ε_k from the distribution $N\left(0,\hat{\hat{\sigma}}_\varepsilon^2\right)$ with left-truncation at $\left(1-z_k\hat{\hat{\beta}}\right)$.

6.2. For each $k=1,2,\ldots,K$, compute $\delta_k^{**}=z_k\hat{\hat{\beta}}+\varepsilon_k$, where ε_k has been drawn in Step 6.1.

6.3. Regress δ_k^{**} on z_k (cf. Eq. 7) to obtain the maximum likelihood estimates $\left(\hat{\hat{\beta}}^*,\hat{\hat{\sigma}}_\varepsilon^*\right)$.

---

[1] The i.i.d. draws from $N\left(0,\sigma^2\right)$ with left-truncation at c can be facilitated by considering the standard normal distribution function, $\Phi\left(\cdot\right)$, and its inverse, $\Phi^{-1}\left(\cdot\right)$ as well as the randomly drawn variable, v, where $v\sim Uniform\left(0,1\right)$. After drawing v and setting $v'=\Phi\left(c'\right)+\left(1-\Phi\left(c'\right)\right)v$ with $c'=c/\sigma$, the desired left-truncated normal deviate can be given as $u=\sigma\Phi^{-1}\left(v'\right)$.

[2] The DEA estimator then becomes $\hat{\delta}_0=\max\left\{\delta>0\left|\begin{array}{l}\sum_{k=1}^{K}\lambda_k x_{i,k}^*\le x_{i,0},\sum_{k=1}^{K}\lambda_k y_{j,k}^*\ge\delta y_{i,0},\sum_{k=1}^{K}\lambda_k=1,\\ i=1,2,...,p,\ j=1,2,...,q,k=1,2,...,K\end{array}\right.\right\}$.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

7. Use the bootstrap values, C, and the original estimates, $\left(\hat{\hat{\beta}}, \hat{\hat{\sigma}}_{\varepsilon}\right)$, to construct the confidence intervals for each element of β and σ_{ε}.

The confidence intervals for β_l, the l-th element of β, could be established if the distribution of $\left(\hat{\hat{\beta}}_l - \beta\right)$ were known. Indeed, it would be enough to find the values a_{α} and b_{α} such that $\Pr\left(-b_{\alpha} \le \left(\hat{\hat{\beta}}_l - \beta_l\right) \le -a_{\alpha}\right) = 1-\alpha$. Given the distribution $\left(\hat{\hat{\beta}}_l - \beta\right)$ is unknown, the confidence intervals are constructed on a basis of the bootstrap values $\hat{\hat{\beta}}^*$: $\Pr\left(-b_{\alpha}^* \le \left(\hat{\hat{\beta}}_l^* - \hat{\hat{\beta}}_l\right) \le -a_{\alpha}^*\right) \approx 1-\alpha$, where $0 \le \alpha \le 1$ is a confidence level. The latter method is referred to as the percentile method. Furthermore, Efron and Tibshirani (1993, p. 184f) presented the bias-corrected accelerated (BC_a) method for estimation of confidence intervals.

Research results

The technical efficiency (TE) was assessed in terms of the input and output indicators commonly employed for agricultural efficiency and productivity analyses. More specifically, the utiliSed agricultural area (UAA) in hectares was chosen as land input variable, annual work units (AWU) − as labour input variable, intermediate consumption in Litas, and total assets in Litas as a capital factor. The monetary variables were deflated by respective real price indices. On the contrary, the three output indicators representing crop, livestock, and other outputs in Litas were deflated by respective real indices and aggregated into a single output indicator.

The data for 200 farms selected from the FADN sample cover the period of 2004−2009. Therefore, a balanced panel of 1200 observations is employed for the analysis. The analysed sample covers relatively large farms (mean UAA − 244 ha). As for labour force, the average was 3.6 AWU. The data were analysed in a cross−section way.

The following variables were chosen for the second stage analysis: the time trend (*Time*) was used to assess whether a general increase in efficiency scores was observed throughout the research period. The UAA in hectares (*UAA*) was used as a proxy for farm size. A ratio of assets to labour force in AWU (*Assets/AWU*) was used to capture the degree of sufficiency of the capital. The share of the crop output in the total output (*Crop*) was employed as a measure of farm specialisation. Finally, the ratio of production subsidies to the total output (*Subsidies*) was included into the model to account for the accumulated public support. Note that the first three variables were mean-scaled in order to ensure a faster convergence of the maximum likelihood model.

The double bootstrap algorithm described in the preceding section was then employed for the analysis. The distribution of the efficiency scores is not discussed in this paper for sake of brevity. The numbers of the bootstrap replications were set as $L_1 = 100$ and $L_2 = 2000$.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The first bootstrap loop aimed at estimating the bias-corrected output efficiency scores. For that purpose, each bootstrap replication aimed at obtaining the corrected output quantities (Step 3.3) and, subsequently, the bootstrap efficiency scores (Step 3.4). The plots of the bootstrap output quantities, y_k^*, against the original observations, y_k, for the first bootstrap replications indicate that a number of farms were attributed with augmented output quantities. Therefore, the reference technology set, $\hat{T}^*$, moved outwards.

The second bootstrap loop was used to estimate the confidence intervals for the parameters of the truncated regression. Analysis of the kernel distributions of the bootstrap estimates, $\hat{\hat{\beta}}^*$, obtained in Step 6 enabled to make a certain inference. Noteworthy, the densities for *Time* and *UAA* covered the value of zero, which, in turn, is associated with insignificance of a coefficient. The remaining densities lie in either side of the coordinate axis.

The regression was estimated without an intercept. The confidence intervals for the parameters of the truncated regression (Step 7) were estimated by both the percentile method and BC_a method. The resulting intervals are given in Table 1. Note that the dependent variable was the output-oriented Farrell efficiency score which gets higher values as farm becomes more inefficient. Therefore, the negative coefficients in Table 1 indicate sources of efficiency; whereas, the positive ones indicate factors negatively related with efficiency.

Table 1

Double bootstrap estimates for determinants of the farming inefficiency

Variables	$\hat{\hat{\beta}}$	Sig.	Confidence intervals					
			$\alpha = .1$		$\alpha = .05$		$\alpha = .01$	
BC_a method								
Time	-0.061	*	-0.113	-0.010	-0.122	0.002	-0.144	0.016
UAA	-0.154	***	-0.270	-0.051	-0.292	-0.033	-0.335	-0.002
Assets/AWU	-0.484	***	-0.634	-0.355	-0.666	-0.327	-0.722	-0.288
Crop	1.947	***	1.747	2.145	1.711	2.181	1.625	2.283
Subsidies	1.555	***	1.386	1.717	1.357	1.750	1.304	1.810
Percentiles method								
Time	-0.061	*	-0.113	-0.009	-0.121	0.002	-0.143	0.017
UAA	-0.154	*	-0.262	-0.046	-0.283	-0.029	-0.332	0.004
Assets/AWU	-0.484	***	-0.630	-0.348	-0.659	-0.323	-0.715	-0.279
Crop	1.947	***	1.752	2.149	1.713	2.187	1.631	2.288
Subsidies	1.555	***	1.387	1.721	1.359	1.753	1.306	1.816

Significance codes: '*' - 0.01, '**' - 0.05, '*' - 0.1**

Source: authors' calculations

The three variables, namely, ratio of assets to labour, crop share in the total output, and production subsidy intensity, remained significant at 1% level of significance irrespective of the method employed for estimation of the confidence intervals. Meanwhile, the farm size variable featured higher significance

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

under the BC_a method. The time variable exhibited the same significance across both the methods. Indeed, the time trend was significant at the confidence level of 10%.

The negative coefficients associated with the time trend, farm size, and ratio of assets to labour indicate that these variables contributed to the increase in efficiency. Therefore, the efficiency was likely to increase during the research period given the remaining factors remained constant. The larger farms did also feature higher levels of efficiency. The latter finding might be related with both economies of scale and higher abilities for investment. The crop farms appeared to be less efficient if compared with livestock ones (the positive coefficient was observed for the corresponding variable). The production subsidies tended to decrease farming efficiency possibly due to lower incentives for adoption of innovative practices and market-oriented production.

The ordinary least squares (OLS) model was also specified in order to check the robustness of the obtained results. The OLS estimates are presented in Table 2. As one can note, the coefficients associated with the model variables were specific with the same signs as in case of the truncated regression. The differences in absolute values of the coefficients might be explained by different magnitude of the variables (for instance, ratio of asset to labour might feature higher variance even after mean scaling). Indeed, both the significance and absolute value of the *Assets/AWU* increased significantly in the truncated regression model.

Table 2

Ordinary least squares estimates

Variables	Estimate	SE	*t* value	*p*	Sig.
Time	-0.04138	0.01531	-2.703	0.00697	***
UAA	-0.05581	0.03191	-1.749	0.08053	*
Assets/AWU	-0.01825	0.02744	-0.665	0.50602	
Crop	1.91746	0.05759	33.293	2.00E-16	***
Subsidies	1.29016	0.06536	19.741	2.00E-16	***
R^2	0.8443	Adj R^2		0.8436	
F *p*-value	2.20E-16				

Significance codes: '*' - 0.01, '**' - 0.05, '*' - 0.1**

Source: authors' calculations

Obviously, the significance of the efficiency determinants varied across the truncated regression and OLS estimations. Particularly, the ratio of assets to labour was not significant in the OLS model, albeit it featured a negative coefficient. The crop and subsidy indicators featured the same significance in both cases. The time and farm size variables were significant at different levels of confidence depending on model type and method for confidence intervals. Therefore, the results yielded by the bootstrapped truncated regression can be considered as confident ones.

Conclusions

The truncated regression coefficients associated with the time trend, farm size, and ratio of assets to labour indicate that these variables contributed to the increase in efficiency. Therefore, the efficiency was

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

likely to increase during the research period given the remaining factors remained constant. The larger farms did also feature higher levels of efficiency. The latter finding might be related with both economies of scale and higher abilities for investment. The crop farms appeared to be less efficient if compared with livestock ones (the positive coefficient was observed for the corresponding variable). The production subsidies tended to decrease farming efficiency possibly due to lower incentives for adoption of innovative practices and market-oriented production.

Even though, livestock farming is declining in Lithuania, the findings of the paper imply that the latter type of farming exhibited higher efficiency. Indeed, the measures of efficiency are not observed by the farmers and make no impact upon them in the short run. Similarly, the relative measures of efficiency might not be directly linked to the absolute measures of profit which are the main factor affecting farmer decisions. However, the future agricultural policy should pay more attention for increasing the attractiveness and viability of the livestock farming.

Acknowledgments

This research was funded by the European Social Fund under the Global Grant measure.

Bibliography

1. Afonso, A., Aubyn, M.S. (2006). Cross-Country Efficiency of Secondary Education Provision: A Semi-Parametric Analysis with Non-Discretionary Inputs. *Economic Modelling*, Volume 23, Issue 3, pp. 476–491.
2. Alexander, W.R.J., Haug, A.A., Jaforullah, M. (2010). A Two-Stage Double-Bootstrap Data Envelopment Analysis of Efficiency Differences of New Zealand Secondary Schools. *Journal of Productivity Analysis*, Volume 34, Issue 2, pp. 99–110.
3. Assaf, A.G., Agbola, F.W. (2011). Modelling the Performance of Australian Hotels: A DEA Double Bootstrap Approach. *Tourism Economics*, Volume 17, Issue 1, pp. 73–89.
4. Balcombe, K., Fraser, I., Latruffe, L., Rahman, M., Smith, L. (2008). An Application of the DEA Double Bootstrap to Examine Sources of Efficiency in Bangladesh Rice Farming. *Applied Economics*, Volume 40, Issue 15, pp. 1919-1925.
5. Balezentis, T., Krisciukaitiene, I. (2012). Application of the Bootstrapped DEA for the Analysis of Lithuanian Family Farm Efficiency. *Management Theory and Studies for Rural Business and Infrastructure Development*, Issue 34(5), pp. 35–46.
6. Bogetoft, P., Otto, L. (2011). *Benchmarking with DEA, SFA, and R*. International Series in Operations Research and Management Science, Vol. 157. Springer, p. 351.
7. Efron, B., Tibshirani, R.J. (1993). *An Introduction to the Bootstrap*. Chapman & Hall, p. 436.
8. Farrell, M.J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society. Series A (General)*, Volume 120, Issue 3, pp. 253–290.
9. Hoff, A. (2007). Second Stage DEA: Comparison of Approaches for Modelling the DEA Score. *European Journal of Operational Research*, Volume 181, pp. 425–435.
10. Latruffe, L., Davidova, S., Balcombe, K. (2008). Application of a Double Bootstrap to Investigation of Determinants of Technical Efficiency of Farms in Central Europe. *Journal of Productivity Analysis*, Volume 29, Issue 2, pp. 183–191.
11. Olson, K., Vu, L. (2009). Economic Efficiency in Farm Households: Trends, Explanatory Factors, and Estimation Methods. *Agricultural Economics*, Volume 40, Issue 5, pp. 587–599.
12. Simar, L., Wilson, P. (2007). Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes. *Journal of Econometrics*, Vol. 136, pp. 31–64.
13. Wilson, P. W. (2008). FEAR 1.0: A Software Package for Frontier Efficiency Analysis with R. *Socio-Economic Planning Sciences*, Volume 42, pp. 247–254.

AN INPUT-SPECIFIC ANALYSIS OF THE COST EFFICIENCY ON LITHUANIAN FAMILY FARMS

Irena Krisciukaitiene[1+], Dr; **Tomas Balezentis**[2]; **Alvydas Balezentis**[3], Prof. Dr

[1] Lithuanian Institute of Agrarian Economics

[2] Vilnius University

[3] Mykolas Romeris University

Abstract. The productive technology can be analysed in terms of the technical and economic (cost) efficiency. This paper analyses the performance of the Lithuanian family farms in terms of the economic (cost) efficiency. Specifically, the economic efficiency is decomposed across specific inputs in order to identify the major sources of inefficiency. The livestock farms exhibited the highest overall cost efficiency (65%) and input-specific cost efficiencies. The mixed farms were peculiar with a somehow lower level of the cost efficiency (52%). Finally, the crop farms featured the lowest cost efficiency (42%). The dynamic analysis of the input-specific cost efficiencies was presented in the paper.

Key words: family farms, allocative efficiency, cost efficiency, frontier.

JEL code: C44, C61, Q12.

Introduction

The agricultural efficiency constitutes an important research object due to certain peculiarities of the agricultural sector and the prevailing production processes. Specifically, farming is the most important economic activity in the rural areas and, thus, is supported by the means of the public support. Accordingly, the support measures should meet the dynamic patterns of efficiency in the latter sector. The profitability of farming does also depend on the economic efficiency (Henningsen, 2009). Furthermore, the agricultural sector impacts the welfare of the population through the value added chain of the food products (Samarajeewa et al., 2012).

The productive technology can be analysed in terms of the technical and economic (cost) efficiency. The former one measures farm's ability to transform the certain inputs to outputs; whereas, the latter one involves input price data and, thus, enables to measure the degree to which the observed input-mix meets the structure of the optimal input-mix. The optimal input-mix is constructed by minimising input cost associated with a certain output level (Thanassoulis et al., 2008).

The Lithuanian agricultural sector has already been analysed by the means of the non-parametric frontier methods (Balezentis et al., 2013; Balezentis, 2013; Balezentis, Balezentis, 2013). The previous studies, however, did not analyse the cost efficiency associated with specific inputs. The present study aims at revealing the main sources of the cost inefficiency. The following tasks are thereby set: 1) to discuss the preliminaries for input-specific cost efficiency measurement; and 2) to analyse the dynamics

[+] Corresponding author. Tel.: + 370 5 262 10 78; fax: +370 5 261 45 24
E-mail address: irena@laei.lt

of the cost efficiency indicators. The research relied on the micro-data for 200 farms reporting to the Farm Accountancy Data Network throughout 2004–2009. The efficiency estimates were obtained by the virtue of the non-parametric data envelopment models. Specifically, the linear programming problems were solved to obtain the optimal input quantities.

Preliminaries

The analysis of efficiency relies on the Koopmans definition of the productive efficiency. In order to relate the concept of efficiency to the structure of production technology, it is useful to introduce some notation and terminology (Fried *et al.*, 2008). Let producers use inputs $x = (x_1, x_2, ..., x_m) \in \Re_+^m$ to produce outputs $y = (y_1, y_2, ..., y_n) \in \Re_+^n$. Production technology then can be defined in terms of the production set:

$$T = \{(x, y) | x \text{ can produce } y\}. \quad (1)$$

Thus, Koopmans efficiency holds for an input-output bundle $(x, y) \in T$ if, and only if, $(x', y') \notin T$ for $(-x', y') \geq (-x, y)$.

Technology set can also be represented by input requirement and output correspondence sets, respectively:

$$I(y) = \{x | (x, y) \in T\}, \quad (2)$$

$$O(x) = \{y | (x, y) \in T\}. \quad (3)$$

There are two types of efficiency measures, namely, Shepard distance function and Farrel distance function. These functions yield the distance between an observation and the efficiency frontier. Shepard (1953) defined the following input distance function:

$$D_I(x, y) = \max\{\lambda | (x/\lambda, y) \in I(y)\}. \quad (4)$$

Here $D_I(x, y) \geq 1$ for all $x \in I(y)$, and $D_I(x, y) = 1$ for $x \in isoI(y)$. The Farrel input-oriented measure of efficiency can be expressed as:

$$TE_I(x, y) = \min\{\theta | (\theta x, y) \in I(y)\}. \quad (5)$$

Comparing Eqs. 4 and 5 one can arrive at the following relation:

$$TE_I(x, y) = 1/D_I(x, y), \quad (6)$$

with $TE_I(x, y) \leq 1$ for $x \in I(y)$, and $TE_I(x, y) = 1$ for $x \in isoI(y)$.

Farrel (1957) defined the two types of efficiency which are known as technical and economic efficiency. The economic efficiency and its measures were described above. The economic efficiency is divided into cost, revenue, and profit efficiency. A respective frontier is established for each of the three measures. Here one may focus solely on cost efficiency. However, revenue efficiency is a straightforward modification of the cost efficiency.

Assume that producers face input prices $w = (w_1, w_2, ..., w_m) \in \Re^m_{++}$ and seek to minimise cost. Thus, a minimum cost function—cost frontier—is defined as:

$$c(y, w) = \min_x \{w^T x | D_I(x, y) \geq 1\}. \quad (7)$$

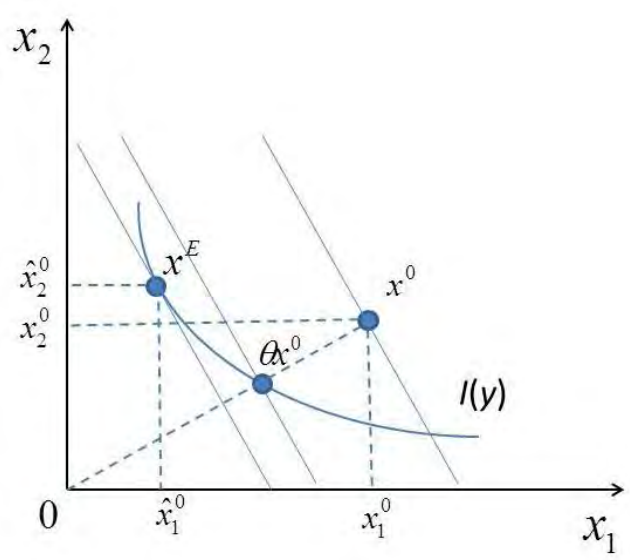
Then, a measure of the cost efficiency (CE) is defined as the ratio of the minimum cost to the actual cost:

$$CE(x, y, w) = c(y, w) / w^T x. \quad (8)$$

A measure of input-allocative efficiency AE_I is obtained by employing Eqs. 7 and 9:

$$AE_I(x, y, w) = CE(x, y, w) / TE_I(x, y). \quad (9)$$

Thus, the cost efficiency can be expressed as a product of technical efficiency and cost allocative efficiency. Figure 1 depicts these measures.



Source: authors' construction

Fig. 1. The concept of cost efficiency

The three lines in Figure 1 represent respective isocosts, namely, $w^T x^E$, $w^T \theta x^0$, and $w^T x^0$ for points x^E, θx^0, and x^0, in that order. Here, the efficient point x^E minimises costs and, thus, defines the cost frontier $c(y, w) = w^T x^E$. The cost efficiency of the point x^0 is then given by ratio $c(y, w) / w^T x^0 = w^T x^E / w^T x^0$ (cf. Eq. 8). The cost efficiency of x^0 can be further decomposed into technical efficiency $\theta^0 = \theta^0 x^0 / x^0 = w^T (\theta^0 x^0) / w^T x^0$ and allocative efficiency determined by the ratio $w^T x^E / w^T (\theta^0 x^0)$.

The cost efficiency can be estimated by employing the non-parametric data envelopment methodology. Suppose that there are $k = 1,2,...,K$ farms, each producing $j = 1,2,...,n$ outputs from

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

$i = 1,2,...,m$ inputs. Hence, the *t*–th farm ($t = 1,2,...,K$) incurs cost equal to $\sum_{i=1}^{m} w_i^t x_i^t$. The optimal cost can be obtained by implementing the following linear programming problem (Thanassoulis et al., 2008):

$$c(y,w) = \min_{\lambda_k, x_i} \sum_{i=1}^{m} w_i^t x_i$$

s. t.

$$\begin{aligned} &\sum_{k=1}^{K} \lambda_k x_i^k \le x_i, \quad i = 1,2,...,m \\ &\sum_{k=1}^{K} \lambda_k y_j^k \ge y_j^t, \quad j = 1,2,...,n \\ &\sum_{k=1}^{K} \lambda_k = 1 \end{aligned} \qquad (10)$$

where w_i^t are the input prices for the *t*–th farm. Indeed, this model yields the minimum cost, $c(y,w)$, at the given output level and input prices which can be used to estimate the cost efficiency.

Furthermore, the optimal input quantities, x_i, are obtained with respect to the underlying technologies and input prices. Denoting the input quantities that solve Eq. 10 for the *t*-th farm by $\hat{x}_i^t$, one can define the overall cost efficiency (CE) for the *t*-th farm as:

$$CE^t = \frac{c(y,w)}{\sum_{i=1}^{m} w_i^t x_i^t} \equiv \frac{\sum_{i=1}^{m} w_i^t \hat{x}_i^t}{\sum_{i=1}^{m} w_i^t x_i^t} \qquad (11)$$

where CE^t approaches unity in case of the cost efficiency and $CE^t < 1$ otherwise. Similarly, the input-specific cost efficiency can be defined as the following ratio:

$$CE_i^t = \frac{\hat{x}_i^t}{x_i^t}, i = 1,2,...,m \qquad (12)$$

where CE_i^t exceeds (is below) unity in case the farm should increase (reduce) the use of the *i*-th input and equals unity in case the observed input quantity corresponds to the optimal one.

Research results

The utilised agricultural area (UAA) in hectares was chosen as the land input variable, annual work units (AWU) – as the labour input variable, the intermediate consumption in Litas was treated as the variable costs, and total assets in Litas as a capital factor. On the contrary, the three output indicators represent crop, livestock, and other outputs in Litas, respectively. The cost efficiency was estimated by defining respective prices for each of the four inputs described earlier. The land price was obtained from

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

the Eurostat and assumed to be uniform for all farms during the same period. The labour price is the average salary in agricultural sector from the Statistics Lithuania. The price of capital is depreciation plus interests per one Litas of assets. Meanwhile, the intermediate consumption is directly considered as a part of total costs.

The data for 200 farms selected from the FADN sample cover the period of 2004−2009. Thus, a balanced panel of 1200 observations is employed for the analysis. The analysed sample covers relatively large farms (mean UAA − 244 ha). As for labour force, the average was 3.6 AWU. The farms were classified into crop, livestock, and mixed ones. In case the crop (livestock) output constituted at least 2/3 of the total output, the respective farms were treated as the specialised crop (livestock) farms; whereas, the remaining ones were treated as the mixed farms.

The linear programming model given by Eq. 10 was implemented to estimate the optimal input consumption quantities. Subsequently, the input-specific cost efficiencies were derived in the spirit of Eq. 12. The general results are presented in Table 1. As one can note, the livestock farms exhibited the highest overall cost efficiency (65%). The latter farming type was followed by the mixed and crop farms in that order (52% and 42% respectively). An input-specific analysis implied that the UAA was used excessively in the production process. The latter finding might be partially resulted to the research methodology which assumed that all the UAA is owned rather than rented. Anyway, this assumption held for all the observations and, thus, did not affect a particular farming type.

Table 1

The average overall and input-specific cost efficiencies (CE) across different farming types

	Farming types			Weighted average
	Crop	Livestock	Mixed	
Labour CE	0.75	0.93	0.90	0.86
Land CE	0.33	0.51	0.40	0.41
Intermediate consumption CE	0.60	0.88	0.75	0.74
Asset CE	0.80	0.84	0.80	0.82
Overall CE	0.42	0.65	0.52	0.53

Source: authors' calculations

Assets and labour were the two inputs used in the quantities that were closest to the optimal ones. However, the labour input could be reduced in the crop farming (input-specific CE) in order to increase the cost efficiency. The input-specific CE associated with assets virtually did not vary across the farming types (80-84%). In order to analyse the input-specific cost efficiencies across different farming types and time periods, the following Tables 2−5 present the dynamics of the input-specific estimates.

The CE associated with labour input was generally declining during 2004-2009 (cf. Table 2). However, it still remained one of the highest if compared with those associated with the remaining inputs. Specifically, crop farms featured the lowest labour CE which fluctuated in between 70% and 87% during the research period. Livestock and mixed farms featured higher labour efficiencies even though they usually employ higher amounts thereof. Accordingly, the crop farms might require some additional measures aimed at the further modernisation of the agricultural practices.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 2

The average cost efficiencies associated with the labour input

Year	Farming types			Weighted
	Crop	Livestock	Mixed	average
2004	0.72	1.00	1.08	0.93
2005	0.74	0.97	0.80	0.84
2006	0.75	0.89	0.86	0.83
2007	0.87	0.95	0.86	0.89
2008	0.75	0.96	0.97	0.89
2009	0.70	0.85	0.86	0.80
Average	0.75	0.93	0.90	0.86

Source: authors' calculations

Land efficiency was the lowest one among the analysed inputs. Indeed, the annual averages were not extremely volatile if compared with those associated with other inputs (Table 3). Whereas, the crop farms maintained their land CE around the average value of 33%, the livestock and mixed farms exhibited decreasing CE. Specifically, land CE dropped from 57% down to 48% with the average of 51% in the livestock farming during 2004-2009. The same trend prevailed in the mixed farming: land CE fell from 47% down to 36% (average − 40%). Therefore, the crop farms exhibited rather stable land CE and the lowest average level; whereas, the remaining farming types featured negative trends of CE alongside with the higher levels.

Table 3

The average cost efficiencies associated with the land input

Year	Farming types			Weighted
	Crop	Livestock	Mixed	average
2004	0.32	0.57	0.47	0.45
2005	0.29	0.57	0.37	0.41
2006	0.24	0.40	0.36	0.33
2007	0.40	0.53	0.42	0.45
2008	0.40	0.55	0.44	0.46
2009	0.31	0.48	0.36	0.38
Average	0.33	0.51	0.40	0.41

Source: authors' calculations

The CE associated with the intermediate consumption was extremely time-variant in the crop and mixed farming (Table 4). Indeed, the technological peculiarities of the cropping induce these fluctuations. The livestock farming managed to somehow increase the latter type of efficiency from 69% in 2004 up to 76% in 2009.

Table 4

The average cost efficiencies associated with the intermediate consumption

Year	Farming types			Weighted
	Crop	Livestock	Mixed	average
2004	0.67	0.69	0.84	0.73
2005	0.55	0.85	0.77	0.72
2006	0.45	0.97	0.67	0.69
2007	0.73	1.07	0.86	0.88
2008	0.70	0.91	0.76	0.79
2009	0.49	0.76	0.65	0.63
Average	0.60	0.88	0.75	0.74

Source: authors' calculations

The asset input was that used in the closest-to-the-optimal quantities (Table 5). The CE associated with the latter input dropped during 2006 and 2009 across all the farming types. These declines can be explained by the fact that interests are paid and the depreciation is incurred at a stable rate and, thus, become excessive during the periods of decreasing agricultural production prices or increasing input prices. The livestock farms exhibited higher average CE (84%) than the initial level (81%); whereas, the remaining farming types featured the decreasing trends in CE.

Table 5

The average cost efficiencies associated with the asset input

Year	Farming types			Weighted
	Crop	Livestock	Mixed	average
2004	0.95	0.81	0.86	0.87
2005	0.80	0.92	0.95	0.89
2006	0.63	0.85	0.84	0.77
2007	0.88	0.90	0.82	0.87
2008	0.89	0.93	0.79	0.87
2009	0.64	0.61	0.61	0.62
Average	0.80	0.84	0.80	0.82

Source: authors' calculations

To sum up, the land and intermediate consumption were the two most problematic inputs in terms of the cost efficiency. On the one hand, these findings do indicate that the yields specific for the Lithuanian agriculture need to be increased given the input consumption remains at a similar level. On the other hand, the farm expansion processes occurred after the accession to the European Union might be related with the certain sunk costs, namely, increased intermediate consumption aimed at land amelioration.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Conclusions

The carried out input-specific cost efficiency analysis implied that the utilised agricultural area was too large given its price and the output levels. Assets and labour were the two inputs used in the quantities that were closest to the optimal ones. However, the labour input could be reduced in the crop farming in order to increase the cost efficiency. The input-specific cost efficiency associated with assets virtually did not vary across the farming types (80-84%).

The livestock farms exhibited the highest overall cost efficiency (65%) and input-specific cost efficiencies. The mixed farms were peculiar with a somehow lower level of the cost efficiency (52%). Finally, the crop farms featured the lowest cost efficiency (42%). However, the crop farming might require certain long- and short-term investments aimed at land amelioration which could reduce the cost efficiency in the short run.

The future studies might attempt to estimate the farm-specific prices of all the inputs involved in the production process and, thus, obtain even more robust results.

Acknowledgements

This research was funded by the European Social Fund under the Global Grant measure.

Bibliography

1. Balezentis, T. (2013). Partial Factor Productivity in Lithuanian Family Farms: The Multiplier Data Envelopment Analysis Approach. *Management Theory and Studies for Rural Business and Infrastructure Development*, Volume 35, Issue 1, pp. 23−31.
2. Balezentis, T., Balezentis, A. (2013). Estimation of the Efficiency of the Lithuanian Family Farms via the Order-m Frontiers. *Management Theory and Studies for Rural Business and Infrastructure Development*, Volume 35, Issue 3, pp. 355−367.
3. Balezentis, T., Krisciukaitiene, I., Balezentis, A. (2013). The Trends of Technical and Allocative Efficiency in Lithuanian Family Farms. *Economic Science for Rural Development, Proceedings of the International Scientific Conference, Rural Business and Finance*, Issue 30, pp. 91−98.
4. Banker, R.D., Charnes, A., Cooper, W.W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Sciences,* Volume 30, Issue 9, pp. 1078−1092.
5. Charnes, A., Cooper, W.W., Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research*, Volume 2, Issue 6, pp. 429−444.
6. Farrell, M.J. (1957). The Measurement of Technical Efficiency. *Journal of the Royal Statistical Society Series A General*, Volume 120, pp. 253−281.
7. Fried, H.O., Lovell, C.A.K., Schmidt, S.S. (2008). Efficiency and Productivity. In: Fried, H.O., Lovell, C.A.K., Schmidt, S.S. (Eds.). *The Measurement of Productive Efficiency and Productivity*. New York: Oxford University Press, pp. 3-91.
8. Henningsen, A. (2009). Why is the Polish Farm Sector Still So Underdeveloped? *Post-Communist Economies*, Volume 21, Issue 1, pp. 47−64.
9. Samarajeewa, S., Hailu, G., Jeffrey, S.R., Bredahl, M. (2012). Analysis of Production Efficiency of Beef/Calf Farms in Alberta. *Applied Economics*, Volume 44, pp. 313−322.
10. Shepard, R.W. (1953). Cost and Production Functions. Princeton, New Jersey, Princeton University Press, p. 104.
11. Thanassoulis, E., Portela, M.C.S., Despic, O. (2008). Data Envelopment Analysis: The Mathematical Programming Approach to Efficiency Analysis. In: Fried, H.O., Lovell, C.A.K., Schmidt, S.S. (Eds.). *The Measurement of Productive Efficiency and Productivity*. Oxford University Press, New York, pp. 251−420.

ECONOMIC PROBLEMS OF POLISH MEAT SECTOR DEVELOPMENT - A COMPARATIVE STUDY

Katarzyna Boratynska, PhD.[1]; Emilia Wloczewska, MSc[2]

[7] Department of Economics and Organisation of Enterprises, Faculty of Economic Sciences, Warsaw University of Life Sciences

[2] Department of Economics and Organisation of Enterprises, Faculty of Economic Sciences, Warsaw University of Life Sciences

Abstract. Since the meat sector has recently been mentioned as one of the most exposed to financial difficulties and threat of bankruptcy in Poland, it is necessary to have a better understanding of the complexity of factors determining business activity in this sector. The main aim of the paper is to present a scientific discussion of conditions, profile, and economic problems of Polish meat sector and its comparison with food industry. It is a comparative study. The factors performing risk sensitivity of the meat industry are also introduced in the paper. The market is being cleaned up and ineffective enterprises disappear which will contribute to consolidation and improve the production capacity of the meat sector.

Key words: economic problems of meat sector, risk, corporate bankruptcy.

JEL code: Q130, M210

Introduction

The low production concentration, typical for the Polish meat sector, makes it highly competitive. Competition may lower prices and profitability. The dispersion of the meat industry is mainly attributable to low concentration of hog and bovine livestock supply caused by the dispersed agricultural structure and increasing number of entities in the meat industry, especially in slaughter business, characterised by low technical and sanitary standards. Insufficient livestock supply raises the costs of production for companies specialised in meat processing. The difficult situation of the meat sector is also the result of the transition period (ended in 2009), during which Polish enterprises were required to undertake measures to meet the EU standards. The adjustments led to substantial investment outlays. These factors can increase the risk of corporate bankruptcy.

Study aim, method and tasks

The main aim of the paper was to present a scientific discussion of the conditions, profile, and economic problems of Polish meat industry and its comparison with food industry.

In scope of the first task, the authors presented the characteristics and economic problems of Polish meat industry. The next task involved presentation of selected financial ratios of analysed entities against the industry average. The study covers an extremely interesting time frame since it includes the sector's figures from the situation before the global economic crisis as well as the figures from the

[7] Corresponding author. Tel. +48 225934231; fax. +48 225934230

E-mail address: katarzyna_boratynska@sggw.pl

situation during the crisis. Therefore, it was possible to analyse how far the crisis affected meat industry. Finally, an overall conclusion was presented on the meat sector development.

The authors have analysed the financial standing of four selected meat sector companies during the 2007-2010 period (Indykpol S.A., Zaklady Miesne Herman Sp. z o.o., PMB Bialystok S.A., and Polski Przemysl Miesny i Drobiarski MAT S.A.). All of them are or until recently were categorised as stock companies. Two of them − Zaklady Miesne Herman Sp. z o.o. and Indykpol S.A. − are still operating on the market. The two other companies went bankrupt in 2012 (PMB Bialystok S.A. and Polski Przemysl Miesny i Drobiarski MAT S.A.). The data presented were available through Info Veriti database, which is a provider of economic and financial data in Poland.

Each year was assessed by computing different ratios and discussing their interpretation with meat industry average. At first, the paper describes the chosen ratios.

Applied ratios and their interpretation

In the following part of the study, the authors present the applied selected ratios. It is also explained how these ratios help evaluate financial data. Financial ratios are generally divided into five different categories: profitability; liquidity; debt; asset activity (Gallagher and Andrew, 2007); and leverage ratios. The authors have focused only on selected profitability and debt ratios in the paper.

Profitability ratios

In the first step, the authors calculated profitability ratios. Profitability ratios measure how much revenue is eaten up by expenses, respectively, how much is earned compared with sales generated and the amount earned compared with the firms' assets and equity. Stockholders in particular are interested in profitability ratios as profit leads to cash flow which is a primary source of value for the firm (Gallagher and Andrew, 2007). The five important profitability ratios are gross profit margin, net profit margin, return on equity, return on assets, and return on sales. In the paper, the authors focused only on return on sales (ROS) and return on equity (ROE).

Return on sales (ROS) is defined as ratio of net profit and net revenue. The ratio measures how efficient a company is in converting one sales dollar into a profit dollar. The ROS depends very much on the industry the company is operating in (Tyson and Schell, 2012).

$$Return\ on\ Sales = \frac{Net\ Profit}{Net\ Revenue} \quad (1)$$

Return on equity (ROE) equals net profit divided by equity. The resulting figure indicates how many dollars/euro of income were generated for each dollar invested by common stockholders (Gallagher and Andrew, 2007).

$$Return\ on\ Equity = \frac{Net\ Income}{Common Stockholder's\ Equity} \quad (2)$$

Debt ratios

Debt ratios measure the size of a firm's debt and its ability to pay off the debt. Two primary debt ratios are debt to assets and debt to equity. The authors focused only on debt to equity ratio in the article. When a company's debt increases significantly, the risk of a bondholder as well as a lender

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

increases because more parties compete for the firm's resources in times of financial difficulties. Stockholders are also concerned since bondholders are paid before stockholders. A healthy debt ratio depends on the industry. Generally, a stable industry can handle higher debt ratios.

The debt to equity ratio indicates debt the company has for every dollar/euro of equity (Brigham and Erhardt, 2011).

$$Debt/Equity\ Ratio = \frac{Total\ Debt}{Total\ Equity} \quad (3)$$

Description of the analysed enterprises from the meat sector

Indykpol S.A. is the biggest producer of Turkey meat in Poland with its share accounting for 20% in the Polish meat sector. It possesses a raw material base and farms which provide about 35% of the raw material being processed by Indykpol S.A. In June 1990, two key plants were separated from the structures of the enterprise, the Poultry Company in Ilawa and the Breeding Production Company in Frednowy. In 2000, the latter entity came back into the structures of Indykpol capital group under a new name the Turkey Breeding Centre. It produces poultry for the needs of Indykpol Capital Group (www.indykpol.pl).

The company Zaklady Miesne Herman SA analysed in this paper is located in Hermanowa, Tyczyn municipality, Rzeszowski poviat, Podkarpackie voivodship. The company employs approximately 220 people and supplies more than 500 customers, including Makro, Real, Carrefour, Kaufland, and Auchan store chains. The financial situation of the company started to worsen in 2008. The following factors contributed to this worsening: growing costs of labour; power supply; fuel; transport; and animal stock. A recovery plan was formulated based on the company's financial sources provided by its shareholders (PLN 1.5 million). These funds will be allocated for debt reduction and current activity. The recovery plan assumes downsizing of operating costs, improvement of profitability of products, closing of approximately 10 unprofitable stores which generate losses and sale of non-core assets.

Important changes within the company took place while preparing Polish market enterprises to meet the European Union standards. In 2003, Herman S.A. invested more than PLN 8 million with SAPARD (Special Accession Programme for Agriculture and Rural Development) and PHARE (Poland and Hungary Assistance to Restructuring their Economies) subsidies. Investment contained firm's modernisation and development by adjusting to the European Union standards. A new production area of 1.5 thousand square metres was built and the modernisation of machines of particular production departments took place. *ISO 9001 and BRC certificates were introduced and HACCP system implemented, which yields high production standards. In 2004, Herman obtained NATO Commercial and Governmental Code (NCAGE).

As for the day of registration, the name of the next presented company was Polski Przemysl Miesny i Drobiarski MAT Spolka Akcyjna w Grudziadzu, hereinafter in the paper referred to as MAT S.A. The company was established on 9 September 1998 and was registered in KRS on 30 January 2002. On the registration day, the company had 31 branches in various Polish cities. The field of activity of PMB S.A. was processing and preserving of meat and meat products. On 9 October 2009, the company started to operate under the name Polski Przemysl Miesny i Drobiarski MAT Spolka Akcyjna. On 17 September 2012, MAT S.A. declared bankruptcy.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The PMB S.A. was established in 1962 with the previous name Wojewodzkie Przedsiebiorstwo Przemyslu Miesnego w Bialymstoku (http://www.pmb.com.pl). In 1964, it was merged with the meat companies from Oleck, Suwalki, and Augustow. It was being constantly modernised through many years. In 2002, by the process of privatisation the entity started to operate under the name PMB Spolka Akcyjna (hereinafter in the paper referred to as PMB S.A). In 2004, PMB S.A. received the updated ISO 9001:2000 certificate. The field of activity of PMB S.A. was processing and preserving of meat and meat products. It was selling nearly 200 tonnes of meat a day, employing almost 1000 employees and its firm occupied the area of 11 hectares. It exported a significant part of its production to the countries of Eastern and Western European countries, the United States, Georgia, and Uzbekistan.

There were considerable limitations when the case came to the empirical data analysis. The most problematic companies from the data availability point of view were the bankrupt companies. Both of them went bankrupt in 2012. While PMB Bialystok S.A. had submitted all the financial statements until the end of 2011, while in case of MAT S.A., the financial statement of December 2010 was the last one which the company had filled in.

Research results and discussion

1. Economic situation of the Polish meat sector and its development in the comparison with food industry

The food production sector is the largest production sector in Poland. It constitutes a share of 17% of employees and 18% of turnover in the industry. It is based on a large-scale agricultural production − Poland is among those European Union countries with the largest agricultural population.

However, profitability ratios of the meat industry in Poland are very low comparing with the food industry in general (Table 1).

Table 1

Profitability ratios for the Polish meat and food industry in 2003, 2007 and average 2009-1st half of 2012

Industry	Net profit (loss) as a percentage of net revenues			ROE		
	2003	2007	average 2009-1st half of 2012	2003	2007	average 2009-1st half of 2012
Meat industry	0.9	2.3	2.2	5.1	12.9	12.7
Food industry	1.6	4.3	4.2	5.3	14.5	13.1

Source: Poczta, W., Pawlak, K., Ratajczak, P., Sieminski, P., 2012

A significant period for the meat sector in Poland was the period before 2004 when Poland joined the European Union. Some development programmes were implemented in order to adapt to the European Union industry level. Actions of modern management adoption methods led to structural changes in the market of Polish meat sector.

Another important change that took place in the meat industry in Poland along with joining the European Union was placing the Polish industry in international business networks. While

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

preparing Poland for European standards, inward investments started to appear and export in food industry increased significantly.

The highest growth of investment in the meat sector was observed from 2004 to 2007 (Table 2). In this period, foreign investors were modernising the meat production companies and gross investment per year increased by almost 90% compared with the period before Poland's accession to the EU.

Table 2

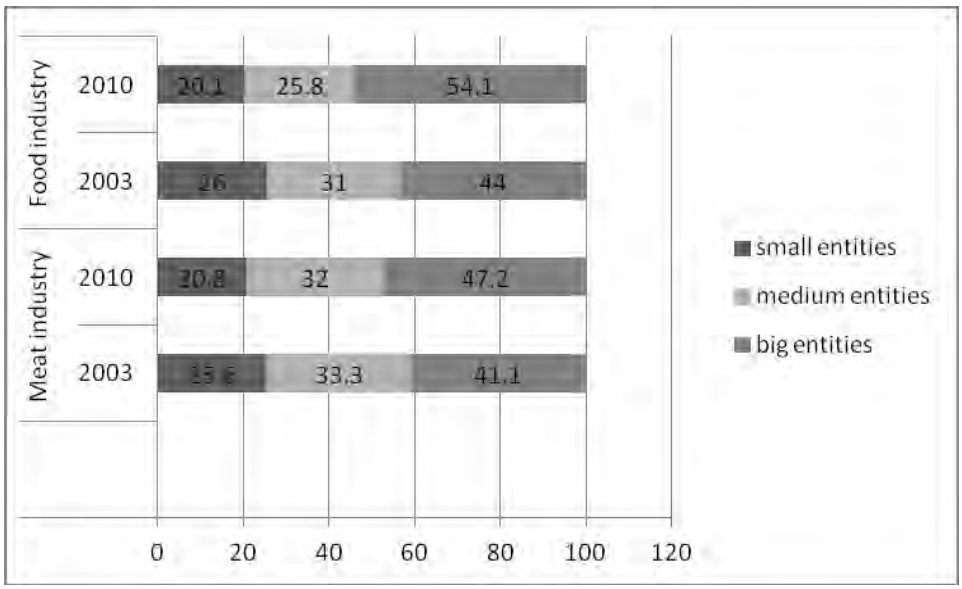
Investment in the meat sector companies in 2000-2011 (in million PLN)

Industry	Years				Dynamics 2011/2003
	2000-2003	2004-2007	2008-2011	2011	
Meat industry	755	1 246	792	804	106.5
Food industry	4 772	6 911	6 434	6 530	136.8

Source: Poczta, W., Pawlak, K., Ratajczak, P., Sieminski, P., 2012

The period of 2004-2007 was the most significant if it comes to the investment in the meat industry and in the food sector in general. The increase of investment from 2000 to 2011 in the meat industry amounted to 6.5% and was rather modest comparing with the food industry, which achieved almost 37% of investment increase in that period of a time. It is worth emphasising that the meat industry invested the biggest share of 15.3% of PLN 68.6 billion invested in all food sectors during 2000-2011.

The Polish meat industry is considered to have a diversified structure by the size of entity and a quite low concentration (Figure 1). Despite the fact that the number of the companies from this sector is decreasing mainly due to restriction performed to join the European Union, it is still quite high in comparison with the Western countries. After the decline starting from 2004, the numbers of enterprises reached 15500 in 2007.



Source: Poczta, W., Pawlak, K., Ratajczak, P., Sieminski, P., 2012

Fig. 1. **The structure of meat and food industry by size of entity in 2003 and 2010 (in percentage terms)**

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

There is a smaller group of big entities in the meat industry than in the food sector in general. This fact weakens the position of Polish meat producers on the international market and possibility of negotiations with huge distributive networks.

Among those Polish meat sector companies that took advantage of foreign investments are: the Animex Capital Group with 13 companies in Poland; Sokolow S.A., the biggest meat company listed on Warsaw Stock Exchange with seven companies in Poland; Indykpol Group, the biggest producer of turkey and meat products in Poland, with five companies (Rycombel, 2004).

Table 3 shows the trend of efficiency in Polish meat industry. A decreasing tendency was observed until 2004, which could have been an effect of higher costs of implementing modern methods of production than profitability. Since Poland's joining to the European Union, larger markets were available and gross operating surplus kept increasing. There were various factors influencing the growing level of turnover. Foreign investments followed by improvement of technology level in the meat sector caused a faster increase of deliveries. In addition, the meat consumption was growing in this period, causing the increase of demand for meat which is reflected in gross operating surplus level. A decrease of financial results was noted in 2008, the first year of the world economic crisis; however, it was temporary, and in 2009, a significant improvement was pointed out. In 2011, the financial results of the food industry companies deteriorated as a result of increasing prices of raw materials being ahead of sales price rise. More than 20% of the companies were unprofitable.

Table 3

Efficiency in the meat and food industry measured in value of sold production in 2003, 2007 and 2011

Industry	thousand PLN per capita			Dynamics 2011/2003
	2003	2007	2011	
Meat industry	264.2	337.3	394.9	149.5
Food industry	346.3	455.8	528.1	152.5

Source: Poczta, W., Pawlak, K., Ratajczak, P., Sieminski, P., 2012

Work efficiency in the Polish meat industry was increasing significantly from 2003 to 2011 but the dynamics of the growth was lower than in the food sector in general. A relatively low work efficiency of the meat industry is caused, among other things, by high share of human work and fragmented structure.

Table 4

Work efficiency in the meat, dairy and food industry measured in value of sold production in 2008 compared with other European countries

Industry	Poland	Germany	EU-15	EU-12	EU-27
	EUR, thousand per capita				
Meat industry	126.4	181.3	214.2	119.6	188.5
Food industry	160.4	193.2	231.5	130.4	205.8

Source: Poczta, W., Pawlak, K., Ratajczak, P., Sieminski, P., 2012

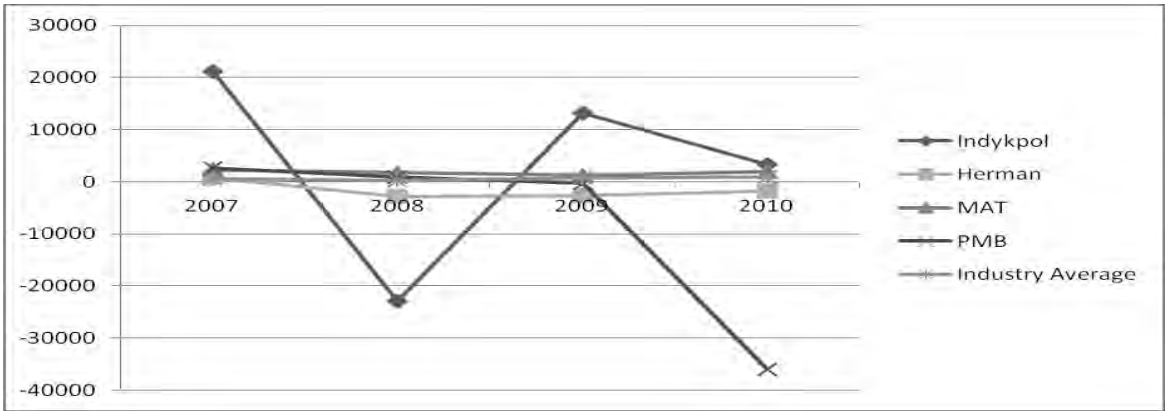
An improvement in a work efficiency, which could have been observed in Poland during the period from entering the EU to 2008, brought Poland nearer to the developed countries of the EU-15, including Poland's largest demander - Germany. In 2008, the work efficiency in Poland was by about 30% lower than in the EU-15 countries. In the meat industry, this difference was higher - about 40% (Table 4).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

It has to be noted that recently Polish meat industry companies are in a difficult situation. According to the report from January 2013, based on the EULER HERMES data, in 2012, 941 of Polish companies went bankrupt, which has been the biggest number since 2004. There are many threats that do not concern other industries such as animal diseases, strict animal welfare codes, and laws imposed by authorities. This is evidenced by the fact that even in December 2012, in the peak of the pre-holiday demand, next companies, also the big ones, went bankrupt (Upadlosci firm…, 2012).

2. Comparison of selected meat companies an economic standing with meat industry averages

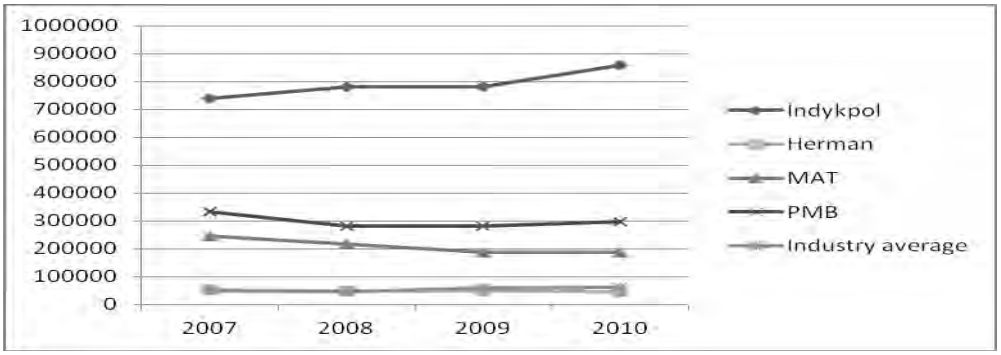
In order to assess well the position of the company and its financial performance, the main features were illustrated along with the industry average values. The availability of the industry data was limited, that is why the period of 2007-2010 is analysed in this section. At first, the net income comparison of Indykpol, Herman, MAT and PMB can be observed in the below figure.



Source: authors' construction based on the financial statements of selected companies

Fig. 2. **Net income of four companies and meat industry average in 2007-2010, in thousand PLN**

As it can be observed in Figure 2, Indykpol represents the highest values of the net income among the four companies analysed, though, at the same time, it has the biggest fluctuations. As it was noted while analysing its financial statements, the bad situation in 2008 was temporary, and the company managed to earn profit of more than PLN 3 million.



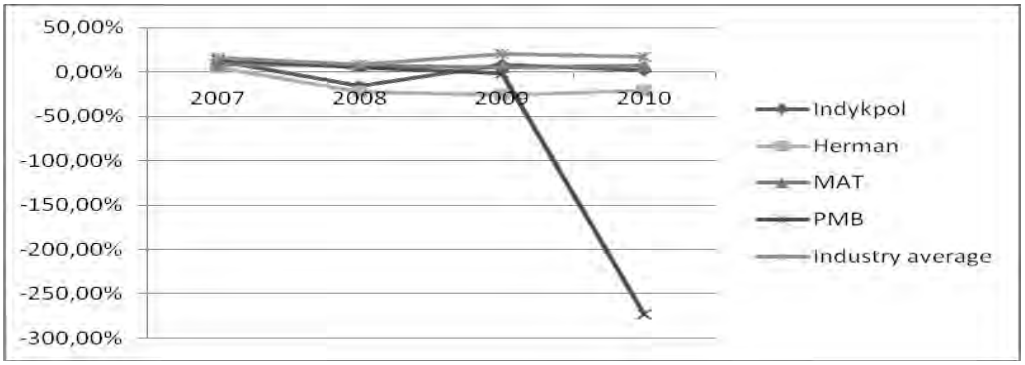
Source: authors' construction based on the financial statements of selected companies

Fig. 3. Revenues of four companies and meat industry average in 2007-2010, in thousand PLN

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Regarding Herman, from 2008 to 2010, it generated loss, which, however, decreased in 2010 to nearly PLN -2 million. The values of the net income of MAT are quite stable over the time analysed and they are close to the industry average. In 2010, its net revenues were PLN 2 million, while industry average was nearly PLN 1 million. PMB profit has been decreasing since 2007 and in 2010, dropped drastically to PLN -36 million.

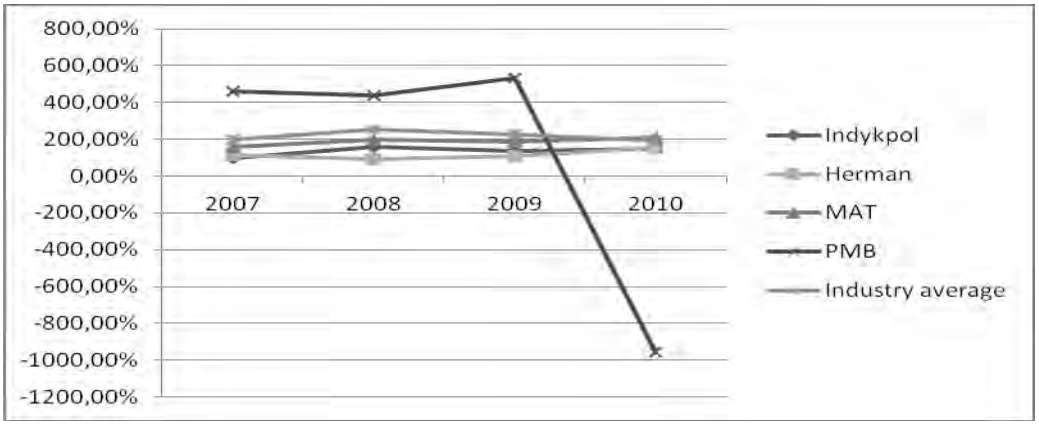
When it comes to the values of revenues, Indykpol is an undoubted leader with almost PLN 860 million in 2010. Much lower is PMB which reached almost PLN 300 million in 2010, followed by MAT with PLN 187 million in 2010. Herman is close to the industry average with revenues of PLN 47 million (Figure 3).



Source: authors' construction based on the financial statements of selected companies

Fig. 4. **Return on equity ratio (ROE) of four companies and meat industry average in 2007-2010, in thousand PLN**

While observing the above figure of the return on equity ratio, a huge decrease of this feature in case of PMB attracts attention, which again shows seriously deteriorating financial performance of the company. From 2008, the values of all the companies are below the industry average with Herman representing the lowest ROE values until 2009 (Figure 4).



Source: authors' construction based on the financial statements of selected companies

Fig. 5**. Debt-to-equity ratio of four companies and meat industry average in 2007-2010, in thousand PLN**

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The last feature compared with the industry average was the debt-to-equity ratio. PMB S.A. represents the highest values of this ratio of more than 400% until 2009. In 2010, Figure 5 shows a negative value which was caused by a negative equity value. The company is aggressive in financing its development with debt. In addition, the difficult debt situation of MAT S.A. is visible in this case. In 2010, debt-to-equity ratio was more than 200% which was a sign that the company is facing a risk of distress while using its debt; though, this value only slightly exceeded the industry average. In 2010, the debt-to equity ratio values of Herman S.A. and Indykpol S.A. were lower than industry average, accounting for of 155% (Herman) and 150% (Indykpol).

Conclusions, proposals, recommendations

Summing up the results of the foregoing analysis, the authors have drawn the following conclusions.

1. Meat production companies are among the sectors with the highest risk of bankruptcy. In this industry characterised by low profitability and often higher costs of modernisation implemented few years ago, companies are very sensitive to the demand fluctuations.
2. Factors pointing to the worsening financial condition of the analysed companies include, among others, systematic decrease of net income and lower liquidity triggering excessive growth of liabilities. One should underline the specific nature of the operations of the meat sector enterprises, which are characterised by very a low concentration of production.
3. Polish meat sector needs changes and innovations. Its production is still highly scattered, ineffective and expensive in compared with other countries of the EU. The meat industry has changed significantly during the past ten years but growing competition of the Western European countries force Poland to undertake further improvements, focusing on substitution of human work with computing systems and higher production concentration.

Bibliography

1. Brigham, E. F. and Erhardt, M. C. (2011). *Financial Management. Theory and Practice.* Cengage Learning, Mason, 13th Edition, p. 95.
2. Financial Statements of Researched Companies, namely: Indykpol S.A., Zaklady Miesne Herman Sp. z o.o., PMB Bialystok S.A. and Polski Przemysl Miesny i Drobiarski MAT S.A., collected in the Info Veriti database. Retrieved: http://www.infoveriti.pl/ Access: 01.12.2013.
3. Gallagher, T. J. and Andrew, J. D. (2007). *Financial Management. Principle and Practice.* Freeload Press, 4th Edition, pp. 89-95.
4. Poczta, W., Pawlak, K., Ratajczak, P., Sieminski, P. (2012). *Analiza potrzeb i kierunkow wsparcia sektora przetworstwa, przetwarzania, wprowadzania do obrotu i rozwoju produktow rolnych w Polsce w latach 2014-*2020 *(Analysis of Demands and Directions of Support of Processing, Agricultural Products Development Introduction in Poland in 2014-2020).* Retrieved: http://ksow.pl/fileadmin/user_upload/ksow.pl/pliki/ANALIZY_ekspertyzy/Ekspertyza_Przemysl_spozywczy_POCZTA_Poznan.pdf. Access: 03.01.2014.
5. Retrieved: http://www.indykpol.pl Access: 03.01.2014.
6. Retrieved: http://www.pmb.com.pl Access: 03.01.2014.
7. Rycombel, D. (2004). *Przemysl miesny – mieso czerwone*, IERiGZ, Warszawa, pp. 1-2.
8. Tyson, E., Schell, J. (2012). *Small Business for Dummies*. John Wiley & Sons, Inc, Hoboken, 4th Edition, p. 240.
9. *Upadlosci firm w Polsce Raport* (2012). Retrieved: http://gielda-inwestora.pl/polecane/upadlosci-firm-w-polsce-raport-2012. Access: 03.01.2014.

CHANGES IN LITHUANIAN FLAX INDUSTRY EXPORTS

Asta Saboniene[1+], Dr, assoc. prof.; **Jurate Pridotkiene** [2], Dr, assoc. prof.
[1,2] Kaunas University of Technology, Lithuania

Abstract. Most industries of small economies are vulnerable to the changes on international markets, and the issue of declining industries is a relevant scientific problem which induces scholars for deeper analysis of the issue. The paper aims to explore how the economic integration influenced the exports of Lithuanian flax industry and also to reveal why traditional flax fibres and linen textile industry, which prevailed in the Lithuanian manufacturing a decade ago, is decreasing. The research study analyses the changes of trade-based indices for flax fibres and linen textile commodities over the period of 1996-2012 and employs the revealed comparative advantage approach in order to illustrate the relevance of the raised scientific problem. The methods of the scientific research employed in this study are the analysis of scientific literature, mathematic calculations of RCA index, and the comparative analysis of statistical indexes. In the presence of competitive pressures and the changing structure of the world demand, economic integration and harmonisation of the common EU policy, this study calls for a reassessment of the factors that influenced Lithuanian flax industry's decline. The present study showed that decreased support for flax cultivation, insufficient quality of raised flax stalks, lower prices of foreign suppliers, and lack of advanced technology were the main reasons which influenced the decline of Lithuania's flax industry after 2004. Besides, agricultural policy and applied regulatory measures play important role for the performance of the industry.

Key words: flax industry, linen textile, exports, revealed comparative advantage.
JEL code: F14, L67.

Introduction

In scientific literature, the industrial development and manufacturing problems are closely related with the competitiveness aspects of industries on international markets. The undergone structural changes of economy presented market failures and imperfections in Lithuanian industry, especially, in the areas of human recourses, innovation, management, progress of science, and technique. The transformational period disclosed the significance of traditional manufacturing branches which adapted to market demand changes more flexibly and faster. On the contrary, the Lithuanian textile industry experienced the visible decline and the flax industry is not an exception.

Scholarly discussions related with the development of flax industry, are based on the analysis of positive quality characteristics of the flax and flax fibres, such as stalk length, fibre strength and fineness, cellulose content, moisture content, and selection of new varieties (Easson, Cooper, 2002; Sampaio *et al.*, 2005; Jankauskiene, Bacelis, 2007) The research studies are also directed to the issue of employment of fibre flax not only in textile, paper and panel manufacturing but in high-tech as vehicle and aeronautical industry as well. Wonneberger, Vanfleteren (2013) argue that flax fibres are the best

[+] Corresponding author. Tel.: + 370 37 300576
E-mail address: asta.saboniene@ktu.lt

natural fibres according to technical requirements, such as low density, good fire protection properties, water absorption, and mechanical properties which are close to e-glass.

Flax and linen industries as traditional ones attain little attention as an object of industry competitiveness research. Recent studies of linen industry stress global shrinkage of the sector. Glinskiene, Daraskeviciute, Lipinskiene (2006) addressed the problem of raw material shortages for linen industry in Lithuania. Baltina, Siksnane (2008) shortly reviewed export dynamics and decrease of Latvian linen industry in the context of general textile industry export activity. Zotikova, Zotikov (2009) pointed out the problem of Russian linen industry competitiveness decrease, namely, low technological level in the industry.

The core aim of the research paper is to reveal the changes of export performance of Lithuanian flax and linen textile industry and to discuss the problems of its development.

Research tasks of the paper are to evaluate the changes of export share of flax commodity groups in the world exports, to reveal the main changes of export amounts, to perform the analysis of revealed comparative advantage (RCA) indexes of Lithuanian flax commodity groups during 1996-2012, and finally, to analyse the main issues in Lithuania's flax industry exports development.

The methods of the scientific research employed in this study are scientific analysis and summarising of literature, mathematical calculations and the comparative analysis of statistical indexes. The authors used revealed comparative advantage indices to examine the changes in export performance and specialisation of different Lithuanian flax industry commodity groups. The Balassa (1965) developed the Revealed Comparative Advantage index and outlined that the employment of export and import values of the imported intermediate goods, which were used for manufacturing of export commodities, could take useful information for evaluating the comparative advantages of a country. Some of modified indices use only exports data, while others also take imports into account when measuring export specialisation. The modified Revealed Comparative Advantage (RCA) indices were suggested by Vollrath (1991), Lafay (1992), Mlangeni (2000) and applied in numerous research studies (Laursen 1998, Amir 2000, Prasad 2004 and others). This paper uses the RCA index which is modified as follows:

$$RCA_i = \left(\frac{X_i - M_i}{X_i + M_i} - \frac{\sum (X_j - M_j)}{\sum (X_j + M_j)} \right) * \frac{100}{1 - \frac{\sum (X_j - M_j)}{\sum (X_j + M_j)}} \quad (1)$$

$$\text{if } \frac{X_i - M_i}{X_i + M_i} > \frac{\sum (X_j - M_j)}{\sum (X_j + M_j)}$$

and

$$RCA_i = \left(\frac{X_i - M_i}{X_i + M_i} - \frac{\sum (X_j - M_j)}{\sum (X_j + M_j)} \right) * \frac{100}{1 + \frac{\sum (X_j - M_j)}{\sum (X_j + M_j)}} \quad (2)$$

$$\text{if } \frac{X_i - M_i}{X_i + M_i} < \frac{\sum (X_j - M_j)}{\sum (X_j + M_j)},$$

where:

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

X_i - country A exports of product i;

M_i - country A imports of product i;

X_j - country A exports of all other products except i (j =1 to n and j ≠ i);

M_j - country A imports of all other products except i (j =1 to n and j ≠ i).

The values of RCA index indicate comparative disadvantage when it ranges between −100 and 0. When the RCA value ranges between 0 and +100, it illustrates a specialisation and comparative advantage; if it is equal to 0, it indicates that export and import of a particular product are equal. The RCA index determines what commodity groups achieved the revealed comparative advantage and allows evaluating the level of import penetration into the domestic market.

Research results and discussion

The evident decline of textile industry during transformational process of Lithuanian economy, when the share of total manufacturing industry sales decreased from 7.2% in 1996 to 1.9% in 2012, forces to seek for problematical issues pointing out the abilities of sector's companies to compete on international markets. The flax and linen textiles industry, being a part of the Lithuanian textile sector, has incurred a drastic decrease as well. Although, flax is used to make products ranging from flax seed oil, heat insulation, paper, soap to others, there are two main kinds of flax: fibre flax, from which linen and other spun flax products are made; and seed flax, from which linseed oil and linseed meal are produced (Rada, Deloach, 1942). The main focus of research analysis is paid to the industry of flax fibres, yarn, and linen textiles.

Lithuanian flax and linen textiles have been widely known for a long time on international markets, as before 1940 Lithuania was the third largest cultivating country in the world, most of the linen fabrics and manufactures were exported, mainly to France, Belgium, and other European countries (Kniuksta, 2013). However, up to date, flax cultivating areas are close to zero, while linen textiles producers use imported raw material from other largest flax cultivating and processing countries, like France, Belgium, and Belarus. Considering changes of individual industry, set of trade-based indicators should be viewed by deeper analysis. The exports share and growth/decline of share in total world exports of main producers are presented in Figure 1. The main rivals in flax fibre production and also exporters to Lithuania are producers from France and Belgium, the two countries that are famous for flax processing traditions and for abilities to compete with good price/quality ratio worldwide. France exported 48.0% of total world exports of *5301 Flax, raw or processed*[8] in 2011, and although, this share slightly decreased, the country kept the leader's position.

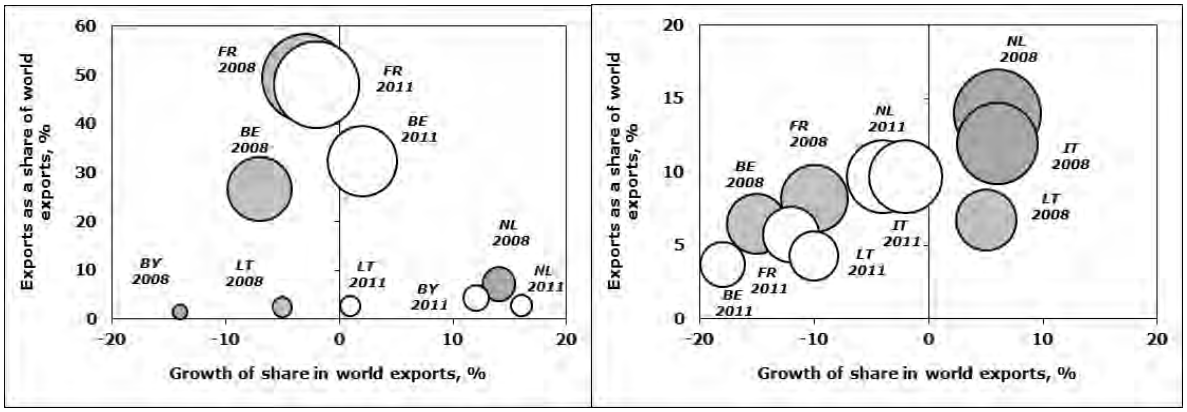
As Figure 1(a) shows, Belgium increased the export share to 32.3% of *5301 Flax, raw or processed* in 2011. Belarus (4.3% in 2011), and the Netherlands (2.8% in 2011) held small share with increasing trend of exports in this commodity group. According to the data of the ITC[9], Lithuania made 2.7% share of world exports of *5301 Flax, raw or processed* in 2011. Figure 1(b) illustrates that decreasing in export share of *5306 Flax yarn* is relevant to majority of the producers. Italy and the Netherlands each held 9.7% export shares in *5306 Flax yarn* in 2011, accordingly, France − 5.7%, and Lithuania − 4.3%.

[8] Commodity groups are classified according to the Combined Nomenclature 2011, http://osp.stat.gov.lt/en/klasifikatoriai1/-/asset_publisher/YZxMaiqRO1LT/content/kombinuotoji-nomenklatura

[9] ITC - International Trade Centre, www.trademap.org

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Relatively small export share in *5309 Woven fabrics of flax* was made by Lithuanian companies (1.0% in 2011). Italy kept the largest share of *5309 Woven fabrics of flax* (16.0% in 2011), Belgium accordingly had 6.8%, Germany − 4.1%, and France − 3.3% in 2011 (see Figure 1(c)).



5301 Flax, raw or processed
(a)

5306 Flax yarn
(b)

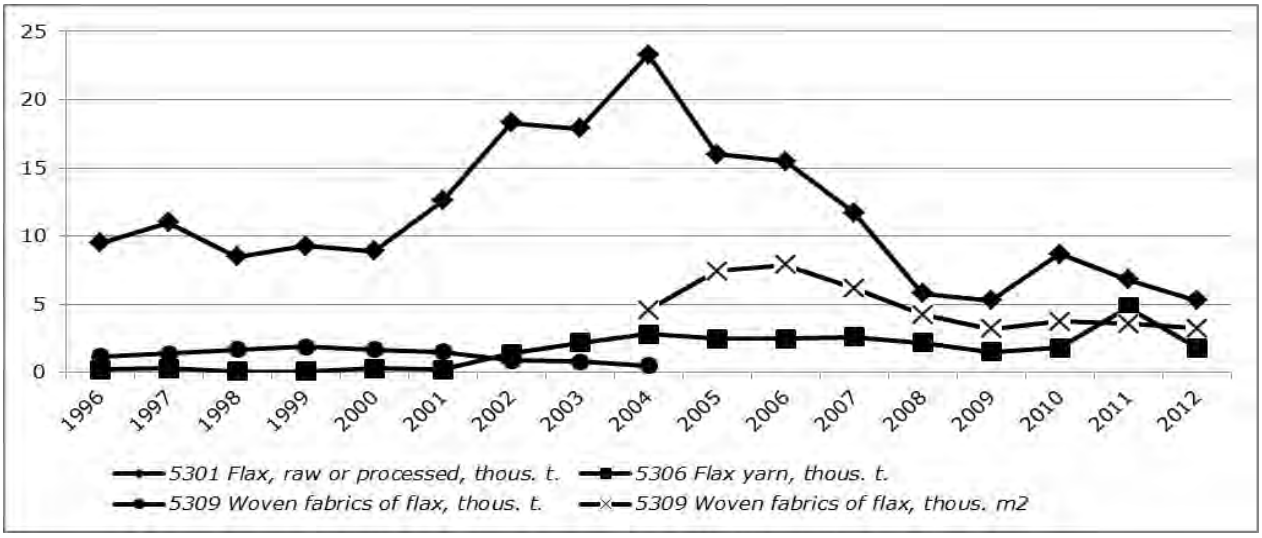
5309 Woven fabrics of flax
(c)

Source: authors' construction based on the data of the International Trade Centre

Fig. 1. **Exports shares of Flax commodity groups in the world exports and growth dynamics of the main producers, %, 2008 and 2011**

The absolute amounts of Lithuanian flax and linen textile exports are shown in Figure 2. The statistical data presents evident decline of exports amount of *5301 Flax, raw or processed* from 23.3 thou. t in 2004 to 5.3 thou. t in 2012. The least export amount in this commodity group was fixed in 2009 and 2012 during the analysed period of 1996-2012. *The 5309 Woven fabrics of flax* experienced export decrease from 7.9 thou. m^2 to 3.3 thou. m^2 or by 58% in 2006-2012. The export of *5306 Flax yarn* moved up from 0.2 to 2.8 thou. t during 1996-2004 and gradually decreased to 1.8 thou. t in 2012.

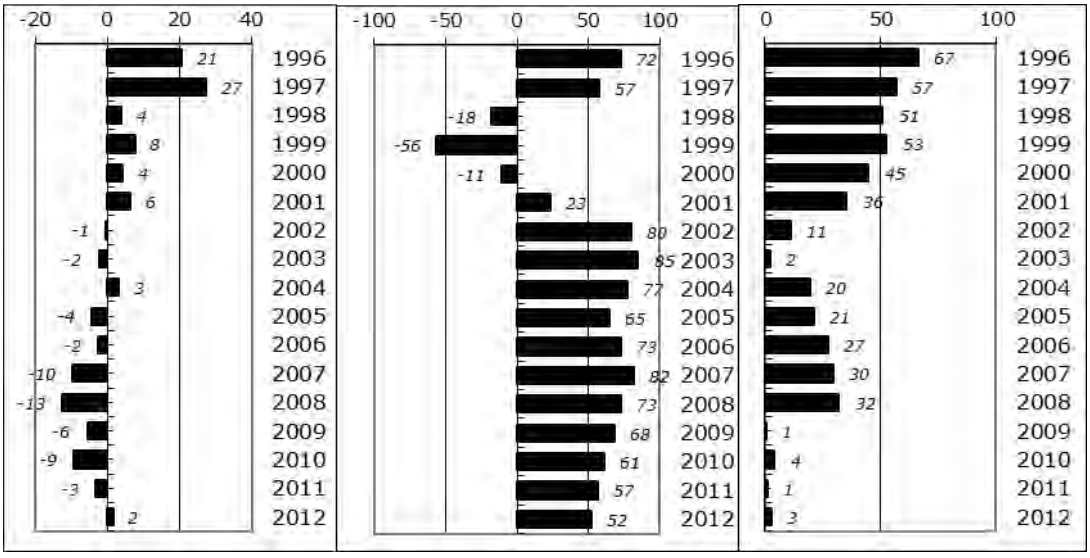
ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014



Source: authors' construction based on the data of the Department of Statistics to the Government of the Republic of Lithuania

Fig. 2. **The dynamics of Lithuanian flax commodity groups exports, 1996-2012**

The analysis showed that the RCA index of *5306 Flax yarn* achieved relatively good values but the index has decreased during 2003-2012 (Figure 3). The *5306 Flax yarn* is intermediate good, which export amount depends on demand of involved industries. It is worth noticing that Lithuanian flax yarn producers showed excellent results in 2003, when flax yarn export exceeded import sixfold. However, this competitive strength decreased sharply, as in 2012 flax export exceeded import only threefold.



5301 Flax, raw or processed (a) *5306 Flax yarn* (b) *5309 Woven fabrics of flax* (c)

Source: authors' calculations based on the data of the Department of Statistics to the Government of the Republic of Lithuania

Fig. 3. **The RCA indices of Lithuanian flax commodity groups in 1996-2012**

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Research findings showed that the RCA of *5309 Woven fabrics of flax* significantly decreased during the analysed period and this commodity group lost its comparative advantage on international market from 2009. Finally, the RCA of *5301 Flax, raw or processed* did not illustrate the comparative advantage in international market.

The application of relative RCA indices is based on perceiving their limitations and lack of qualitative information; on the contrary, indices provide a useful insight into the export performance and further trends of a particular commodity as well as reveal the trade patterns that reflect both relative costs and differences in non-price factors.

The textile industry is one of traditional sectors of Lithuanian economy: flax and linen textiles are among the oldest industries in the country. The evident decline of flax industry export encouraged to analyse the factors which affected the actual results and processes. The Lithuanian flax industry covered the eleven flax processing companies as well as the research institutes in 2003. The main activity of Upyte Research Station of the Lithuanian Institute of Agriculture is flax and cereal seed production, breeding of the new fibre flax varieties. However, it is worth noticing that local flax growers do not take into consideration Upyte Research Station achievements, though competitors from Asia highly appreciate it, as it is known that the quality of Asian linen is worse if compared with European linen quality. Therefore, Chinese representatives bought the seeds of new flax varieties in Upyte Research Station and adapted them to China, where these new varieties are grown and processed. The processed flax fibre or produced linen cloth is imported back to Lithuania for further use, or finished linen items made in China create additional competition on export markets for Lithuanian linen textiles producers (Burvyte, 2013). Therefore, Lithuanian producers experience boomerang effect, which further reduces international competitiveness of Lithuanian flax and linen industries.

Earlier Lithuanian flax industry relied on local raw material, because the fibre flax used to be extensively cultivated crop in Lithuania. According to statistics, the fibre flax was cultivated in 96.3 thou. ha in 1939, about 30 thou. ha in 1980, and 22.3 thou. ha in 1990. Nowadays, the situation has changed radically. The main problem faced by flax industry is the drastic decrease in fibre flax cultivation. This is due to the fact that after Lithuania became a member of EU, the direct payments for flax crops decreased threefold, thereby, the fibre flax cultivation experienced the drastic downturn from about 10 thou. ha in 2003 nearly to 6 thou. ha in 2004, 250 ha in 2008, and only 8 ha in 2012 (Jagaite, 2012). Such a decline in flax crops influenced the growth of prices for flax fibres as well as flax yarn and linen textiles. Lithuanian companies experienced the increased pressure from foreign competitors, especially Asian ones, and flax weavers began to import the cheaper flax fibres and flax yarn. In contrast, while the fibre flax cultivation was among the main agriculture activities in Lithuania, the flax cultivation is very sensitive to climatic conditions like precipitation, and soil richness. The climate conditions are more favourable in the West coastal European countries and that is why fibre flax raw material is of poorer quality in Lithuania, though the soil quality flax cultivation is the best in Lithuania, Poland, and Belarus (Baronyte, 2013).

Though, the global production and demand for linen textiles is decreasing, still the linen products are very highly appreciated in high-income countries, like Japan, the Scandinavian countries, or the USA. The customers in these markets prefer high quality linen textiles, and there Lithuanian producers still have competitive advantage. Linen textiles are of increasing popularity among elderly Japanese customers who

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

pay special attention to the highest quality. Having in mind ageing society in the country, the market becomes especially attractive. Also other emerging markets with growing purchasing power and middle- and high-income class, like China, India and others could be potential markets, where Lithuanian linen textile could be capable to compete in high quality segment. However, the governmental support to Lithuanian producers to increase linen textiles export is inevitable. Export support could be oriented not only to support participation in international fairs and exhibitions but to the development of Lithuanian producers' own brand names and to the development of the general high-quality associated brand "Made in Lithuania".

Another issue related with the flax industry is the agrarian policy in Lithuania, where the question of larger EU support for flax cultivation is raised. The amount of payments to different agricultural spheres will be redeemed in 2014, so economic reason to increase support for flax cultivation should be grounded. As it was mentioned earlier, problems in flax cultivation are related with not so favourable climatic conditions, on the contrary, flax fibre processing companies have obsolete equipment that should be changed to modern ones. However, revitalised flax cultivation would have very positive effect on high unemployment rates in rural areas, as flax cultivation and processing are labour-intensive processes (Burvyte, 2013, Kniuksta, 2013). Policy makers in Lithuania should recognise that revitalised flax cultivation could help solve one of the state's strategic aims, namely, to reduce unemployment rate in rural areas. In contrast, the government assistance is required to promote flax and linen textiles exports to promising markets of Japan, Scandinavia, the USA, and emerging countries, where purchasing power and demand is increasing.

Conclusions

1. The decline of traditional flax industry's exports is actual issue to producers, scholars and policy makers, and calls for a reassessment of the factors that influenced flax industry's performance. The factors highlighted the market failures and imperfections in Lithuanian industry and insufficient abilities of companies to compete and flexibly adapt to the changes of decreasing global demand. This fact is confirmed by the analysis of Lithuanian trade-based indices.

2. Lithuanian exports of *5301 Flax, raw or processed* and *5309 Woven fabrics of flax* made small share of the world exports, 2.7% and 1.0% respectively in 2011. The export amounts of *5301 Flax, raw or processed* declined more than fourfold from 23.3 thou. t in 2004 to 5.3 thou. t in 2012. Accordingly, the export amounts of *5309 Woven fabrics of flax* decreased more than twice. The Lithuanian export performance of *5306 Flax yarn* was characterised by export share of the world exports which made 6.8% in 2008, while exports share decreased to 4.3% in 2011. The absolute export amounts of *5306 Flax yarn* declined from 7.9 thou. m^2 in 2006 to 3.3 thou. m^2 in 2012. The analysis of statistical data has shown Lithuanian exports decline of all flax commodity groups and cause for deeper discussions of flax industry development problems.

3. The estimation of the modified RCA index for Lithuanian flax industry's exports, which takes into account both export and import amounts, enables to determine the comparative advantages and to analyse the changes. The *5306 Flax yarn* is characterised by relatively high RCA values, this shows low import penetration into domestic market, while the index has obviously decreased during 2003-2012 from 84.7 to 51.7. Such a decrease was not a result of decreased competitiveness of Lithuanian flax yarn

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

producers but a result of diminishing production of this kind in Lithuania. The RCA of *5309 Woven fabrics of flax* significantly decreased from 66.6 in 1996 to only 2.6 in 2012 that shows Lithuanian producers lost competitive advantage in international markets. The RCA of *5301 Flax, raw or processed* does not illustrate the achieved comparative advantage on the global market.

4. the drastic decreasing of fibre flax cultivation is among significant factors, which influenced the decline of Lithuanian flax industry exports. The flax fibre and linen textile industry is resource-based industry, the fibre flax used to be extensively cultivated crop in Lithuania. After Lithuania became a member of EU, the direct payments for flax crops decreased threefold; while the flax crop has been reared in nearly 10 thou. ha in 2003 and only in 8 ha in 2012. Because of growth of cost for flax fibre, flax yarn and linen textiles, Lithuanian companies experienced the increased pressure of cheaper producers. This impacted the growth of imports of cheaper flax fibre and flax yarn. The cost differences are also based on fibre flax quality, while the climate conditions are more favourable in the West European countries and Asia.

Funding

This research was funded by a grant (No. IEP-01/2012) from the Research Council of Lithuania.

Bibliography

1. Amir, M. (2000). Export Specialization and Competitiveness of the Malaysian Manufacturing. Trends, Challenges and Prospects; Conference on International Trade Education and Research, Melbourne. Retrieved: http://www.apec.org.au/docs/ mahmood.pdf. Access: 25.10.2013.
2. Balassa, B. (1965). Trade Liberalization and Revealed Comparative Advantage. *The Manchester School of Economic and Social Studies*, Vol. 119, pp. 93-123.
3. Baltina, I., Siksnane, A. (2008). An Assortment and Foreign Trade of Bedding Items. *Material Science,* Issue 3, p.45-62.
4. Baronyte, V. (2013). Nostalgija melynziedziams linams (Nostalgia for Blue Blossom Flax). *Ukinininko patarejas, Nr. 83 (3040).*
5. Burvyte, M. (2013). Nedarba sunaikintu linininkyste (Flax Cultivation Could Wipe out Unemployment). *Vakaro zinios.* Retrieved: http://www.respublika.lt/lt/naujienos/ lietuva/ verslas /nedarba _sunaikintu_linininkyste/. Access: 11.12.2013.
6. Easson D. L., Cooper K. (2002) A Study of the Use of the Trimesium Salt of Glyphosate to Desiccate and Ret Flax and Linseed (Linum usitatissimum) and of its Effects on the Yield of Straw, Seed and Fibre. *Journal of Agricultural Science*, Vol. 138, p.p. 29-37.
7. Glinskiene, R., Daraskeviciute, B., Lipinskiene, D. (2006). The Tendencies of Strategic Industry Development in Lithuania. *Engineering Economics,* No 2(47), pp. 38-44.
8. Jankauskiene, Z., Bacelis, K. (2007). New Fibre Flax Variety 'Dangiai'. *Zemdirbyste / Agriculture*, Vol. 94, No 4 (2007), pp. 56–61.
9. Jagaite, R. (2013). Ar linu vieta uzims pluostines kanapes? (Will Hemp Take Place of Flax?) *Ukinininko patarejas, Nr. 84 (2889).*
10. Kniuksta, G. (2013). Ar sugris linas i Lietuva? (Will Flax Return to Lithuania?) *Verslas ir politika.* Retrieved: http://www.verslaspolitika.lt/ar-sugris-linas-i-lietuva/. Access: 23.11.2013.
11. Lafay, G. (1992). The Measurement of Reveal Comparative Advantages. International Trade Modelling, Chapman & Hall, pp. 209-234.
12. Laursen, K. (1998). Revealed Comparative Advantage and the Alternatives as Measure of International Specialization, Danish Research Unit for Industrial Dynamics, Working Paper 30, Copenhagen, Denmark. Retrieved: http://www3.druid.dk/wp/19980030.pdf. Access: 09.10.2013.
13. Mlangeni, T. (2000). Revealed Comparative Advantage in SADC Economies, South African Update. Trade and Industrial Policy Secretariat (TIPS), Vol. 5. Retrieved:

http://www.commerce.uct.ac.za/Economics/Programmes/postgraduate_programmes/masters/Specialisations/TRP/Research/sa_update5.pdf. Access: 20.10.2013.

14. Prasad, R. N. (2004). Fiji's Export Competitiveness: a Comparison with Selected Small Island Developing States. Reserve Bank of Fiji, Working Paper. Retrieved: http://rbf.reservebank.gov.fj/docs/WP%2004_06.pdf. Access: 20.10.2013.
15. Rada, E. L., Deloach, D. B (1942). The Oregon Fibre-flax Industry. With Particular Reference to Marketing. Oregon State monographs. Studies in Economics Number 3, July. Retrieved: http://ir.library.oregonstate.edu/xmlui/bitstream/ handle/1957/35336. Access: 28.10.2013.
16. Sampaio, S., Bishop, D., Shen, J. (2005). Physical and Chemical Properties of Flax Fibres from Stand-retted Crops Desiccated at Different Stages of Maturity. *Industrial Crops and Products,* Vol. 21, iss. 3, pp. 275-284.
17. Vollrath, T. L. (1991). A Theoretical Evaluation of Alternative Trade Intensity Measures of Revealed Comparative Advantage. *Weltwirtschaftliches Archiv*, 130, pp. 265-279.
18. Wonneberger, M., Vanfleteren, F. (2013). ECO/10/277239 CAYLEY Project Presentation. Innovative Composites Summit. Sustainability Conference, Paris, March 14, 2013. Retrieved: http://www.cayley.eu/fileadmin/cayley/media/docs/JEC%20Europe%2003-2013.pdf. Access: 25.10.2013.
19. Zotikova, O, Zotikov, A. (2009). Analysis of Chemical Fibre Product Production. *Fibre Chemistry,* Vol. 41, Issue 3, pp. 214-219.

CHANGE OF THE POSITION OF POLISH AGRICULTURE IN RELATION WITH THE EUROPEAN UNION IN LIGHT OF THE AGRICULTURAL CENSUSES OF 2002 AND 2010[1]

Antoni Miciewicz[2], PhD, professor**, Bartosz Mickiewicz[3],** PhD, professor
West Pomeranian University of Technology in Szczecin

Abstract. The main aim of this paper is to present the position of Polish agriculture in comparison with the EU as well as the changes that occurred between the agricultural censuses of 2002 and 2010. The study shows that between the agricultural censuses the position of Polish agriculture did not fall, while it improved in many areas. Polish agriculture can be ranked on the 4th-5th position among the EU countries, which in relation to all 27 states of the Community constitutes a relatively high position. Agrarian structure has improved in Poland; although, not as much as it did in the EU. Farm holding fragmentation was accompanied by agrarian overpopulation, while the holding of small farms served farmers as an element of social security. The productivity of Polish agriculture was low, which was shown through the crop and yield volumes of major agricultural products.

Key words: position of agriculture in comparison with the EU, agrarian structure, agricultural population, plant and animal production.

JEL code: Q18

Introduction

In 2004, Poland along with the remaining nine countries became a European Union member. The process of integration was accompanied by both fears and hopes, which can be best evaluated from the perspective of years passed. Agricultural producers evolved from the position of a local farmer to the position of a European farmer, gaining both in prestige and respect as producers of good quality food, which was in high demand among the European consumers. Integration processes required farmers to adopt the principle of economic activity transparency through the disclosure of their assets, starting with the surface of a farm, the structure of crops, the number of livestock owned, and ending with the production methods and observance of good farming practices (Oskam A., Meester G., Silvis H, 2010).

The process of adapting Polish agriculture to the EU requirements has been a long-term phenomenon that has not been completed yet. The process comprised a number of actions which were undertaken in order to achieve a new quality of life in rural areas. Farmers went through various phases of the adaptation, starting with education activities, through absorption of the EU funds and alignment processes (Mickiewicz, 2011). The CAP reform was designed to reduce traditional forms of support for agriculture, and it aimed at satisfying new social expectations, such as protection of the environment,

[1] The research project was financed from the funds of the National Science Centre
[2] Corresponding author. Tel.: +48 9144 96980; fax: +48 9144 96980
E-mail address: Antoni.Mickiewicz@zut.edu.pl
[3] Corresponding author. Tel.: +48 9144 96980; fax: +48 9144 96980
E-mail address: Bartosz.Mickiewicz@zut.edu.pl

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

landscape, or biodiversity. The concept of sustainable development of agriculture was implemented with simultaneous emphasis on the increase of farm competitiveness, catching up with the developed EU Member States (Baum, Wielicki, 2007).

The main aim of this paper is to present the position of Polish agriculture in comparison with the EU as well as the changes that occurred between the agricultural censuses of 2002 and 2010.

The tasks of the research aimed at determining a change in the position of Polish agriculture. In order to demonstrate more distinctly the position of Polish agriculture, some of the census results were presented in comparison with selected large-scale production farms of the EU states, namely, those of France, Spain, and Germany. In respect of the arable land surface, they occupy 73.9 million ha which constitutes 39.2% of total farmland in the EU. In terms of population percentage, these three countries constitute 11.1% of total population of the EU members (EU-27). Selecting countries of higher level of development for confrontation was intentional, since it was meant to demonstrate the position which Poland currently occupies and the directions of changes in which it needs to progress in order to obtain the designation of a developed agriculture.

Research object and methods

The data gathered in the national agricultural censuses of 2002 and 2010 provided the fundamental source for this paper. The agricultural census of 2002 was conducted in 10 countries of the Central-Eastern Europe that aspired to becoming members of the European Community. The European Commission wanted to find out the characteristics of agriculture and its socio-economic condition in order to ensure adequate financial support, intended to align production level and strengthen neglected regions and those lagging behind. The General Agricultural Census of 2010, in turn, was the first census conducted since Poland joined the European Union, performed on the same date and in the same scope of subject matter as in other EU Member States. The data gathered through the agricultural census enabled an analysis of changes that occurred in Polish agriculture before and after the EU accession and their comparison with the data on farms in other Member States. They were to provide detailed information on entities operating in agriculture, socio-demographic and economic situation of farmers, and conducted agricultural activity. In combination with the information accumulated in a study of agricultural production methods and in the National General Census of 2011, the data were to provide an answer to numerous questions regarding, inter alia, the aging of rural population and the problem of successors, employment in agriculture, rural areas, and the impact of the agriculture on the environment. The General Agricultural Census of 2010 was conducted in order to provide a database on agricultural holdings and homesteads associated with them, which was necessary for the implementation of national, regional and local agricultural and social policy in the countryside and in order to analyse the changes that occurred in agriculture in the course of 2002-2010.

Research results and discussion

General description of the position of Polish agriculture in relation with the EU

The historical process of adapting Polish agriculture to functioning in the EU was conducted on conditions of diversified production factors which were being shaped by the Common Agricultural Policy.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

In 2004, ten new Member States (NEU-10) joined the previous 15 EU members (EU-15). It altered the operating conditions of the Common Agricultural Policy, which needed to change certain rules of its implementation, for instance, how to introduce a new mechanism of implementing direct subsidies (for example, SPS and SAPS). At the time of integration, the EU-15 states held 72.5% of the Community farmland, and in a one-off act of accession the EU accepted 10 new members, holding 27.5% of farmland. This simultaneous acceptance of such a large number of countries was as unprecedented yet. Later, a small number of countries was typically accepted, e.g. in 2007 − Bulgaria and Romania, while in 2013 − Croatia.

European countries feature quite varied soil and climatic conditions and eating habits; hence, it is difficult to attempt a direct comparison of agriculture of individual countries. This specificity has an impact on agricultural production, while climatic zones contribute to undertaking different agricultural production, for instance, in the North of Europe in comparison with the South of Europe. Poland lies in moderate climate zone and it has none too fertile soils that require substantial expenditure of labour and means of production.

Table 1

Poland's share and position in the European Union

Item	Poland's share in %		Poland's share in the EU	
	2002	2010	2002	2010
Surface of farmland	9.7	7.2	6	5
Agricultural population	24.8	26.0	1	1
Production of certain agricultural articles, of which				
Wheat	8.9	6.8	4	4
Rye	43.5	36.7	1	2
Barley	7.0	6.4	6	5
Potatoes	32.9	14.2	1	2
Sugar beet	11.4	9.6	3	3
Rape and agrimony	10.2	10.2	4	4
Animal production				
Meat	8.6	8.3	6	5
Milk	9.7	8.3	4	4
Eggs	9.2	9.1	7	7
Stock population				
Number of cattle	6.9	6.4	7	7
Number of pigs	15.2	10.0	3	3

Source: Statistical Yearbooks of Agriculture, 2012

Basic factors of production include soil, which nationwide occupied 15.6 million ha of farmland, which gave Poland the fifth position in the EU, following France (29.3 million ha), Spain (27.7 million ha), the

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

UK (17.3 million ha), and Germany (16.9 million ha) In 2010, Poland's share decreased from 9.7% to 7.2% in the scale of the entire European Union, owing to the fact that subsequent two countries accessed in 2007, i.e. Bulgaria (5.0 million ha) and Romania (13.5 million ha). The share of farmland per one inhabitant in Poland was equal to 0.33 ha and it was higher than in the entire EU-27 (0.22 ha).

Table 2

The use of farmland in selected EU countries (in million ha)

Item	2002	2010	2002	2010	2002	2010	Arable land in 2010	
	agricultural land in mln ha		arable land		meadows and pastures		per 1 inhabitant in ha	in % of total surface
European Union	198.9	188.4	114.9	108.8	71.1	67.6	0.22	25.1
France	29.7	29.3	18.4	18.3	10.1	9.9	0.29	33.4
Spain	29.8	27.7	13.5	12.5	11.5	10.5	0.27	24.7
Germany	17.1	16.9	11.8	11.9	5.0	4.7	0.14	33.3
Poland	17.8	15.6	13.7	12.1	3.2	3.9	0.33	38,7

Source: Statistical Yearbooks of Agriculture of the particular years, 2012

Moving on to an overview of the general position of agriculture in comparison with the EU, only two types of production, namely, that of rye and potatoes, gave Poland high (1^{st} or 2^{nd}) places on the European scale. Polish share of rye is equal to 36.7% of that plant crop, while the share of potatoes is 14.2% respectively. The harvest of sugar beet (9.6%) as well as that of rape and agrimony (10.2%) can be classified as a substantial share in total crops. Poland held a rather high position (4^{th} place) in milk production but the possibilities of any further growth were limited by milk production quota. On the European scale, Poland also kept a relatively high number of pigs (3^{rd} place).

Preliminary analysis of the position of Polish agriculture in the EU in global numbers demonstrates that the country maintained the position it had held prior to Poland's accession to the EU. Polish agriculture among the EU states can be ranked as the 4^{th}-5^{th}, which in relation to all 27 states of the Community is a relatively high position. The position of Polish agriculture is owed to a relatively vast surface of agricultural land with poor land concentration, high resources of labour force, low objectification of work, and low level of production means used, achieving small productivity and low scale of agricultural income. However, this analysis must not lead to an incorrect conclusion that nothing changed in that position during the inter-census period. Polish agriculture underwent deep restructuring and modernisation, the EU law was implemented, the EU subsidies for agriculture were introduced, and an obligation of respecting cross compliance was imposed on farms which ensured the supply of healthy food. The transformation of agriculture created favourable conditions for adoption of innovations, introduction of changes in production profile, and a shift towards the goods economy linked to the market.

Agrarian structure of farms

Agrarian structure is a distribution of small holdings according to their size, assuming that land is the decisive production factor, while the remaining factors are correlated with it linearly. Agrarian structure

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

constitutes "the supporting structure" on which farms rest, creating jointly the fundamental elements of rural areas. Agrarian structure contains in itself, as if in a lens, the entirety of ownership relations and principles of agricultural production organisation in connection with the agricultural market. It tells of the system of land management, the size of a production unit, and it characterises legal and economic elements affecting the positing of a family farm owner (Mickiewicz, 2012).

In all the European Union countries there were 7.9 million farms, which in comparison with 1.5 million farms in Poland, constituted 18.9% of the entire share in that number. The share was higher than the one for the surface of agricultural land (8.3%), which is a proof for agricultural fragmentation. Polish agriculture represents family type farms, which are frequently owned by multi-generational families, with no chance of changing the present state. Disposal by farmers of small agricultural holdings constituted an element of their social security.

Table 3

Farms according to area group (in thou.)

Item	2002					2010				
	total	up to 5 ha	5-20	20-50	50 and more ha	total	up to 5 ha	5-20	20-50	50 and more ha
European Union	14482	10349	2615	826	693	7876	4654	1910	700	613
%	100.0	71.5	18.0	5.7	4.8	100.0	59.1	24.2	8.9	7.8
France	567	147	110	110	200	516	139	97	88	192
%	100.0	26.1	19.4	19.4	35.1	100.0	24.1	17.2	15.3	33.3
Spain	1079	577	291.0	111	100	990	526	253	108	104
%	100.0	53.5	26.9	10.3	9.3	100.0	53.1	25.5	10.9	10.5
Germany	390	88	129	889	84	299	27	111	76	85
%	100.0	22.6	33.1	22.8	21.5	100.0	9.1	37.1	25.4	28.4
Poland	2477	1751	608	97	21	1507	831	554	95	27
%	100.0	70.7	24.5	3.9	0.9	100.0	55.1	36.8	6.3	1.8

Source: Statistical Yearbooks of Agriculture, 2012

In the scale of the entire European Union, positive phenomena include a constant decrease in the number of farms, which amounted to 45.6% in the analysed period of 2002-2010. It needs to be understood as a desire for land concentration aimed at a more rational use of means of production. The decrease in the number of farms in Poland was lower and it was equal to 39.2%. In Poland, farm fragmentation is also the highest of all the EU, owing to the fact that large-scale production farms falling into 20-50 ha and over 50 ha categories jointly amounted to 8.1%, while the EU average in this respect was 16.7%. The examples of France and Germany cited here hold 48.6% and 53.8% in these size categories, respectively. The farming model of agriculture preferred in those countries demonstrates a growing trend, which in the future will also likely to spread to Polish agriculture (Mickiewicz, 2012).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The territorial structure of farms in the EU showed great differences. Average surface of an agricultural holding in the EU was 18.4 ha. The smallest farms were found in Greece (4.3 ha) and Italy (6.4 ha). In relation with Poland (10.6 ha), Portugal and Lithuania had farms of similar sizes (9.3 ha and 9.2 ha respectively).

Human factor in Polish and in the EU agriculture

The European Union attaches great significance to farmers' professional qualifications, their level of education, system of further education, and the age of individuals managing production entities. The factors of agricultural production, namely, soil, capital and labour, do not exhaust all the economic categories. Researchers are becoming increasingly convinced that the factor of labour needs to be reinforced with an additional element in the form of the so-called human factor, which in certain publications is promoted to the fourth, independent factor of production (Wawrzyniak, Wojtasik, 2001). The labour factor accumulates a variety of labour attributes in the forms of roles and functions fulfilled, human resources, and intellectual potential expressed through level of education as well as occupational skills and experience. The human factor has adaptive, and at the same time, creative capabilities, enabling quick adaptation to changing agricultural environment (Paszkowski, 2007).

Table 4

Agricultural population and professionally active population (in thou.)

Item	Agricultural population				Population professionally active in agriculture			
	2002		2010		2002		2010	
	in thou.	in % of total population	in thou.	in % of total population	in thou.	in % of total population	in thou.	in % of total population
European Union	30971	6.4	21745	4.3	14955	3.1	10714	2.1
France	1976	3.3	1271	2,0	878	1.5	573	0.9
Spain	2934	7.3	2038	4.4	1339	3.3	1015	2.2
Germany	2066	2.5	1295	1.6	1016	1.2	661	0.8
Poland	7270	19.0	5658	14.8	3763	9.8	2960	7.7

Source: Statistical Yearbooks of Agriculture, 2012

Over the period of 2002-2010, the size of agricultural population in the European Union fell from 30.9 million to 21.7 million people which constituted 29.8%. An even greater drop was recorded in Germany amounting to 37.3%. In turn, the number of agricultural population fell by 22.2% in Poland. An analysis of the population professionally active in agriculture offers a wider view of the results. Professional activity in agriculture is interpreted as a fact of performing work on a farm. A decrease of the population professionally active in agriculture in the scale of the entire EU in the analysed period was equal to 28.4%, while the figure stood at 21.3% in Poland. When in the European Union, professionally active population in relation with the total of agricultural population amounted to 2.1%; in Poland, that relation

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

stood at 7.7%. It shows the distance existing between Poland and the developed countries. Furthermore, labour force in Poland continued to play a significant role in view of high fragmentation of farmsteads and low labour objectification.

A global trend demonstrates an increase of agricultural production, which is achieved not through higher involvement of labour force but through the implementation of modern techniques and technology.

The process of decreased employment was accompanied by the phenomenon of even greater reduction of the share of agriculture in creating the national income (GDP); whereas, a comparison of that ratio frequently constitutes the basis for declaring low agricultural production efficiency. With an average share of agriculture in the creation of the GDP amounting to 1.7% in the EU, the share was twice as high in Poland and it was equal to 3.5%.

Characteristics of plant production

On account of its characteristics, plant production constitutes the basis for setting the directions of development of widely understood agricultural production. In the hierarchy of importance, it occupies the first position before animal production, because it defines and sets its volume by providing adequate amount of animal feed and other components necessary for the functioning of the entire farmstead. Although, there are farms without livestock in agriculture; though, only in case of factory farms do we observe the phenomenon of managing without land, own animal feed and raw material base (Adamowicz, 1998).

A general proposition can thus be made, namely, that the basis for the entire agriculture is provided by plant production, which through the phenomenon of photosynthesis, the use of soil and other natural resources, enables the production of food and raw materials in a renewable fashion for further processing and animal feed.

An analysis of plant production demonstrates the dominant position of grains in the crop structure which constituted 52.8% in relation with the surface of arable land. The share of grains in the analysed countries was varied, i.e. the surface of grains in relation with arable land in France occupied 53.4% of land, in Spain - 47.9%, in Germany - 55.4%, and in Poland - 63.1%. The surface of potato crops holds a dominant position in Poland, although, in terms of total crops Poland takes the second position following Germany. As a result of a deep reform of the sugar beet market, aimed at opening the way for imported sugar, sugar beet cultivation fell in all the EU Member States; however, it continues to maintain a high position in France (30.7%) and Germany (22.9%). Together with Poland, the three countries produce jointly 63.0% of the crop in the entire EU. Eight relatively small countries completely abandoned sugar beet production (Bulgaria, Cyprus, Estonia, Ireland, Luxembourg, Latvia, Malta, and Slovenia), while sugar beet crops are of marginal importance in the remaining countries.

The crops of agricultural products varied depending on the analysed plant. The highest position belonged to grains, which during the analysed period showed an increase in the entire European Union at the level of 8.6%, while in Poland the increase was equal to 14.1%. Nevertheless, a comparison of grain crops obtained in Poland against the EU shows the distance that separates Poland from the leading EU Member States. For instance, grain crops in Belgium reached the level of 92.5 dt/ha, the Netherlands – 85.7 dt/ha, Ireland – 74.1 dt/ha, and at the same time the results demonstrate a potential for growth of grain yield.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 5

Surface, crop and yield of selected plants

Item	Surface in thou. ha in 2010	2002	2010	2002	2010	Share in the EU in % in 2010
		crops in mln tonnes		yield from 1 ha in dt		
grains in total						
European Union	57458	277,9	283,4	45,4	49,3	100,0
France	9769	65,7	68,3	72,4	69,9	24,1
Spain	5984	24,6	19,3	36,1	32,3	6,8
Germany	6596	45,3	44,3	64,5	67,2	15,6
Poland	7638	22,3	27,2	25,3	35,6	9,6
potatoes						
European Union	2018	83.6	57.5	256	285	100.0
France	168	6.4	7.2	396	431	12.6
Spain	77	3.1	2.2	259	295	4.0
Germany	255	13.7	10.2	450	400	17.7
Poland	388	24.2	8.2	194	211	15.2
sugar beet						
European Union	1587	137.4	104.1	552	658	100.0
France	383	31.1	31.8	759	831	30.7
Spain	44	7.9	3.4	633	767	3.3
Germany	367	27.8	23.8	617	650	22.9
Poland	206	13.1	9.7	394	483	9.4

Source: Statistical Yearbooks of Agriculture, 2012

The possibilities of improving sugar beet yield are significant, be it only on the example of an analysis of the yield obtained in Belgium (753 dt/ha), the Netherlands (748 dt/ha), and Austria (698 dt/ha), with Polish results of 483 dt/ha.

Volume of animal production in selected EU countries

Animal production is integrally linked with widely understood agricultural production and it constitutes its inseparable part, ensuring statistical balance of production factors. The significance of animal production needs to be considered through the prism of functions it fulfils. External factors of animal production include its importance for the operation of a farm by supplying food to a homestead, ensuring the use of animal feed and ensuring soil fertility. It is further compounded by multi-purpose use of animals in the form of meat, milk, fibre, eggs, leather etc. External factors of animal production also include commercial production delivered to the market, typically in unprocessed form. This role is taken over by specialised agro-food processing plants (Shucksmith, Thomson, Roberts, 2005).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 6

Livestock population and density

Item	2002	2010	2002	2010	Share of the EU in % in 2010
	in thou. ind.		per 100 ha UR in ind.		
cattle					
European Union	97636	89442	49.1	47.5	100.0
France	20311	19621	68.4	67.0	21.9
Spain	6217	6075	20.9	21.9	6.8
Germany	14658	12810	85.9	75.9	14.3
Poland	6083	5761	34.1	37.2	6.4
pigs					
European Union	159796	152610	80.3	81.0	100.0
France	14930	14532	50.3	49.7	9.3
Spain	22418	25343	75.3	91.6	16.6
Germany	25633	26509	150.2	157.0	17.4
Poland	17122	15278	96.0	92.2	9.7
sheep					
European Union	122674	99863	61.7	53.0	100.0
France	9578	7977	32.2	27.3	8.0
Spain	23965	18552	80,5	67.0	18.6
Germany	2743	2089	16.1	12.4	2.1
Poland	362	258	2.0	1.6	0.3

Source: Statistical Yearbooks of Agriculture, 2012

Cattle played a significant role in animal production, since next to slaughter cattle, cows provide equally valuable milk. In general, cattle population fell during the analysed period by 8.4%, and the decrease concerned more or less all Member States. Apart from the countries listed in the table, the UK (11.2%) had a dominant position in the cattle population market, being jointly responsible for 60.7% of slaughter cattle and milk in the European Union. Total milk production decreased from 155.4 million tonnes in 2002 to 147.4 million tonnes (by 5.4%) in 2010, while the dominant position in the milk market was still occupied by Germany (20.1%), France (15.8%), and the UK (9.6%), with Poland taking the 4th place at 8.3%.

The result of stock-farming is production of meat from slaughter, which found various directions of distribution. During the analysed period, meat production from slaughter grew slightly from 43.1 million tonnes to 44.7 million tonnes (by 3.8%). In turn, the level of the production per inhabitant remained similar.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 7

Production of meat from slaughter in selected EU countries

Item	2002	2010	2002	2010	share in the EU in %
	in thou. tonnes		per 1 inhabitant in kg		
European Union	43141	44771	89.6	89.4	100.0
France	6502	57163	110.1	93.0	13.0
Spain	4910	5338	121.9	115.8	11,9
Germany	6252	8224	75.9	99.9	18.4
Poland	2887	3727	75.4	96.8	8.3

Source: Statistical Yearbooks of Agriculture, 2012

Among the countries analysed, Poland was the only one to have recorded a significant rise in the production of meat from slaughter from 6.2 million tonnes to 8.2 million tonnes (by 22.5%), most of which was export.

Conclusions

For Polish agriculture, Poland's accession to the European Union in 2004 constituted a significant change of socio-economic conditions of production and it translated into a different approach to the paradigm of operation of the institutions associated with rural areas. The changes were deep and they encompassed major rules of support for agriculture through the implementation of the financial instruments of the Common Agricultural Policy, which led to the establishment of new operating principles of agricultural market, foreign trade barriers were lifted, new rules of intervention and buying went into effect, and above all, means of support programmes for rural areas and direct subsidies were initiated. The deep changes meant that rural development policy was not only implemented through support of agriculture but also through a number of actions involving stimulation of entrepreneurship, competitiveness, actions related with environment protection, and infrastructural undertakings.

In light of the conducted comparative analysis, both in relation with the European Union and the leading EU countries, Poland, in principle, maintained its position, despite strong competition from many countries of the European community. The factors the prevent Poland from overcoming the competition include historical reasons that shaped Poland's agriculture, considerable agrarian fragmentation, high degree of production for own needs with a low level of commercial production as well as low degree of competitiveness and innovativeness. The level of financial support from the CAP, which in the new Member States remained lower, particularly in respect of direct subsidies, was also a significant factor. Another barrier to quick modernisation and restructuring of agriculture was the requirement of adopting the EU law, which caused the need to reorganise previous methods of production and farm management, while observing good farming practices, maintaining biodiversity, and ensuring mutual compliance, which prevented implementing too intensive methods of farming.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The EU-15 states had been functioning under the rules resulting from the common agricultural policy for over 50 years, gaining from its resources not only financial support instruments but also rules of conduct and legal standards. Poland along with other countries, when it acceded the EU, encountered a period of deep CAP restructuring, which undertook maintaining production levels at unchanged level as its mission but it attributed a lot of attention to the need of maintaining food safety, human and animal welfare, conserving landscape, and green area enclaves. On the one hand, the analysis showed what potential productivity possibilities exist in agriculture, while on the other hand, one needs to realise that such results can never be achieved on Polish soil and climatic conditions.

Bibliography

1. Adamowicz, M. (1998). Rolnictwo swiatowe, Encyklopedia Agrobiznesu (World Agriculture, Business Encyclopedia), In: Fundacja Innowacja, Warszawa, p. 368
2. Buam, R., Wielicki, W. (2007). Prognoza przeobrazen w rolnictwie do roku 2030 w kontekscie zrownowazonego rozwoju (Prognosis of Changes in Agriculture until 2030 in Context of Sustainable Development), In: Wies i Rolnictwo, nr 1, Warszawa, pp. 123-132.
3. Mickiewicz, B. (2011). Tendencje zmian poziomu wyksztalcenia ludnosci rolniczej i sposobow kierowania gospodarstwem rolnym (Tendencies of Education Level Changes of Rural Inhabitants and Ways of Farms Management), In: Stowarzyszenie Ekonomistow Rolnictwa i Agrobiznesu, nr. 1, Poznan, pp. 88-96.
4. Mickiewicz, B. (2012). Kierunki zmian produkcji roslinnej w swietle powszechnego spisu rolnego z 2002 i 2010 (Directions of Changes of Plant Production According to Common Agricultural Index from 2002 and 2010). In: Determinanty rozwoju regionow w Europie, Społeczenstwo, Gospodarka, Turystyka, Poli Druk Poznan, pp. 220-229.
5. Mickiewicz, B. (2012). Charakterystyka produkcji zwierzecej w swietle powszechnego spisu rolnego z 2002 i 2010 (Characteristic of Animal Production According to Common Agricultural Index from 2002 and 2010). In: Problemy Rolnictwa Swiatowego, SGGW, Warszawa, pp. 176-181.
6. Oskam, A., Meester, G., Silvis, H. (2010). EU Policy for Agriculture, Food and Rural Areas, In: Agricultural University, Wageningen, p. 439.
7. Paszkowski, S. (2007). Kwalifikacje rolnicze jako instrument oddzialywania na ustroj rolny w Polsce (Agricultural Qualifications as Instrument of Pressure on Rural Law in Poland), In: Wies i Rolnictwo, nr 1, pp. 215-221.
8. Rocznik statystyczny rolnictwa i obszarow wiejskich (Statistical Yearbook of Agriculture and Rural Areas), 2005. In: GUS, Warszawa, p. 543.
9. Rocznik statystyczny rolnictwa (Statistical Yearbook of Agriculture), 2012. In: GUS, Warszawa, p. 378.
10. Shucksmith, M., Thomson, K. J., Roberts, D. (2005). The CAP and the Regions: the Territorial Impact of the Common Agricultural Policy. In: CABI Publishing, London, p. 289.
11. Wawrzyniak, B. M., Wojtasik, B. (2001). Kategoria poziomu wyksztalcenia jako wskaznik aktywnosci ekonomicznej ludnosci wiejskiej (Category of Education Level as Factor of Economic Activity of Rural Population). In: Rola agrobiznesu w ksztaltowaniu jakosci zycia, AE, Wroclaw, pp. 36-45.

IMPORTANCE OF HORIZONTAL INTEGRATION IN ORGANIC FARMING

Adam Pawlewicz[1], PhD

Department of Agribusiness and Environmental Economics, University of Warmia and Mazury in Olsztyn, Poland

Abstract. The paper presents the importance of horizontal integration in organic farming, according to opinions of the owners of farms specialising in production of organic food raw materials and operating in Warminsko-Mazurskie province in Poland. The research was conducted using both an opinion poll and participant observation among 297 randomly selected respondents. In Poland, organic farming has been developing rapidly in the recent years. The number of both producers of food raw materials, along with the acreage of agricultural area, and of processing plants has been on the increase. Moreover, groups of producers of organic food raw materials are being established. However, commodity production falls behind, and the market for organic foodstuffs is developing slowly. The main factor affecting organic farming is the agro-environment payment scheme. It has been demonstrated that the process of horizontal integration in organic farming also has an important role, since, according to the research, in the opinion of organic farm owners, such a measure is an important factor for organisation of the market for both organic food raw materials and organic food products. It contributes to the concentration of supply, which allows increasing the economic effectiveness of farms owned by members of producer groups through higher selling prices as well as lower prices of the purchase of means of production. At the same time, it allows reducing the prices being offered to consumers. On the contrary, forming associations entails certain limitations which may restrain activities being undertaken by producer groups.

Key words: horizontal integration, cooperation, organic agriculture, economic development.

JEL code: D22, L11, O13, Q12, Q13, Q18

Introduction

The main problem of producers of food raw materials (including organic ones) is the fact that the competitiveness of an individual farmer on the market is low. This primarily results from the small batches of goods being usually offered by the farmer, which leads to a barrier to individual farmers' influence on the selling prices of their products, and thus, their income. Unfortunately, this contributes to formation of prices of both products from agricultural farms and means of agricultural production, virtually without participation of the farmers. Additionally, as for the market for organic foodstuffs, prices are higher than those of conventional products which results in this sector being a niche market.

At the same time, it needs to be borne in mind that consumers are not willing to accept substantially large price differences between organic products and conventional ones, and, additionally, the accepted differences between prices of those products have recently been on the decrease (Runowski H., 2009). An important form of the rationalisation of production of food raw materials (including organic ones), tackling the effects of the fragmentation of farms, obtaining reliable market information, and, primarily,

[1] Corresponding author. Tel.: +48895233313; fax: +48895233775
E-mail address: adampawl@uwm.edu.pl

the concentration of supply of agricultural products, is horizontal integration, primarily in a form of farmers' associations. Horizontal integration in agriculture is a process of establishing economic ties between farms producing agricultural products in the same category. In this case, however, full (capital) integration is not being implemented, since only selected measures, such as joint sales, marketing and promotion, are being taken jointly (Kapusta F., 2010). This is an effective manner of mitigating the market-related consequences of small-scale production and the high heterogeneity thereof, and for organic farming, also the existing niche-nature of this market.

An additional problem in the market of organic food raw materials is the small number of entities on the supply side, i.e. both agricultural producers and processors. The currently observed increase in the number of organic farms is mainly associated with the opportunity for receiving higher direct payments than in the case of conventional agriculture which results in a proportion of these entities failing to participate in market exchange (Pawlewicz A., 2007; Jarecki W., Borawski P., 2008; Bobrecka-Jamro D., Romaniak M., 2013). The main forms of farmers' cooperation include producer groups, marketing groups, and cooperatives[2]. These are supposed to include group production (it needs to be noted that each member of a producer group is engaged on their own in the production process in accordance with the all-group guidelines and standards), storage, processing, trading, and supply.

The basis for considerations and analyses in this paper is the argument that in the opinion of organic farm owners, horizontal integration is an important factor in the process of organisation of the market for organic food raw materials, and contributes to the concentration of supply as well as to increasing the economic effectiveness of associated farms, and that the organic farm owners' level of knowledge in this field is high. The truth of this argument is proved by the fact that over the recent couple of years in Poland, both the number of organic farms and processing plants as well as the number of groups of producers of organic food products, has been on the increase. This may also be evidenced by the increasing demand for foodstuffs produced from organic raw materials. Therefore, there is a basis for horizontal integration of agricultural farms in a form of group entrepreneurship, which is supposed to reduce negative market consequences in this sector, namely, the lack of the concentration of supply of agricultural products, the absence of market information, and the fragmentation of farms.

As regards organic farming in Poland, for several years one has been observing both a rapidly increasing number of certified farms and an increasing acreage of organic agricultural area; however, those values continue to be not significant market-wise. According to the Main Inspectorate of Agricultural and Food Quality Inspection (*GIJHARS*), there were 23,449 organic producers being engaged in production of food raw materials at the end of 2011 (both after the conversion from conventional production into organic production, and during the conversion) (*Number of Organic Producers* ..., 2012). This only accounted for 1.04% of the total of 2,253,135 farms in Poland which ranks Poland the third among the EU Member States after Italy (45,852) and Spain (30,462) (Statistical Yearbook..., 2012). In turn, in terms of the acreage of agricultural land, the acreage of the land being utilised in an organic manner amounted to 605,519.61 ha (*The Area of Organic Agricultural Land*..., 2012), which accounted for slightly more than 3% of agricultural area in Poland. On the contrary, horizontal integration in this sector is only just developing. The number of producer groups in Poland, being engaged in production of

[2] All organisational and legal forms are referred to, both commonly and in official documents (e.g. RDP), as Agricultural Producer Groups (APGs). The designation "producer groups" generally refers to the idea of the association-forming agricultural producers

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

organic food raw materials, amounted to 7 entities at the beginning of 2013 (in the total number of 1,255 producer groups, one entity has appeared since 2011) (*List of Groups*..., 2013). In contarst, in terms of the market, certified foodstuffs accounted for only 0.3% of sales of food products. It should be borne in mind, however, that in the countries where the analogous market is well-developed, the percentage of organic foodstuffs accounts for only 4-5% (*The Organic Food Market*..., 2013).

The object of the research were the owners of organic farms in Warminsko-Mazurskie province which sold organic food raw materials on the market, and the subject of the research were their opinions and data on farms. The basis for selection of entities for the research was "*List of Agricultural Producers in Organic Farming in 2011, in Warminsko-Mazurskie province*"[3]. According to this source, there were 1,438 registered agricultural farms in Warminsko-Mazurskie province after the conversion period was completed. On the national scale, this accounted for nearly 10% of organic farms, which ranked Warminsko-Mazurskie province third among the total of 16 provinces.

The aim of the paper is to present the importance of horizontal integration in organic farming in Poland. The base of information was opinions of the 294 owners of farms specialising in production of organic food raw materials, operating in Warminsko-Mazurskie province in Poland. The paper focused on three issues. The first one is a short description of respondents and their farms. The second one is the respondents' opinions on the need to organise such entities, while the third one is a discussion on the benefits and inconveniences to be possibly experienced by potential members of producer groups.

As already mentioned, a very large proportion of farms is only being converted due to the opportunity for receiving higher agro-environment payments than those under the conventional scheme. However, this process is not accompanied by an increase in commodity production. With such an assumption, the list was verified in the first phase of the selection of entities for the research. On the basis of description of the specialisation of activity (type of crop/type of livestock/type of product) and the indications of agricultural advisors from the Warminsko-Mazurski Agricultural Advisory Centre (*W-MODR*) in Olsztyn, the following were excluded from the research: farm owners with no contacts with the market for organic food raw materials, and those being engaged in organic production for their own needs (e.g. animal feeds) or who only owned grassland. As it turned out, there were over 60% of such entities. Therefore, the research population included 575 owners of organic farms. In the second phase of the selection of the research sample, 294 entities were selected for the research as a representative group (a permissible error of 4% with the significance level $\alpha = 0.05$). The measurement was performed in late March and early April of 2013.

For the purpose of the research, the interview method was used along with a standardised questionnaire. Additionally, the participant observation was used, where the researcher becomes both an observer and a participant of the group under research by which he/she is accepted. This allowed the verification of some disadvantages of the selected research method in accordance with the principle of scientific objectivity and obtaining reliable information.

[3] List of Agricultural Producers in Organic Farming in 2011, in Warminsko-Mazurskie province (Wykaz producentow rolnych w rolnictwie ekologicznym – 2011 r. – wojewodztwo warminsko-mazurskie. The list as made available includes data on producers as communicated to the Main Inspector of Agricultural and Food Quality (GIJHARS) by authorised certification bodies in accordance with Article 9(1)(2) of the Act of 20 April 2004 on organic farming (Journal of Laws No 93, item 898, as amended); the list being most up-to-date for the period of the measurement (Issue 5 of 15 March 2012)

Methods of tabular and descriptive statistics were mainly used for the purposes of the paper and analysis of the collected materials. The paper also used the generally available secondary data, namely, information included in the literature and source documents.

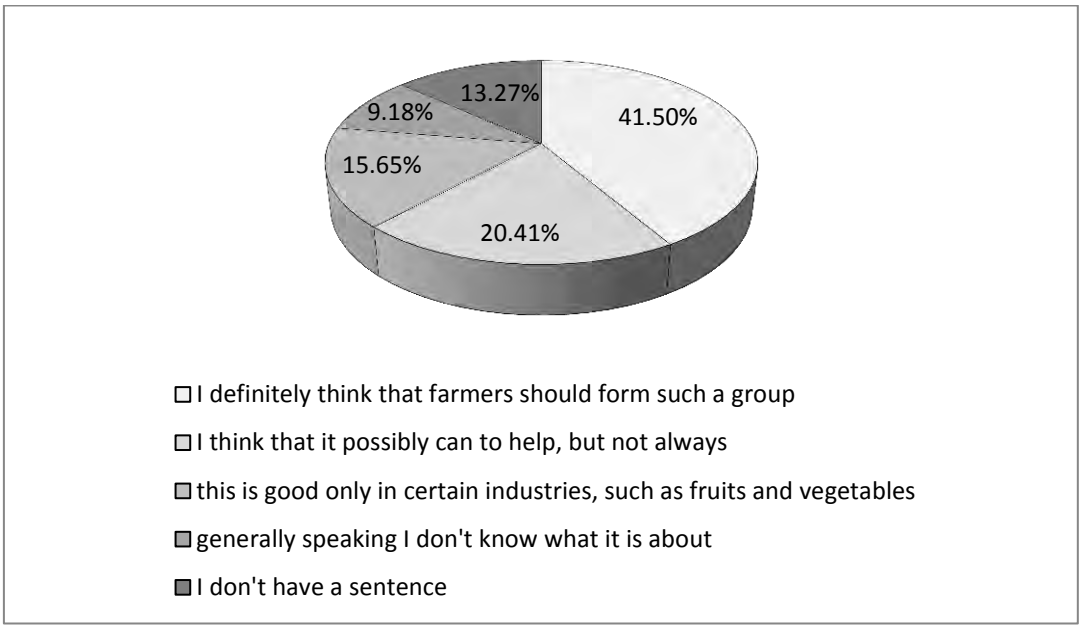
Research results and discussion

The respondents' average age was nearly 40. These were predominantly men who accounted for over 65% of the group under research. Almost a half of the respondents (47.82%) had received secondary education, while every third farmer (34.78%) participating in the measurement had received higher education. Participants of the research mainly held diplomas of agricultural higher education facilities and schools.

The average area of an organic farm as owned by the farmers participating in the research amounted to 20.15 ha, i.e. nearly twice as much as the average area of a farm in Poland (*Average Area*..., 2012). In turn, the acreage of agricultural area amounted to 19.84 ha on average. The minimum area of the farms under analysis amounted to 3.09 ha, while the maximum area was 101.21 ha. As regards the land use pattern in the respondents' farms, grassland was predominant (meadows – 58.60%, pastures – 4.83%). In turn, cereals accounted for 18.37%. As for the pattern of orchard crops, apple trees (61%) and raspberries (37.33%) were predominant. Livestock production was incidental, and only reported in 8.7% of farms.

It should be noted that all respondents reported having had problems with sales of organic food raw materials. Almost 69% of the respondents indicated that they had been selling organic raw material as conventional ones. On the contrary, only 16% were selling organic raw materials directly in the farm to permanent or one-time customers (mainly individual ones), 9.7% did so single-handedly on marketplaces, and only 5.35% to "organic" processing plants. Nawrocka T. (2012) points out that problems with sales are mainly associated with the preparation of a ready batch of goods meeting all the required criteria, and primarily with the insufficient amount of products accumulated in one location. Therefore, the market for organic food products in Poland virtually does not operate. This is why measures that will allow the development of this food market, for example, horizontal integration, are of significance.

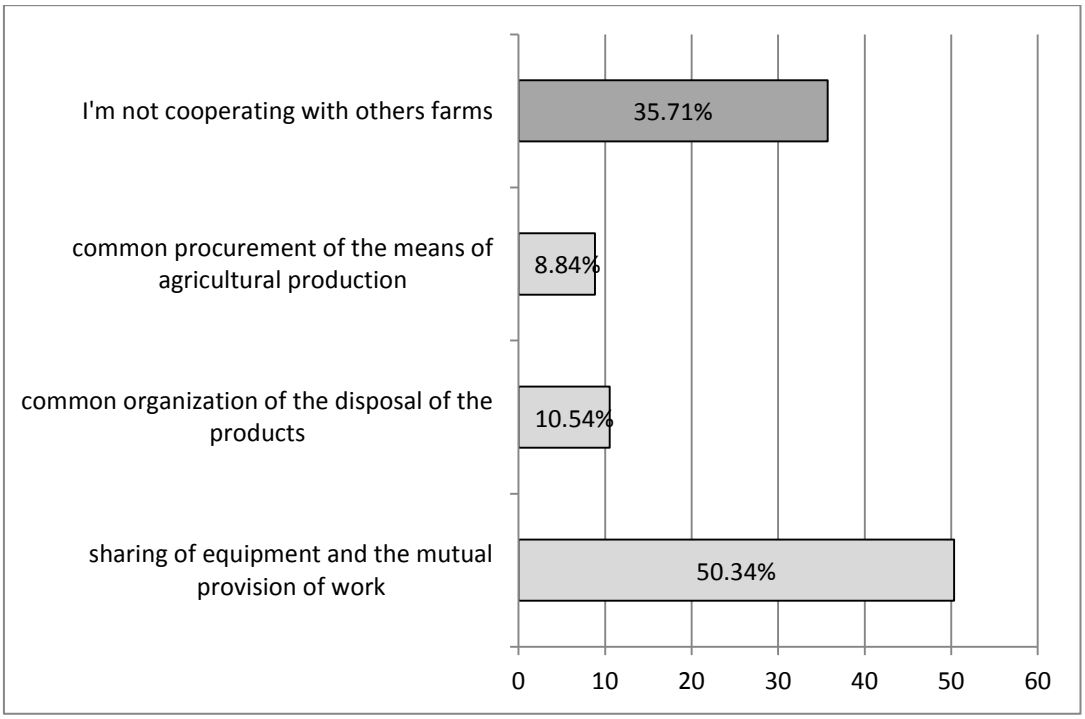
While analysing the problems of Polish organic farming, one can notice an insufficient level of cooperation which would facilitate both advantageous negotiations and sales of the produced agricultural products (e.g. the previously mentioned small number of registered "organic" producer groups). However, the research shows that over 41% of the respondents strongly emphasised the importance of forming associations to enhancing the competitiveness of farms on the market. This implies that they are highly aware of the need to establish producer groups. In turn, a fifth (20.41%) of organic farm owners participating in the research did not have a high opinion of such a measure. According to them, formal or informal cooperation may not always be successful, especially in a situation where farmers participating in horizontal integration are not able to define similar objectives of their activities. Over 15% of respondents believed that this was a good idea but only in certain sectors, e.g. fruit and vegetable production. Less than 9% of the persons interviewed did not know what producer groups were, while over 13% had no opinion whatsoever on this subject (Figure 1).



Source: author's construction

Fig. 1. **Opinion of the owners of the organic farms on creation of producer groups, % of indications**

Approximately 65% of the respondents indicated that they had already cooperated informally with other farmers, and achieved benefits in production, market, and financial areas. The lack of registration of the activity may result from certain convenience and simplicity of unregistered cooperation as well as an opportunity for avoiding a variety of additional administrative and legal fees.



Source: author's construction, respondents could indicate more than one answer

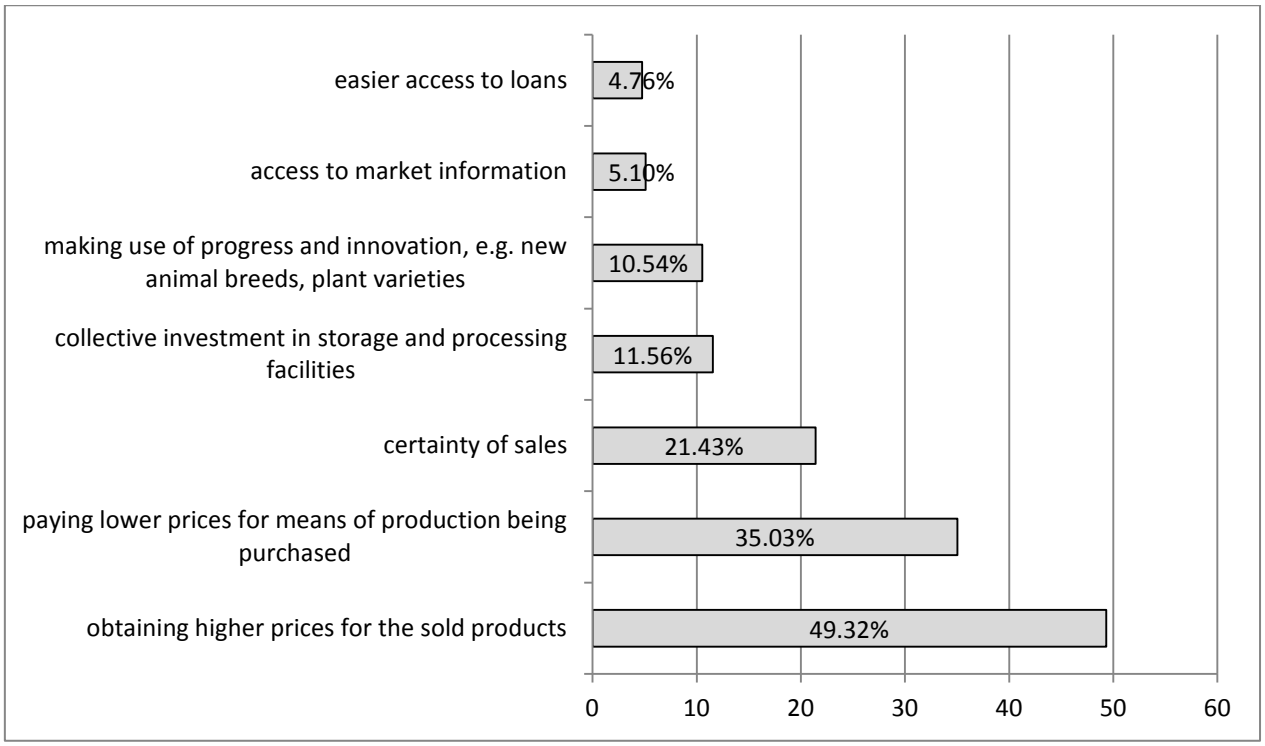
Fig. 2. **Opinion of respondents on working with other farmers in the producer group, % of indications**

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The collaboration as indicated primarily includes both the collective use of equipment and mutual provision of labour services (50.34%), thereby, being quite an obvious form of cooperation. Unfortunately, few respondents indicated cooperation in terms of the joint organisation of sales of raw materials (10.54%), and joint procurement of means of production (8.84%). Mainly through such measures the competitiveness on the primary market may be enhanced, and the activity developed, e.g. through investments in distribution infrastructure or processing. It should be added that over a third of the farmers did not cooperate with other farms (Figure 2). The main reason as indicated for that was difficulties in communication as well as other farmers' unwillingness to cooperate.

The main objective of joint activity should be considered the maximisation of benefits, mainly financial ones, of the integrated shareholders, and thus, an increase in profitability of agricultural activity of each farmer. Other motives for which producers voluntarily merge, include: distribution of expenses on the purchase of equipment; organisation of transport; joint negotiation of contracts; group trading in stock exchange; and taking marketing measures. Each of those reasons results from the willingness to survive on the market in which the competitiveness is growing, and the laws of demand and supply apply (Pawlewicz A., 2009).

The conducted research confirmed the above, and indicated that over two-thirds of the respondents were of the opinion that operation of such an entity may yield benefits. As regards the objectives to be possibly achieved, nearly a half of the farmers participating in the research (49.32%) indicated obtaining higher prices for the sold products through the concentration of supply, joint transport, or getting rid of trade agents. Over one-third of opinions (35.03%) concerned paying lower prices for means of production being purchased jointly. In turn, 21.43% of the farmers participating in the research indicated the certainty of and lack of risk in the sales of agricultural products which had been produced on a farm.



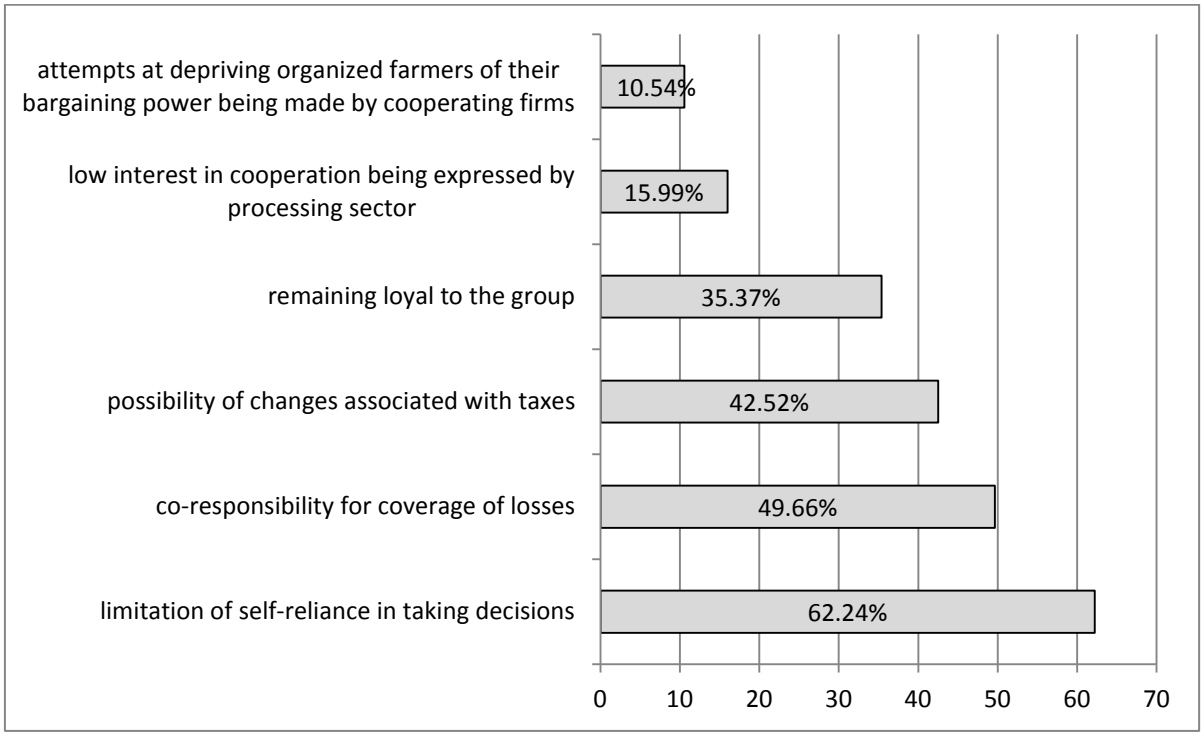
Source: author's construction, respondents could indicate more than one answer

Fig. 3. **Benefits to be possibly achieved by farmers after having joined a production group, according to the respondents' opinions, % of indications**

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Less significant was the collective investment in infrastructure for storage and processing (11.56%), and the opportunity for making use of progress and innovation (10.54%). Moreover, easier access to market information and advisory services (5.10%) and to loans (4.76%) were also mentioned (Figure 3).

On the one hand, forming farmers' associations provides a possibility for cooperation with large customers (retail networks, processing plants), while, on the other hand, raises many concerns and much uncertainty. Since contractors often impose requirements that are difficult to be met, only strong and large producer groups being able to negotiate favourable conditions for cooperation may meet them. Therefore, willingness to establish a producer group should be preceded by the potential members' deep thought of the inconveniences accompanying the joint activity. However, the respondents drew attention, in particular, to the limitation of the existing self-reliance (62.24% of indications). According to nearly a half of the opinions (49.66%), another problem may be the co-participation in coverage of losses to be possibly caused by other members or entities cooperating with the group. Over 42% of the farmers participating in the research indicated the rather significant difficulty, namely, the possibility of changes in the existing tax charges. In turn, according to more than a third of the respondents, a certain difficulty is remaining loyal to the group, for instance, in a situation where independent activity would yield bigger benefits. This may be associated with the cooperating firms' attempts to deprive organised farmers of their bargaining power (10.54% of indications). Producers of organic food raw materials also indicated low interest being expressed by the processing sector (15.99%); this, however, may result from the small number of entities in that sector which operate in Poland and are engaged in production of organic foodstuffs (Figure 4).



Source: author's constrcution, respondents could indicate more than one answer

Fig. 4. **Inconveniences which arise at the time of cooperation, according to the respondents' opinions, % of indications**

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Conclusions, proposals, recommendations

In Poland, organic farming has been developing rapidly in the recent years. Both the number of producers of food raw materials, along with the acreage of agricultural area, and of processing plants, have been on the increase. Moreover, groups of producers of organic food raw materials are being established. However, commodity production falls behind, and so does the market for organic foodstuffs, which is developing very slowly. This results in a situation where despite the rather great interest being expressed by consumers, the supply is small, and prices of the products being offered are higher than those of conventional ones. Unfortunately, organic farm owners sell agricultural products either as conventional ones or accidentally. Another serious problem is the number of entities which are being converted exclusively due to higher agro-environment payments. Therefore, it is necessary for the development that, *inter alia*, farmers form associations, which will enhance their position on the market, and make it easier to provide an appropriate volume of sales of raw materials at prices being accepted by consumers. Additionally, it is very important to establish a system of organised distribution and marketing for organic products as well as increasing investments in the processing of organic food raw materials.

Despite the above-mentioned problems, the majority of respondents were aware of the need to cooperate, although, a proportion of them concluded that such activity may not be always appropriate. On the contrary, a small proportion of the farmers participating in the research did not know anything at all of horizontal integration, or had no opinion whatsoever on that subject. However, it is a surprising fact that more than two-thirds of the respondents had already cooperated with other farmers, primarily through the joint use of machinery, mutual provision of labour, and, on a small scale, through joint sales and procurement of means of production. These were informal measures, which probably results from being aware that registering the activity may involve the need to pay a variety of additional administrative and legal fees.

As regards benefits, the respondents primarily noticed the possibility of the concentration of supply which allows obtaining higher prices, and maintains the certainty of sales. Another important objective as indicated by the farmers participating in the research was reducing the costs associated with the purchase of means of production. Less significant was the collective investment in storage and processing facilities, making use of progress and innovation, and access to market information and loans.

However, cooperation − in particular the formal one − requires the members of producer groups to meet their obligations. As regards the inconveniences of cooperation, the respondents primarily indicated the limitation of self-reliance in taking decisions relating with the food raw materials being produced on the farm. What was rather significant was the co-responsibility for coverage of losses which may generate costs in the future. The farmers were also concerned about the possibility of changes in taxation of income. A serious problem is also the need to remain loyal to the group, especially in a situation where attempts to deprive cooperating farmers of their bargaining power are being made by firms receiving raw materials or selling means of production. A rather significant issue is also the low interest in cooperation being expressed by the processing sector, which primarily results from the small number of such entities in Poland.

In conclusion, organic farming in Poland will, in a longer-term perspective, continue to develop, yet, not so rapidly, in terms of the number of entities on the supply side; however, without a significant impact on the market. This primarily results from the existing policy of supporting such activities. It

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

should be expected that it will remain the source of food raw materials for the still limited proportion of consumers (a niche market), since the main determinant of this market is the high retail price. Therefore, the process of horizontal integration in organic farming has an important role since, according to the research, in the opinio of organic farm owners such a measure is an important factor for the organisation of the market for both organic food raw materials and processed foodstuffs. This also contributes to the concentration of supply, which allows, on the one hand, increasing the economic effectiveness of the farms owned by members of producer groups, and on the other hand, limiting the prices offered to consumers.

Bibliography

1. Borawski, P. 2008. Ecological Farm Development in Poland. Acta Scientiarum Polonorum − seria Oeconomia 7(1), Warszawa, pp. 15-24.
2. Jarecki, W., Bobrecka-Jamro, D., Romaniak, M. (2013). *The Development of Organic Farming in Poland and its Economic Conditions between 2001 and 2010*. ББК 65 Е45: pp. 244-249.
3. Kapusta, F. (2008). Agrobiznes (Agribusiness). Difin. Warszawa, p. 310.
4. *Liczba producentow ekologicznych w Polsce wg stanu na 31 grudnia 2011 r.* (Number of Organic Producers in Poland on December 31, 2011) (2012). Inspectorate of Agricultural and Food Quality Inspection (IJHARS). Warszawa, p. 1.
5. Nowogrodzka, T. (2012). *Stan i perspektywy rozwoju rolnictwa ekologicznego w Polsce* (Current Status and Prospects of Organic Farming in Poland). Zeszyty Naukowe Szkoly Glownej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Swiatowego. Warszawa, Volume 12(2), pp. 54-65.
6. Pawlewicz, A. (2007). *Rolnictwo ekologiczne w Polsce − wybrane wskazniki* (Ecological Agriculture in Poland − Selected Indicators). Zeszyty Naukowe Szkoly Glownej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Swiatowego. Warszawa, Volume 2(17), pp. 415-419.
7. Pawlewicz, A. (2009). *Korzysci zespolowej przedsiebiorczosci producentow proekologicznych surowcow zywnosciowych* (Advantage of Team Producers' Enterprise of Organic Food Materials). Pamietnik Pulawski. Wyd. Instytutu Uprawy Nawozenia i Gleboznawstwa. Pulawy, Issue 151 (2). pp. 585-596.
8. *Powierzchnia ekologicznych uzytkow rolnych w Polsce wg stanu na 31 grudnia 2011 r.* (The Area of Organic Agricultural Land in Poland on December 31, 2011). (2012). Main Inspectorate of Agricultural and Food Quality Inspection (IJHARS). Warszawa, p. 1.
9. Runowski, H. (2009). *Rolnictwo ekologiczne − rozwoj czy regres?* (Organic Farming − Progress or Regress?) Roczniki Nauk Rolniczych, Seria G, T. Volume 96, Issue 4, pp. 182-193.
10. *Rynek ekozywnosci jest wart 700 mln zl. Zachod bedziemy gonic 20 lat* (The Organic Food Market is Worth 700 million Zlotys. West we will Chase for 20 Years). Gazeta Wyborcza. Retrieved: http://wyborcza.biz/biznes/1,100969,15065584,Rynek_ekozywnosci_jest_wart_700_mln_zl__Ale_Zachod.html?biznes=olsztyn#BoxBizTxt. Access: 03.12.2013.
11. *Rocznik statystyczny rolnictwa 2012* (Statistical Yearbook of Agriculture 2012). GUS. Warszawa, p. 435.
12. *Srednia powierzchnia gospodarstwa*. Ogloszenie Prezesa Agencji Restrukturyzacji i Modernizacji Rolnictwa z dnia 20 wrzesnia 2012 r. w sprawie wielkosci sredniej powierzchni gruntow rolnych w gospodarstwie rolnym w poszczegolnych wojewodztwach oraz sredniej powierzchni gruntow rolnych w gospodarstwie rolnym w kraju w 2012 roku (Average Area of a Farm. Announcement of the President of the Agency for Restructuring and Modernisation of Agriculture (ARMA) of 20 September 2012 on the Average Area of Agricultural Land in an Agricultural Farm in Individual Provinces, and the Average Area of Agricultural Land in an Agricultural Farm in the Country in 2012). Retrieved: http://www.arimr.gov.pl/dla-beneficjenta/srednia-powierzchnia-gospodarstwa.html. Access: 28.03.2013.
13. *Wykaz Grup Producentow Rolnych w podziale na wojewodztwa wraz z odnosnikami do stron internetowych, na ktorych zamieszone sa rejestry grup producentow rolnych, prowadzone przez marszalkow wojewodztw* (zgodnie z przepisami ustawy z dnia 15 wrzesnia 2000 r. o grupach producentow rolnych i ich zwiazkach oraz o zmianie innych ustaw (List of Groups of Agricultural Producers by Provinces, along with Links to Websites on which Registers of Groups of Agricultural Producers are Provided, Being Kept by Province Marshals (in accordance with Provisions of the Act of 15 September 2000 on Groups of Agricultural Producers and their Associations, and on the Amendments to Other Acts (Journal of Laws No 88, Item. 983, as amended). Retrieved: http://www.minrol.gov.pl/pol/content/download/42866/236851/file/WYKAZ%20GPR%2003%2012%202013.pdf. Access: 21 November 2013.

BUSINESS PERFORMANCE MANAGEMENT IN FOOD COMPANIES IN THE CZECH REPUBLIC WITH EMPHASIS ON NON-FINANCIAL ASPECTS OF BUSINESS

Petra Stamfestova[1], PhD[+]

[1] University of Economics, Prague, Czech Republic

Abstract. The article deals with business performance in food companies, especially focusing on non-financial aspects of a company and their impact on financial business performance in agriculture and relationships between non-financial indicators. The aim of this article is to point out the importance of measuring business performance by not only financial indicators but also non-financial indicators. The research uses correlation coefficients in order to analyse the relationship between performance constructs in food companies and the whole manufacturing companies in the Czech Republic. The author explores and analyses the differences between these two groups of companies.

Key words: business performance, non-financial indicators, food companies.

JEL code: D22, G32, G39, L25

Introduction

The evaluation of business performance is an essential element for understanding the source of business competitiveness and at the same time, it is a source for support implementation of business strategy. Today, companies compete in a global and turbulent environment; thus, performance monitoring becomes a great challenge, especially for small and medium-sized enterprises in the daily management. According to Taticchi, companies are accustomed to use financial instruments such as ROA and ROCE but he adds that it is already time to change the view from a financial perspective to a non-financial one (Taticchi et al., 2008). In today's world, business performance must be understood as a perception of customers, employees, suppliers etc. (the stakeholders) and in the end, these non-financial determinants improve financial performance. Therefore, the need to identify the determinants of non-financial performance arises, which will provide to management knowledge which non-financial aspects of business they should manage in order to improve financial performance. The main aim of this article is to help managers in food companies in the Czech Republic find out which non-financial areas are crucial to improve financial performance in and to find differences between food companies and manufacturing companies as a whole. Literature points out four most important non-financial aspects that could improve companies' financial performance. These aspects include quality, information technology, human capital, and customer capital. The research has confirmed a relationship between quality, market share, and profitability of invested capital. Studies examining the impact of quality production on market share confirm that the achievement of high quality can have a positive effect on direct costs in some sectors (Lynn, Chang, Buzzell, 1983). The fact that the application of TQM strategy measurably improves the

[+] Corresponding author. Tel.: + 420 224 09 8652
E-mail address: petra.stamfestova@vse.cz

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

performance of businesses in the form of higher profit margins and growth in share price is brought by Lemak, Reed and Satish in their research (Lemak, Reed, Satish, 1997). Madu, Kuei, and Jacob (Madu, Kuei, Jacob, 1996) have also confirmed the relationship between quality and performance.

Whether investment in information technology brings a positive impact on the performance of Greek firms, measured by value added and labour productivity, was examined by Loukis et al. (Loukis et al., 2009). They found positive and statistically significant effects on both the value added and labour productivity. Brynjolfsson and Hitt or Stolarick (Brynjolfsson and Hitt, 1996 Stolarick, 1999) drew the same conclusion. It is important to mention that information technology alone is not sufficient to improve financial performance; companies need to combine information technology with human capital which could then lead to positive effects on business performance.

As a result of the globalisation process, business performance increasingly depends on the disposition of human capital - the only source able to actively respond to turbulence and changes in business environment. There is no doubt that human capital builds higher competitiveness and performance (Agarwal, 2003). To be objective, it is necessary to mention that studies dealing with this relationship vary in finding the strength of the relationship. On the one hand, the output of some studies had found an average or even very strong positive relationship, such as Frese´s (Frese et al., 2007) study, on the other hand, some studies speak about a positive but very weak correlation, for example, Davidsson´s study (Davidsson et al., 2003). The explanation of this phenomenon lies in the fact that individual studies vary in the concept of human capital as well as in the selection of indicators measuring the company performance. The most common human capital is measured by employee innovativeness, employee education, and employees' job satisfaction and by their motivation to work better.

Literature declares that customer capital is also immensely important in improving financial performance. The finding that customer capital, measured by customer satisfaction, has a positive effect on the company's financial results is shown by Andersen or in Metal's and Kamakura's study (Anderson et al., 1994; Mittal, Kamakura, 2001). It is true because highly satisfied customers have a tendency to buy more often and in larger volumes and at the same time, the same manufacturer they tend to buy other products from. It is also shown that satisfied customers are less sensitive to price changes. Customer capital can be also measured by company image. Positive company image is one of the factors to maintain a long-term performance and in a short time horizon, cannot be easily exceeded by competitors. To verify the impact of non-financial determinants on financial performance and relationship between non-financial aspects in food companies and to compare these findings with manufacturing companies as a whole in the Czech Republic, an empirical investigation was implemented in October 2012. Research respondents were manufacturing enterprises in the Czech Republic (joint stock companies, limited liability companies, limited partnership, general commercial companies, and cooperatives). The data were collected from 2 October 2012 to 31 October 2012. The author obtained exactly 777 completed questionnaires; hence, the return of the surveyed enterprises was 13.5%. The return due to all companies from the basic sample was 2%. The sample incorporated 51 food companies. Measurement of constructs was performed by scoring (marking) scales appropriate for the characters (properties) that cannot be measured precisely. Specific indicators measuring various constructs were determined separately based on the author's knowledge from studying relevant literature. Indicators for measuring individual constructs are displayed in Table 1.

Table 1

Measurement of constructs defined

Construct	Question	Construct	Question
Quality	Customer's wishes are the priority for us.	Employee motivation	Rewarding of employees is fair.
	Customers have a positive experience with products.		Employees are rewarded and praised for good work.
	We have a positive feedback from customers.		We provide employee benefits.
	Our products are reliable.		Managers support employee's productivity.
	Our products can be evaluated as a high quality.		Employees have enough opportunities for personal growth.
	Company's sources provide professional outputs.		Employees have good relationships with superiors.
Information technology	We actively seek and implement technological changes.		Employees have good relationships with co-workers.
	As the main vehicle for presenting our production, we use the internet.	Customer satisfaction	Customers are informed about our products.
	Relative to other firms in the industry, we have better technical knowledge.		We see our customers' needs regularly.
	Technological changes in the industry bring us significant opportunities.		Our customers regularly return to us.
	Availability of information technology provides that our company is at a high level.		Staff is courteous and helpful to the customers.
	Most of our activities are based on the electronic exchange of data (orders, invoices, accounting documents etc.).		We solve customer's complaints immediately for their satisfaction.
Innovativeness	Employees themselves are coming to introduce innovative features into business operations.		Customers recommend our products to each other.
	Employees are creative.		Customers do not complain for the price and quality of our products.
	We consider innovation business process (of an enterprise) as very important.	Company image	Image of our company can be assessed as positive.
	Our business is innovative in the area of services.		Image of our company is increasing.
	Our business is innovative in the area of business processes.		The public has a positive view of our business.
	The business dominates an innovative corporate culture.		Equipment of our company is sufficient and modern.
Employee training	Employees are provided with regularly training.		Location of business is attractive for customers.
	Workers have good conditions for potential development.		Our brand is perceived more positively than competitor's brand.
	We put emphasis on the development of hard skills.	Financial performance	ROI due to competition is growing.
	We put emphasis on the development of soft skills.		Revenues due to competition are growing.
	Our employees have greater expertise than our competitors do.		Profit due to competition is growing.
	Our employees consider a degree of training sufficient.		Liquidity is better due to competition.
Employee satisfaction	Employees have enough information to do their jobs.		Indebtedness is adequate due to the competition
	Employees receive feedback about their performance.		The company uses the assets more efficiently than the competition.
	We find the needs of our employees and respond to them.		The growth of our investments is due to competition greater.
	Staff departures are low.		Growth in the number of employees is due to competition greater.
	Employees are loyal.	Market perf.	Market share is increasing.
	Employees do not complain about working conditions.		

Source: author's construction

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Research results and discussion

Statistical analysis of the dependence of individual components of the measured constructs was made in each group, i.e. in the group of food companies and in manufacturing companies as a whole, and then there were found differences between them. First, the author decided to construct indices of the constructs in Table 1 by factor analysis and then applied correlation analysis on these indices. Factor coefficients (factor loadings) of individual questions in the first factor obtained would be the basis of weights of the individual questions in each construct defined in the weighted average of questions. The outputs of correlation analysis can be seen in Table 2 and Table 3.

Table 2

Correlations in manufacturing companies

	IT	Innov.	Edu.	Empl. sat.	Empl. mot.	Cust. sat.	Image	Fin. perf.	Market perf.
Quality	0.26	0.41	0.33	0.48	0.44	0.54	0.45	0.29	0.23
IT		0.61	0.53	0.28	0.31	0.33	0.45	0.43	0.39
Innov.			0.64	0.46	0.48	0.45	0.56	0.41	0.34
Edu.				0.47	0.52	0.44	0.52	0.41	0.35
Empl. sat.					0.73	0.51	0.48	0.29	0.20
Empl. mot.						0.51	0.51	0.36	0.26
Cust. sat.							0.57	0.36	0.27
Image								0.50	0.46
Fin. perf.									0.75

Source: author's calculations

The closest dependence was found between market performance (market share) and financial performance, the value of correlation coefficient is 0.751, thus, the higher is market share, the better is financial performance. High value of correlation coefficient is between employee motivation and employee satisfaction. Here, the coefficient's value is 0.729, thus, the more motivated employees are, the happier they are and vice versa.

Table 3

Correlations in food companies

	IT	Innov.	Edu.	Empl. sat.	Empl. mot.	Cust. sat.	Image	Fin. perf.	Market perf.
Quality	0.25	0.13	0.32	0.37	0.56	0.59	0.55	0.42	-0.08
IT		0.68	0.58	0.10	0.26	0.30	0.42	0.45	0.34
Innov.			0.66	0.27	0.38	0.37	0.51	0.33	0.18
Edu.				0.42	0.58	0.47	0.50	0.40	0.15
Empl. sat.					0.73	0.66	0.53	0.13	-0.07
Empl. mot.						0.69	0.62	0.29	-0.08
Cust. sat.							0.71	0.39	0.12
Image								0.46	0.15
Fin. perf.									0.25

Source: author's calculations

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Conversely, the least close relationship was found between employee satisfaction and market share (value of coefficient is 0.202), between quality production and market performance (value of coefficient 0.234), and quality production and information technologies. The related analysis has shown that this is because of the so-called intermediate variables between these constructs.

The big surprise comes upon realising the weak correlation between market and financial performance, the value of correlation coefficient is only 0.25. Consequently, in food companies, it is not crucial to have a big market share to achieve good financial results. However, between employee motivation and employee satisfaction the situation is the same as in manufacturing companies as a whole. The relatively close relationship in each group is also between innovativeness of employees and information technology (coefficient 0.6) and between innovativeness and education of employees (coefficient 0.6). It means that when a company wants to be innovative, it can hardly realise this without investment in information technology and staff. Nevertheless, developing information technology and employee training can help companies be more innovative. In each group, there is also a relatively strong correlation between innovativeness and the image of a company.

Interesting differences can be seen between the image and customer satisfaction. In manufacturing companies, the value of coefficient showing the relation between company's image and customer satisfaction is 0.565, while in food companies, this value is higher. Consequently, in food companies it is clearer seen that happier customers value the company's image better than the dissatisfied ones or vice versa companies can expect that better image attracts customers due to their higher satisfaction.

Food companies also share a closer relationship between quality and customer satisfaction, employee satisfaction and motivation and between information technology and employee training. In food companies, higher degree of implementing information technology in business operations requires more emphasis on education of employees, which is quite understandable. The more satisfied customers are, the more quality production they evaluate. This finding is consistent with the literature which highlights that the quality is often measured by customer satisfaction. It was also confirmed by food companies that motivation and job satisfaction has a positive impact on customer satisfaction, so helpful and accommodating staff affects the perception of quality and customer satisfaction.

In food companies, the least close relationship is also between market performance and other constructs measured but interesting is the fact that there are also negative correlations. Negative correlations occur between market performance and quality, employee satisfaction and employee motivation. Why is it so? In food companies it could be true that higher quality means higher prices leading to the decrease in the market share.

Conclusions

Non-financial indicators are beginning to play an important role in building competitiveness of the company, especially in food companies, and it was proved by the research, as in food companies the author found a closer relationship between them and also between non-financial determinants and financial performance than in manufacturing companies as a whole in the Czech Republic.

In food companies, the employees play a key role in building a good relationship with customers and generating customer satisfaction. Companies may affect the quality of production by managing directly human capital, by supporting their innovation and job satisfaction as well as expressing interest in their

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

highest motivation to work better. The innovativeness of employees can be improved by increasing their motivation in job performance (e.g. through stimulation), the implementation of information technologies, and by increasing their training. Better work conditions (in the form of material support or positive social climate in the company) can support employee's innovative potential in food companies.

Restrictions in spending on information technology, investment in human capital, building customer capital and quality management currently have been reported as favourable financial results, however, this fact also causes potential losses and failures in the future. Ideally, companies should finance these expenses from profit margins. The most difficult task for a company's management is to maintain a balance between the present and the future. The above findings give evidence that the difference between successful and unsuccessful company lies in their approach to management of non-financial determinants of performance.

Acknowledgements

This article is one of the outputs of IGA project, focusing on crucial aspects of competitiveness of enterprises and national economies in the global economic system registered at VSE under the code IP300040.

Bibliography

1. Agarvala, T. (2003). Innovative Human Resource Practices and Organizational Commitment: An Empirical Investigation. *International Journal of Human Resource Management*, Volume 14, Issue 2, pp. 175-197.

2. Anderson, E. W., Fornell, C, Lehmann, D. R. (1994). Customer Satisfaction, Market Share, and Profitability: Findings from Sweden. *Journal of Marketing*, Volume 58, Issue 3, pp. 53-66.

3. Brynjolfsson, E., Hitt, L. M. (1996). Productivity, Profit and Consumer Welfare: Three Different Measures of Information Technology Value. *MIS Quarterly*, Volume 20, Issue 2, pp. 121-142.

4. Davidsson, P., Honig, B. (2003). The Role of Social and Human Capital among Nascent Entrepreneurs. *Journal of Business Venturing*, Volume 18, pp. 301-331.

5. Frese, M., Krauss, S. I., Keith, N., Escher, S., Grabarkiewicz, R., Luneng, S. T., Heers, C., Unger, J. M., Friedrich, C. (2007). Business Owners' Action Planning and Its Relationship to Business Success in Three African Countries*. Journal of Applied Psychology*, Volume 92, Issue 6, pp. 1481-1498.

6. Lemak, D. J., Reed, R., Satish, P. K. (1997). Commitment to Total Quality Management: Is There a Relationship with Firm Performance? *Journal of Quality Management*. Volume 2, Issue 1, pp. 67-86.

7. Loukis, E., Sapounas, I., Milionis, A. (2009). The Effect of Information and Communication Technologies Investments and Strategic Alignment on Greek Firms´ Performance. *Journal of Money, Investment and Banking*, Issue 9.

8. Lynn, W. P., Chang, D. R., Buzzell, R. D. (1983). Product Quality, Cost Position and Business Performance: A Test of Some Key Hypotheses. *The Journal of Marketing*, Volume 47, Issue 2, pp. 26-43.

9. MADU, C. N., KUEI C. H., JACOB, R. A. (1996). An Empirical Assessment of the Influence of Quality Dimensions on Organizational Performance*. International Journal of Production Research*, Volume 34, Issue 7, pp. 1943–1962.

10. Mittal, V., Kamakura, W. A. (2001). Satisfaction, Repurchase Intent, and Repurchase Behavour: Investigating the Moderating Effect of Customer Characteristics. *Journal of Marketing Research*, Volume 38, Issue 1, pp. 131-142.

11. Stolarick, K. (1999). IT Spending and Firm Productivity: Additional Evidence from the Manufacturing Sector. Center for Economic Studies, U. S. Census Bureau, Working Paper 99- 10

12. Tatitcchi, P., Cagnazzo, L., Botarelli, M. (2008). Performance Measurement and Management for SMEs: a Literature Review and a Reference Framework for PMM Design*.* POMS 19th Annual Conference La Jolla, California, USA, 9-12 May 2008.

ASSESSING THE PERFORMANCE OF MILK PRODUCER IN ESTONIAN FARMS USING PCA-DEA APPROACH

Reet Põldaru[+], Dr.oec.; **Jüri Roots**, PhD
Institute of Economics and Social Sciences, Estonian University of Life Sciences

Abstract. This paper examines the formulation of PCA-DEA models for milk production on Estonian farms and analyses the results of this modelling. PCA-DEA method consists of a two-stage analysis that starts with the principal component analysis (PCA). In the second stage, the authors use the standard data envelopment analysis (DEA). The data comprise a balanced panel of 69 Estonian farms drawn from the Farm Accountancy Data Network (FADN) database of Estonia during the period from 2000 to 2009. In this paper, the authors consider PCA-DEA models as an alternative method for estimating and predicting the efficiency and rankings of decision-making units (DMUs). In DEA, the entrepreneur (milk producer) under study is called a DMU. The results of both conventional DEA model and PCA-DEA models are compared and contrasted with each other, and the comparison of these methodologies demonstrates that PCA-DEA is a more powerful tool for performance ranking.

Key words: DEA, PCA, Estonia, milk production.
JEL code: C14, C38, Q12

Introduction

Improving the competitiveness of Estonia's agriculture is a primary objective of Estonian agricultural policy. The outcome and impacts of the pertinent policy actions will strongly depend on developments on the world's agricultural markets. Because the milk sector is one of the most important sectors of Estonian agriculture, the need to improve further the competitiveness of this sector is obvious.

In recent years, the DEA has become a central technique in productivity and efficiency analysis, and it is applied to different aspects of economics and the management sciences (Avkiran et al. 2011; Bogetoft et al., 2011; Coelli et al., 2005; Cooper et al., 2007; Drake et al., 2006; Zhu J., 2009). The DEA method measures technical efficiency relative to a deterministic best-practice frontier, which is built empirically from observed inputs and outputs using linear programming techniques. This method's main advantage is that it allows several inputs and several outputs to be considered at the same time.

However, due to the complex nature of efficiency, DEA is not yet able to measure it in a robust way. For instance, with the increasing availability of panel data, if one measures technical efficiency with the current static DEA models, the mean efficiency scores generally exhibit volatile patterns over time (Liu J., Tone K., 2008).

Within the DEA context, problems of discrimination between efficient and inefficient decision-making units (DMUs) often arise, particularly if there are a relatively large number of variables with respect to

[+] Corresponding author. Tel.: + 372 313 024
E-mail address: Reet.Poldaru@emu.ee

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

the given observations. In extreme cases, the majority of DMUs may prove to be efficient. Therefore, there must be a trade-off between complete DEA information and the need to improve discrimination. To solve these problems, some researchers (Adler N., Golany B., 2001; Adler N., Golany B., 2002) have suggested using principal component analysis (PCA) to produce uncorrelated linear combinations of the original inputs and outputs.

The aim of this paper is to establish the differences in the efficiency scores and rankings of DMUs for different DEA models using panel data. The main idea in the authors' approach to integrating DEA and PCA is to apply first PCA to separately reduce the data to a number of principal component scores of input and output type. A PCA is performed on the input data and a significant number of output-oriented principal component scores were considered for DEA. Similarly, a PCA is performed on the output data variables and only another set of a significant number of output-oriented principal component scores is considered for DEA.

The following research tasks were set to achieve the research aim: 1) to define variables identifying efficiency of milk producing farms; 2) to apply the PCA and DEA models to analyse efficiency of different farms; and 3) to evaluate the economic performance of Estonian milk producers.

Theoretical foundations of efficiency measurement using DEA and PCA (Tone K., 2001; Adler N., Golany B., 2001; Adler N., Golany B., 2002; Adler N., Yazhemsky E., 2010) are used to solve the established tasks. In this study, the DEA method was applied to measure efficiency, using SBM (slack-based measure) model with output orientation (Cooper et al., 2007). In the PCA-DEA model first, PCA is applied to separately reduce the data to $q<p$ principal component scores of input and output scores (Adler N., Golany B., 2001). Detailed description of implemented methods is provided in the authors' previous paper (Poldaru R., Roots J., 2013). R-system packages are used (R-system …, 2010) to estimate the parameters of the PCA and DEA models.

Research results and discussion

The data from the Estonian FADN for the years 2000−2009 were used for empirical research. To conduct the analysis, the authors constructed a balanced panel that covers ten years (T = 10) for N = 69 Estonian milk producers. Since the employment of panel data would enable the DEA modelling approach to track producers' progress over time, it is appropriate to seek ways to enhance the credibility of DEA analysis. Whereas the dependent (output) variables are the milk yield per cow (Y1), the milk production (Y2), and the total value of the milk sales (Y3); the independent (input) variables are the number of cows (X1), the relative importance of milk sales (X2), the hourly pay (X3), the fodder per cow (X4), and the total cost that is required to produce the milk (X5). Descriptive statistics on inputs and outputs are presented in Table 1.

For the sake of comparison, the authors conducted the typical static DEA analysis to estimate the efficiency scores using the original data. The basic model DEA53 consists of three outputs and five inputs (Table 1). The analysis showed that, in the case of the basic model, all of the first 104 DMUs (from a list of 690 DMUs) have efficiency score 1.0, and thus, the authors cannot rank the DMUs.

Having carried out a PCA on both the input variables and the output variables, the authors obtain the synthetic inputs and synthetic outputs.

Table 1

Descriptive statistics on inputs and outputs in the DEA models for Estonian milk producers (DMUs)

Variable	Description	Unit of measurement	Average	Standard deviation	Minimum	Maximum
Outputs (dependent variables)						
Y1	Milk yield per cow	kg/cow	6000	1301	2975	9940
Y2	Milk production	tonnes	234.6	152.6	36.8	878.5
Y3	Total value of milk sales	thousand EUR	44.8	32.7	5.0	201.7
Inputs (independent variables)						
X1	Herd size	Number of cows	39.1	24.7	10.0	148.0
X2	Relative importance of milk sales	-	0.87	0.17	0.20	1.00
X3	Hourly pay	EUR/hour	1.92	0.77	0.55	4.72
X4	Fodder per cow	EUR/cow	744.0	253.0	208.0	1522.0
X5	Total cost	thousand EUR	56.0	39.0	6.0	278.0

Source: authors' calculations based on the FADN data, 2000-2009

Using PCA-DEA approach, five different model specifications have been considered, and a different aggregation has been made for each of them. These aggregations include different synthetic inputs (principal components) and synthetic outputs (principal components). Table 2 presents the specifications for the employed DEA models using principal components.

Table 2

The specifications for the employed DEA models using principal components

Characteristics of the models	PCA-DEA model specifications				
	DEAPC11	**DEAPC21**	**DEAPC12**	**DEAPC22**	**DEAPC42**
Number of input variables	1	2	1	2	4
Number of output variables	1	1	2	2	2
Synthetic output variables	YPC1	YPC1	YPC1, YPC2	YPC1, YPC2	YPC1, YPC2
Synthetic input variables	XPC1	XPC1, XPC2	XPC1	XPC1, XPC2	XPC1, XPC2, XPC3, XPC4

Source: authors' construction based on the research data, 2013

The results of all the five DEA analyses are presented in Table 3. Whereas each column of Table 3 presents the results of the DEA analysis for different specifications, each row refers to a summary

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

characteristic of a model specification. For each specification, the average performance result over all specifications is reported in a summary table.

The first performance measure is the number of efficient DMUs as determined by DEA. Table 3 shows that this number ranges from 62 (for model DEAPC42 which had two outputs and four inputs) to five (for model DEAPC11 which had one output and one input). Based on Table 3, it is clear that the dimensionality (the numbers of inputs and outputs) has a profound impact on this performance measure.

Table 3

The specifications for the employed DEA models using principal components

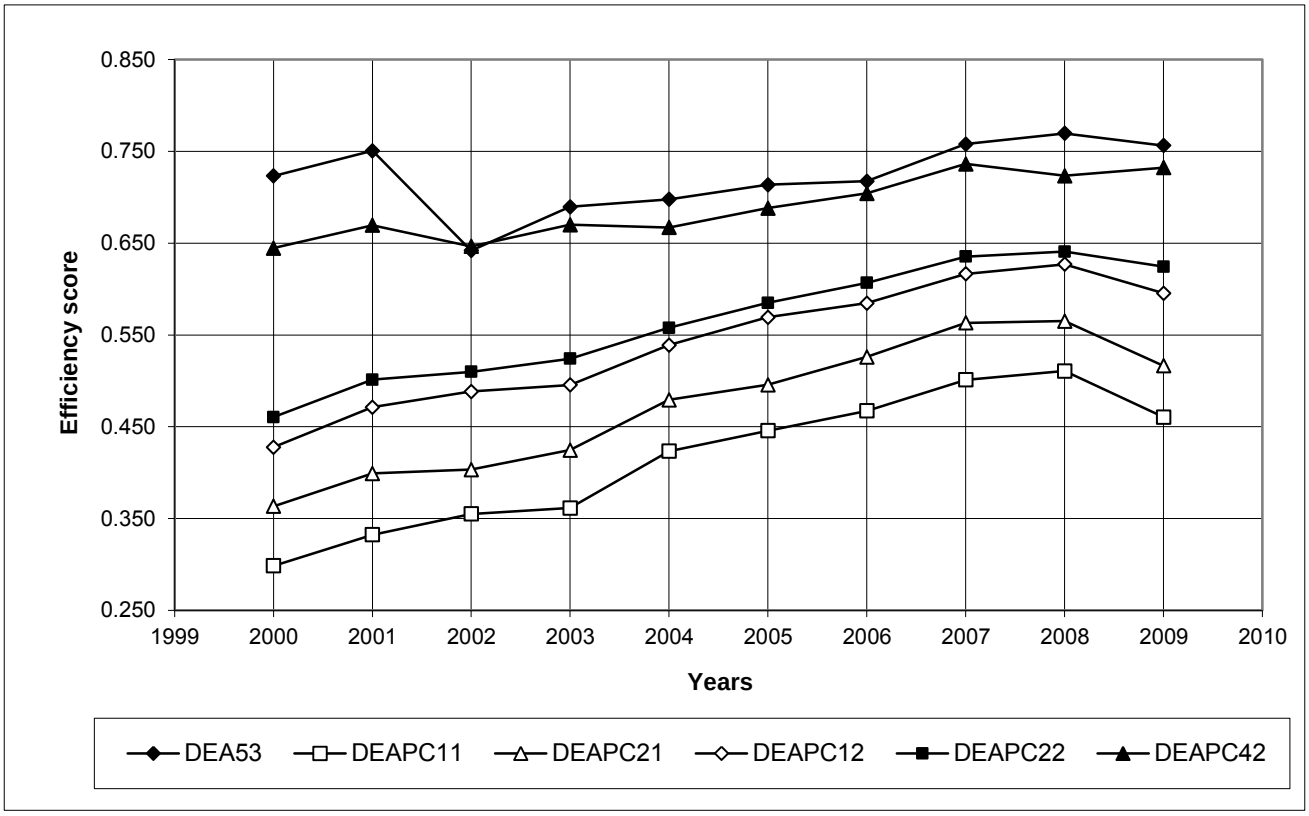
Summary characteristics of the models specifications	PCA-DEA model specifications				
	DEAPC11	DEAPC21	DEAPC12	DEAPC22	DEAPC42
Number of synthetic inputs and outputs	2	3	3	4	6
Number of efficient DMUs	5	15	7	14	62
Proportion of DMUs deemed inefficient	99.3	97.8	99.0	98.0	91.0
Average efficiency score	0.42	0.47	0.54	0.56	0.69
Minimal efficiency score	0.14	0.14	0.23	0.23	0.36

Source: authors' calculations based on the research data, 2013

The second measure is the proportion of DMUs which are deemed inefficient by DEA. Table 3 shows that this proportion ranges from 99.3% (for model DEAPC11 which had one output and one input) to 91.0% (for model DEAPC42 which had two outputs and four inputs). Therefore, Table 3 confirms the high sensitivity of DEA models with respect to the numbers of parameters (i.e. of inputs and outputs). In considering the results reported in Table 3, it is important to recognise that when the number of inputs and outputs of a model's specification is increased, the average efficiency score increases.

A consideration of the panel data enables the authors to track the progress of milk producers over time. Next, the authors analyse that progress using the results of the PCA-DEA model's different specifications. The plots presented in this section illustrate the general findings of PCA-DEA analysis using principal components. When the authors used panel data, Figure 1 characterises the progress of the efficiency scores over time. The unit of the horizontal axis is the year and the unit of the vertical axis is the average efficiency score for different specifications of the PCA-DEA model.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014



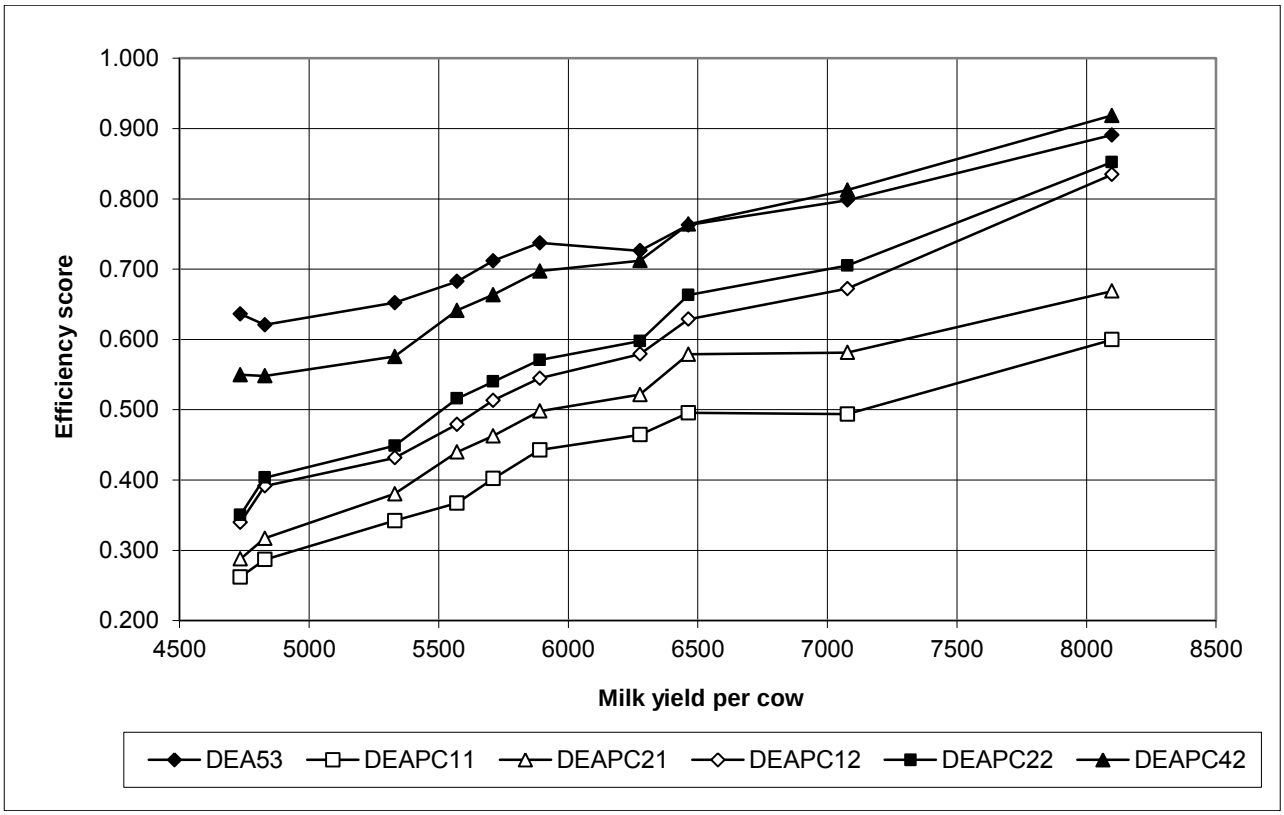
Source: authors' construction based on the research data, 2013

Fig. 1. **A comparison of the mean efficiency scores of different specifications of PCA-DEA models (that used principal components)**

Figure 1 shows the dynamics of the mean efficiency scores for different specifications of PCA-DEA models (that used principal components) in a ten-year period from 2000 to 2009. The dynamics of the efficiency score for five PCA-DEA specifications are provided for comparison with the basic model (DEA53). Figure 1 shows that all but two of the graphs (DEA53 and DEAPC42) behave analogously.

The four graphs in Figure 1 (DEAPC11, DEAPC21 DEAPC12 and DEAPC22) do not differ substantially from the previous graphs. In the case of the four considered specifications, the models have only one or two input variables (PCs) and output variables (PCs) (Table 2). Furthermore, the graphs exhibit a more stable upward pattern. The increasing mean is consistent with the Arrow theory of learning-by-doing (Arrow K.J., 1964). Consequently, for all five of the PCA-DEA model specifications, the mean efficiency score values exhibit a stable upward pattern that is consistent with the Arrow theory (Arrow K.J., 1964) of learning-by-doing.

The milk yield per cow is a very essential efficiency characteristic of milk production. Figure 2 shows the relation between the milk yield per cow and the average efficiency scores for different specifications of the PCA-DEA model. The unit of the horizontal axis is the milk yield per cow and the unit of the vertical axis is the average efficiency score for different specifications of the PCA-DEA model and for the ten years between 2000 and 2009. The plots of the relationships between the mean efficiency scores from the milk yield per cow for different specifications of DEA models are provided in the further research for comparison. Figure 2 shows that all of the graphs behave analogously and they have a maximum at 8100 kg per cow and a minimum at 4700 kg per cow.



Source: authors' construction based on the research data, 2013

Fig 2. **The dependence of the mean efficiency scores from the milk yield per cow for different specifications of DEA models (that used the original data)**

The increasing trend of the mean efficiency scores for all of the PCA-DEA specifications is consistent with economic theory. The milk producers who have a higher milk yield per cow also have higher efficiency scores. From the previous discussion, it follows that in the case of the considered PCA-DEA specifications, the efficiency scores adequately describe the economic situation. Consequently, the efficiency scores may be implemented to rank the DMUs.

Table 4

The Spearman correlation coefficients between the rankings for different PCA-DEA model specifications

PCA-DEA model specifications	PCA-DEA model specifications					
	DEA53	**DEAPC11**	**DEAPC21**	**DEAPC12**	**DEAPC22**	**DEAPC42**
DEA53	1					
DEAPC11	0.586	1				
DEAPC21	0.658	0.892	1			
DEAPC12	0.561	0.790	0.760	1		
DEAPC22	0.601	0.724	0.829	0.938	1	
DEAPC42	0.729	0.483	0.569	0.654	0.703	1

Source: authors' calculations based on the research data, 2013

The next step in analysing the PCA-DEA results is to compare the rankings of DMUs for different specifications. The distinct PCA-DEA specifications' rankings are compared using the Spearman measure of correlation. Table 4 provides the correlation coefficients between the rankings for different PCA-DEA model specifications.

The results indicate that the rankings between specifications DEAPC22 and DEAPC12 (r = 0.938), between DEAPC21 and DEAPC11 (r = 0.892), and between DEAPC22 and DEAPC21 (r = 0.829) are highly correlated. All of the correlations are positive. The rankings between specifications DEAPC42 and DEAPC11 are the most modestly correlated (r = 0.4833 and the p-value = 0.00000).

Comparing the rankings of DMUs for different PCA-DEA model specifications reveals that the specifications DEAPC12 and DEAPC22 are the most analogous to basic DEA model DEA53 and that these specifications may be recommended to rank the performance of Estonian milk producers.

Conclusions

1. This study's major contribution is to construct a framework that combines the DEA and PCA approaches and to use it to rank DMUs (in this case, Estonian milk producers).
2. The PCA-DEA analysis showed that the discriminatory power of different model specifications is different. In the case of model specification DEAPC42 (which had four inputs and two outputs, and all of these inputs and outputs were principal components) all of the first 62 DMUs (from 690 DMUs) have efficiency score 1.0, and hence, the authors cannot rank the DMUs. In the case of model specification DEAPC11 (which had one input and one output), only five DMUs have efficiency score 1.0; the other 57 DMUs have different efficiency scores and different rankings.
3. The mean efficiency score that is measured in the PCA-DEA model specifications (using panel data) exhibits a more stable upward pattern, which is consistent with the Arrow theory of learning-by-doing.
4. The analysis showed that the relation between the milk yield per cow and the average efficiency scores for different specifications of PCA-DEA models is consistent with economic theory: the milk producers who have higher milk yields per cow also have higher efficiency scores. Based on the previous discussion, it follows that the efficiency scores (the rankings of DMUs) of the considered PCA-DEA specifications adequately describe the real economic situation.
5. The comparison of the two methodologies (DEA and PCA-DEA) that was carried out in the study identifies PCA-DEA as a more powerful discrimination tool than conventional DEA.

Bibliography

1. Adler, N., Golany, B. (2001). Evaluation of Deregulated Airline Networks Using Data Envelopment Analysis Combined with Principal Component Analysis with an Application to Western Europe. *European Journal of Operational Research*, Volume 132, pp. 260-273.
2. Adler, N., Golany, B. (2002). Including Principal Component Weights to Improve Discrimination in Data Envelopment Analysis. *Journal of the Operational Research Society*, Volume 53, Issue 9, pp. 985–991.
3. Adler, N., Yazhemsky, E. (2010). Improving Discrimination in Data Envelopment Analysis: PCA–DEA or Variable Reduction. *European Journal of Operations Research*, Volume 202, Issue 1, pp. 273–284.
4. Arrow, K.J. (1964). The Economic Implications of Learning by Doing. *Review of Economic Studies*, pp. 154–73.

5. Avkiran, N.K., Rowlands, T. (2008). How to Better Identify the True Managerial Performance: State of the Art Using DEA. *OMEGA, International Journal of Management Science*, Volume 36, Issue 2, pp. 317–24.
6. Bogetoft, P., Otto, L. (2011). *Benchmarking with DEA, SFA, and R*. New York: SpringerScience+Business Media. p. 351.
7. Coelli, T., Rao, P.D.S., O'Donnell, C.J., Battese, G.E. (2005). *An Introduction to Efficiency and Productivity Analysis*. USA: Springer Science+Business Media Inc., p. 353.
8. Cooper, W.W., Seiford, L.M., Tone, K. (2007). *Data Envelopment Analysis: a Comprehensive Text with Models, Applications, References and DEA Solver Software 2nd ed*. New York: Springer, p. 490.
9. Drake, L., Hall, M.J.B., Simper, R. (2006). The Impact of Macroeconomic and Regulatory Factors on Bank Efficiency: a Non-parametric Analysis of Hong Kong's Banking System. *Journal of Banking & Finance,* Volume 30, Issue 5, pp. 1443–1466.
10. Liu, J., Tone, K. (2008) A Multistage Method to Measure Efficiency and its Application to Japanese Banking Industry. *Socio-Economic Planning Sciences*, Volume 42, Issue 2, pp. 75–91.
11. Poldaru, R., Roots, J. (2013). A PCA-DEA Approach to Measure the Quality of Life in Estonian Counties. *Socio-Economic Planning Sciences*. Retrieved: http://dx.doi.org/10.1016/j.seps.2013.10.001.
12. R-system*: A Programming Environment for Data Analysis and Graphics*, Version 1.10.1. Retrieved: http://cran.at.r-project.org. Access: 26.03.2010.
13. Tone, K. (2001). A Slacks-based Measure of Efficiency in Data Envelopment Analysis. *European Journal of Operational Research*, Volume 130, Issue 3, pp. 498–509.
14. Zhu, J. (2009). *Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets 2nd ed.* USA: Springer Science+Business Media Inc. p. 327.

SHIFTS IN PATTERN OF SPECIALISATION OF LITHUANIA'S AGRI-FOOD PRODUCTS EXPORT[1]

Evaldas Serva[2], MA, Aleksandras Stulginskis University
Vlada Vitunskiene, Dr., prof., Aleksandras Stulginskis University

Abstract. The article focuses on the evolution of Lithuania's Agri-Food products' market shares in the world exports and main markets over the period of 2001-2012. Since the authors are interested in the shift of export of Lithuania within the main markets' context, this study aims to analyse shifts in specialisation of Lithuania's Agri-Food products' export and to investigate the link between competitiveness in major markets and specialisation. A world market share methodology was used for this purpose: changes of share in the main partners' markets and two specialisation indices – RCA, proposed by Ballasa (1965) and Local competitiveness, proposed by Imagawa (2004). The shift level in pattern of geographical and product specialisation was calculated as ratio of Local competitiveness (LCI) and RCA indices.

Key words: foreign trade, shift, revealed comparative advantage.
JEL code: F14

Introduction

The debates on the export specialisation and shifting in patterns of trade measures have been continuing for more than 50 years since Bela Balassa published a study using a measure of revealed comparative advantage. In recent academic literature, the pattern of foreign trade specialisation has been measured using various variations of Balassa index. Alessandrini et al. (2007) examined the pattern of specialisation analysing the growth in the world demand using Lafay's index like a signal that trade specialisation has improved precisely among those sectors that could bring the largest benefits to the economy, in terms of their export potential. Amador et al. (2008) investigated the evolution of Portuguese market shares in the world exports using decomposed market share technique, which consists of market share effect, taking into account the effective changes of share in each product/geographical market and two additional terms that show how the geographical and product composition of Portuguese exports affected developments in the overall market share. Widodo (2008) employs statistical hypothesis test procedure of correlation on the Revealed Symmetric Comparative Advantage (RSCA) for the shift analysis. Del Gato et al. (2012) uses ratio of the change in world exports decomposed as the sum of changes across product categories to clarify the changes in total export shifts.

This study aims to examine empirically the patterns and dynamics of Lithuania's Agri-food export specialisation in main markets over the period of 2001-2012. Seeking for this aim, the authors focus on the following research tasks:

- to assess the patterns and dynamics of Lithuania's Agri-food export specialisation;

[1]The article is presented under the financing of Research Council of Lithuania
[2] Corresponding author. Tel.: + 370 611 30817
E-mail address: Evaldas.Serva@asu.lt

- to provide methodology for analysing shifts in trade patterns in the main partners' markets.

The structure of the article is organised as follows: the methodology for shift changes is presented in the first section. Section 2 presents the results of the Lithuania's Agri-food export analysis over the period of 2001-2012. The final section provides the outcomes and conclusions of the study.

Research results and discussion

1. Measuring shifts in the pattern of specialisation of Lithuania's agri-food products' export

Based on the integrated evaluation method, which is defined as integrated shift of export specialisation indicator, the authors performed the measurement of the country's specialisation and shift changes. Specialisation and shifts were measured according to the following categories.

The first – the significance of indicators (*SI*) is determined and significance for 2-digit of Harmonised Nomenclature (HS4) agriculture and food products over the period 2001-2012 is computed employing the following equation:

$$SI_{01-24} = \text{rank}(Mx_k ; EMS_k) \quad (1)$$

where

$$Mx_k = \begin{cases} 1, if\ Mx_k > 0.8\ (average\ share\ in\ total\ export\ in\ 2001-2012) \\ \mathbf{0}, otherwise \end{cases};$$

$$EMS_k = \begin{cases} 1, if\ EMS_k > 0.003\ (average\ world\ market\ share\ in\ 2001-2012) \\ \mathbf{0}, otherwise \end{cases}$$

Major export category (Mx) defines the values of the largest sectoral (HS4 01-24) export share in total exports of a *k* economy:

$$Mx = \left(\frac{X_i^k}{\sum_k X_i^k}\right) * \mathbf{100} \quad (2)$$

where

Mx – major export; x - export; k – any specified commodity; i – exporting country.

Export market share (EMS) measures the degree of importance of a country within the total exports of the world:

$$EMS = \left(\frac{X_{ij}^k}{\sum_k M_{sj}^k}\right) \quad (3)$$

where

Ms – market share; x – export; m – import; k – any specified commodity; i – exporting country; j – importing country; s – set of countries.

The second – the level of specialisation. RCA being determined as the main indicator of specialisation is measured. The concept of RCA is widely used in practice and linked to the analysis of a country's capabilities and its potential productive capacity (Ferrarini et al., 2011). Imagawa (2004) and Cai et al. (2009) indicate that there are wide variations in measuring the index of export specialisation as well as in asymmetric and symmetric ways (Laursen, 1998). The RCA index shifts from 1 to +∞. Another method or matrix method is suggested by Hinloopen et al. (2001). They divide the Balassa's index into 4 classes which can be readily interpreted: class a: 0 < Balassa's Index <1; class b: 1 < Balassa's Index <2; class c: 2 < Balassa's Index <4; class d: 4 < Balassa's Index. Class a captures all the products / industries /

sectors without a comparative advantage. The other three classes, b, c, and d, include products / industries / sectors with a comparative advantage, roughly divided into "weak comparative advantage" (class b), "medium comparative advantage" (class c), and "strong comparative advantage" (class d).

Specialisation in our research is determined by the following equation:

$$RCA = \frac{\frac{X_{ij}^k}{\sum_k X_{ij}^k}}{\sum_i \frac{X_{ij}^k}{\sum_k \sum_i X_{ij}^k}} \quad (4)$$

where:

RCA – revealed comparative advantage; k – any specified commodity; i – exporting country; j – importing countries.

As pointed by Cai et al. (2009), Balassa's RCA index is a measure of comparative advantage at a point in time, it seems natural to use the difference between RCA indexes at the beginning and the end of a period to measure the change of comparative advantage during the period. Although, this has been a common practice, the direct use of the difference between RCA indices at different time periods measures specialisation shifts.

The third – the level of specialisation in major markets is identified. For this purpose, the Balassa's RCA index variation composed by Imagawa (2004) is used to study the international competitiveness in the specific (local) region. If international competitiveness index exceeds 1, the sector of the considered country is competitive on the partners market and it is non-competitive when it is lower than 1.

Specialisation on the specific market is determined employing the following equation:

$$LCI = \frac{\frac{X_{ij}^k}{\sum_k X_{ij}^k}}{\sum_i \frac{M_{ij}^k}{\sum_k \sum_i M_{ij}^k}} \quad (5)$$

where

ICM – international competitiveness on a specific market

x – export; m- import; k – any specified commodity; i – exporting country; j – importing country.

The last – shift level (*SL*) is identified. The shift level was calculated as a ratio of LCI and RCA indices:

$$SL = \frac{\frac{\frac{X_{ij}^k}{\sum_k X_{ij}^k}}{\sum_i \frac{M_{ij}^k}{\sum_k \sum_i M_{ij}^k}}}{\frac{\frac{X_{ij}^k}{\sum_k X_{ij}^k}}{\sum_i \frac{X_{ij}^k}{\sum_k \sum_i X_{ij}^k}}} \quad (6)$$

To determine the Lithuania's Agri-Food products' specialisation and competitiveness in the main markets' shifts, the LCI was used as the numerator and RCA as the denominator. If calculated index *SL*

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

exceeds 1 over the period, the relative significance of a particular market is greater than specialisation of *k* product export, and the relative significance of a particular market is lower when the calculated index is lower than 1. This method is particularly useful when linking the competitiveness at a geographical level and trade specialisation of the country.

The findings of the authors' study allowed choosing the evaluation scale (Table 1).

Table 1

Division of shifts by classes in terms of specialisation

Class	Criterion	Description
a	0<SL<1	class a captures products without shifts in
b	1<SL<2	class a captures products with weak shifts in
c	2<SL<4	class a captures products with medium shifts in
d	SL>4	class a captures products with strong shifts in

Source: authors' construction based on Balassa, B. (1965) Trade Liberalisation and Revealed Comparative Advantage, 2013

2. Data and empirical findings

Having presented the theoretical background in the previous section, in this section, an empirical examination of Lithuania's agricultural products export shifts on the main partners' market will be presented by the authors. As it has already been indicated in Section 2, the empirical analysis is based on major export (Mx, results presented in chart 1), export markets share (EMS, results are presented in chart 2), revealed the comparative advantage (RCA, results are presented in Table 1), local international competitiveness (LCI, results are presented in Appendix 1), ratio between LCI and RCA, and shifts on the main partners markets (results are presented in Table 4).

The empirical analysis is based on the annual time series data on agricultural exports, extracted from TRADEMAP database. Shift indices are calculated as aggregated 2-digit of Harmonised Nomenclature (HS4) over the period of 2001-2012. There are 24 two-digit headlines in the HS4 categories: 01 Live animals; 02 Meat and edible meat offal; 03 Fish, crustaceans, molluscs, aquatic invertebrates nes; 04 Dairy products, eggs, honey, edible animal product nes; 05 Products of animal origin, nes; 06 Live trees, plants, bulbs, roots, cut flowers etc; 07 Edible vegetables and certain roots and tubers; 08 Edible fruit, nuts, peel of citrus fruit, melons; 09 Coffee, tea, mate and spices; 10 Cereals; 11 Milling products, malt, starches, inulin, wheat gluten; 12 Oil seed, oleagic fruits, grain, seed, fruit, etc, nes; 13 Lac, gums, resins, vegetable saps and extracts nes; 14 Vegetable plaiting materials, vegetable products nes; 15 Animal, vegetable fats and oils, cleavage products, etc; 16 Meat, fish and seafood food preparations nes; 17 Sugars and sugar confectionery; 18 Cocoa and cocoa preparations; 19 Cereal, flour, starch, milk preparations and products; 20 Vegetable, fruit, nut, etc food preparations; 21 Miscellaneous edible preparations; 22 Beverages, spirits and vinegar; 23 Residues, wastes of food industry, animal fodder; 24 Tobacco and manufactured tobacco substitutes.

Table 2 shows the changes of agricultural and total products' export to the world. From 2001 to 2012, the Agri-Food products' export to the World increased almost tenfold – from 567007 to 5451343 thousand US dollars. It is worth mentioning, that the growth of export was declining only in 2009 (both totally and in agricultural products).

Table 2

Lithuania's trade (HS4 01-99) from 2001 to 2012 (USD, thousand)

Year	Export to the World (Total, HS4 01-99)	Change (%)	Export to the World (Total, HS4 01-24)	Change (%)
2001	4583050	-	567007	-
2002	5475632	19.48	587543	3.62
2003	7162433	30.81	833677	41.89
2004	9302609	29.88	1066592	27.94
2005	12070444	29.75	1524285	42.91
2006	14135190	17.11	1974431	29.53
2007	17162396	21.42	2925245	48.16
2008	23769895	38.50	3776070	29.09
2009	16496339	-30.60	3232880	-14.39
2010	20813923	26.17	3764567	16.45
2011	28068648	34.86	4596398	22.10
2012	29652662	5.64	5451343	18.60

Source: authors' calculations based on Trade Statistics from Trademap.org database, 2013

Significance for 2-digit of Harmonised Nomenclature (HS4) agriculture and food products over the period of 2001-2012 were calculated using Equation 1, taking into further analysis product groups with export share greater than 0.8 (average share in the total export in 2001-2012 and world market share greater than 0.003 (average world market share in 2001-2012).

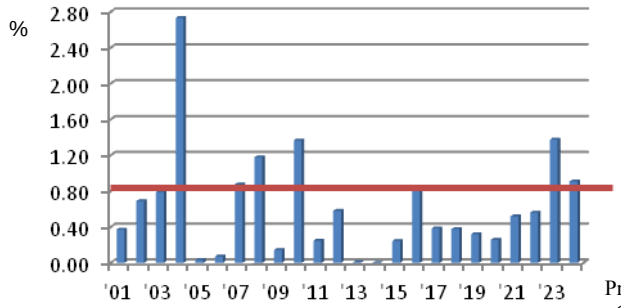


Fig. 1. **Constant export share analysis (share in the total export) of Lithuania Agri-food products exports, 2001-2012**

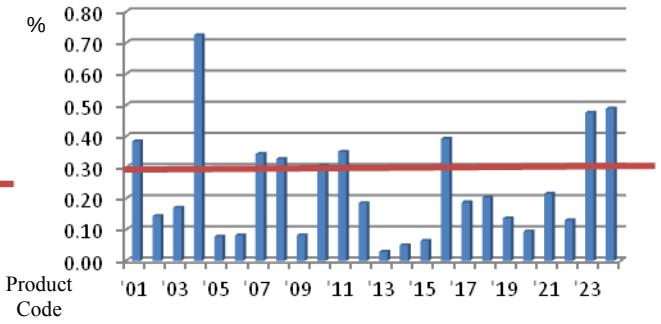


Fig. 2. **Constant market share analysis (percentage in the world export) of Lithuania Agri-food products exports, 2001-2012**

Source: authors' calculations based on Trade Statistics from Trademap.org database, 2013

Live animals (code 01) and Tobacco and manufactured tobacco substitutes (code 24) group products were excluded from further specialisation and market analysis. Hence, those product groups have significant world market share (Chart 2, Live animals – 0.0038 and Tobacco and manufactured tobacco substitutes 0.0049 percent), Live animals product group were excluded because of a low export share in a total Lithuania's export (average export share in 2001-2012 – 0.37 percent), Tobacco and manufactured tobacco substitutes' group products were excluded because of lack of markets (main export goes to one market – the Netherlands). Finally, Dairy (code 04) products (2.7 average share in the total export in 2001-2012 and the world market share 0.0072), Edible vegetables and certain roots and tubers (code 07) group products (0.87 average share in the total export in 2001-2012 and the world market share 0.0034), Cereals (code 10)

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

group products (1.36 average share in the total export in 2001-2012 and the world market share 0.0031), Meat, fish and seafood food preparations (code 16) group products (0.80 average share in the total export in 2001-2012 and the world market share 0,0039), Residues, wastes of food industry, animal fodder (code 23) group products (1.37 average share in the total export in 2001-2012 and the world market share 0.0048) were included into analysis.

Table 3 presents RCA indices for five main export groups in 2001-2012. As indicated, during 2001-2012, there was a shift towards comparative advantage ($\overline{RCA}$ - 6.05) exporting Dairy products that indicates greater specialisation in Lithuania's 04 category group products exports. As expected from the previous analysis, the results for other four product groups (07, 10, 16, 23), also revealed comparative advantages, while the variation of RCA indices for each category was greater than in 04 group (Table 3). Also, the decline in RCA values for 07, 10, 16, 23 category group products was greater after crisis in 2008-2009 than for 04 category group products.

Table 3

The Balassa RCA index in agri-food products, 2001-2012

Code	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\overline{RCA}$	St. deviation	V_{RCA}
04	7.21	5.85	5.26	6.59	6.12	6.72	7.26	5.39	6.04	5.70	5.10	5.38	6.05	0.75	12.3
07	1.39	0.76	1.34	1.45	1.24	2.36	3.13	3.87	2.79	3.51	3.94	5.01	2.57	1.35	52.5
10	1.91	1.29	2.40	1.98	2.85	1.95	2.41	3.02	3.39	2.74	1.87	3.42	2.44	0.66	27.2
16	2.30	2.66	2.74	3.03	3.49	3.62	3.52	3.25	4.45	4.45	2.36	2.49	3.20	0.74	23.2
23	5.40	5.08	5.41	4.58	4.05	4.59	4.55	3.45	3.74	3.45	2.73	2.49	4.13	0.98	23.7

Source: authors' calculations based on Trade Statistics from Trademap.org database, 2013

Final step of the analysis was to identify the link between competitiveness at a geographical level and the country's trade specialisation. This ratio method is useful for analysing stable and growing export markets.

During the period from 2001 to 2012, the export of the 04 group products was found unstable at international markets positions - 6 of 10 top markets upon the ratio between LIC and RCA were in the first group (products without shifts in the patterns of trade). The increases in the export share in Italy (as indicated by LIC and RCA ratio raised from 0.15 in 2001 to 5.32 in 2008 and 3.80 in 2012) and in Poland (as indicated by LIC and RCA the ratio in last five considered years raised from 2.00 to 2.67) was the major explanation for the observed positive *SL* effect. During the period from 2001 to 2012, all 07 group products' markets (except for Switzerland) were without shifts in patterns of trade. However, it is worth mentioning the decline on a German market (as indicated by LIC and RCA ratio declined from 1.90 in 2001 to 0.24 in 2012). During the period from 2006 to 2012, the increases in the export share of 10 group products in the Saudi Arabia (as indicated by LIC and RCA ratio during the period of 2006-2012 increased from 5.15 to 14.11), Turkey, Iran (as indicated by LIC and RCA ratio in 2012 − 3.52, no export before 2012), German, Spain were the major explanation for the observed positive *SL* effect. The *SL* on the mentioned markets was either in the third or the forth class.

Table 4

Shifts in geographical specialisation of Lithuania agri-food products export, 2001-2012

Product	0<SL<1	1<SL<2	2<SL<4	SL>4
HS4 04, Dairy products	Russian Federation, Germany, Latvia, the United States of America, Estonia, the United Kingdom	the Netherlands, Spain	Italy, Poland	
HS4 07, Edible vegetables	Russian Federation, Germany, Latvia, Sweden, France, Estonia, Italy, Belarus, Poland			Switzerland
HS4 10, Cereals	Belarus, the Netherlands, Poland	Latvia	Iran, Germany, Spain	Saudi Arabia, Turkey, Algeria
HS4 16, Meat, fish and seafood food preparations	Germany, Estonia, Belgium, the United Kingdom, Poland	Latvia, Russian Federation	France, Spain, Italy	
HS4 23, Residues, wastes of food industry, animal fodder	Russian Federation, Poland, Belarus, Latvia, the Netherlands, Denmark, Italy, Norway	Germany		the United Kingdom

Source: authors' calculations based on Trade Statistics from Trademap.org database, 2013

Increases in export of 16 group products in France (observed LIC and RCA ratio raised from 2.12 in 2001 to 3.85 in 2012), Italy (observed LIC and RCA ratio raised from 0.15 in 2001 to 5.32 in 2012) and Spain (observed LIC and RCA ratio raised from 0.79 in 2001 to 2.02 in 2012) explain the shifts on the mentioned markets. During 2001 and 2012, all the 23 group products' market (except the United Kingdom) was without shifts in patterns of trade (Table 4).

Conclusions

This study employs a new analytical tool to investigate the patterns of shift in trade in Lithuania's Agri-Food products' export in the period from 2001 to 2012. The findings of the empirical study allow making the following conclusions:

1) regarding the significance of export and market share for 2-digit of Harmonised Nomenclature (HS4), agriculture and food products over the period of 2001-2012, 04, 07, 10, 16 and 23 group products were included into analysis;
2) regarding the stability of the distribution of RCA, for all 5 group products results revealed comparative advantages with high variation of RCA indices for each category (except for the class 04);
3) regarding competitiveness on the international markets and shifts to/from new/old markets, there is a relatively low degree of shifting, except for the export of 10 group products and growing position in new markets (Saudi Arabia, Iran, Turkey);
4) despite the shortcomings of the new analytical tool, the ratio between LCI and RCA indices still provides a useful tool to detect shifts in market changes and also offers additional information

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

on the specialisation and competitiveness of Lithuania's Agri-food products on international markets.

Bibliography

1. Balassa, B. (1965). Trade Liberalisation and Revealed Comparative Advantage. The Manchester School of Economic and Social Studies, 33. Assessment. New York: Cambridge University Press, pp. 99-123.

2. Laursen, K. (1998). Revealed Comparative Advantage and the Alternatives as Measures of International Specialisation. Working Paper No. 98-30. DRUID.

3. Hinloopen, J., Van Marrewijk, Ch. (2000). On the Empirical Distribution of the Balassa Index. Rotterdam.

4. Ferto, I., Hubbard, L.J. (2003). Revealed Comparative Advantage and Competitiveness in Hungarian Agri-Food Sectors. The World Economy, No 26, pp. 247-259.

5. Havrila, I., Gunawardana, P. (2003). Analysing Comparative Advantage and Competitiveness: An Application to Australia's Textile and Clothing Industries. Australian Economic Papers, Volume 42, Issue 1, pp. 103-117.

6. Imagawa, T. (2004). Use of BTM for Measuring International Competitiveness - Japanese Manufacturing Exports in the US Market. Prepared for 12th INFORUM World Conference Held at University of Florence, Italy September 5-11, 2004. Retrieved: http://www.inforum.umd.edu/papers/conferences/2004/Imagawa.pdf. Access: 16.11.2013.

7. Alessandrini, M., Fattouh, B., Scaramozzino, P. (2007). The Changing Pattern of Foreign Trade Specialisation in Indian Manufacturing. Oxford Review of Economic Policy, Volume 23, Number 2, 2007, pp. 270–291.

8. Amador, J., Cabral, S. (2008). The Portuguese Export Performance in Perspective: a Constant Market Share Analysis. Retrieved: http://www.bportugal.pt/en-us/bdp%20publications%20research/ab200813_e.pdf. Access: 11.11.2013.

9. Widodo, Tri. (2008). Shifts in Pattern of Specialization. Case Studies of India and China. Gadjah Mada International Journal of Business, January-April 2008, Vol. 10, No. 1, pp. 47–75.

10. Cai, J., Leung Ping, S., Hishamunda, N. (2009). Assessment of Comparative Advantage in Aquaculture. Framework and Application on Selected Species in Developing Countries. Retrieved: http://www.fao.org/docrep/012/i1214e/i1214e.pdf. Access: 29.12.2013.

11. Ferrarini, B., and Scaramozzino, P. (2010). Indicators and Patterns of Specialization in International Trade. Retrieved: http://www.wti.org/fileadmin/user_upload/nccr-trade.ch/wp6/Indicators_and_Patterns_of_Specialization.pdf

12. Lee, J. (2010). Export Specialisation and Economic Growth around the World. Retrieved: http://www.sciencedirect.com/science/article/pii/S0939362510000749. Access: 28.12.2013.

13. Del Gatto, M., di Mauro, F., Gruber, J., Mandel, B. (2012). The Structural Determinants of the US Competitiveness in the Last Decades a 'Trade-Revealing' Analysis. European Central Bank. Working Paper Series No 1443.

14. Gathani, S., Stoelinga, D. (2012). Export Similarity Networks and Proximity Control Methods for Comparative Case Studies. Retrieved: http://www.laterite-africa.com/wp-content/uploads/2013/04/Gathani-and-Stoelinga-_-Export-Similarity-Networks-and-Proximity-Control-Methods-for-Comparative-Case-Studies-_-Published-version.pdf. Access: 19.11.2013.

Appendix 1

Lithuanian LC Index for HS4 04 group products, 2001-2012

Ran	Market	2001	2002	2003	200	200	200	200	200	200	201	201	201
1	Russian	6.39	5.05	4.98	6.23	6.09	10.7	9.70	8.50	8.44	5.93	6.13	3.57
2	Italy	1.05	2.07	2.64	18.2	27.8	23.9	20.6	28.6	26.3	22.5	20.3	20.4
3	Germany	2.51	1.08	3.29	8.47	6.94	7.31	8.50	6.27	4.11	4.17	4.78	5.05
4	Poland	14.63	7.46	21.31	13.2	10.8	13.5	19.3	10.7	13.4	14.1	12.8	11.7
5	Latvia	3.25	4.44	4.49	4.86	3.29	2.26	2.35	2.39	2.47	1.73	1.72	1.87
6	Netherland	22.27	11.18	6.09	6.95	6.29	2.91	11.0	6.19	4.44	3.00	2.52	1.82
7	USA	209.0	229.3	199.6	37.0	5.79	1.67	2.89	4.12	5.28	2.22	2.66	7.02
8	Estonia	3.24	4.63	4.24	6.15	4.72	4.36	3.48	2.21	1.63	2.24	2.63	1.93
9	Spain	0.00	0.00	0.13	3.92	3.56	7.46	9.32	6.50	6.91	8.39	5.85	9.12
10	United	0.11	0.01	0.03	1.43	4.48	5.23	2.34	0.95	1.09	0.99	1.59	1.44

Lithuanian LC Index for HS4 07 group products, 2001-2012

Rank	Market	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	Russian Federation	0.30	0.24	0.26	0.37	0.64	4.54	6.60	8.42	5.86	6.64	6.55	8.85
2	Germany	2.64	1.60	2.90	2.88	2.58	2.77	1.52	2.69	1.54	1.24	1.49	1.21
3	Latvia	0.89	0.89	0.97	1.07	0.85	1.22	1.07	0.90	0.97	1.07	0.89	0.80
4	Sweden	1.05	0.51	0.97	1.54	1.28	1.72	2.00	2.44	3.02	2.71	2.32	2.27
5	France	4.66	1.06	2.65	1.63	0.77	1.58	1.61	0.86	0.91	0.73	0.93	1.30
6	Estonia	0.89	0.68	1.00	0.93	0.87	1.46	3.64	2.57	1.36	0.58	0.51	0.59
7	Italy	6.04	1.52	4.63	5.98	3.58	3.24	1.30	2.41	1.81	1.84	1.87	2.02
8	Belarus	0.36	1.06	0.52	0.52	0.59	1.77	1.39	1.11	1.16	1.71	2.28	2.93
9	Switzerland	5.96	1.65	0.29	1.17	7.72	6.63	13.97	4.06	10.76	16.50	23.04	18.09
10	Poland	0.36	0.47	2.12	1.42	0.62	0.55	0.38	0.46	0.26	0.34	0.52	0.88

Lithuanian LC Index for HS4 10 group products, 2001-2012

Ran k	Market	2001	2002	200 3	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	Latvia	0.35	0.18	2.05	4.16	3.09	4.47	3.50	4.31	5.00	4.97	2.75	2.97
2	Saudi Arabia	0.00	0.00	0.00	0.00	0.00	27.5 5	24.6 1	-	17.4 2	23.0 9	25.9 8	25.3 6
3	Iran	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	0.00	0.00	12.0 7
4	Germany	2.51	19.0 1	1.81	0.13	4.62	0.13	8.94	6.86	4.01	7.35	6.36	9.15
5	Spain	0.00	1.80	0.00	6.92	21.5 4	14.9 5	3.22	1.85	18.9 9	7.71	5.79	7.80
6	Belarus	11.3 8	1.51	7.99	15.6 1	7.86	5.92	1.19	3.40	1.41	0.05	1.38	0.58
7	Turkey	0.00	0.00	3.68	0.00	0.00	0.00	0.00	20.1 9	26.1 6	44.9 0	18.6 0	7.62
8	Netherland s	0.00	0.39	3.58	0.71	16.9 6	6.78	0.21	0.29	2.81	1.06	1.58	2.78
9	Poland	0.43	1.36	2.01	0.78	0.06	0.37	2.16	8.82	0.69	1.79	2.23	5.77
10	Algeria	0.66	0.00	0.00	0.00	0.00	0.00	13.9 3	9.70	15.6 8	0.00	0.00	0.00

Lithuanian LC Index for HS4 16 group products, 2001-2012

Rank	Market	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	Germany	4.18	2.65	1.54	3.32	2.63	1.73	1.47	0.99	1.00	1.21	2.68	2.59
2	France	4.88	5.87	9.41	9.04	7.68	11.16	11.80	7.37	14.58	12.28	8.75	9.61
3	Latvia	3.71	3.28	2.91	3.64	6.77	9.16	7.80	12.72	15.71	15.14	2.50	4.26
4	Estonia	1.84	2.68	2.18	2.63	3.29	3.49	2.32	2.14	2.23	2.02	1.65	1.71
5	Russian Federation	3.13	5.17	8.83	9.06	7.72	5.85	5.64	3.58	3.21	3.71	3.42	2.78
6	Spain	2.29	40.45	37.35	15.93	8.96	8.68	12.50	8.58	11.75	15.78	7.89	7.43
7	Belgium	0.05	0.00	0.00	0.20	0.25	6.33	0.44	0.47	0.24	0.08	0.06	1.01
8	Italy	1.82	4.92	7.86	9.83	10.75	7.23	5.86	5.07	6.44	14.43	4.62	5.03
9	United Kingdom	0.09	0.21	0.43	0.43	0.46	1.07	1.34	1.04	0.83	0.85	1.21	0.95
10	Poland	0.11	0.26	0.25	1.65	2.35	2.85	3.94	3.85	3.05	2.90	2.53	2.71

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Lithuanian LC Index for HS4 23 group products, 2001-2012

Rank	Market	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	United Kingdom	6.17	10.60	17.32	16.63	20.80	32.97	29.08	17.28	22.05	15.33	12.41	7.78
2	Russian Federation	5.36	4.38	7.80	5.06	3.78	2.21	1.91	2.93	3.26	2.61	2.16	1.03
3	Germany	13.68	13.10	11.47	8.87	5.55	6.58	7.49	4.42	4.61	3.05	1.94	2.95
4	Poland	0.76	0.24	1.98	2.24	1.40	1.28	1.93	2.44	1.35	2.22	1.71	1.87
5	Belarus	5.37	3.90	4.11	4.63	3.12	2.78	2.47	1.83	1.06	0.94	0.83	1.08
6	Latvia	0.34	0.31	0.39	0.69	0.51	0.72	0.84	0.72	0.66	0.91	1.21	0.90
7	Netherlands	3.24	3.48	3.40	2.35	3.08	2.17	3.25	1.69	1.88	1.14	0.68	0.90
8	Denmark	0.93	0.72	0.53	0.36	0.44	0.28	0.63	0.93	1.05	1.36	1.97	0.90
9	Italy	2.73	0.57	0.65	3.57	5.90	8.74	3.86	2.84	4.31	6.48	5.77	5.11
10	Norway	3.06	1.64	1.80	1.86	1.64	0.85	0.97	4.41	2.33	2.51	1.89	1.80

Source: authors' calculations based on Trade Statistics from Trademap.org database, 2013

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

INPUT-OUTPUT MODEL IN ASSESSMENT OF EFFECTIVENESS OF AGRICULTURAL SECTOR – THEORETICAL PREREQUISITES AND PRACTICAL IMPLICATIONS[1]

Andrzej Czyzewski [2], prof., head
Katarzyna Smedzik-Ambrozy [3], PhD
Department of Macroeconomics and Food Economics, University of Economics

Abstract. The study turns attention to the use of the *input-output* model (account of interbranch flows) in macroeconomic assessments of the effectiveness of the agricultural sector. The essence of the account of interbranch flows has been specified, pointing to its historical origin and place in the economic theory, and the morphological structure of the individual parts (quarters) of the model has been presented in the introductory part. Then, the study discusses the application of the account of interbranch flows in macroeconomic assessments of the effectiveness of the agricultural sector, defining and characterising a number of indicators which allow to conclude on the effectiveness of the agricultural sector on the basis of the account of interbranch flows. The last, empirical part of the study assesses the effectiveness of the agricultural sector in Poland on the basis of interbranch flows statistics for the years 2000 and 2005. The analyses allowed to demonstrate increased efficiency of the agricultural sector in Poland after Poland joined the EU, and also to say that the account of interbranch flows was an important tool enabling comprehensive assessment of the effectiveness of the agricultural sector in the macro-scale, through the prism of the effect - disbursement, which accounted for its exceptional suitability in this type of analyses.

Key words: *input-output* model, account of interbranch flows, effectiveness of the agricultural sector in Poland.

JEL code: E02, H23, Q18

Introduction

The highly complex nature of the relations between the suppliers of the factors of production and material costs for the agricultural sector, and the farms and the final recipients of their final products, meaning the existence of many of them at the same time in the role of supplier, the producer and the consumer, triggers the necessity to look for increasingly more and more sophisticated tools to evaluate the effectiveness of the agricultural sector through the prism of the relationship of the type of disbursement - effect. Showing this type of relations underpins the accounts of interbranch flows, published by the majority of statistical offices of the particular national economies, structured by sector (branches) occurring in them, including the agricultural sector. The essence of the account of interbranch flows

[1] The project was funded with the means of the National Science Centre allocated on the basis of the decision number DEC-2012/07/D/HS4/01601
[2] Corresponding author. Tel.: + 48618543017; fax: + 48618543017
E-mail address: a.czyżewski@ue.poznan.pl
[3] Corresponding author. Tel.: + 48618543017; fax: + 48618543017
E-mail address: katarzyna.smedzik@ue.poznan.pl

refers to the model of determining quantitative relations among the different sectors, based on the type of relations disbursement – effect in the scale of the entire economy as well as individual branches (sectors). At the same time, interbranch flows, through the analysis of the relationship type of supplier-recipient, flesh out the ideas of functioning of the economic mechanism, its internal relationships, and dependencies. The main aim of the article is to point out the applicability of the *input-output* model (account of interbranch flows) in macroeconomic assessments of the effectiveness of the agricultural sector. The research tasks: the determination of indicators to assess the effectiveness of the agricultural sector on the basis of *input-output* model and the use of *input-output* table for the Polish economy in the years 2000 and 2005 to assess the effectiveness of the agricultural sector in Poland.

The idea of input-output has its own dimension, both theoretical, deeply embedded in the history of economic thought, and the application referring to publishing the relevant balance sheets (Czyzewski A., Grzelak A., 2012). The first who noticed and took advantage of the sense of the flow analysis was Quesnay, the court physician of Louis XV, who, using an economic table, presented flows of goods between the three branches of the economy: agriculture (production class), the sphere of non-agriculture (arid class) and the owners (the secular authority and the clergy). On this basis, he presented the interdependence of the manufacturing sphere of the economy, the distribution of the social product manufactured, and the sphere of income, answering the question: who and what kind of income gets (Quesnay F., 1928). Also the Marxian analysis of the processes of reproduction is presented in the input-output language (Marks K., 1955). It shows the dependencies between the two branches of the economy: production of the means of production (I), and production of means of consumption (II), and on this basis he formulates the basic equations of general balance in the economy. The idea of presenting the theory of general balance, by the presentation of the related systems of equations, was specified also by Walras (Walras L., 1926). The four systems of equations of production, on the conditions of openly competitive prices, he presented a general balance model in a relatively complete form (Czyzewski A., 2011). Modern analyses are based on Leontief's most transparent model of the relations of type supplier – recipient, as a record of checker material and financial flows (Leontief W., 1936). Its essence comes to the assumption that the national economy is the aggregate of resources and streams consisting of several systems coupled together: manufacturing and services and foreign issues, households, budget and banks which are described with the use of the disbursement and effects method (input-output) in the tabular (checkered) form. This model consists of four parts.

The first one presents the different stages of production specifying the meeting of the intermediate demand of production branches, including the agricultural sector. The lines relating with agriculture include descriptions of streams of flow of products for which the (intermediate) demand was carried out by other branches, in order to further process them. The columns show the cost structure of the individual manufacturers: branches (sectors), and the entire economy. Therefore, the columns relating with agriculture include the structure of purchases of goods and services (except for labour costs which are provided in the third part) performed by agriculture to order to create agricultural production (Czyzewski A., 2011).

The second part refers to the final demand. Its recipients are: the individual and collective consumers (society) as well as the investment sphere acquiring fixed and current assets. In this section, the exporter may also occur if the "foreign" is not treated as a branch of production (in this case, it shall

be transferred to the first part). In the agricultural sector, assessment refers to the streams of the distribution of agricultural products, used to meet the final demand reported by the economic entities as well as the export of agricultural products (Czyzewski A., 2011).

The third part shows the income generated in the branches of production. It concerns not only the income received in the branches (sectors) but also the retransfer of income received in advance through the state budget. The lines mention the individual elements of the value added, including salaries and operating surplus as well as the influence of changes in the quantity of issue money and the liability resources for the amount of the revenue and taxation, and depreciation. The information contained in this part of the model can evaluate the macroeconomic effects of agricultural activities, including, in particular, the size of the economic surplus, value added in agriculture, or the volume of imports of products for agriculture.

The fourth part refers to the division of the generated revenue. In a market economy, it shows a breakdown of gross income (including depreciation) of individual consumers, the budget and banks. On the revenue side of the budget, it consists mainly of income from fees and taxes but also from other titles, such as corporate profits. On the expenditure side − the funds allocated for social consumption, non-productive investments, grants and subsidies to businesses, local budgets as well as the possible allocation of the proceeds from other titles. This table design provides the opportunity to observe both the factual side as well as financial flows (e.g. Czyzewski A., 2011 Czyzewski A., Grzelak A., 2012). The market mechanism that depreciates agriculture in the process of generating income, by a transfer of the earned economic surplus from producers to processors, traders and consumers is in this part modified by budget retransfers, using mostly non-automatic stabilisers of the economic trend, referring both to agriculture and rural areas. As a result of direct financial support, mainly direct payments, also through other market regulators and subsidies, agricultural producers receive additional income to improve their income situation towards the level of the average household in the country or those who are employed outside of agriculture (Czyzewski B., Mrowczynska-Kaminska A., 2010).

Therefore, the table of interbranch flows is a reflection of all business transactions taking place between the various sectors in the national economy. It illustrates the relationship and dependencies, enabling a comprehensive analysis of the costs, value added, and directions of flows of resources and annuity between the productive sector and services, abroad, households, budget and banks. In the agricultural sector, it is basically the only tool available, enabling macroeconomic and engaging many aspects assessment of the effectiveness of its components on the general background (of other sectors of the entire national economy). This allows both the assessment of financial performance, specifying the impact of market relations on the economic situation of the sector and also the relationships stemming from discrepancies in terms of resource productivity. It is also useful the fact that the interbranch flows statistics need not be confined to one region of the world, or one economy. The input-output model allows the agricultural sector to be seen not only as at the national or regional level but as an integrated food system in the global economy (Coleman W., Grant W., Josling T., 2004). Therefore, it is hypothesised that the input-output model is a useful tool in macroeconomic assessments of the effectiveness of the agricultural sector. A verification of this hypothesis will be carried out later in the study through an attempt to assess the efficiency of the agricultural sector in Poland on the basis of the latest available input-output statistics.

Research results and discussion

1. The input-output model in the evaluation of the effectiveness of agri-food sector

The balance of inputs and outputs, as a developed form of a synthetic account of the creation and distribution of the global product and national income, allows not only to recognise the linkages between the various branches (sectors) of the national economy but it also allows to make complex calculations of basic economic relationships, appropriate to the sectoral performance analyses. On the basis of the statement of cash interbranch flows, one can calculate measuring instruments of economic efficiency of the individual branches (groups of companies) against the others or those separated from the immediate environment. The authors mean, inter alia, such measures of the economic efficiency of the flows, as, e.g. the relationship of the output in a particular industry (sector) to the own costs (material, personal and depreciation) borne for their production or conversion of pure net production of per one thousand PLN of the consumed fixed assets (effectiveness of fixed assets) or per one employee (labour productivity). These are the basic indicators of sectoral assessment of financial performance which input-output balances allow.

Table 1

Indicators of the effectiveness of the agricultural sector based on the statistics of monetary interbranch flows

Name of indicator	Construction of indicator	Interpretation
effectiveness (efficiency) of own costs	output / own costs including material costs (Part I), personnel and depreciation (Part III)	value of output per own costs unit
effectiveness (efficiency) of fixed assets	pure gross production / consumption of fixed assets (depreciation – Part III of the table)	value of pure gross production per consumed fixed assets unit
effectiveness (efficiency) of work	pure gross production / personnel costs (Part III of the table)	value of pure gross production per labour unit
absorbency of costs - the converse of own cost efficiency ratio	own costs / output	value of own costs per unit of global created production
technical factor of production (direct consumption of materials)	material costs (Part I) / output	value of material costs per unit of global created production
absorbency of assets	consumption of fixed assets (depreciation – Part III of the table) / output	consumption of fixed assets per unit of global created production
absorbency of labour	value of personnel costs / output	labour charge per unit of global created production

Source: authors' study based on Czyzewski A., 2011

Going further, the reversal of cost effectiveness ratios and the different types of inputs enables the assessment of "absorption capacity", thus, the absorption of direct and indirect current expenses and current assets needed to produce a unit (a zloty) of the effect (production). Therefore, the goal is

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

achieved due to, among others, the factors of the absorbency of costs, the direct material consumption as well as the absorbency of property and labour. The ratio of direct material consumption is called the technical quotient of production. It determines the relation of the value of goods consumed directly by the test branch (group of companies) to the value of the production volume. It is, thereby, the relationship of the current (annual) consumption of raw materials, spare parts, energy and services to the value of the global created production. Hence, the direct consumption of materials corresponds to the notion of the material costs of production. In a similar way, as the coefficients of direct absorbency of materials, one can estimate coefficients of labour consumption in specific areas of production, absorbency of assets in relation to the active production assets of the individual branches (sectors) as well as the absorbency of costs which is the reversal of ratio of the effectiveness of own costs (Table 1).

Basic interbranch interdependencies ARE published in national statistics. This applies to both direct material consumption rates and various measures of effective production of the particular branches or group of companies (Czyzewski A., 2011). It is also worth mentioning the use of the input-output model to the assessments of the agricultural sector in the regional structure, which allows for a comparative analysis of the regions (provinces) in terms of the discussed indicators. In the event of such an approach, however, the significant shortage of the source has to be taken into account. There is, in fact, shortage of input-output tables in the regional structure, published by the statistical office. A significant difficulty in perennial comparisons is also due to the remoteness in time of the publication of flow statistics (in Poland every 5 years) and with a considerable time shift (about 4 years) (Czyzewski A., Grzelak A., 2012).

2. An attempt to use *input-output* models to evaluate the efficiency of the agricultural sector in Poland in 2000 and 2005

This part of the study describes an attempt to assess the efficiency of the agricultural sector in Poland on the basis of the input-output balances for the years 2000 and 2005. The indicators listed in Table 1 were used for this reason. It should, however, be noted that only in statistics for 2005 the value of the depreciation of the assets was included as a separate category in the interbranch flows. The balance sheets for 2000 did not include any category that would allow to infer about the costs associated with the involvement of fixed assets in the particular branches of the economy in Poland. The statistics for the year 1995 included the value of fixed assets and gross fixed capital formation, then the balance sheet for 2000 omitted these items, only the statistics for 2005 included the value of depreciation. It is the most appropriate category, allowing inferring about the annual costs of machinery and equipment involvement in agriculture. Therefore, the calculation of some of the indicators listed in Table 1 for 2000 proved not possible.

On the basis of the analyses carried out it can be noted, however, that the efficiency of the agricultural sector in Poland in 2005 compared with 2000, increased, which is evidenced by an increase in the share of gross added value in the value of the output. In 2005, this share was 45% compared with 34 % in 2000. Direct material consumption also decreased, measured by the value of the indirect production needed to produce a unit of the output. In 2005, it amounted to 0.52 which means that the share of indirect production in a zloty of the global agricultural production was then slightly more than 50%, while in 2000 it was nearly 15% higher. This indicator stood at the level of 0.66 then.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 2

Indicators of the effectiveness of the agricultural sector in Poland based on the statistics of interbranch flows in the years 2000 and 2005.

Name of indicator	2000	2005
effectiveness (efficiency) of own costs	-	1.43
effectiveness (efficiency) of fixed assets	-	4.20
effectiveness (efficiency) of work	6.68	6.39
technical factor of production (direct consumption of materials)	0.66	0.52
absorbency of labour	0.05	0.07

Source: authors' calculations based on GUS 2004 and GUS 2009

In 2005, the agricultural sector in Poland as compared with 2000, showed a slight decrease in productivity and increase in labour consumption of production. In 2005, the labour productivity indicator was 6.39 as compared with 6.68 in 2000. In 2000, labour consumption reached the level of PLN 0.05 and in 2005 - PLN 0.07. Therefore, in order to produce a zloty of agricultural production in 2000, it took about PLN 0.02 less costs related with employment than in 2005. The differences in the efficiency of labour in the two years compared were, thereby, small. Definitely a greater difference occurred in the field of direct material consumption (15% decrease in the share of indirect production of the output of the agricultural sector in 2005 compared with 2000) and the total profitability (12% increase in the share of gross value added in the output of the agricultural sector in 2005 against 2000). It enables to state that the effectiveness of the agricultural sector in Poland in 2005 as compared with 2000, significantly improved, which was primarily the result of limitations of direct material consumption and, thus, resulted from the implementation, after Poland joined the EU, of more efficient manufacturing techniques, probably resulting from the implementation of numerous EU programmes aimed at the modernisation of the agricultural sector, and also resulted from including farms in Poland in the programme of the acquisition of payments for certain agricultural products (e.g. Czyzewski A., Stepien S., 2009, Czyzewski A., Poczta-Wajda A., 2009). The components of the gross value added and output in the input-output tables are net taxes which include taxes on products less subsidies. This group includes also, with respect to the agricultural sector, the following transactions *in plus:* the tax on goods and services to pay duties and other import charges, sugar fees and *in minus* subsidies on products. In 2005, the Polish agricultural producers, thanks to the Polish accession to the EU, received supplementary subsidies supporting the following plants: basic crops (cereals, oilseeds, proteins), hops, potatoes, and tobacco (Smedzik-Ambrozy K., 2012). As a result, in 2005 the value of net taxes in the agricultural sector specified in the table of interbranch flows amounted to more than PLN 3 million *in minus*, which means a surplus of subsidies over taxes of nearly PLN 500 thousand *in plus* in 2000, which meant a surplus of taxes over subsidies on products. Therefore, the growth of output, and also of the gross value added of the agricultural sector in Poland after the accession to the EU also resulted from the impact of subsidies on agricultural products. However, bearing in mind that in 2005, the global production of the agricultural sector increased by almost PLN 23 million (40%), and the gross value added of more than PLN 16 million (85%) compared with 2000, it should be stated that the increase of the efficiency of the agricultural sector in Poland in 2005 compared with 2000, resulted primarily from the implementation of more efficient manufacturing techniques and the impact of favourable exogenous conditions (increase in prices of most agricultural

products after the Polish accession to the EU and a significant increase in their exports to foreign markets[4]). The research of B. Czyzewski and A. Grzelak (e.g. Czyzewski B., 2013, Grzelak A., 2012) has also led to similar conclusions. Based on a static analysis of the interbranch flows for 2005, it can also be said that agriculture in Poland achieved higher labour efficiency than that for the fixed assets that year. It amounted to PLN 6.39 against PLN 4.20 in case of the indicator of the efficiency of fixed assets. Therefore, on average, each zloty engaged in the agricultural sector, intended to remunerate the labour factor generated PLN 6.9 of the gross value added (it can be identified with the gross income from agricultural production), and one zloty spent on depreciation of the fixed assets brought, on average, PLN 4.20 of this value. It should also be added that the effectiveness of own costs amounted to PLN 1.43, which allows to specify the overall profitability of the agricultural sector in Poland in 2005 at 43% - without a compensation for the factor of the earth (the own costs include, according to Table 1, the cost of materials, personnel and depreciation).

The analyses carried out show significant fitness of the interbranch flows accounts for the macroeconomic evaluation of the effectiveness of the agricultural sector. On their basis, a dynamic assessment of the amount of output was carried out as well as gross value added, direct material consumption and efficient use of labour resources in the agricultural sector in Poland in 2005 in relation to 2000. No pricing of depreciation in the statistics of the interbranch flows in 2000, however, prevented from inferences on changes in the efficiency of the use of fixed assets in the analyzed period. The overall assessment of the effectiveness of the agricultural sector in Poland, consisting of the assessment of the indicators listed in Table 1 was possible only on the basis of flow statistics for the year 2005. Hence, it is important that statistical offices, preparing input-output tables, apply a uniform methodology for their preparation. This will allow for dynamic evaluation of the effectiveness of individual sectors included in the national economies, including the agricultural sector, in a long term, also increasing the applicational usefulness of the input-output model.

Conclusions, proposals, recommendations

Turning to the conclusions, it must be stated that:

- the account of interbranch flows is an important tool to assess the agricultural sector, through the prism effect - effort relationship. It also allows the analysis of the processes taking place in the sector against the background of the general economy and in relation to each of the branches appearing in it, which causes invaluable usefulness of this tool for macroeconomic cross-sector analyses;
- the input-output model allows not only to recognise the linkages between the various branches (sectors) of the national economy but also allows to make complex calculations of basic economic relationships, appropriate to the sectoral performance analyses, which is proved by making a

[4] In 2003, for the first time after 1993, Poland achieved a positive balance of trade in agricultural products of approximately USD 500 million. In 2004, it doubled to over USD 1 billion. The export of agri-food products increased by 40% then. There was a large increase in the value of exports of the meat industry from USD 660 million to over USD 900 million (Czyzewski A., Smedzik-Ambrozy K., 2013)

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

dynamic assessment of the effectiveness of the agricultural sector in Poland in 2005 with references to 2000, using the input-output statistics for these years;

- these analyses demonstrated an increase in the efficiency of the agricultural sector in Poland after the accession to the EU. This resulted primarily from the implementation of more efficient manufacturing techniques, and the impact of favourable market conditions such as increased prices of most agricultural products and their export to foreign markets. To a lesser extent this increase resulted from the impact of subsidies on agricultural products introduced after 2004. Statistic analyses also made it possible to say that the agricultural sector in Poland in 2005 was characterised by higher efficiency of labour than that of fixed assets;
- considerable difficulty in the analysis turned out to be the omission of depreciation expenses in the interbranch flows account for Poland in 2000 which prevented a reference of performance indicators of the fixed assets to each other, in comparable points in time. Another obstacle to the dynamic analyses is also a significant time distance of each publication of output statistics which causes some difficulties in the sectoral assessments of effectiveness. Standardising the methodology of preparing balance sheets and outputs as well as reducing the distance of time between the publication would certainly increase additionally their further practical fitness in macroeconomic and cross-sectional evaluations, both nationally and internationally. Despite these drawbacks, they are practically the only available tool for a comprehensive, including many aspects, assessment of the effectiveness of individual branches (sectors) of national economies, including also the agricultural sector.

Bibliography

1. Coleman, W., Grant, W., Josling, T. (2004). *Agriculture in the New Global Economy*. Northampton M.A.: E. Elgar, p 88.
2. Czyzewski, A. (2011). *Interbranch Flows as a Macroeconomic Model of the Economy.* Poznan: University of Economics in Poznan, pp. 5-6, 24-25.
3. Czyzewski, A., Grzelak, A. (2012). Possibilities of Using Statistics of Output Balance Sheets for Macroeconomic Assessments of the Economy. *Statistical Review Special Edition,* Volume I, p. 174.
4. Czyzewski, A., Poczta-Wajda, A. (2009). *Role of Decoupling in the System of CAP Financial Support. Dilemmas and Recommendations. Proceedings of the international scientific conference Economic Science for Rural Development*, Issue 18. pp. 202-209.
5. Czyzewski, A., Smędzik-Ambrozy, K. (2013). *Intensive Agriculture in the Process of Specialization and Diversification of Agricultural Production. Regionally and Locally.* Warsaw: PWN, pp 54-59.
6. Czyzewski, A., Stepien, S. (2009). *Changes in the Mechanism of Direct Support and Agricultural Markets Stabilisation in the Aspect of the CAP "Health Check" Proposals. Proceedings of the International Scientific Conference Economic Science for Rural Development,* Issue 18, pp. 231-239.
7. Czyzewski, A., Stepien, S. (2012). Adaptation of Mechanisms of the Common Agricultural Policy to the Expectations of the Member States*. Economist,* Issue 2, pp. 145-174.
8. Czyzewski, B. (2013). *Economic Rents in Food Economy in Poland.* Warsaw: PWE.
9. Czyzewski, B., Mrowczynska-Kaminska, A. (2010). Use of Productivity Surplus Account and Input-output in Agricultural Economics. *Agricultural Economics,* Issue 4(325), pp. 18-19.
10. Grzelak, A. (2012). The Economic Situation in Agriculture against the General Economic Trends in Poland in the Years 1995-2010. *Annals of the Association of Agricultural and Agribusiness Economists.* Volume XIV, Issue 3, pp. 104-109.
11. GUS (2004). *Input-output Table in the Current Basic Prices in 2000.* Warsaw.
12. GUS (2009). *Input-output Table in the Current Basic Prices in 2005.* Warsaw.

13. Leontief, W.W. (1936). Quantitative Input and Output Relations in the Economic System of the United States. *The Review of Economic and Statistics,* Volume XVIII.

14. Marks, K. (1955). *Capital*. Warsaw: KiW, pp. 418, 540, 568.

15. Smedzik-Ambrozy, K. (2013), Impact of Direct Payments on Sustainability of Farms in Poland - Simulation Based on the Example of FADN Farms from Wielkopolska and Slask Region. *Production and Cooperation in Agriculture Finance and Taxes*, Issue 30, pp. 81-86.

16. Quesnay, F. (1928). *Selected Writings.* Warsaw: Gebethnber i Wolf.

17. Walras, L. (1926). Elements d`economie politique pure. Paris, p. 491.

INVESTMENT SUPPORT AND ITS IMPACT ON THE ECONOMIC RESULTS OF RURAL FARMS OF DIFFERENT GROUPS

Armands Veveris[1], Dr.oec., researcher, Latvian State Institute of Agrarian Economics

Abstract. Investment support is a very important type of agricultural and rural support but its evaluation in both Latvian and foreign research is not unequivocal. Therefore, the analysis of the public importance of this investment is a significant part in the evaluation of the impact of the Rural Development Programme.

The aim of the research is a detailed analysis of the investment provided by the RDP Measure *Modernisation of Agricutural Holdings*, taking into account the type of investment and the structure of the supported farms, calculating the yield of different types of investment and the impact on the rural farms of different groups. It has been performed by using the information of the Rural Support Service and the FADN databases as well as statistical data and research of Latvian and foreign scientists.

The findings show that the modernisation support has mainly reached large farms, although, the economic performance results of the small farms are much poorer and their provision with fixed assets is worse. However, the performance of the small farms has significantly increased working with the support. Taking into account the significant role of small farms in the population density of the rural areas of Latvia, this situation is closely linked with attaining the overall goal of the rural development of Latvia. Therefore, the paper offers recommendations that would facilitate the support investment to enhance the development of the rural territory more not only corresponding to the economic interests of a particular entrepreneur.

Key words: agricultural policy, farm subsidy, investment, project evaluation.

JEL code: O130, O220, Q180.

Introduction

Investment support in Latvia is a very important type of agricultural and rural support. Approximately 63% of the public funding of the Rural Development Programme 2007-2013 (RDP) is granted to investment projects. More than a half of this amount of funding (52%) is assigned to agriculture, 8% - to food production, 16% - to other entrepreneurial activities, while 24% - to the development of infrastructure.

However, a wide use of investment support is criticised in some research on agrarian policy, identifying this type of support as inefficient in increasing the revenues of rural farms because the end beneficiaries of most of the support are manufacturers and suppliers of resources.

In Latvia, the investment support and its allocation criteria are not either evaluated unequivocally, thereby, it is very important to perform an objective evaluation of the impact of this support. The Measure 1.2.1 *Modernisation of Agricutural Holdings* of the Rural Development Programme 2007-2013

[1] Corresponding author. Tel.: +371 28676331; fax: +371 67541789
E-mail address: armands@lvaei.lv

comprises the absolutely largest part of support to agriculture in 2007-2013. In the next planning period (2014-2020), the RDP draft also provides a measure of support of a similar character and volume. Taking into consideration the above, the research **hypothesis** is that it is possible to use the resources assigned for the modernisation of agriculture more effectively, providing larger benefits to the development of rural space.

The **research aim** is a detailed analysis of the investment provided by the RDP 2007-2013 Measure 1.2.1. *Modernisation of Agricutural Holdings*, taking into account the structure of the supported farms, calculating the economic results of the rural farms of different groups.

The following tasks were put forward:

1) to analyse the significance of the investment support and the experience of other countries;
2) to analyse the results of support for the modernisation of agriculture in Latvia;
3) to evaluate the support efficiency depending on the amount of the received financing per beneficiary and the economic size of the farm;
4) to summarise the obtained results and offer recommendations to improve the support effectiveness taking into account the overall goal of rural development.

The research object is rural farms of Latvia that have received support for the modernisation of agriculture in the period of 2007-2013. Results of the entire agriculture sector as well as results of the farms of similar size and specialisation that have not received the support are also used to characterise the support impact. The research subject is the RDP 2007-2013 support for the *Modernisation of Agricutural Holdings*.

Methods and approaches of economic analysis were used in the research. The main quantitative methods used in processing data and obtaining results were grouping and comparative analysis. The logical constructive analysis and interpretation were used to make conclusions and develop recommendations. The graphical method was used to illustrate the results.

The theoretical part of the paper is based on the research of Latvian and foreign scientists but practical information was mainly obtained from the databases of the Rural Support Service (RSS) as well as the FADN from which the necessary groupings were made. In addition, the data of the Central Statistical Bureau (CSB) were used in the research.

The aim of this paper is not to analyse all aspects of investment support. Investment support creates not only the direct economic impact but also structural changes related with it, which leave social, territorial, environmental impact etc. All these aspects are very significant when developing investment policy in Latvia but they are objects of another research. Due to the scope limitations, three main indicators that characterise events in farms after receiving the support were selected for the analysis:

1) changes in the net turnover (approve the increase of production volume);

2) changes in the gross value added (GVA) (approve changes of the newly created value, thus, the revenue gaining potential; additional GVA is the main result indicator according to the EU evaluation methodology and is the basis for the calculation of impact indicators (Lukesh R., Schuh B. et al., 2010).

3) changes in employment (it is one of the indicators of the economic impact, and according to the current research on the rural environment, employment is the most topical issue in rural territories).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

A method of comparing the results of the group of the supported farms with the control group was used in cases when it is possible to design a group of the farms to be supported and the control group. To compare changes in the value added in farms of different size the indicator "ratio of GVA change against the support" was used.

The group of supported farms includes those farms that have received the support of Measure 1.2.1 from 2008-2010, while the group of those working without the support comprises the farms that have not received any support of this Measure from 2007-2011. The analysis comprises only those farms about which data were available for the entire period of 2007-2011 (there are 660 such farms in the FADN database).

Taking into consideration the relatively short time between starting the 2007-2013 support measures and the evaluation as well as the fact that a complete return on the capital investment can be expected after several years (at least 5 years for the technical equipment but even more for buildings), the results described in the paper should be considered indicative.

The author has not found any equivalent earlier research on the evaluation of the economic impact of the agriculture investment support in Latvia. There are some similar studies in other EU countries, which in general show similar results (e.g. Medonos T., 2012; Ortner K., 2011), although, they explain results at national level without more detailed structure.

Research results and discussion

1. The importance of the investment support and the analysis of the experience of other countries

Analysing the history and development of the CAP, it can be observed that investment support is a relatively new form of support which has partly substituted the previous support mechanisms (direct price support, export repayment etc.) (European Commission, 2010; Neal L., 2007; Treisijs M., 1996). In Latvia, the investment support has been one of the most significant types of support in agriculture already since the beginning of the SAPARD programme in 2001 (RSS database). However, it has to be admitted that this support also creates direct impact on competition, including the fact that those entrepreneurs who have not received such a support are placed in a significantly worse position (for example, the number of the farms receiving the planned support in Measure 1.2.1 of the RDP 2007-2013 is only around 4.5% of total number of active rural farms but at the regional level this proportion (taking into account farms that have been involved in the measure until 2.07.2012) fluctuates from 0 to 10.5% against the total number of farms (RSS data).

In certain research on agrarian policy, the use of investment support is criticised, identifying this type of support as inefficient in increasing the revenue of rural farms (Upite, 2010). However, irrespective of that, a very large amount of funding is allocated to this support, especially in the EU, including Latvia. In Latvia, this support has received 30-40% of the total financing meant for the funds financing structural changes in agriculture since 2002 (SAPARD, Structural Funds 2004-2006 and RDP 2007-2013).

The negative aspects of investment support are analysed in studies carried out by the OECD. They indicate that setting increase of revenues as a support goal comes along with several significant aspects: first, not all farms need the revenue support. Therefore, it is necessary to define precisely the criteria that will be used to evaluate the appropriateness of farms for such a support. If the support is provided

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

without setting such criteria, a situation is created when less competitive farmers are under a constant pressure: prices of agricultural products decrease due to the cost reduction because of production modernisation, and those manufacturers who have not managed to adjust to the new production methods experience drop in the revenue (OECD, 2002). There it can be concluded that a situation when the investment support is mainly aimed at those farms which are economically stronger (are able to attract credit resources, show better viability indicators etc.) creates an even larger economic stratification – the already strong farms become even more competitive but the revenues of others reduce, which is unwelcome from the perspective of the country's balanced development.

The OECD authors admit ineffective such support programmes that are not aimed at particular target households that experience a topical need to increase revenues. For example, providing support proportionally to the production volume, the largest part of transfer reaches the largest manufacturers, out of which many already have larger revenues. The above mentioned, of course, can also be referred to investment support if it is not purposefully targeted to increase the revenue of groups of farms with lower revenue or, especially, if it is allocated to rural farms that already have high revenues.

In contrary, the OECD authors admit direct revenue support payments as the most effective way of increasing the revenue, especially, if they are completely separated from agricultural operations. The advantage of such payments is also that they can be purposefully targeted at those farms which policy makers consider to be necessary to offer support.

Although, in Latvia, there is no direct research about the end users of support, the analysis of revenues indicates that the revenue of rural farms is significantly and immediately affected by direct payments (from 2004 to 2011 the revenues of rural farms have increased by almost precisely the same amount the direct payments have increased (Veveris A., 2013)) but the impact of the investment support cannot be determined so easily because it cannot be observed within one year. Yet, there are indications about a positive correlation between the investment price and the amount of investment; thus, opening wide support programmes facilitates rise in the resource price (Database of Agricultural …, 2013).

2. Analysis of the results of the agriculture modernisation support

A significant part of the RDP 2007-2013 resources is assigned to investment in agriculture, forestry as well as enterprises of other industries. Considering that 94% of support for agricultural investment is done through the Measure 1.2.1 *Modernisation of Agricutural Holdings*, the particular measure was selected for this research.

The distribution of support beneficiaries and public funding by the groups of the size of the farms was summarised, dividing all farms into seven groups according to standard output (from Group 0 to 6), based on the methodology used by the CSB. This division was performed by the CSB using the data of the RSS about the support beneficiaries. For part of the farms, the standard output (SO) is not indicated (including the non-agricultural enterprises, societies etc. but they are only 3.6% among the participants of Measure 1.2.1). The data reveal a significant support concentration in two groups of larger farms - 942 farms (or 88%) have received support in the group of 1073 farms whose economic size increases EUR 100 thou. SO but the share of support beneficiaries decreases fast with every smaller group and in the group which comprises the largest number of farms – 76 thou. or 92% of total number of rural farms – only 858 or 1% of farms have received this support (Table 1).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Table 1

Intensity of the Measure "Modernisation of Agricutural Holdings" in the groups of farm size (projects 2008-2012)

Group of economic size (thou.EUR standard output)	**Total number of farms (CSB, 2010)**	**No of support benefi-ciaries**	**Public funding in Measure 1.2.1. (thou.EUR)**	**Share of public funding in the farm group**	**Average public funding per beneficiary (EUR)**
0 to 1 (to 14.9)	76 499	858	22 866	6.3%	26 650
2 (15 to 24.9)	2 630	501	12 608	3.5%	25 166
3 (25 to 49.9)	2 117	813	30 674	8.5%	37 730
4 (50 to 99.9)	1 067	684	33 943	9.4%	49 624
5 (100 to 499.9)	924	803	149 157	41.3%	185 749
6 (500 and more)	149	139	111 777	31.0%	804 147
SO is not determined	x	144	23 025	x	159 895
Total	**83 386**	**3 942**	**384 049**	**100.0%**	**97 425**

Source: CSB and RSS data (2010-2012)

Calculating both the hectares of the utilised agricultural area (UAA) and the unit of livestock, the large farms (Group 6) have received the largest support, which are closely followed by medium size farms (Groups 3-5), while the situation is the worst in small farms (Groups 0-2). Whereas, in the very large farms (Group 7), the support level is slightly lower than in the large farms (Group 6) which is related to the structure of the property.

The analysis of the business indicators was performed to evaluate and compare the significance of the investment in the operation of farms, grouping the projects according to the type of investment, as well as the size of the farm. Taking into account that the time period that can be covered using the RSS data is very short, mainly the FADN information was used for data analysis, as their data are offered across the farms, and the time row about 2007-2011 is available. It can be added that the obtained indicators regarding changes of turnover in 2011 against 2010, using the FADN data, are comparable with the data obtained in the RSS database.

Comparing the farms that have received and that have not received the support, it has been stated that the performance results of the supported farms are better. On average, the turnover has increased by 23% in all supported farms from 2007 to 2011 but it has increased by 11% in the farms that have not received the support. However, in 2011, the average GVA in the supported farms reached 90% of the 2007 level and only 77% in the farms that were not supported. Comparing different types of investment, the differences among trends are not significant in most cases. Other potential factors that could significantly affect the results of each studied group were also evaluated during the analysis but significant deviations from the average were not observed (taking into account specialisation, structure of the farm size, amount of the received support against the annual turnover etc.).

The summarised data allow concluding that the impact of the support on the employment in rural farms has been explicitly positive because the average number of the employed in the reporting period has decreased by 20% in the farms that have worked without the support while it has decreased only by 6% in the support beneficiary farms. Among various types of investment, significant differences of these indicators were not observed, although, farms that have invested in buildings exhibit a better balance if compared with the farms that have only purchased machinery and equipment.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

One of the most controversial issues when setting conditions for receiving support is the allowed amount of support (public funding) per beneficiary. In the current period (2007-2013), it has been one of the highest (EUR 4 million eligible costs in agriculture) in Latvia. The RSS data reveal that the support amount paid per beneficiary has been rather large - EUR 97 425 on average. The newly created value of the farms (GVA) from the received support is presented in Table 2. Taking into account the rapid decrease of GVA in 2008 as well as the fact that the decrease in 2008 was more strongly expressed in the farms producing grain, the data about the period from 2008 to 2011 were used for comparison.

The performed analysis reveals that the best results are achieved in the farms whose support amount in Measure 1.2.1 does not exceed EUR 28 thou. within 3 years (2008-2011), the amount of value added has increased by 20-25% in these farms, which is significantly more than in the farms working without the support, and also in those farms that have received larger support. In addition, calculating the increase of value added against the amount of support, the largest coefficient is in these groups – around 0.45 which means that every euro of the received support has created additional value added increase by 45 euro cent.

Table 2

Gross value added and its changes on average per FADN farm depending on the support amount received within the RDP Measure 1.2.1 (2008-2011, EUR)

Amount of suport	No of farms in sample	2008	2011	2011/ 2008	Average support amount	GVA change / support
Without support	321	28 027	28 251	1.01	0	x
Support up to 14 thou. EUR	56	20 412	24 353	1.19	8 094	**0.46**
Support from 14 to 28 thou.EUR	77	38 910	48 794	1.25	21 811	**0.44**
Support from 28 līdz 71 thou.EUR	77	83 486	89 846	1.08	43 228	**0.14**
Support from 71 to 142 thou.EUR	31	195 756	210 490	1.08	96 719	**0.15**
Support above 142 thou.EUR	27	402 258	344 129	0.86	268 862	**-0.22**

Source: author's calculations based on the FADN data (2008-2011)

It can be concluded that the obtained results still encourage to evaluate more carefully the public need to assign large support amounts to one beneficiary, especially, in agriculture where many manufacturers operate.

The initial part of the analysis of the support measure revealed that the absolutely largest part of investment support beneficiaries had been received by large farms (with the standard output above EUR 100,000 per year). Such a situation could be justified if the received support was used effectively. According to the EU evaluation methodology (Lukesch R., Schuh B. et al., 2010), the main criteria for support effectiveness in this period are economic growth (measured as an additional gross value added), increase of work productivity (additional gross value added per labour unit), and enhancement of employment (number of net additional newly created workplaces). Taking into account that the above mentioned indicators are interrelated (additional value added creates either increase of productivity or workplaces but in Latvia both these aims are important), the GVA was selected as a summative indicator in the present analysis. Table 3 summarises the differences between the yield from investment in the

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

groups of farms with various size, using the above mentioned criterion – changes in the gross value added.

It can be observed from the obtained data that there are significant differences in the groups of farm size regarding gaining the additional value added. First, the farms working without the support exhibit a trend – the larger the farm, the better the dynamics of the value added in the reporting period. In small farms, it has decreased from 2008 to 2011, in medium farms – decreased but less; however, in large farms – increased without even receiving this support.

Whereas, these are exactly the small farms, together with medium small up to EUR 25,000 SO, among the support beneficiaries where the fastest GVA increase has been observed – by 37%.

Table 3

Gross value added and its changes on average in a FADN farm as a result of the RDP Measure 1.2.1, distributed across the groups of economic size (2008-2011, EUR)

Farm groups (by Standard Output)	No of farms in sample	2008	2011	2011/ 2008	Average support amount	GVA change / support
With support of 1.2.1. measure						
Small and medium small (4-25 thou.EUR)	36	6 550	8 943	1.37	16 604	**0.19**
Medium (25-100 thou.EUR)	124	25 425	33 034	1.30	31 019	**0.28**
Large (above 100 thou.EUR)	108	223 226	217 015	0.97	104 395	**-0.17**
Without 1.2.1. measure support						
Small and medium small (4-25 thou.EUR)	180	5 695	4 971	0.87	0	x
Medium (25-100 thou.EUR)	112	18 784	17 615	0.94	0	x
Large (above 100 thou.EUR)	29	202 339	213 833	1.06	0	x

Source: author's calculations based on the FADN data (2008-2011)

The next group of farms does not lag behind much – increase by 30%. Though, the GVA has even decreased in the large farms, irrespective of the support. The GVA change coefficient (net GVA changes in the respective farm group against the received support amount) is the largest in the group of medium farms (0.28), slightly lower in the group of small farms (0.19) but it is negative (-0.17) in the group of large farms, which indicates that the GVA increase has been bigger for the ones working without support in this group.

Obtained results correspond with findings of some other research done in Latvia, where important role of small and medium enterprises in Latvian economy and necessity to increase the number of companies, including farmers in all Latvian regions is highlighted (Kantane I., Sloka B., Vilcina A., 2010). Of course, such companies should be competitive. The investment support could be one of the tools to reach this goal, if to use it more targeted.

To plan further support, it is important to investigate the reasons that caused the reduction of the GVA in the supported large farms. One of the reasons, which is revealed in the summarised data, is that these farms have been slower recovering from the recession in 2008-2009. The number of farms comprised in the sample (108) and the case study do not allow attributing the obtained results only to the failure of

certain farms (the sample does not comprise farms with the annual turnover above EUR 14.2 million). It has to be added that the summarised results of 2012 were not available during the research.

Conclusions, proposals, recommendations

1. The analysis revealed significant differences of economic indicators based on the following two criteria:

1) amount of support per beneficiary;
2) economic size of the supported farms.

The available data revealed that farms the support to which within the Measure 1.2.1 did not exceed EUR 28,000 had attained the best results. Comparing the economic performance based on the size of the farm, similar results were obtained − the group of medium farms (with SO from EUR 25,000 to 100,000 per year) demonstrated higher yield; the results were close also in the group of small farms (with SO from EUR 4,000 to 25,000), while the data obtained in the group of large farms did not approve that the support would have facilitated the creation of additional value added.

2. The results of the analysis indicatively revealed that it was rational to limit the amount of public support to be allocated per beneficiary within one period to EUR 142,000 because the performance results of the farms which received support exceeded this amount were worse than those of the farms with a smaller support. Exceptions could be allowed in certain cases when the public significance of a larger support was justified (for cooperatives, rural development centres etc.). However, the analysed data do not offer an exhaustive answer to the causes why large support beneficiaries showed worse performance results, thus, additional research would be useful.

3. The objective of rural support should be support first those that would not be capable of investing without the support. First of all, those are farms with the economic size (SO) up to EUR 25 000. In addition, the development of these farms would require support for developing cooperation, development of the market of agricultural services (enterprises renting specialised equipment or its service etc.), and availability of consultations.

4. Taking into consideration that with similar opportunities for support use, economically strong farms use it more actively, support quotas can be divided based on the farm size, with the goal to balance the distribution of support flow among the farm groups. Allocating the support amount within the quotas, the present provision with fixed assets and the real need also have to be taken into account. The farm size before taking the decision can be taken into account not to encourage artificial division of farms to obtain support.

5. At the same time, the development of large farms into rural economic centres with diverse operations (to provide work places for the entire year) into service providers to other farms; development of cooperatives and extension of the existing ones involving small farms in them etc. should be supported. These activities should have a separate support, evaluating the contribution of the particular project to the territorial development.

Such solutions would help attain complex rural development goals, including the overall goal "a prosperous man in sustainable populated rural areas of Latvia" (Ministry of Agricultureof the Republic of Latvia, 2012), not only the development of single economically strong enterprises.

Bibliography

1. Central Statistical Bureau of Latvia (2011). Agricultural Census in Latvia of 2010. Collection of Statistical Data. Riga, p.124.
2. Database of Agricultural Market and Prices. Retrieved: www.ltvc.lv. Access: 28.11.2013.
3. Database of Rural Support Service. Retrieved: http://www.lad.gov.lv/lv/statistika/lauku-attistibas-programmas-pasakumi/. Access: 04.11.2013.
4. European Commission (2010). The CAP towards 2020: Meeting the Food, Natural Resources and Territorial Challenges of the Future. Brussels, p.15. Retrieved: http://eur-lex.europa.eu /LexUriServ/LexUriServ.do?uri=COM:2010:0672:FIN:en:PDF. Access: 06.01.2014.
5. Kantane, I., Sloka, B., Vilcina, A. (2010). Provision of Sustainable Development of Small and Medium Size Enterprises in the Regions of Latvia. Economic Science for Rural Development Nr.23, Jelgava, 2010.
6. Lukesh, M., Schuh, B. et al. (2010). Approaches for Assessing the Impact of the Rural Development Programmes in the Context of Multiple Intervening Factors. European Evaluation Network for Rural Development, Working Paper, p.223. Retrieved: https://webgate.ec.europa.eu/myenrd/app_templates/filedownload.cfm?id=6999FF39-0307-D7F3-EE33-16D47E2C2144. Access: 06.01.2014.
7. Medonos, T., Ratinger, T. et al. (2012). The Assessment of the Effects of Investment Support Measures of the Rural Development Programmes: the Case of the Czech Republic. Available at: http://purl.umn.edu/146265. Access: 29.01.2014.
8. Ministry on Agriculture of the Republic of Latvia (2012). Latvian Rural Development Programme 2007-2013 (11th edition). Retrieved: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/23/67/LAP_11_versija_091112.pdf. (in Latvian). Access: 25.11.2013.
9. Neal, L. (2007). The CAP and Reforms: Feeding Europe and then Some. The Economics of Europe and the EU, Cambridge. p.440.
10. OECD (2002). Agricultural Policies in OECD Countries. A Positive Reform Agenda. OECD, p.40.
11. Ortner, K. (2011). Evaluation of Investment Support in Rural Development Programmes: Results for Selected Measures. Bundesanstalt fur Agrarwirtschaft, Wien. p.10. Available at: www.agraroekonomik.at/fileadmin/download/Or_Evaluation_Invest.pdf. Access: 30.01.2014.
12. Treisijs, M. (1996). Lauksaimnieciba un partika tirgus ekonomika (Food and Agriculture in a Market Economy). Riga, LVAEI. p.406.
13. Upite, I. (2010). Use of Investment Support in Latvian Agriculture. Summary of the Doctoral thesis. Jelgava, p.96.
14. Veveris, A. (2013). Eiropas Savienibas atbalsta loma Latvijas lauksaimniecibas attistiba (Impact of the EU Support on the Development of Latvian Agriculture). The Doctoral thesis. Riga, p.269.

CHARACTERISTICS OF SHEEP FARMING SECTOR AND ITS DEVELOPMENT IN LATVIA

Ivars Ozolins[1], Mg.oec.
Latvia University of Agriculture

Abstract. The research aim was to study the development of sheep farming sector in Latvia and to appraise the current situation of the sheep farming sector in Latvia. The following methods were used - method of analysis, analysis of regulatory enactments, monographic or descriptive, graphical methods, content analysis, and statistical analysis - to analyse the research so that it would be possible to achieve the aims and to accomplish the tasks defined in the study. As a result, the research provides characteristics of the sheep farming sector and analysis of the historical development in Latvia, description of the figures of sheep industry in Latvian agriculture and assessment of the information and statistical data on production of the sheep farming sector on both domestic and foreign markets. This study has reflected laws and regulations governing the processes of sheep farming sector in Latvia. This study uses data of Agricultural Data Centre of Latvia and the Central Statistical Bureau on sheep farming from 2008 to 2013. It has been found that one of the main problems in the sector in Latvia is small total number of sheep. High fragmentation of the farms and insufficient total volume of production is the cause for import of products of the sheep industry. Positively that sheep farming is one of the fastest growing sectors of agriculture in Latvia, as indicated by the number of sheep on 1 July 2013 – 99412 sheep, or an increase of 22% compared with 1 July 2008, when 76877 sheep were registered in Latvia.

Key words: sheep farming in Latvia, agricultural development.

JEL code: Q1, Q15

Introduction

It is important to carry out research on the sheep farming sector which is one of the components of the concept of sustainable development as defined by the European Parliament, as on 19 June 2008 in its resolution about future of the sheep farming and goat farming sector in Europe, the European Parliament has recognised the role of sheep farming and goat farming sector in sustainable rural development, pointing to the significant contribution of these agricultural sectors and their importance in social, economic, and environmental area as well as noticed the need to take steps to ensure profitability and sustainability for EU sheep and goat meat and dairy sector also in the future, to promote consumption of such products as well as to retain and attract new entrepreneurs in this sector (Committee on Agriculture and Rural Development, 2008). While analysing scientific literature, scientists have emphasised the importance of sustainable development in the sheep farming sector in various theories. The basic idea of sustainable development calls to meet the needs for the current generation by balancing the interests of public welfare, the environment and economic development, while ensuring respect for the environment and the conservation of biological diversity, as not to undermine the ability for future generations to meet their needs, thus, it is necessary to strive to combine economic, ecological, and social objectives in agricultural development to ensure is sustainability. The development of sheep farming also has its role

[1] Corresponding author. Tel.: + 371 29187077; fax: + 371 63084927
E-mail address: ivars.ozolins@vpd.gov.lv

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

in reaching this goal. In addition to consumer products (such as meat, wool, leather, and milk), sheep farming offers public goods: assurance of environmental safety, natural resources, conserves the rural environment and local farming traditions (Latvian Sheep Breeders Association, 2013a). It should be noted that the sheep are considered an essential part of organic farms, because it is an effective way to use biological plant products, to ensure crop farming with integration of animal production, and to provide natural fertilisers for crops (Raducuta, 2012).

It is, thereby, important to continue the study in the sheep farming sector, and to develop strategy for sustainable breeding of animals, which requires setting up a lot of goals, breeding activities, keeping the adaptation abilities and promoting the biodiversity which also focuses on additional profitability (e.g. Olesen, 2000; Nielsen 2005, 2006). By the way, biological farming is an agricultural sector which has steadily increased in recent years around the world and, especially, in the European Union (Raducuta, 2011, Willer, Kilcher, 2011).

The sheep farming sector in agriculture of Latvia has been developing steadily since joining the European Union, and furthermore, it has experienced a steady growth in recent years (Figure 1). The sheep farming is very important also for the regions of Latvia, since the benefit of sheep is a thrifty use of natural resources and efficient way to manage resources in the production process. Sheep farming is one of the most relevant sectors in order to be able to engage successfully less favoured areas for agriculture and for production units with relatively little agricultural land (hereinafter - AL) area. In Latvia, sheep farming sector uses about 3.4 thousand hectares, i.e. agricultural land engaged in manufacture (Garkalne, 2013). Sheep farming in Latvia is on the path of development, as shown also by the characteristic values of sheep farming, while in the author's view, more rapid development requires additional funding from the state, as the current situation development perspectives of sheep farming are provided by cooperative societies and organisations of sheep breeders.

In the author's view, sheep farmers and other stakeholders must have specific long-term goals and strategies to further effectively use existing resources in Latvia and increase economic efficiency of farms as well as to attract potential resources available. The author believes that these issues need to be addressed and updated by all the parties involved and to promote communication between local governments and sheep farmers, promoting human awareness, and education in sheep farming questions. In Latvia, farmsteads with small, non-utilised area have remained, which could potentially be involved in the development of sheep farming, since the sector does not require significant financial investment. **The research hypothesis:** sheep farming industry is one of the most stable traditional agricultural sectors which tends to develop by an increase in the total number of sheep in Latvia. **The research aim** was to study the development of sheep farming sector in Latvia and to appraise the current situation of the sheep farming sector in Latvia.

The following tasks were set forth to achieve the research aim:

1) to describe sheep farming and its historical development in Latvia;
2) to study the production resourcing for sheep farming in Latvia;
3) to evaluate the performance of sheep farming sector in Latvia.

In the study, theoretical knowledge on the history and sector development of the sheep farming in Latvia was obtained by analysing both specific and general literature, national and foreign scientific articles and publications. The study used the EU, including Latvia's, legal enactments. Information of Latvian Sheep Breeders Association, the Central Statistical Bureau, the Rural Support Service, and the

State agency Agricultural Data Centre was used for business and economic analysis of sheep farming sector.

The following research methods were applied: analysis and monographic method – to find theoretical knowledge on the historical development of sheep farming sector in Latvia and to describe the present situation as well as to obtain the sheep farming sector development perspectives. Laws of the Republic of Latvia and the Cabinet Regulations governing sheep farming sector were analysed for document analysis. Statistical analysis is used to analyse the statistical data provided by the Agricultural Data Centre on performance indicators of the sheep farming sector from 2008 to 2013. Graphical method - the acquired information and statistical data on the sheep farming industry are summarised and shown in the figures to give a better understanding of the existing and future possible trends in the analysed period.

Research results and discussion

1. Description of sheep farming sector and historical development in Latvia

Latvia is suitable for the development of sheep farming, besides Latvia has a long sheep farming tradition, as historically Latvia, among other Nordic countries, has been the largest sheep farmer; thus, the knowledge on farming is significant in Latvia. In 1935, there were 1347000 sheep in Latvia, and the number was several times higher than the number of sheep per km^2 in Sweden (Latvian Sheep Breeders Association, 2013b). Sheep breeders' previous experience has shown that the development of sheep farming sector is possible also in less-favoured areas for intensive farming.

Sheep farming business in Latvia can be divided into two economic areas: 1) breed farms, and 2) farms engaged in the production of meat. Nowadays, sheep farming in Latvia is becoming a profitable employment, because the demand for lamb meat and breeding animals is growing rapidly in Europe, so it is important to adjust the sector for it to give the maximum benefit to farmers and the country's economic development. In total 4430 farms in Latvia were registered in the Agricultural Data Centre before 1 July 2013 with a total number of sheep – 99412, including 34547 registered ewes as well as there are 42 breed farms in Latvia engaged in the growing of materials of breed and their reproduction.

Historically, Latvian dark-head sheep breed is grown in Latvia. Latvian dark-head sheep breed was created by crossing local sheep with Oxfordshire and Shropshire rams, which were imported from Sweden and England. From 1927 to 1937, Latvia imported 257 Shropshire and 83 Oxfordshire breed rams; ram stations and sheep farms were created. In 1937, a total of 587 ram stations and 172 sheep farms were created. After 1937 import of Shropshire and Oxfordshire breeds was stopped, since it was believed that enough breeding material had been grown to be able to make a successful breeding work of Latvian dark-head breed. At a later time, a number of popular European sheep breeds were used for breed improvement: in the 1970s to increase fertility - Finnish Landrace, in the 1980s for fast-growth and to improve the quality of meat – meat breeds of sheep - Il-de-France and Texel, at the end of the 1990s - the German blackheads and Il -de -France.

Latvian dark-head sheep breed is characterised by a strong constitution, a strong bone structure, wide and long body. The sheep are healthy, have adapted to relatively humid Latvian climate, ewes live weight is 55-65kg, rams - 100 to 120kg. Sheep fertility is 150-160%.

Experts believe that a positive characteristics of Latvian dark-head sheep breed need to be maintained and further develop properties like animal constitutional strength and adaptation to local

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

conditions, the ability of sheep reproduction (fertility and lamb viability) as well as good fast-growth of sheep (a properly raised new sheep can be used for breeding of 9 - 10 months of age), and merchantable quality of the meat. It appears that the implementation of preservation programme of the Latvian dark-head sheep has been successful in recent years, and in addition an increased interest in Latvia is observed in the use of pure-bred rams for natural sheep mating, thus, arriving at genetically homogeneous herds, which is an important prerequisite for further production of lambs. Latvia's breeders shall do research on ewe genealogy (Latvian dark-head sheep).

2. Production resourcing for sheep farming in Latvia

While analysing resources of the production of sheep-farming, the study describes production resources such as land, labour and knowledge, technical support, financial resources and the flow of information and availability. The study describes the above mentioned resources which are related with production resourcing of sheep farming sector (Latvian Sheep Breeders Association, 2013b). According to the data provided by the association "Latvian Sheep Breeders Association" (hereinafter - LAAA), Latvia's institutions have registered and issued certificates to total 43 breed farms of which 30 farms are in Vidzeme region. The situation is due to several factors: 1) LAAA office and ram control growth and control fattening station "Klimpas" is located in Vidzeme region, and there is an active communication and exchange of information between breeders and the association, 2) Vidzeme region has less favoured areas where manufacturing of other agricultural products is less likely or limited, thus, the farms choose to engage in biological farming, including sheep farming. However, sheep are registered, in all regions of Latvia suggesting that climatic conditions throughout the territory of Latvia are suitable for raising sheep. Most sheep are registered in the regions of the Northern Kurzeme as well as in Vidzeme and Latgale regions.

Meadows and pastures are most important ways for the use of AL, which as a resource for forage is needed for the development of sheep farming sector. The provision of need of forage has a decisive role in the process of sheep farming, which is largely provided by usage of meadows and pastures. In sheep feed ration, the largest proportion consists of forage. Concentrated feed, grains and feed additives (minerals, microelements, vitamins) are needed in addition. In grazing period, sheep mainly use pasture grass (Warren). Sheep need a good quality, protein-rich animal feed, so farms need to create high-quality grasslands with a sufficient percentage of legumes; lands require for soil conditioning (removal of stones and bushes, fertilisation, liming) (Latvian Sheep Breeders Association, 2013a). In Latvia, sheep farming sector includes a large proportion of farms which cannot provide grassland of adequate quality because of the lack of finance (Latvian Sheep Breeders Association, 2013a). Despite this, a number of sheep farming workers have insufficient knowledge directly of sheep farming and also other related fields, which is necessary to acquire in order to choose an optimal management model, innovate production, and make a profit. New farms engage people with a good knowledge on business management, however, insufficient specific knowledge on animal husbandry, agronomy, and biological farming.

Unlike many other agricultural sectors, sheep farming does not need such a big investment in technical facilities and structures; however, mechanisms, machines, buildings, and equipment are necessary: pasture fencing, light type, unheated barn where the animals can survive the winter, equipment for watering, dispensing the concentrated feed, silage harvesting equipment and storage as well as equipment significantly reducing the need for manual handling - mechanical scales replaced with

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

electronic, PC compatible scales, special sheep catching devices, electronic ear tag readers and other equipment. Co-financing from the EU Structural Funds is available for purchase of technological equipment, for individual farms as well as for collaborative projects (Latvian Sheep Breeders Association, 2013a). Financial resources are necessary for starting-up as well as for development of sheep farming for investment in technological equipment and purchase of working capital (purchase of animals, purchase of feed etc.). Information on the key areas for development of the industry is provided by the state institutions, non-governmental organisations (LAAA), scientific community, educators and consultants (LLKC) as well as local governments.

3. Latvian sheep farming sector development indicators in Latvia

When evaluating the sheep farming sector development indicators in agriculture of Latvia, the study assessed the information on the sheep farming sector production on both domestic and foreign markets. Overall, in Latvia the sheep industry is experiencing a positive trend in recent years, the number of farms in sheep farming and the total registered number of sheep in them is increasing. Increase in the number of sheep is positively impacted by the increasing demand for sheep meat on both local and foreign markets as well as live sheep exports to Germany, Belgium, Denmark, and Bulgaria. As the result of focused breeding it has been possible to increase the fertility of ewes, preservation and fast-growth of lambs, so the further work in the field of sheep breeding is needed (Latvian Agriculture 2012, 2013). Goal of sheep breeding is to create a stable sector of sheep breeding and processing. In recent years, both the total number of sheep and herds has significantly increased in Latvia. By the data of the Agricultural Data Centre (Table 1) 99412 sheep are registered on 1 July 2013 in Latvia, which is about 22535 sheep more than on 1 July 2008, or it has been about 22% increase in the number of sheep.

Table 1

The dynamics of the number of sheep, ewes and rams in Latvia in the period from 1 July 2008 to 1 July 2013

Year	Sheep			Ewes			Rams		
	number	Δm(k)*	tm(k)** %	number	Δm(k)	tm(k), %	number	Δm(k)	tm(k), %
01.07.2008	76877	-	-	27223	-	-	48	-	-
01.07.2009	81134	4257	5.54	28758	1535	5.64	104	56	116.67
01.07.2010	87885	6751	8.32	31052	2294	7.98	147	43	41.35
01.07.2011	93532	5647	6.43	32988	1936	6.23	170	23	15.65
01.07.2012	98580	5048	5.40	34253	1265	3.83	207	37	21.76
01.07.2013	99412	832	0.84	34547	294	0.86	240	33	15.94

Source: author's construction based on data of the Agricultural Data Centre, 2013

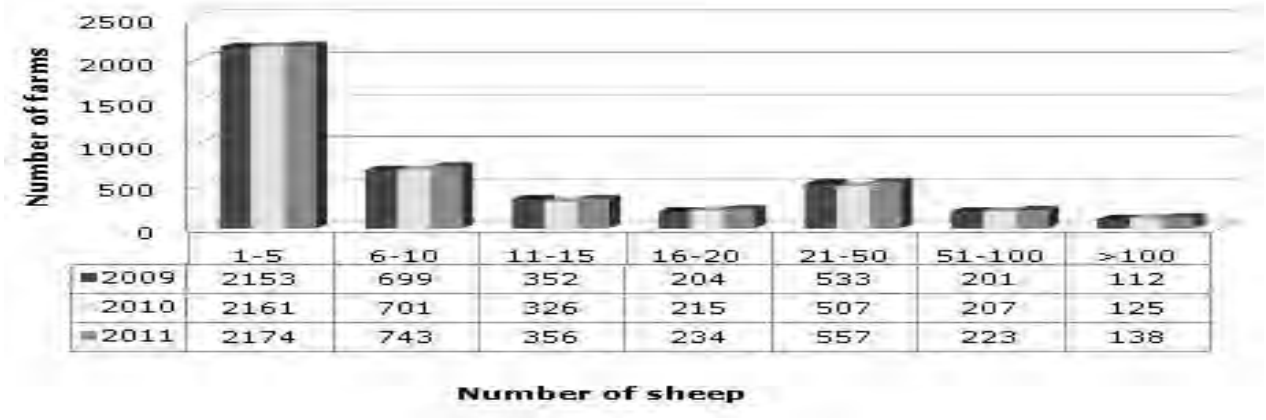
* ***Chain absolute increase*** $\Delta_{m(k)}$ is obtained by subtracting the previous level y_{m-1}. from the current level of row y_m. $\Delta_{m(k)} = y_m - y_{m-1}$ ****Chain and base increase rates*** $t_{m(k)}$ are obtained from the current chain growth rates subtracting 1 (i.e. 100%). Increase rates, like growth rates, are expressed as fractions or percentages $t_{m(k)} = T_{m(k)}\text{-}100$ (Krastins, 1998).

While analysing (Table 1) the development of sheep farming sector during the past years, it can be concluded that this sector is stable in recent years, as demonstrated by the statistics i.e. on 1 July 2008 there were registered 76877 sheep in Latvia, while on 1 July 2013, the number has risen to 99412 sheep.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

There are several factors for the rapid development growth of sector capacity and production volume is promoted by natural conditions of Latvia that are suitable for sheep farming, improvement of livestock genetic quality, as a key factor is the accession of Latvia to the European Union, which, thus, contributed to the increase in demand for sheep meat. While analysing the change of the number of ewes and rams, the total number of ewes and rams in Latvia has also increased including the growth in the number of sheep. In recent years, both the total number of ewes and rams in Latvia has significantly increased. By the data of Agricultural Data Centre (Table 1) on 1 July 2013 there were registered 34547 ewes in Latvia, which is by 7324 more than on 1 July 2008 or there has been around a 26.9% increase in the number of ewes. When accordingly analysing changes in the number of rams, then the number of rams in Latvia on 1 July 2013 has increased four times compared with 1 July 2008, or by 192 rams.

The sheep farming sector farms for the period of 2009−2011 were analysed in the analytical part of the study. To perform a calculation-based analysis, the study author (Figure 1) showed a distribution of farms by the number of sheep in the period of 2009-2011.

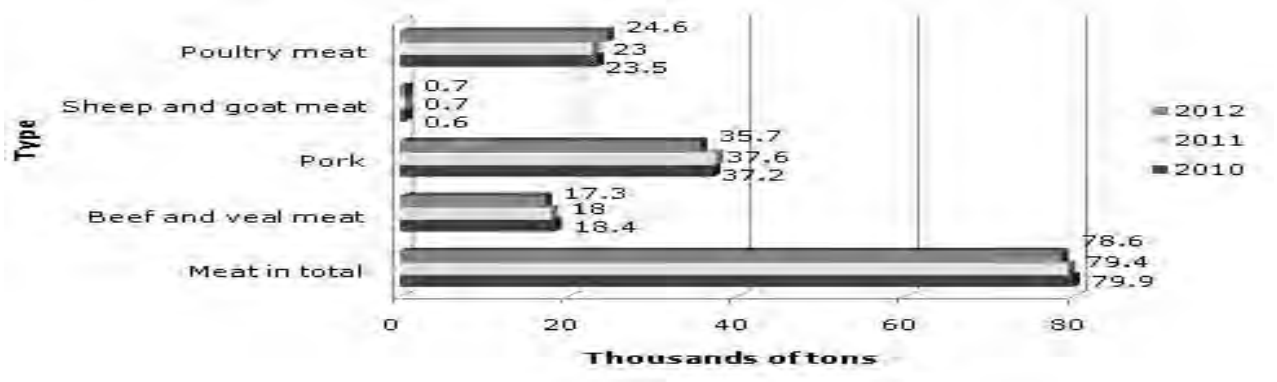


	1-5	6-10	11-15	16-20	21-50	51-100	>100
2009	2153	699	352	204	533	201	112
2010	2161	701	326	215	507	207	125
2011	2174	743	356	234	557	223	138

Source: author's construction based on the data of Agricultural Data Centre, 2012, 2013

Fig.1. **Distribution of farms in Latvia by number of sheep in the period of 2009−2011**

The situation in Latvia shows that 48% of farms have 1-5 sheep, which means that farms have small number of animals. While analysing the structure of sheep farms (Figure 1), it can be concluded that there has been an increase in the number of large farms in recent years. The largest increase in the number of farms, by 10.4%, was observed in farms with 100 or more sheep, while the number of farms with 51 to 100 sheep increased by 7.7%. At the same time, the number of small farms retains trend of previous years that small farms make up the largest proportion of the total number of farms. In 2011, 65% of total number of farms is registered as farms with 1 to 10 ewes, which mean that farms with a small number of sheep are not farms of meat production but sheep are farmed more for self-consumption as well as such farms have difficulties to provide the local market with a constant meat offer. Therefore, the exchange of information and co-operation among small farms to create more competitive farms with existing supply must be promoted. Complementing problem raised by previous studies in connection with the high fragmentation of the farms with a small number of sheep, causing insufficient meat production, the analysis was carried on the production of sheep farming sector in Latvia in the period from 2010 to 2012. The author of the study created Figure 2, which shows meat production volumes in Latvia.



Source: author's construction based on the data of Central Statistical Bureau, 2013

Fig.2. **Volume of meat production in Latvia by type (carcass weight, thousand of tonnes) 2010-2012**

It is possible to come to a conclusion that sheep farming is one of the most stable sectors of all traditional agricultural sectors, because meat production volumes are not decreasing; besides that Table 1 and Figure 1 show that the number of sheep and the number of farms in Latvia have increased during the past few years. The analysis (Figure 2) shows that meat production volumes in Latvia have decreased. The increase due to the growth of capacity of sector and production volume has been promoted by natural conditions of Latvia, also by demand of sheep in market. Improvement of livestock genetic quality is also taking place. Therefore, here, in the author's opinion, is one of the problems for the development of sheep farming, as there is a small total number of sheep and a small total average production volume on farm. The fact that the mutton demand in Latvia exceeds local farm output supply can be seen in Table 2, which shows mutton foreign trade in Latvia in 2012. Basically, sheep farming sector is characterised by three main product lines: meat, wool, and milk production. In Latvia, meat production is a major direction, while other sheep farming products are also used.

Table 2

Foreign trade of mutton in Latvia in 2012

Production type	Export			Import		
	EUR	*kg*	*EUR/kg*	*EUR*	*kg*	*EUR/kg*
Live sheep (number of pieces)	641			1689		
Fresh or chilled lamb carcasses and half	864	66	13.09	240	15	16.00
Fresh or chilled lamb carcasses and half (except lamb)	26 089	16 389	1.59	32 042	2 568	12.48
Fresh or chilled sheep meat with bone in (excl. carcasses, half-carcasses)	1 339	129	10.38	1791	220	8.14
Fresh or chilled boneless sheep meat	365	31	11.77	6958	2 084	3.34
Frozen sheep carcasses and half-carcasses (except lamb)	1 603	325	4.93	4118	843	4.88
Frozen sheep meat with bone (except carcasses and half-carcasses)	82 868	8 674	9.55	222 933	34 935	6.38
Frozen boneless sheep meat	41515	6355	6.53	181199	41 337	4.38
Total	154 643	31 969	x	449 281	82 002	x

Source: author's construction based on Latvian Sheep Breeders Association, 2013a, 2013

A very big problem in sheep farming sector is that farmers cannot produce enough to be sufficient for local consumption, and while farmers will not be able to produce for local consumption, they cannot expect a growth in exports. Table 2 shows the current situation of trends of sheep meat on the external market. The analysis of mutton foreign trade results in 2012 shows that the value of imported product

per unit of weight (Euro/kg) in some product groups is significantly higher than in the same group of products exported. It can be seen that in both the import and export the most valuable products (price per unit of weight) were fresh or chilled lamb carcasses and half-carcasses. Of quantities of fresh or chilled lamb carcasses export, one can conclude that the Latvian sheep breeders' farms exported 51.26% of total export quantity.

Conclusions, proposals and recommendations

1. The sheep farming sector in agriculture has been stable during the past few years, the number of sheep farms and the total registered number of sheep in them have increased, there were 76877 sheep registered in Latvia on 1 July 2008, while by 1 July 2013 the number increased to 99412 sheep, int. al., 34547 registered ewes. There are 42 breeding farms in Latvia that practice cultivation of breed material and reproduction.

2. The development factors involve the development of technologies, an increase of sector capacity, and growth of production volume, supported by the natural conditions of Latvia that are suitable for sheep farming as well as improvement of livestock genetic quality and the increase in demand for sheep meat.

3. The sheep farming is one of the most stable sectors of all traditional agricultural sectors in the regions of Latvia; its advantages are the economic use of natural resources and the rational method of resource management during the process of production.

4. In 2011, 65% of total number of farms were farms with 1 to 10 sheep in sheep breeding sector, which means that farms with the small number of sheep are not the ones that produce meat but the sheep are bred for their own use; for the farms like these it is also difficult to provide local market with a regular meat supply; however, it is positive that the number of the farms with 100 and more sheep increased by 10.4% in 2011, which stimulates the growth of competitiveness.

5. In 2012 Latvian sheep breeder farms mainly exported fresh or frappe lamb carcasses, that constitutes 51.26% of total amount of export, and frozen sheep meat with bones constituting 8 674 kg or 27.13%.

Bibliography

1. Agricultural Data Centre (2013). Animal Statistic. Retrieved: http://www.ldc.gov.lv/en/animal_database/animal_statistic/. Access: 14 December 2013.
2. Agricultural Data Centre (2012). The Statistics of Number of Animals. Retrieved: http://pub.ldc.gov.lv/pub_stat.php?lang=lv. Access: 30 November 2013.
3. Central Statistical Bureau of Latvia. Meat Production by Type (Carcass Weight, thousand tone). Retrieved: http://data.csb.gov.lv/Table.aspx?layout=tableViewLayout1&px_tableid=lauks%5cIkgad%C4%93jie+statistikas+dati%5c05Lopk%5cLL0110.px&px_language=lv&px_type=PX&px_db=lauks&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0. Access: 30 November 2013.
4. Committee on Agriculture and Rural Development (2008). Report on Proposal for a Council Regulation Establishing Common Rules for Direct Support Schemes for Farmers Under the Common Agricultural Policy and Establishing Certain Support Schemes for Farmers (COM(2008)0306 – C6-0240/2008 – 2008/0103(CNS)). The European Parliament. Retrieved: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A6-2008-0402+0+DOC+PDF+V0//LV. Access: 8 January 2014.

5. Garkalne, K. (2013). Report of Sheep Industry. Retrieved: http://www.losp.lv/node/2155. Access: 30 November 2013.
6. Krastins, O. (1998). Statistics and Econometrics. Central Statistical Bureau of Latvia, p. 435.
7. Latvian Agriculture in 2012, (2013). Ministry of Agriculture, p. 133. Retrieved: http://www.zm.gov.lv/doc_upl/LS_2012.pdf. Access: 11 November 2013.
8. Latvian Dark-head Sheep. Ministry of Agriculture. Retrieved: http://www.zm.gov.lv/doc_upl/Latvijas_Tumsgalves_aita.pdf. Access: 13 November 2013.
9. Latvian Sheep Breeders Association (2013a). Latvian Sheep Industry Development Strategy by 2023, p. 43. Retrieved: http://www.latvijasaita.lv/doc/LAAA_Strategija_2023.pdf. Access: 9 November 2013.
10. Latvian Sheep Breeders Association (2013b). Report of Sheep Industry 2012. Addition Nr.1. p. 52. Retrieved: http://www.losp.lv/sites/default/files/articles/attachments/publications/15.01.2013_-_2034/3459_aitkopibas_nozares_zinojums_2012_laaa.pdf. Access: 16 December 2013.
11. Nielsen, H.M., Christensen, L.G., Groen, A.F. (2005). Derivation of Sustainable Breeding Goals for Dairy Cattle Using Selection Index Theory. J. Dairy Sci.88, pp. 1882−1890.
12. Nielsen, H.M., Christensen, L.G., Ødegard, J. (2006). A Method to Define Breeding Goals for Sustainable Dairy Cattle Production. J. Dairy Sci. 89, pp. 3615−3625.
13. Olesen, I., Groen, A.F., Gjerde, B. (2000). Definition of Animal Breeding Goals for Sustainable Production Systems. J. Anim. Sci. 78, pp. 570−582.
14. Raducuta, I. (2011). Research on the Situation of Agricultural Land and Livestock Exploited in the Organic System in European Union. Scientific papers, Series D, Animal Science, Vol. LIV, pp. 258-263.
15. Raducuta, I. (2012). Research on the Sheep Breeding in Organic Farming System in Romania. Scientific papers, Series D, Animal Science, Vol. LIV, pp. 219-222.
16. Warren, G. Applied Sheep Behaviour. Animal Science Department, the University of Tennessee, p. 24. Retrieved: http://animalscience.ag.utk.edu/sheep/Publications-Sheep.html. Access: 8 January 2014.
17. Willer, H., Kilcher, L. (2011). The World of Organic Agriculture. Statistics and Emerging Trends 011, IFOAM, Bonn, & FiBL, Frick, pp. 26-32.

BIOGAS PRODUCTION FROM AGRICULTURAL RAW MATERIALS

Kaspars Naglis-Liepa [1], Dr.oec., assistant professor[+]; **Modrite Pelse** [2], Dr.oec., professor
[1,2] Latvia University of Agriculture

Abstract. Nowadays no one doubts the need for alternative energy sources; yet, their choice and conditions of use are quite complicated and difficult to understand. In Latvia, the experience in the use of biogas from agricultural raw materials to generate energy is quite small, and optimal resources and their mixtures are sought constantly. The research aim of the present paper is to identify the optimal type and quantity of substrate for a biogas facility for the conditions in Latvia by means of a simulation model. To achieve the aim, the following research tasks were set: to develop and describe a simulation model for the fermentation of a substrate for biogas production; and to identify an optimal substrate mixture for biogas production. It is necessary to examine several factors for the choice of a biogas substrate. If calculations are based on the energy potentials of substrates and their cost, an optimal substrate consists of a mixture of silage (22%) and manure (78%). The cheapest energy could be obtained if only manure is used; yet, the necessary electric capacity of the bioreactor would not be reached in this case. The optimisation model can be effectively used for identifying the optimal biogas substrate and its quantities and for calculations of alternative energy production.

Keywords: biogas, agricultural raw materials for energy, cost, energy potential.

JEL code: Q1; Q4

Introduction

The EU strategy Europe 2020 envisages increasing the output of energy from renewable energy sources until 2020 compared with the level of 1990. These targets set at the EU level are aligned with each Member State's national energy targets. Modern energy solutions are very complicated due to the diversity of production possibilities, the integrity of markets, and changes in the purchasing power of society. The association of energy production with other fields is especially explicitly seen in biogas production, which plays an increasing role in Latvia's economy. Biogas production affects not only the supply of and demand for energy but also, to a great extent, agriculture.

A complete assessment of biogas production cannot be presently made in Latvia, as this field is relatively new and little researched. There is a lack of statistical data, and credible information has to be obtained, which would allow examining the possibilities to use biogas in the energy sector. For this reason, the authors of the paper have developed a simulation model to assess biogas as a source of energy. The assessment was based on economic considerations. The research aim of the present paper is to identify the optimal type and quantity of substrate for a biogas facility for the conditions in Latvia by means of a simulation model. The model is approximated to the performance of the biogas facility on the research and training farm (RTF) "Vecauce" of Latvia University of Agriculture, which ensures that the data obtained fit practical performance results. This biogas facility is the first facility of this type in Latvia, which was established in 2008 and in which agricultural materials, including manure, are used as a

[+] Corresponding author. Tel.: + 26184585; fax: + 371 630 84987
E-mail address: Kaspars.Naglis.@llu.lv

substrate. To achieve the aim, the following research tasks were set: 1) to develop and describe a simulation model for the fermentation of a substrate for biogas production; and 2) to identify an optimal substrate mixture for biogas production.

A production model is actually a production function, which involves production of agricultural products (preparation of a substrate), biogas production, and cogeneration resulting in the generation and sale of electricity and thermal energy. The paper will contain calculations for the production model's first part focusing mainly on economic gains from the use of resources and the maximum output of biogas. The amounts of electricity and thermal energy and their sales will not be considered in this paper.

Research results and discussion

Replacement of energy resources in the context of economic considerations

For raising economic efficiency, alternatives in the supply of energy are constantly sought based on economic efficiency as the leading criterion. Every new economic cycle starts with the use of new types of energy or innovations in this field.

Marceti, whose research was based on the Fisher-Pry model of energy substitution, discovered a shift in the historical life cycles of primary energy sources from wood, coal, oil and natural gas to nuclear energy and, in the future, solar energy (Devezas T. et al., 2008). Kondratieff's long waves reflect the logarithmic movement of economic growth from the perspective of technological progress or innovation. The waves replace one another by significantly overlapping each other, which enables some regions to review their energy supply policies. Due to technological progress, new waves might emerge more frequently, which may be explained by the fact that there is no so efficient (from the public point of view) source of energy that would be able to take a similar position as once coal was. From this point of view, it is possible to explain the change of the type of energy as well. Georgescu-Roegen (1975), one of the founders of the energy theory of value, emphasises that economic efficiency, ease of use and capital intensity determine innovations in the choice of energy. This evolution highlights the decreasing role of factors of stock and the increasing role of factors of flow in energy supply, while at the same time stressing economic efficiency.

Along with technological progress, economic growth is ensured by a transition to a higher level of energy. It contradicts the energy theory of value that envisages the transition to a cheaper type of energy source. The price of energy as the leading determinant in the choice of alternatives is also contended by I.Matutinovic (2009), the Gfk Group, an expert of one of the largest research companies in the world. He points that in a foreseeable future, high prices will not be the leading determinant that will define the production/export level according to foreign demand; those will be domestic, not global, economic, or political decisions.

The cyclical use of energy sources may be viewed not only from the perspective of progress but also from the perspective of possibilities for the use of sources. There is no conformity of opinions regarding the period for which mineral reserves can meet demand, as the efficiencies of extraction and use constantly rise. Yet, to identify the need for alternative energy based on the amount of dominant energy reserves, the situation may be examined by using simulation models. The paper presents simulation results of the model for the biogas production, which assumes that biogas is produced from agricultural products.

Simulation model for the fermentation of a biogas substrate

Using the optimisation model, the authors analysed various agricultural substrates and the efficiency of their use for biogas production, focusing mainly on substrate production costs.

The values were initially calculated assuming that fertilisers are used for crops. Biogas energy production is based on examining the following technical indicators: content of substrate dry matter, biogas yield, potential capacity, optimal substrate mixture etc. The model for simulating biogas production assumes an electric capacity of 260 kW in cogeneration (the designed capacity of the biogas facility is 0.26 MW). The electricity generated is a product for sales.

Besides the characteristics of substrates, the volume of the biogas fermentor or bioreactor and the allowed content of dry matter that is needed to ensure optimal biochemical processes should be considered when choosing an optimal substrate mixture. In the particular case, the volume of the fermentor is 2000 m^3 (the effective fermentation volume is 1870 m^3) and the allowed content of dry matter is 17%.

The average period of keeping a substrate in the fermentor depends on the type of bioreactor and the substrate depletion period. For biogas facilities running mainly on livestock manure and/or livestock manure combined with industrial organic waste, it takes from 15 to 40 days, depending on the temperature mode in the fermentor. For biogas facilities using mainly energy crops as a substrate, it takes a longer period – from 60 to 100 days – in the mesophilic digestion process (30 - 42^{o}C) (Al Saedi et al., 2008).

In Denmark, the thermophilic process (43-55^{o}C) is mainly used at biogas facilities, as it significantly shortens the substrate depletion period; for instance, the substrate depletion period in the mesophilic process lasts for 25 days, while in the thermophilic process it takes only 12-15 days. The thermophilic process ensures a saving of volume up to 40% (Birkmose T. et al., 2007). Yet, a mesophilic fermentor is more stable and simple; it is less affected by changes in substrate mixtures (Frandsen T. et al., 2011). For simulations, the authors assume that the bioreactor operates in the mesophilic process (at approximately 38^{o}C) just like at the facility on the RTF "Vecauce".

Biogas is a gaseous fuel resulting from anaerobic fermentation; it consists of methane (CH_4), 50-70%, carbon dioxide (CO_2), 30-40%, and other components, for example, N_2O, O_2, NH_4, H_2S. Biogas can be obtained in a natural process in swamps, peat swamps, and waste deposit sites as well as from manure, sewage, fresh biomass, and biodegradable waste by using special fermenters. The energy value of biogas is usually within a range of 5-7 kWh m^{-3} depending on the content of methane in biogas, which is affected by the composition of nutrients in the fermented substrate, moisture, a type of waste and other factors.

The fermentation process takes place in the bioreactor, and the substrates needed for anaerobic fermentation may be very different. The substrates may differ by origin, methane yield, dry matter content etc. Yet, the common attributes are their ability to degrade biologically, energy is generated in this process and methane as a component of biogas is produced.

The energy obtained from a substrate may be calculated according to an equation:

$$Q_{en} = Q_{biogas} * K_{met} * Q_{met} \quad , \qquad (1)$$

where Q_{en} – total amount of energy, kWh;

Q_{biogas} – amount of biogas, m^3;

K_{met} – proportion of methane in biogas, m^3;

Q_{met} – lowest calorific value of methane, kWh m^{-3}.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The lowest calorific value of methane is assumed to be 10 kWh m^{-3}, and this choice is based on the recommendations of several scientists (Blumberga D. et al., 2009), while the amount of biogas obtained may be calculated by an equation:

$$Q_{biogas} = Q_{substr} * K_{biogas} \quad , \qquad (2)$$

where Q_{biogas} – amount of biogas, m^3;

Q_{substr} – amount of substrate, t;

K_{biogas} – biogas yield from fresh biomass, m^3.

The characteristics of various types of agricultural substrates – biogas yield, content of methane in substrates, and content of dry matter – differ, and the period needed for fermentation has to be also taken into consideration (Table 1). Accordingly, the unit cost among substrates is quite different.

Biogas yield from fresh biomass is a standard value that is based, in Table 1, on research conducted by German scientists, while in Latvia this indicator is lower. Laboratorial tests have been carried out both at the laboratories of the Faculty of Engineering, Latvia University of Agriculture, under the guidance of V.Dombrovskis and at laboratories in Germany on maize substrates grown under the guidance of professor Z.Gaile. The test results have been reported in numerous research papers (Dubrovskis V. et al., 2010; Dubrovskis V. et al., 2008;Bartusevics J., Gaile Z., 2010).

Table 1

Characteristics of biogas from agricultural substrates and the price of substrates

Type of substrate	Biogas yield, m^3, from fresh biomass	Proportion of methane in biogas, %	Content of dry matter in fresh biomass, %	Time needed for fermentation, days*	Substrate price, EUR t^{-1}
Winter wheat	596-616	52	87	80-100	161
Winter barley	596-616	52	87	80-100	195
Triticale	596-616	52	87	80-100	239
Barley	596-616	52	87	80-100	194
Oats	616	52	87	80-100	100
Silage (spring mixed crops, in trenches)	137-225	52-55	35	60-100	50
Haylage (in trenches)	137-225	52-55	35	60-100	26
Silage (grass)	137-225	52-55	35	60-100	43
Silage (maize)	187-218	49-59	35	60-100	29
Bran	200	52	87		336
Liquid manure (cattle)	20-30	55	7-10	15-40	3
Rapeseed granules	616	52	87	80-100	117
Milk (spoiled)	245	63	12	15-40	14

Note: * mesophilic digestion; substrate prices of 2010 for the RTF "Vecauce"

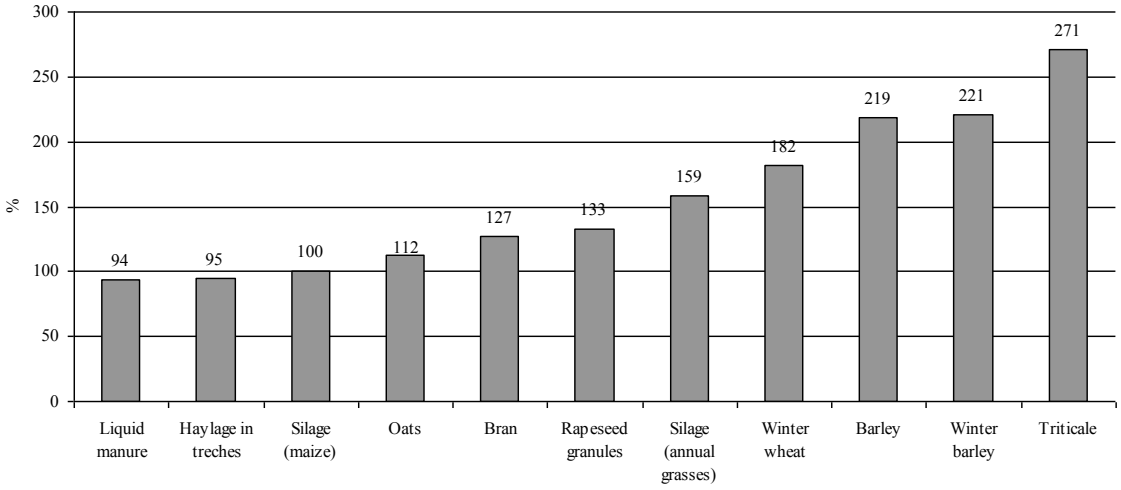
Source: authors' calculations based on Blumberga et al., 2009; Kalnins, 2009; Kalnins, 2007; Al Saedi et al., 2008

Table 1 presents information on the most popular types of substrates for biogas production in Latvia; prices are approximate to show the range of substrate prices. The prices range from 3 EUR t^{-1} for manure to even 336 EUR t^{-1} for bran. The methane content for these substrates is within a range of 49-63%, while the greatest differences are observed for the content of substrate dry matter, as it changes from

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

12% to 87%. Besides the mentioned bran, the most expensive substrates are grains – winter wheat, barley and triticale, the prices of which range from 161 to 239 EUR t^{-1}–, whereas the cheapest crop products are haylage and maize silage. According to Table 1, the biogas yield from these crops is quite different – from 20-30 m^3 for manure up to 616 m^3 for bran. Therefore, the choice of a biogas substrate is a complicated issue.

Figure 1 shows the efficiency of substrates chosen by the farm if the choice is based only on the biogas yield from various substrates and the cost. Yet, the choice is much more complicated, as a range of various indicators have to be taken into consideration, for instance, proportion of methane in fresh biomass, content of organic dry matter as well as a range of biochemical indicators, for example, content of sulphur in biogas or use of grain in the substrate (the key purposes of grain is food as well as feed for livestock). The use of grain may be justified by the insufficient volume of the bioreactor, which is a considerable precondition for the choice of a substrate.



Source: authors' calculations based on RTF Vecauce data, 2010

Fig.1**. Cost of energy from substrates for biogas production as a percentage of the cost of energy from maize**

It is important to compare the cost of production of a substrate and the potential of energy obtained from the particular raw material. Figure 1 assumes maize silage as a standard substrate and shows the total cost of one kWh of energy generated from a substrate expressed as a percentage. In the given case, the cost of maize silage is assumed to be 100%. It has to be noted that the costs and their ratios are calculated based on the economic performance indicators of the RTF "Vecauce"; thereby, as the prices change, the ratios may also change.

According to the scientific literature, the biogas yields from substrates used by the given farm are highest for milk (900 l of biogas from one kg of organic dry matter) and winter wheat (700 l of biogas from one kg of organic dry matter). Yet, if analysing these substrates in terms of their cost per unit of energy generated, the cost is high. The cost of winter wheat reaches 182% of the cost of maize silage or, for instance, to produce the necessary amount of energy by using barley for biogas production, two times more funds have to be spent as compared with maize silage. The cheapest energy can be generated from manure.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Determination of an optimal substrate mixture

The process of fermentation within a biogas facility is limited by various factors that have to be considered to obtain the recipe for the optimal composition of a substrate. The required conditions can be expressed as a system of conditions and calculated as an optimisation problem (3), thus, identifying the optimal amount of a substrate and its optimal mixture ratio.

$$\begin{cases} a_i x_1 + a_i x_2 + a_i x_3 + ...a_i x_n = b \\ \dfrac{e_i x_1 + e_i x_2 + e_i x_3 + ...e_i x_n}{x_1 + x_2 + x_3} = g \\ x_1 + x_2 + x_3 + ...x_n = X \end{cases} \quad (3)$$

where a – electricity yield from a type of substrate, kWh t^{-1} per day;
b – maximum capacity of a cogeneration plant, kWh per day;
e – dry content of substrate, %;
g – optimal content of dry matter in the fermentor, %;
x – optimal amount of a type of substrate, t per day;
X – maximum possible amount of substrate supply, t per day.

The electricity yield a_i and the dry content of substrate e_i depend on the type of substrate – i. This equation has to minimise the function's value or, in the given case, the cost of substrate mixture (4):

$$F = cx_1 + cx_2 + cx_3 + ... cx_n \quad (4)$$

where c – cost of a type of substrate, EUR t^{-1}.

In the optimisation problem, the authors set an energy limit, which is affected by the capacity of the cogeneration plant. Electricity production is considered a type of basic economic activity; thus, for instance, the value of minerals of the digestate, which is a by-product of fermentation process, plays no considerable role. Therefore, the maximum amount of electricity generated per day is calculated by the equation 5:

$$b = Q_{el.yield} * 24h, \quad (5)$$

where b – amount of electricity generated, kWh per day;
$Q_{el.yield}$ – nominal electric capacity of a cogeneration plant, kWh.

Electricity yield is derived from the indicators of the corresponding type of substrate and is calculated by the equation 6:

$$ax = Q_{biogas} * K_{met} * R_{met} * \dot{\eta}_{el} \quad , \quad (6)$$

where ax – electricity yield, kWh;
Q_{biogas} – amount of biogas, m^3;
K_{met} – amount of methane in biogas, m^3;
R_{met} – lowest calorific value of methane, kWh m^{-3};
$\dot{\eta}_{el}$ – electric efficiency of the cogeneration plant.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Based on the data on the biogas facility of the TRF "Vecauce", a calculation table may be created for the selected types of substrates (Table 2). The types of substrates were voluntarily selected with the purpose of providing the diversity of substrates and representing some group of substrates: liquid manure, grain, maize, and grass silages. It was assumed that the optimal fermentation period is 32 days. Since the unit of measure in the equation is m^3 – to switch to a single unit of measure in the calculations – it was assumed that a ton of silage is equal to 0.7 m^3 of substrate, while the ratio of weight to volume for liquid manure was assumed to be 1:1.

Table 2

Basic characteristics of the biogas substrates used for simulation

Indicator	Type of substrate			
	liquid manure	grain (winter wheat)	maize silage	grass silage
Electricity yield (ax), kWh t^{-1}	39.00	1085.00	350.00	254.00
Content of dry matter, %	7.00	87.00	33.00	35.00
Substrate price, EUR t^{-1}	3.00	160.78	29.27	42.94

Source: authors' calculations based on RTF Vecauce data, 2012

The cheapest substrate was liquid manure; yet, if taking into account only the allowable amount of liquid manure per day, which is derived from the optimal fermentation period, there is only one third acquired of the required capacity. In the present example, it means that the 55 tonnes of liquid manure required for processing would produce only 2145 kWh of electricity or 34% of the required capacity – 6240 kWh per day. Since the most important condition is not met, this alternative is not optimal. After analysing all the substrates in terms of energy generated and cost, one can find that the most optimal mixture is 12.7 tonnes (22%) of maize silage and 46.1 tonnes (78%) of liquid manure. Such a mixture allows reaching the required capacity, which fits the volume limit of the selected bioreactor; yet, it does not allow reaching the required average content of dry matter (17%). The total cost of such a substrate mixture amounts to EUR 502.64 per day or EUR 0.08 per kWh^{-1} of electricity.

Conclusions

1. The present optimisation model and its options can be successfully used for biogas facilities in Latvia to determine the optimal type of substrate and the optimal substrate mixture if the raw materials are substrates of agricultural origin. Given the economic considerations, it allows reaching the required electric capacity of a biogas facility.
2. For small biogas facilities with a bioreactor capacity of less than 0.3 MW, under the conditions of Latvia, an optimal substrate mixture is as follows: 78% manure and 22% maize silage. In this case, the average cost of the substrate mixture amounts to EUR 502.64 per day or EUR 0.08 per kWh^{-1} of electricity. It allows reaching the maximum electric capacity of the bioreactor.
3. The use of various cereals for biogas production is not recommendable not only due to ethical reasons, as it reduces the availability of food; but also because the economic calculations show that the energy generated from grain is from 2 to 3 times more expensive than the energy produced from other agricultural products.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

Bibliography

1. Al Saedi, T., Rutz, D., Prassl, H., Kottner, M., Finsterwalder, T., Volk, S., Janssen, R. (2008). *Biogas*: Handbook [on line]: Denmark: University of Southern Denmark Esberg. pp. 126. Retrieved: http://www.lemvigbiogas.com/BiogasHandbook.pdf. Access: 04.12.2013.
2. Bartusevics, J., Gaile, Z. (2010). Kukuruzas organiskas sausnas razas nozime biogazes razosana (Role of the Output of Organic Dry Matter of Maize in Biogas Production). Zinatniska seminara rakstu krajums "Razas svetki Vecauce-2010, *Zinasanas- visdrosakais ieguldijums darbam un dzivei*" (Scientific seminar proceedings "Harvest Festival Vecauce-2010, Knowledge – the Safest Investment for Work and Life". Jelgava: LLU, pp. 12-16.
3. Birkmose, T., Foged, H.L., Hinge, J. (2007). State of Biogas Plants in European Agriculture Negotiated Procedure No. IP/B/AGRI/IC/2007-020, Danish Agricultural Advisory Service. pp. 70. Retrieved: http://www.inbiom.dk/download/viden_oevrige_emner/state_of_ biogas_final_re port.pdf. Access: 18.12.2013.
4. Blumberga, D., Dzene, I., Al Sedi, T., Rucs, D., Prasls, H., Ketners, M., Finstervalders, T., Folka, S., Jansens, R. (2009). *Biogaze*: rokasgramata (Biogas: a Guidebook). Riga: Ltd Ekodoma, p. 155.
5. Devezas, T., LePoire, D., Matias Joao, C.O., Silva Ambilio, M.P. (2008). Energy Scenarios: Toward a New Energy Paradigm. In: *Futures*: The Journal of Policy, Planning and Futures Studies. Volume 40, Issue 1, pp. 1.-16.
6. Dubrovskis, V., Plume, I., Adamovics, A., Auzins, V., Straume, I. (2008). Galega Biomass for Biogas Production. *Engineering for Rural Development*: Proceedings of the 7th International Scientific Conference, Jelgava: LLU, pp. 61-65.
7. Dubrovskis, V., Plume, I., Bartusevics, J., Kotelenecs, V. (2010). Biogas Production from Fresh Maize Biomass. *Engineering for Rural Development:* proceedings of the 9th International Scientific Conference, Jelgava: LLU, pp. 220-225.
8. Frandsen, T. Q., Rodhe, L., Baky, A., Edstrom, M., Sipila, I.K., Petersen, S.L., Tybirk, K. (2011). *Best Available Technologies for Pig Manure Biogas Plants in the Baltic Sea Region*. Published by Baltic Sea 2020, Stockholm. pp. 159 Retrieved: http://www.balticsea2020.org/english/images/Bilagor/best%20available%20technologies%20for%20pig%20manure%20biogas%20plants%20in%20the%20bsr%20final%20technical%20report.pdf. Access: 27.11.2013.
9. Georgescu-Roegen, N. (1975). Energy and Economic Myth. *Southern Economic Journal*, Volume 41, No 31. Retrieved: http://www.issi.it/gruppi%20di%20lavoro/sviluppo%20sostenibile/Decrescita/docs/Georgescu/Energy%20and%20Economic%20Myths.pdf Access: 8.12.2013.
10. Kalnins, A. (2009). *Biogazes razosanas saimnieciskie un vides ieguvumi (Economic and Environmental Gains from Biogas Production)*. Rokasgramata biogazes razosanas iespeju izvertesanai (Guidebook for Assessing Possibilities for Biogas Production). Riga, p. 147.
11. Kalnins, A. (2007). *Biogazes iespejas un tas ka transportlidzeklu degvielas izmantosana (Possibilities of Biogas and its Use as a Fuel for Vehicles)*. Riga: Ministry of Economics of the Republic of Latvia, p. 95
12. Matutinovic, I. (2009). Oil and the Political Economy of Energy. *Energy Policy*, Volume 37, Issue 11, pp. 4251-4258.

LAND USE CHANGES AND BIOENERGY IN LATVIA

Ligita Melece[1], Dr.oec.[+]; **Peteris Lakovskis**[2], Dr. geogr.
[1] Head of Department of Quality and Environment, Latvian State Institute of Agrarian Economics
[2] Researcher of Department of Rural Development Evaluation, Latvian State Institute of Agrarian Economics

Abstract. The paper presents results of studies devoted to the changes of land use caused by implementation of bioenergy policy in Latvia. The period of 2007-2012 was chosen and chiefly data on declared utilised agricultural area on municipal and region level from the Rural Support Service were used for assessment of land use changes. In Latvia, utilised agricultural areas (UAA), which is mainly used for bioenergy feedstocks production - rape and maize for silage - are located in the territories/regions (Zemgale and Kurzeme) with the highest proportion of agricultural lands and the highest soil fertility. The growing trends in these regions are statistically significant. The biogas plants are also located in these territories. Meanwhile, slight but decreasing tendency of the share of unused UAA in all regions, except Latgale, was observed. Moreover, the share in Latgale, the most undeveloped region, increases and reached 18% in 2012. The observed changes in land use in Latvia show some contradictions to bioenergy policy which is oriented to: returning the unused agricultural land in the production of feedstock; improving the quality of the environment, particularly, biodiversity and the landscape; and encouraging rural development.

Key words: agricultural land, bioenergy policy, region, Latvia.

JEL code: Q15, Q20, Q53, R14

Introduction

Bioenergy as one of the renewable energy resources is currently at the global focal point, both due to its effect on environment and the necessity to replace rapidly decreasing fossil energy sources with renewable and more environment-friendly source. The possible benefits from the environmental point of view, including the lower greenhouse gas (GHG) emissions when replacing the fossil fuel with biomass, is among the main driving forces for wider usage of bioenergy. However, in the European Union (EU), production of agricultural biomass, whether used for food, feed, material, or energy, has to meet a series of statutory environmental rules regarding the quality of water, soils, and air. The EU Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (The European Parliament…, 2009), provides a legislative framework for the Community. Regarding the expand of bioenergy, particularly biofuels, use in the EU, the Directive aims to ensure the use of sustainable biomass only, which generate a clear and net GHG saving without negative impact on biodiversity and land use.

Therefore, Latvia has also developed the national renewable energy policy and the support programme based on the EU principles. Support measures for bioenergy production encourage increasing cultivation of energy plants for biomass feedstock: 1) rapeseed production for biodiesel production; and 2) maize for silage as feedstock in the biogas production. The programme of development of production

[+] Corresponding author. Tel.: +37129196063; fax: +371 67541789
E-mail address: ligita.melece@lvaei.lv

and use of biogas 2007-2013 (Ministru kabinets, 2007) says one of the goals of bioenergy production development is encouraging rural development processes, creating new jobs, and improving the quality of the environment and the landscape.

Along with the benefits of bioenergy generation, the different negative influence caused by some types of bioenergy is also stressed (Wilhelm et al., 2007; Searchinger et al., 2008; Tyner, 2010; Perimenis et al., 2011; Finco, 2012). The majority of such objections are related with the biomass production from the agricultural lands and field crops. It is recommended that before entering into or accepting bioenergy projects, states should make a full calculation of the social, economic, and environmental costs compared with the benefits – and to the ways in which the benefits will be shared (Eide, 2009:33). It is becoming increasingly evident that land is a finite or restricted resource due to conflicting demands for agricultural land for the production of food, animal feed, fibre and biomass for energy (Dauber et al., 2012).

Taking into account the above mentioned, the hypothesis of study was determined - the bioenergy development in Latvia causes changes in land use. The aim of study is to investigate the present situation and processes regarding land use changes initiated by bioenergy development in Latvia. The tasks of study are: to clarify the impact of bioenergy on countryside and landscape, particularly, on land use changes; to investigate land use changes in Latvia regarding the main bioenergy crops as feedstocks: rape for rape seed (biodiesel production) and maize for silage (biogas production); and possible impact on permanent and temporary pastures and meadows (landscape) as well as unused or surplus land. The research is concentrated on the impact of bioenergy, which is closely connected with agricultural sector.

The principal materials used for the studies are as follows: different sources of literature, e.g. scholars' articles, research papers and the reports of institutions, inter alia, governmental; and data from database of the Latvian Rural Support Service (RSS). For investigation the land changes the data of declared areas of utilised agricultural land area (hereinafter - UAA) were used in the period of 2007-2012. The suitable qualitative and quantitative research methods have been used for various solutions in the process of study: monographic; analysis and synthesis; logical and abstractive constructional; spatial analysis of field blocks, using GIS[24]; correlation and regression etc.

Due to limited space, only the most important results of research are set out in the paper.

Research results and discussion

Land use and bioenergy

The bioenergy means any form of energy derived from biomass - living organisms or their metabolic products (Bioenergy, 2013). On the EU level (The European Parliament and the Council of the European Union, 2009: 27), 'biomass' is defined as "…the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture as well as the biodegradable fraction of industrial and municipal waste."

The growing demand for bioenergy crops can create further competition for land and water between the existing agricultural activities and the use of agricultural land for nature conservation, which could result in additional negative environmental pressures from cultivating bioenergy crops (EEA, 2006). Many scholars (e.g. Pingali et al., 2008; Flora, 2010; Kirschenmann, 2010; Krasuska et al., 2010; Piroli et al., 2012) and experts (FAO, 2013) argue that food production has a priority, only surplus land could be used

[24] geographic information system - GIS

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

for non-food crops. Moreover, Krasuska with co-authors (2010) forecast the amount of surplus land in the EU-27 Member States (excluding Cyprus and Malta) that could be available for non-food crops after satisfying food and feed demands. In Latvia, the percentage of surplus land was 7-9% in the period of 2003-2007 but projections show that surplus land could be 14-17% in 2020 and 22-27% in 2030 (Ibid.). The proposed potential non-food cultures for Poland, the Baltic States (Estonia, Latvia, and Lithuania) and the Nordic countries (Finland, Sweden) are: willow, poplar, reed canary grass, rapeseed, flax (Ibid.), which could be cultivated on surplus land, mainly fallow. Surplus land could be seen as the all-embracing umbrella term for areas potentially available for bioenergy cultivation. Indicating that there is no clear definition for this term, Dauber with co-authors (2012) distinguish two different origins of surplus land: 1) land currently not in use for the production of food, animal feed, fibre, or other renewable resources due to poor soil fertility or abiotic stress, and 2) land currently no longer needed for food and feed production, because of intensification and rationalisation of production. Moreover, Nuwer (2012) stressed that Dauber et al. (2012) encountered a plethora of terminology of surplus land that seemingly all referred to different versions of the same thing, including marginal land, reclaimed land, and degraded land.

Some scholars (Divan and Kreikebaum, 2009) argue that expansion of farming for biofuel production causes unacceptable loss of biodiversity for a much less significant decrease in fossil fuel consumption. The loss of biodiversity also makes heavy dependence on biofuels very risky by reducing ability to deal with blights affecting the few important biofuel crops (Ibid.). Perimenis et al. (2011) and Finco (2012) note that land use changes and intensification of cultivation following the increased demand for biofuels may cause new GHG emissions and affect the biodiversity, the soil quality, and the natural resources. To handle these problems, attention is focused on the development of next generations − second and third generation of biofuels (e.g. lignocellulosic ethanol, Bio-SNG, synthetic biofuels) that will use a wider range of feedstock including lignocellulosic material, waste and residues, and will not compete with food production (Perimenis et al., 2011) or stimulate production of algae origin biodiesel (Ziolkowska, 2014). Moreover, Howard et al. (2009) affirm that the first generation biofuels are inefficient both in terms of economy and the environment.

Regarding biomass or feedstock development, scholars (e.g. Berndes et al., 2012; Kusch and Evoh, 2013) conclude that the need for bioenergy can reinforce through efficient and sustainable waste management strategies.

Land use changes in Latvia

The structure of agricultural land and its spatial distribution is essential for both: 1) development of agricultural sector related with basic resource; 2) environment and nature protection, which is an essential part of the Common Agricultural Policy. For estimation, the UAA was divided into main agricultural crops: arable land (different crops); perennial grass sown into arable land or temporary grassland (hereinafter - TG); permanent pastures and meadows (hereinafter − PPM); and fallow and unused and unmanaged (hereinafter - unused) UAA.

The results show that TG constituted 17% from area of field blocks in 2012; other arable land − 40%, while PPM − 22%. No information is available about 20% of area, since it has not been declared for support payment. However, previous studies and results (LVAEI, 2013b) suggested that this undeclared area mainly consists of extensively managed PPM or fellow, and unmanaged grasslands. Overall, more than half of the UAA is being managed intensively but more than one third of the UAA is being managed extensively or not managed at all. Positive trend is observed in case of fellow share in the UAA, where

decreasing of fellow area in all regions is observed (Table 1). Moreover, the coefficient of correlation (r) is significant in all municipalities.

Table 1

The changes of share (%) of fallow area from the UAA in Latvia's regions and significance of trends, 2007-2012

Regions	2007	2008	2009	2010	2011	2012	Correl. coef. of trend	Significance level
Kurzeme	0.8	0.6	0.7	0.7	0.6	0.4	r = 0.85	$\alpha<0.05$
Latgale	0.9	0.7	0.7	0.7	0.6	0.4	r = 0.95	$\alpha<0.01$
Pieriga	0.8	0.5	0.6	0.6	0.5	0.3	r = 0.82	$\alpha<0.05$
Vidzeme	1.0	0.7	0.7	0.7	0.6	0.4	r = 0.91	$\alpha<0.01$
Zemgale	0.5	0.4	0.4	0.4	0.4	0.3	r = 0.92	$\alpha<0.01$

Source: authors' calculations based on the unpublished data from Latvian Rural Support Service

The results of spatial analysis show that the share of cereals and technical crops has increased in some municipalities most of all – more than 8%. The changes of share of rape area from the UAA in Latvia's regions are increasing in all regions (Table 2). Statistically, this trend is significant in all regions, except Zemgale, where the share was very high (10.2%) in 2007 and tops other regions. In 2012 the highest share is seen in Zemgale (10.6%) and Kurzeme (7.1%) but the lowest - in Latgale (2.7%) and Vidzeme (3.5%).

Table 2

The changes of share (%) of rape area from the UAA in Latvia's regions and significance of trends, 2007-2012

Regions	2007	2008	2009	2010	2011	2012	Correl. coef. of trend	Significance level
Kurzeme	3.9	3.1	4.4	6.2	6.7	7.1	r = 0.93	$\alpha<0.01$
Latgale	1.6	0.9	1.0	1.6	2.5	2.7	r = 0.77	$\alpha>0.05$
Pieriga	4.1	3.3	4.2	5.4	5.6	5.4	r = 0.85	$\alpha<0.05$
Vidzeme	2.9	2.5	2.9	3.3	3.9	3.5	r = 0.82	$\alpha<0.05$
Zemgale	10.2	7.0	9.4	10.1	10.9	10.6	r = 0.56	$\alpha>0.05$

Source: authors' calculations based on the unpublished data from Latvian Rural Support Service

The changes of share of maize for silage area of total UAA in Latvia's regions show (Table 3) that the highest significant increase and share has been observed in Zemgale (1.8%) and Pieriga (1.8%).

Table 3

The changes of share (%) of maize for silage area from the UAA in Latvia's regions and significance of trends, 2007-2012

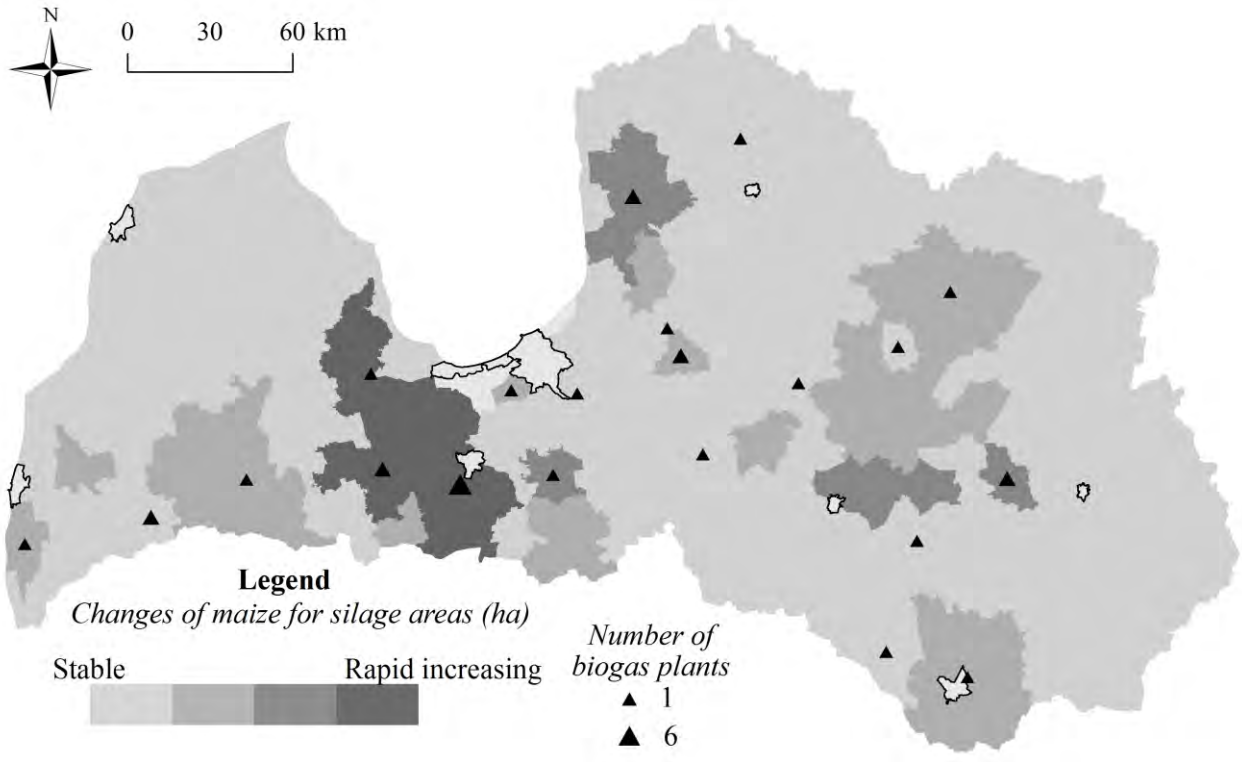
Regions	2007	2008	2009	2010	2011	2012	Correl. coef. of trend	Significance level
Kurzeme	0.2	0.2	0.2	0.2	0.3	0.8	r = 0.80	$\alpha>0.05$
Latgale	0.1	0.1	0.1	0.1	0.1	0.3	r = 0.75	$\alpha>0.05$
Pieriga	0.3	0.3	0.4	0.5	0.9	1.8	r = 0.85	$\alpha<0.05$
Vidzeme	0.1	0.2	0.1	0.1	0.2	0.5	r = 0.69	$\alpha>0.05$
Zemgale	0.5	0.5	0.6	0.6	1.3	1.8	r = 0.88	$\alpha<0.05$

Source: authors' calculations based on the unpublished data from Latvian Rural Support Service

However, an increasing trend was observed in Kurzeme, Vidzeme and Latgale, and it is not statistically significant. Besides, the highest share (0.5%) of maize was in Zemgale compared with other regions, in the evaluation's starting point – in 2007 (Table 3).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The relationship of share of maize area in 2012 and the number of biogas plants in 2012 on municipalities' level was performed For better assessment of increasing maize areas coherence with biogas plants (installations) development (Figure 1). The results of correlation and regression analysis of: 1) share (percentage) of maize for silage area in the total UAA area in municipalities; and 2) biogas plants number in same municipalities show that the correlation is significant (correlation coefficient – r = 0.87, α<0.01). Even though the data (e.g. type and volume) of feedstock used in biogas plants are not available, the results of spatial analysis as seen in Figure 1 show that in general the growing tendency of maize areas more or less corresponds with the location of biogas plants. It must be noted that biogas plants are mostly located in the central region Zemgale, where fertility of soil is the highest and share of arable land is also the highest (Melece, 2013). Moreover, there has been a long-term food and feed crops in this region. Because of this, the region is often referred to as "Latvia's granary". At present, biogas plants are located in those territories of Latvia with the highest proportion of agricultural lands and the highest soil fertility (Ibid.), which fails to stimulate using the unused UAA or surplus land for bioenergy generation. This fact contradicts bioenergy policy, oriented to returning the unused UAA or surplus land in the production of feedstock and improving the quality of the environment, particularly, biodiversity and the landscape.



Source: authors' construction based on the unpublished data from Rural Support Service

Fig. 1. **Location of biogas plants in 2012 and changes of maize for silage areas (ha) in Latvia's municipalities, 2007-2012**

Besides, the analysis of land area changes under wheat, rape, other crops and total area of UAA, was carried out for clarifying bioenergy policy impact on returning unused UAA in production of energy crops. The results (Table 4) demonstrate that raising of areas of rape and wheat probably has occurred due to reducing cultivation of other agricultural crops, including grasslands. The reduction could decrease biodiversity, because more diverse land cover, inter alia, diversification in crop type, creates a greater number of habitats for species from different taxa (EEA, 2006).

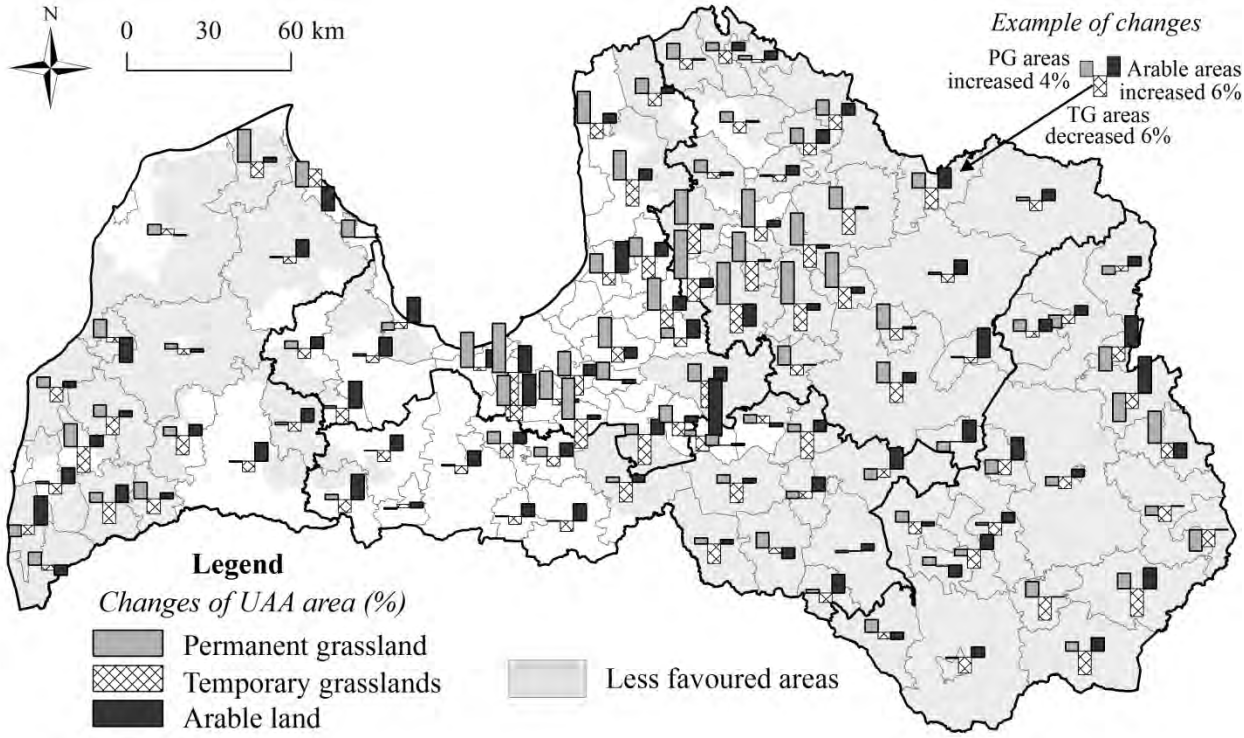
Table 4

The changes of area (ha) of wheat, rape, other crop and total UAA in Latvia, 2007-2012

Crop	2007	2008	2009	2010	2011	2012
Wheat	224168	218405	271734	300258	309931	351268
Rape	98525	70343	89998	108457	121071	117164
Other crops	1282662	1045857	1128615	1164455	1186203	1158582
Total	1605355	1334605	1490348	1573170	1617205	1627014

Source: authors' calculations based on the unpublished data from Latvian Rural Support Service

Spatial analysis of the UAA changes in the period of 2007-2012 show the biggest decrease of TG share (82.5 thousand ha), while other arable land has increased by 65 thousand ha; and PPM – 44 thousand ha. The share of TG in the period of 2007-2012 has increased only in five municipalities and by less than 5% (Figure 2); no changes were registered in six municipalities, while in other municipalities the share has decreased, especially, in municipalities located in Pieriga region.



Source: authors' construction based on the unpublished data from Latvian Rural Support Service

Fig. 2. **The changes of arable land, permanent and temporary grasslands in different Latvian municipalities**

However, the share decreased by more than 10% (Figure 2) in other regions' municipalities (e.g. Ligatne, Vecpiebalga, Amata, Baldone, Priekuli, and Jaunpiebalga). Considering the fact that the main method of PPM managing is grass cutting, performed once year and often the grass is left on field, the biodiversity of grassland also decreases (LVAEI, 2013a). Although, TG has considered better from the land management view, the environmental benefits of long-term grassland are: protection of soil from erosion, improvement in soil structure, reduction in use of plant protection chemicals, and some benefits also for biodiversity (Herzon, 2009). The importance of traditional agriculture landscapes has been widely recognised in Europe and the world (Navarro and Pereira. 2012). In Latvia, the changes of landscapes structure are caused by the changes of UAA, which are connected with processes of marginalisation and polarisation (Nikodemus et al., 2010). The main causes of landscape changes are: unused UAA and

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

overgrowing processes or secondary succession, which is common in the mosaic landscapes (Ibid.). However, the results of study suggest some positive changes observed in the past years, where increasing trends of managed PPM are noted. Some negative impact is related with increasing intensification of the UAA management, which in the recent years has increasingly reduced the morphological quality and biodiversity of landscape, lowering the total value of landscape and ecology.

Comparing the data[25] of unused UAA and its tendencies by different Latvia's regions, one can see in Table 4 that negligible but decreasing tendency of the share of unused UAA was registered in all regions, except Latgale (most undeveloped region). Moreover, the share of unused UAA in Latgale increases and reaches 18% in 2012.

Table 5

The changes of share (%) of unused UAA in Latvia's regions, 2010 and 2012

Regions	**Unused UAA, %**	
	2010	**2012**
Kurzeme	14	11
Latgale	17	18
Pieriga	18	15
Vidzeme	14	12
Zemgale	10	9
Average in the country	**14**	**13**

Source: authors' construction based on the unpublished data from Latvian Rural Support Service

The results of spatial analysis show that the changes in the structure of the UAA concern relatively small areas, where TG areas have been replaced by areas of the cereals and the technical crops. Besides, the unmanaged grasslands are declared as PPM. Therefore, only the small areas of unused UAA are returned in the agricultural production.

Conclusions, proposals, recommendations

1. Due to conflicting demands for land in rural areas for the production of food, animal feed, fibre and biomass for bioenergy, the land is becoming increasingly vital and restricted resource. Moreover, scholars, experts and some officials agree that agricultural land, which could be used for bioenergy plants, must no longer be used for food and feed production due to poor soil fertility or abiotic stress. Besides, more attention could be devoted to non food and feed biomass, and the second and third generation of bioenergy.
2. In Latvia, areas of the utilised agricultural land, mainly used for bioenergy feedstocks production - rape and maize for silage - are located in the territories/regions with the highest proportion of agricultural lands and the highest soil fertility. In the period of 2007-2012, the growing trends of land usage for rape and maize production are statistically significant in the most fertile regions (Zemgale and Kurzeme) with higher share of managed agricultural land. Besides, the increase of rape and wheat areas probably has occurred due to reducing of cultivation of other agricultural crops, including grasslands.
3. At present, biogas plants are mainly located in the territories of Latvia with the highest proportion of utilised agricultural areas and the highest soil fertility. This fact contradicts bioenergy policy, oriented to returning the unused UAA or surplus land in the production of feedstock and improving the quality of the environment, particularly, biodiversity and the landscape.

[25] The data are available only from 2010, when RSS started collect these data

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

4. There are some positive changes observed in the past years - increasing trends of managed permanent pastures and meadows. At the same time, some negative impact is recognised, connected with: decreasing trend of temporary grasslands; increasing intensification of agricultural land management, which has increasingly reduced the quality and biodiversity of grasslands and landscape in the recent years, lowering the total value of landscape and ecology.
5. Even though statistically significant decrease of fellow area in all regions is observed, only small areas of unused utilised agricultural land have been returned to the agricultural production in the past years. A slight but decreasing tendency of the share of unused UAA was registered in all regions, except Latgale. Moreover, the share in Latgale, most undeveloped region, increases and reached 18% in 2012.
6. In general, the observed land use changes in Latvia show some contradictions to bioenergy policy which is oriented to returning the unused agricultural land in the production of feedstock; improving the quality of the environment, particularly, biodiversity and the landscape; and encouraging rural development.

Bibliography

1. Berndes, G., Ahlgren, S., Borjesson, P., Cowie, A.L. (2012). Bioenergy and Land Use Change - State of the Art. *Wiley Interdisciplinary Reviews: Energy and Environment*, Volume 2, Issue 3, pp. 282–303.
2. Bioenergy (2013). Retrieved: http://saveenergy.about.com/od/alternativeenergysources/g/bioenergy.htm. Access: 11.12.2013.
3. Dauber, J., Brown, C., Fernando, A.L. et al. (2012). Bioenergy from "Surplus" Land: Environmental and Socio-economic Implications, *BioRisk*, Volume 7, pp. 5–50.
4. Divan, D., Kreikebaum, F. (2009). Organic (But not Green). *IEEE Spectrum*, Volume 46, Issue 11, pp. 49-53.
5. EEA (2006). *How much Bioenergy can Europe Produce without Harming the Environment*? Copenhagen: EEA, p. 67.
6. Eide, A. (2009). The Right to Food and the Impact of Liquid Biofuels (Agrofuels). Rome: FAO, p. 54.
7. FAO (2013). Biofuel Development should not Compromise Food Security, says CFS. Retrieved: http://www.fao.org/news/story/en/item/202208/icode/. Access: 27.12.2013.
8. Finco, A. (eds) (2012). *Biofuels Economics and Policy. Agricultural and Environmental Sustainability*. Milano: FrancoAngeli, p. 208.
9. Flora, C.B. (2010). Food Security in the Context of Energy and Resource Depletion: Sustainable Agriculture in Developing Countries. *Renewable Agriculture and Food Systems*, Volume, 25, Issue 2, pp. 118-128.
10. Gill-Austern, D. (2011). The Impact of Rising Corn Prices on the Conservation Reserve Programme: An Empirical Model. *Undergraduate Economic Review*, Volume 7, Issue 1, pp. 1-36.
11. Herzon, I. (2009). Biodiversity in Agro-environments: State of Art in Finnish Research. Retrieved: http://media.leidenuniv.nl/legacy/herzon-leiden.pdf. Access: 27.11.2013.
12. Howard, D.C., Wadsworth, R.A., Whitaker, J.W. et al. (2009). The Impact of Sustainable Energy Production on Land Use in Britain through to 2050. *Land Use Policy*, 26, Supplement 1, pp. S284–S292
13. Krasuska, E., Cadorniga, C., Tenorio, J.L. et al. (2010). Potential Land Availability for Energy Crops Production in Europe. *Biofuels, Bioproducts and Biorefining*, Volume 4, Issue 6, pp. 658-673.
14. Kirschenmann, F. (2010). Alternative Agriculture in an Energy- and Resource-depleting Future. *Renewable Agriculture and Food Systems*, Volume 25, Issue 2, pp. 85-89.
15. Kusch, S., Evoh C.J. (2013). Meeting the Growing Semand for Food and Bioenergy in the 21st Century: Synergies through Efficient Waste Management. *Biofuels*, Volume 4, Issue 5, pp. 479-483.
16. LVAEI (2013a). *Lauku attistibas programmas (LAP) 2007-2013 Agrovides apakspasakuma "Biologiskas daudzveidibas uzturesana zalajos" novertejums* (Assessment of Latvian Rural Development Programme 2007-2013 Agri-environment submeasure "Maintaining Biodiversity in Grasslands"). Riga: LVAEI.
17. LVAEI (2013b). VPM un LAP platibu maksajumu raditaji, atbalsta tendences un nozime lauksaimniecibas zemju izmantosana un saimniecibu izaugsme, atskaite. Latvijas Valsts agraras ekonomikas instituts, Lauku attistibas novertesanas nodaļa (Indicators and Support Trends of the Single Area Payment and Rural

Development Programme Area Payments, and their Role in the Use of Agricultural Land and Development of Agricultural Holdings). Retrieved: http://www.lvaei.lv/upload/VPM_atskaite_LANN.pdf. Access: 17.12.2013.

18. Maltsoglou, I., Koizumi, T., Felix, E. (2013). The Status of Bioenergy Development in Developing Countries. *Global Food Security*, Volume 2, Issue 2, pp. 104-109.
19. Melece, L. (2013). Development and Issues of Biogas Production in Latvia, *Proceedings of 34th International Symposium of the Section IV of CIGR* (accepted for publication).
20. Ministru kabinets (2007). Biogazes razosanas un izmantosanas attistibas programmas projekts 2007.-2011. gadam. Ministru kabineta 2007.gada 14.junija rikojums Nr.371. (Project of Development Programme of Biogas Production and Usage). Retrieved: http://www.vidm.gov.lv/.../Biogazes_raz_un_izmant_att_pr_2007-2011.doc. Access: 27.12.2013.
21. Navarro, L.M., Pereira, H.M. (2012). Rewilding Abandoned Landscapes in Europe. *Ecosystems*, Volume 15, pp. 900−912.
22. Nikodemus O., Bell S., Peneze Z., Kruze I. (2010). The Influence of European Union Single Area Payments and Less Favoured Area Payments on the Latvian Landscape, *European Countryside*, Volume 2, pp. 25-41.
23. Nuwer, R. (2012). Ending the Food V. Fuel Debate: Researchers Define Surplus Land. Retrieved: http://www.ecomagination.com/ending-the-food-v-fuel-debate-researchers-define-surplus-land. Access: 9.12.2013.
24. Perimenis, A., Walimwipi, H., Zinoviev, S., Muller-Langer, F. (2011). Development of a Decision Support Tool for the Assessment of Biofuels. *Energy Policy*, Volume 39, Issue 3, pp. 1782-1793.
25. Pingali, P., Raney, T., Wiebe, K. (2008). Biofuels and Food Security: Missing the Point, *Review of Agricultural Economics*, Volume 30, Issue 3, pp. 506-516.
26. Piroli, G., Ciaian, P. and Kancs, D. (2012). Land Use Change Impacts of Biofuels: Near-VAR Evidence from the US. *Ecological Economics*, Volume 84, pp. 98-109.
27. Reynolds, S., Frame, J. (eds) (2005). *Grasslands: Developments, Opportunities, Perspectives*, Rome: FAO, p. 350.
28. Searchinger, T., Heimlich, R., Houghton, R. A., Dong, F., Elobeid, A., Fabiosa, J., Tokgoz, S., Hayes, D., Yu, T-H. (2008). Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land-use Change, *Science*, Volume 319, Issue 5867, pp. 1238-1240.
29. Secchi S, Babcock, B.A. (2007). Impact of High Corn Prices on Conservation Reserve Program Acreage. *Iowa Agronomy Review*, Volume 13, Issue 2, pp. 4-7.
30. Sendzikaite, J., Pakalnis, R., Gudzinskas, Z. (2013). Changes in Botanical Diversity of Sown Grasslands Due to Naturali-Zation and Extensive Management, *Botanica Lithuanica*, Volume 19, Issue 2, pp. 99−110.
31. Swinton, S.M., Babcock, B., James, L.K., Bandaru, V. (2011). Higher US Crop Prices Trigger Little Area Expansion so Marginal Land for Biofuel Crops is Limited, *Energy Policy*, Volume 39, Issue 9, pp. 5254−5258.
32. The European Parliament and the Council of the European Union (2009). Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, *Official Journal*, L 140, pp. 16-62.
33. Tyner, W.E. (2010). The Integration of Energy and Agricultural Markets. *Agricultural Economics*, Volume 41 (s1), pp. 193−201.
34. Wilhelm, W.W., Johnson, J.M.E., Karlen, D.L., Lightle, D.T. (2007). Corn Stover to Sustain Soil Organic Carbon further Constrains Biomass Supply, *Agronomy Journal*, Volume 99, Issue 6, pp. 1665-1667.
35. Ziolkowska, J.R. (2014). Optimizing Biofuels Production in an Uncertain Decision Environment: Conventional vs. advanced Technologies. *Applied Energy*, Volume 114, pp. 366-376.

DEVELOPMENT OF COOPERATION IN DAIRY FARMING

Kristine Polacenko, Mg.oec., lecturer[+]; **Veronika Bugina**, Dr.oec., assoc. professor
[1,2] Latvia University of Agriculture

Abstract. Dairy farming is one of the key industries of agriculture in Latvia with ancient traditions and its role in producing agricultural goods as well as generating the income for farmers has always played an important role.

A large part of dairy farmers have united in cooperatives so the producers can better defend their interests in the market and increase their influence. In 2012, 28% of total number of agricultural cooperatives operated in dairy farming, while 26.9% of total amount of milk produced in Latvia was sold through cooperatives.

The **aim** of the paper is to analyse the development of cooperation in Latvia's dairy farming. The research identifies the key problems in dairy farming, explains the terms cooperation and cooperative society, and analyses the level of development of cooperation as well as provides the characteristics of the largest dairy cooperatives in the European Union (EU) and Latvia. The paper concludes that one of the ways how to raise the competitiveness of small farms is to foster cooperation among these farms; cooperation in dairy farming has successfully developed compared with other agricultural industries, which is evidenced by the changes in the number of cooperatives, the increase in the quantity of milk purchased by cooperatives, and the performance indicators of individual cooperatives.

Key words: dairy farming, cooperation, cooperatives.
JEL code: Q13

Introduction

Dairy farming is one of the key industries of agriculture in Latvia, which is evidenced by the high proportion of the value of milk and dairy products in final agricultural output and exports as well as the large share of dairy farms in the total number of farms. The key factor hindering the development of dairy farming is its fragmented structure, as dairy farms with less than nine cows accounted for approximately 88% of total number of dairy farms in 2012. The main problems of small farms are as follows: low competitiveness; a poor financial situation resulting in poor technological resources (which affects productivity); and farms are price-takers, as individually they can affect neither purchase prices of inputs nor milk sale prices (consequently, the purchase price of milk is often below the cost of milk).

A great deal of dairy farmers has united in cooperatives, so the producers can better defend their interests in the market and increase their influence. The experience of the EU shows that cooperation plays a significant role in the development of dairy farming. Dairy cooperatives are the largest market participants in the dairy industry in the EU. Their turnover comprises a considerable share of the total turnover in the EU's dairy market. The market share of cooperatives in the European Union (EU) in the dairy sector (in terms of turnover) is approximately 57%. In 2012, 28% of total number of agricultural cooperatives operated in dairy farming, while 26.9% of total amount of milk produced in Latvia was sold through cooperatives.

[+] Corresponding author. Tel.: + (371); fax: + (371 630 84987)
E-mail address: (kristine.paberza@llu.lv)

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The aim of the paper is to analyse the development of cooperation in Latvia's dairy farming. Tasks to achieve the aim: 1) to identify problems existing in dairy farming; 2) to describe and analyse the level of development of cooperation in Latvia's dairy farming; and 3) to analyse the characteristics of the largest dairy cooperatives in Latvia. The research methods employed: the monographic and graphic methods, analysis, synthesis, and induction and deduction.

Information sources: data of the Central Statistical Bureau (CSB), data of the Agricultural Data Centre (ADC), data of the Latvian Agricultural Cooperatives Association (LACA), publications of the Ministry of Agriculture (MoA), laws of the Republic of Latvia, and publications in the mass media and on the Internet.

Research results and discussion

Characteristics of dairy farming

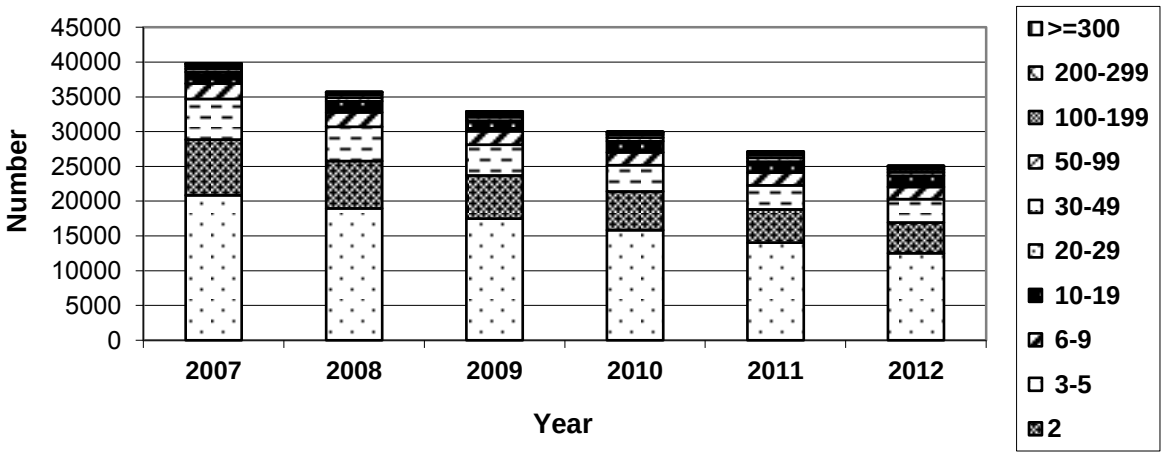
Dairy farming is one of the key industries of agriculture in Latvia, which is evidenced both by the high proportion of the value of milk and dairy products in final agricultural output (according to the Economic Accounts for Agriculture (EAA), in 2013, fresh milk accounted for 23% of final agricultural output) and the quantity of milk and dairy products in Latvia's agricultural and food exports (in 2013, milk and dairy products comprised 10% of total export value of agricultural and food products, including fresh milk – 4%). According to the 2010 Agricultural Census, dairy farms comprised a fifth (20.1%) of total number of farms, which was the second highest proportion after field crop farms (42.5%) (Ministry of Agriculture, 2013; Ministry of Agriculture, 2014).

Key problems of the dairy industry

A fragmented structure**.** In the period of 2007-2012, in general, the number of farms tended to decline – in 2012, the total number of farms declined by almost 37% compared with 2007 (Figure 1).

According to the CSB, dairy farming is characterised by a fragmented structure. In 2012, 20295 farms or 80.8% of total farms had only 1-5 cows, while 22054 farms or 87.8% had 9 cows (inclusive). These farms had 33801 cows or 20.5% and 46569 cows or 28.3% of total cows, respectively. However, in 2012, there were 508 farms with more than 50 cows or 2% of total farms, and these farms had 67884 cows or 41.3% of total milch cows. In 2012, the number of small farms (up to 9 cows (inclusive)) declined by 40.2% compared with 2007; whereas, the number of farms with more than 50 cows rose by 22% over the period of analysis. The decrease in the number of milch cows in the period of 2007-2012 (as compared with the change in the number of farms) is insignificant, 5.7%, i.e. from approximately 174.5 thousand milch cows in 2007 to approximately 164.6 thousand milch cows in 2012. According to the latest CSB data, in 2013, the total number of milch cows rose by 3% compared with 2012, reaching 165 thousand (Central Statistical Bureau, 2014). It leads to a conclusion that the average size of herd tends to increase.

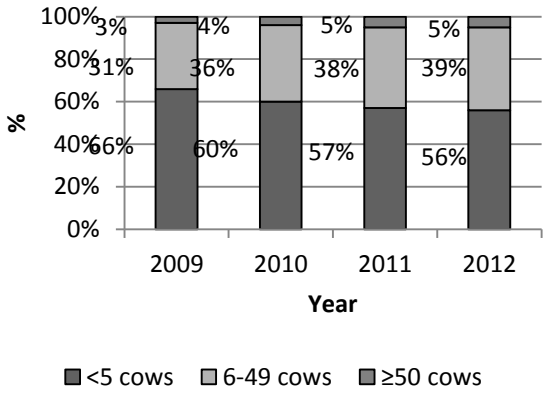
ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014



Source: authors' construction based on the Ministry of Agriculture data

Fig.1. Distribution of farms by the number of milch cows in the period of 2007–2012

According to the Agricultural Data Centre, the structure of milk production is fragmented in Latvia (Figures 2 and 3).



Source: authors' construction based on the Ministry of Agriculture data

Fig.2. Percentage distribution of milk quota owners by the farm size in 2009–2012

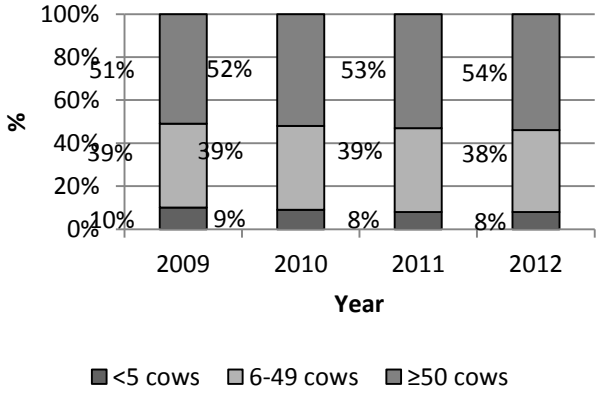


Fig.3. Percentage distribution of the quantity of milk by the size of quota owner herd in 2009-2012

The majority of milk quota owners (56% in 2012) had less than 5 cows (Figure 2), while the quantity of milk sold by these producers comprised only 8% of total quantity of milk sold in 2012 (Figure 3). However, the proportion of large quota owners (with 50 and more cows) is small (5% in 2012), whereas the quantity of milk sold by these producers make up more than half (54% in 2012) of the total.

A comparison of the 2012 data with the 2009 data leads to a conclusion that a positive trend may be observed in the structure of milk production − the number of small quota owners has decreased (in 2012, the decrease was 10 percentage points compared with 2009), the number of medium quota owners has increased (an increase of 8 percentage points compared with 2009), and the number of large quota owners has increased as well (an increase of 2 percentage points compared with 2009). In 2012, the quantity of milk sold by small quota owners has decreased by 2 percentage points compared with 2009; whereas. the quantity of milk sold by large quota owners rose by 3 percentage points.

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

It has to be mentioned that the reform of the Common Agricultural Policy envisages abolishing milk quotas in 2015; thus, no limits will exist in the market and sales will depend on demand (Ministry of Agriculture 2013; Ministry of Agriculture 2012).

A poor financial situation, poor technological resources, and the fact that individual farms are price-takers are the most significant problems faced by small farms, which hinder an increase in their competitiveness and, in its turn, their survival in the future (after the milk quota system is abolished) (Spogis, 1999). These problems serve as reason for the following negative trends characteristic of the industry:

Comparatively low productivity − it relates, in the most direct way, with the fragmented structure of dairy farming. Even though the average milk yield rises in the country from year to year (in 2013 (provisional data), the increase was 18.8%, reaching 5508 kg per cow a year) compared with 2007; yet, the average milk yield in Latvia is one of the lowest compared with other EU countries. According to the Eurostat, in 2011 the average milk yield in the EU totalled 6442 kg per cow or 1378 kg more than in Latvia (Ministry of Agriculture, 2013; Central Statistical Bureau, 2014; Ministry of Agriculture, Department of Agriculture, Livestock and Breeding Division, 2013).

Low producer prices and comparatively high production costs. Experts of the Latvian Rural Advisory and Training Centre (LLKC) have studied the ratio of milk production cost to milk sale price for the group of small and medium farms (with 20 to 65 milch cows in their herd) and estimated that the average milk sale price for the group of small and medium farms was equal to 18.8 santims/kg (approximately 0.27 EUR/kg) in 2011 (Latvian Rural Advisory and Training Centre, 2013). In Latvia, the milk purchase price was 0.29 EUR/kg (294.72 EUR/t) on average in 2011 (Central Statistical Bureau, 2014). However, the milk production cost calculated by the LLKC experts was 21.5 santims/kg in 2011 (approximately 0.31 EUR/kg). After comparing the cost with the milk purchase price calculated by the LLKC experts for small and medium farms in 2011, one can conclude that the milk production cost for these farms is higher than the milk purchase price. The high milk collection costs, the fact that the domestic market is saturated, thus, producers depend on exports and are mainly price-takers and the low quality of milk produced may be mentioned as the key reasons for the low purchase price. However, the main reasons for the high production cost are the low productivity of farms; the high proportion of small farms; the high proportions of energy, labour, feed and fertiliser costs per unit of product; and an unbalanced use of plant protection products and fertilisers (Ministry of Agriculture, 2012).

Given the fragmented structure of milk production in Latvia, one of the ways how individual producers of agricultural products, including milk, can survive and raise their competitiveness is cooperation, as the experience of the world and the historical evolution of cooperatives show that cooperative activities develop in territories where, from the perspective of some group, market development is brought to a disadvantage and where the need for new solutions is sufficiently homogenous. It means that assisted by cooperatives, small enterprises seek to improve their position on the market and respond to the increasing competition, pressure from abroad, and the poorly structured market.

Development of cooperation in dairy farming

The term cooperation originated from the Latin word cooperation that means participation, joint operation, working together, collaboration, and teamwork. According to a definition developed by A.Miglavs, cooperation is an activity when several individuals having common interests unite their efforts to achieve a certain goal that cannot be achieved by each of them individually (Bugina, 2002).

A cooperative or cooperative society is a formal implementer of cooperation ideas. The term cooperative is usually designated as a form of cooperation that is registered in accordance with the legislation of the state. The Cooperative Societies Law (1998) defines a cooperative society as a voluntary association of individuals and legal entities whose goal is to provide services to its members in order to raise their economic activity efficiency (Cooperative Societies Law, 1998). So, the main goal of a cooperative is to satisfy the interests of its members by providing certain services to them. In 2002, significant amendments were made to the Cooperative Societies Law, integrating the term agricultural services cooperative society (ASCS), which is a cooperative society that provides services to producers of agricultural products but is not engaged in the production of agricultural products, except the processing of the products of its members (Cooperative Societies Law, 1998).

The experience of the EU shows that cooperation plays a significant role in the development of dairy farming. Dairy cooperatives are the largest market participants in the dairy industry in the EU. Their turnover comprises a considerable share of the total turnover in the EU's dairy market. According to the calculations performed by Hanisch M., Müller M., and Rommel J. within the European Commission project "Support for Farmers' Cooperatives" (the project was carried out in the period of 2011-2012), the market share of dairy cooperatives (in terms of turnover) in the EU's dairy sector is approximately 57% (the European Union share has been calculated by using the national shares for dairy indicated in the country reports, weighted with the relative size of national markets by turnover from the Eurostat data). Cooperatives in dairy farming dominate in the Central and the Northern Europe, a strong cooperation movement exists in the Scandinavian countries, Austria, and Germany. In 2010 in Austria, the market share of dairy cooperatives reached 95%, in Denmark – 94% (including Arla Foods – 87%), Finland – 97%, Ireland – 99%, Malta – 91%, the Netherlands – more than 80%, Poland – 70-74%, and Sweden – almost 100% (Hanisch M. et al., 2012).

Table 1

Characteristics of the largest EU cooperatives

	FrieslandCampina			Arla Food		
	2012	2013	2013/2012	2012	2013	2013/2012
Revenue, million EUR	10309	11418	+10.8%	8457*	9863*	+16.6%
Net profit, million EUR	278	157	-43.5%	253.9*	299.6*	+17.8%
Employees	20045	21186	+5.7%	:	19600	:
Number of member dairy farmers	19487	19244	-1.2%	12256	12629	+3.04%
Milk supplied by member dairy farmers, million kg	8860	9261	+4.5%	10410	12676	+21.8%
Milk price, EUR/100kg	36.24	42.49	+17,2%	35.80	40.33	+12.6%

* converted into EUR according to the exchange rate 1DDK = 0.134003350084 EUR (InfoEuro, 2014)

: no data

Source: authors' calculations based on the data of FrieslandCampina, Arla Food

Table 1 presents the data on two largest EU dairy cooperatives: *FrieslandCampina* (the Netherlands), which unites dairy farmers from the Netherlands, Germany, and Belgium and, according to Hanisch M., is the fourth largest dairy enterprise in the EU and *Arla Foods* (Denmark), whose members are farmers from six countries and which is the fifth largest dairy enterprise in the EU. The comparison of data for 2012 and 2013 leads to a conclusion that overall the two cooperatives have expanded their activity, nevertheless, the membership of *FrieslandCampina* decreased by 1.2% in 2013, its revenues and

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

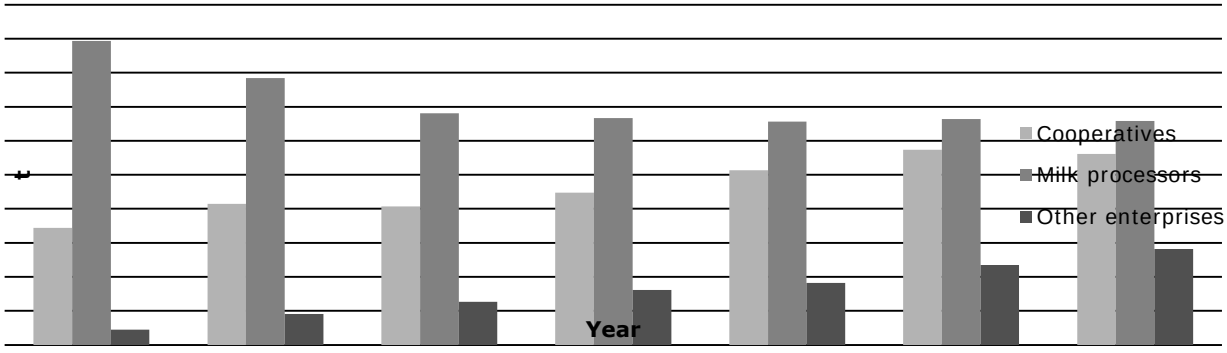
quantity of milk supplied rose. As regards *Arla Foods,* all its performance indicators rose in 2013; besides, the quantity of milk supplied by the cooperative rose faster than its membership.

In Latvia, the market share of dairy cooperatives was relatively low compared with other EU countries. According to the LLKC data, in the dairy industry, 26.9% of total quantity of milk is sold through cooperatives (Rural Development Programme..., 2014).

However, the analysis of the development of cooperation in dairy farming compared with other agricultural industries in Latvia, allows concluding that the level of cooperation in dairy farming is relatively high. The dairy industry, in terms of number of ASCSs, is the second largest one (most ASCSs are reported in grain farming). At the end of 2012, 34 ASCS or almost 28% of total number of ASCSs (122) operated in the dairy industry. In the period of 2007-2012, the ASCSs of the dairy industry comprised slightly more than a third of the total ASCSs. In this period, the number of ASCSs in dairy farming in absolute figures was volatile. In 2008 and 2009, a decrease in the number of ASCSs was observed (by 5 cooperatives during two years, reaching a number of 28 in 2009), which was affected by a decrease in the membership of cooperatives, a fall in the milk purchase prices, a rise in fuel prices, a lack of funds to modernise the park of milk collection vehicles, and other economic factors related with the crisis in the dairy industry. However, over the recent years, an increase in the number of ASCSs could be observed, reaching the above mentioned number of 34 in 2012 (Latvian Agricultural Cooperatives Association, 2012; Latvian Rural Development…, 2014).

In regard to the number of cooperatives, the LACA mentions a decrease in the number of cooperatives as a course of development for cooperation in dairy farming, since the cooperatives not being competitive exit the market (one of the options is that the weakest cooperatives merge with the strongest ones) until not more than one sectoral cooperative operates in every municipality; the second option is to develop a second level cooperation by forming one leading cooperative in the industry, into which smaller cooperatives have entered as members (Latvian Agricultural Cooperatives Association, 2012)

Figure 4 presents information on the quantities of milk purchased by cooperatives, milk processors, and other enterprises in the period of 2007-2013.



Source: authors' construction based on the information provided by the Agricultural Data Centre

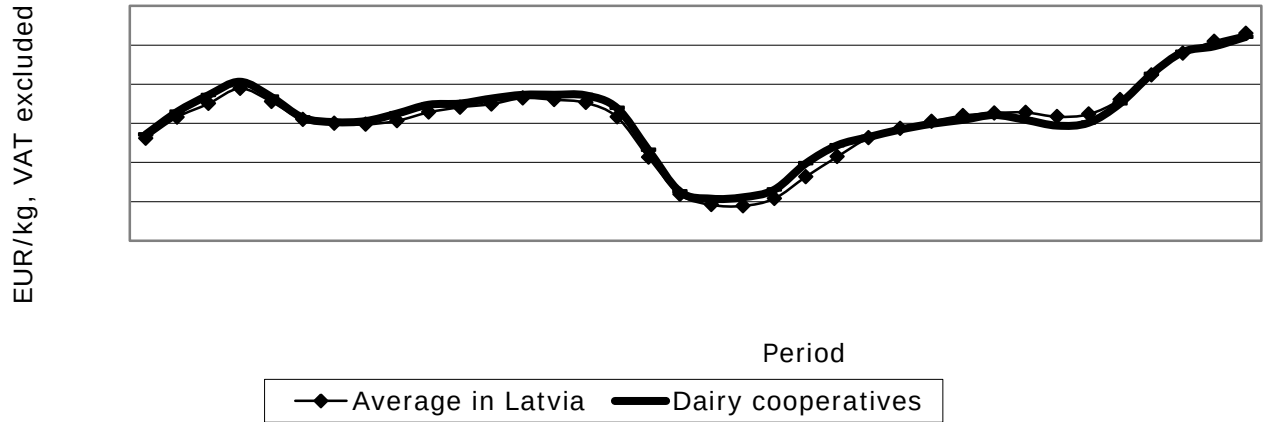
Fig.4. **Quantities of milk purchased by cooperatives, milk processors and other enterprises in the period of 2007-2013, t**

The total quantity of milk purchased rose from 631 thousand tonnes to 736 thousand tonnes in the period of 2007-2013. An increase in the quantity of milk purchased by cooperatives from 172.05 thousand tonnes in 2007 to 280.48 thousand tonnes in 2013 or by 63% indicates the increasing role of cooperatives. In 2013, the quantity of milk purchased by cooperatives decreased by approximately 2%

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

compared with 2012. The reasons for a gradual increase in the quantity of milk purchased by cooperatives are as follows: an increase in the membership of cooperatives, farmers become increasingly aware of the advantages of cooperatives − both economic (a higher milk purchase price (Figure 5), lower prices on the agricultural inputs needed for their economic activity) and social (services provided by cooperatives, education, exchange of experience) etc.

The ADC data show (Figure 5) that in the period from 2011 to 2012, in general, the milk price offered by cooperatives was higher than the average national price (except July 2011 and June 2012). However, in 2013, the price offered by cooperatives was lower, for several months, than the average national price (except August, September, and October). Despite this fact, an analysis of Lursoft data shows that eighth out of ten largest dairy cooperatives in Latvia in 2013 (all these cooperatives were ranked in Top 20 of agricultural cooperatives) increased their turnover compared with 2012. The reasons were both an increase in membership and the relatively high milk purchase price compared with the previous years (Diezina S., 2014).



Source: authors' construction based on the ADC data

Fig.5. **Average monthly milk purchase prices offered by cooperatives and the average price in the country in the period 2011-2013, EUR/kg**

According to the information provided by the Agricultural Data Centre, in the period of 2011-2013, the largest cooperatives in dairy industry, in terms of quantity of milk purchased and turnover, were ASCS Trikata KS and ASCS Piena cels (Table 2) (Agricultural Data Centre..., 2014).

Table 2

Characteristics of the largest agricultural cooperatives of Latvia in the period of 2010 – 2012

	ASCS Trikata KS				ASCS Piena cels			
	2010	2011	2012	2013	2010	2011	2012	2013
Net turnover, million EUR	20.02	23.89	25.50	25.8	16.81	21.68	22.09	22.4
Membership	:	221	231	212	:	86	84	78

: no data

Source: authors' construction based on the data of Lursoft, ASCS Trikata KS, and ASCS Piena cels

ASCS Trikata KS (founded in 2003) is the third largest agricultural cooperative and the largest dairy cooperative in Latvia (in terms of turnover and quantity of milk purchased). In 2013, its membership declined by 8.2% compared with 2012; whereas, the cooperative's turnover rose by approximately EUR 0.3 million. The cooperative collects and sells the milk produced by its members and offers various agricultural inputs at lower prices (feed, microelements, fertilisers etc.).

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

The cooperative owns a milk processing plant, Trikatas siers. Therefore, the cooperative provides a full life cycle of milk for its members. Besides, its members may also receive accounting services as well as participate in the exchange of experience, get educated in various business-related issues etc. According to the Latvian Business Report, ASCS Trikata KS, in terms of turnover, was ranked the 1st in 2012 in the dairy product wholesale and food sector, comprising 22% of total turnover in this sector (the analysis included only the enterprises whose turnover exceeded EUR 142 287.18 (LVL 100 000); in the particular sector, 27 enterprises were analysed), while the JSC Trikatas siers, in terms of turnover, was ranked the 22nd in the milk processing and food sector (the analysis included 60 enterprises of this sector with a turnover exceeding EUR 142 287.18). The ASCS Trikata KS is a holder of the enterprise Latvijas Piens owned by farmers' cooperatives (Trikatas siers (s.a.); Lursoft, 2014; Firmas.lv, 2013).

ASCS Piena cels (founded in 2004) is the fourth largest agricultural cooperative in Latvia. In 2012, its membership decreased by 2.3% compared with 2011; whereas, its turnover rose by 1.9%. The milk produced by the cooperative's members is sold on the domestic market, mainly to the JSC Jaunpils pienotava, owned by the cooperative, which will be reconstructed, thus, doubling this dairy plant's production capacity and raising its efficiency in milk processing. Part of its milk is exported to Lithuania, to the JSC Rokiskio Suris. One can conclude that the ASCS Piena cels also provides a full life cycle of milk. According to the Latvian Business Report, the ASCS Piena cels, in terms of turnover, was the eighth largest milk processor in the milk processing and food sector in 2012 (Latvian Agricultural Cooperatives Association, 2013; Lursoft, 2014; Firmas.lv, 2013).

In general, an analysis of the performance of the largest dairy cooperatives shows that the assortment of services offered by them may be very diverse: milk purchases, sales, milk processing (which allows concluding that the cooperatives have experience not only in selling the agricultural commodity but also in seeking a market for their final products), purchase of production resources (feed, disinfectants and detergents, milking equipment etc.), milk quality assurance (milk samples for testing etc.), information and consultancy, experience exchange, educational activities (seminars etc.) etc.

In 2011, the LACA conducted a survey of members of dairy cooperatives, in which the main advantages of activity in a cooperative were identified: an opportunity to sell products, availability of quality transport and agricultural machinery services, the cooperative offers higher purchase prices on agricultural products and regularly pays for the products sold, a fair evaluation system of products; equality in terms of price regardless of the farm's size, problems are tackled and decisions are made jointly; and improvements in the enterprise's activities (Latvian Agricultural Cooperatives Association, 2011).

Latvijas Piens Ltd may be mentioned as a positive example evidencing the increasing role of cooperation in dairy farming, which is a milk processor fully owned by cooperatives (ASCS Trikata KS, ASCS Dzese, and ASCS Piena partneri KS). The company was established with the purpose to process efficiently milk produced in Latvia into high quality dairy products and to stabilise the situation in the dairy industry in the country by guaranteeing the purchase of milk produced by cooperatives' members at a better price (Latvijas Piens, s.a.). Latvijas Piens Ltd unites more than 600 dairy farmers of Latvia. According to Lursoft, the company's turnover reached almost EUR 25.90 million in 2012 (for comparison, EUR 6.86 million in 2011, which was almost four times less than in 2012). Latvijas Piens Ltd produces cheese, skim milk concentrate and cream mainly for export markets where 90% of the company's products are marketed. The cheese produced by Latvijas Piens Ltd has won prizes in international cheese

competitions (Latvijas Piens Ltd …, 2014). According to the Latvian Business Report, Latvijas Piens Ltd, in terms of turnover, was the sixth largest milk processor in the milk processing and food sector in 2012 (Firmas.lv, 2013). Latvijas Piens Ltd is one of the first examples of inter-cooperation in Latvia.

It has to be mentioned that the opportunities to apply for the EU and national financial support as well as to benefit from the advantages stipulated in the legislation relate only with complying ASCSs. In accordance with the Cooperative Societies Law, a complying agricultural services cooperative society is an agricultural services cooperative society complying with the criteria set in the regulatory enactments regarding the receipt of aid for rural development (Cooperative Societies Law, 1998). Table 3 presents data on complying ASCSs in the dairy industry in the period of 2007-2013.

Table 3

Changes in the number of complying ASCSs in the dairy industry in the period of 2008-2013

Indicators	Year						
	2007	2008	2009	2010	2011	2012	2013
Total complying ASCSs	64	51	55	48	47	49	48
Total complying ASCSs in the dairy industry	19	17	19	16	15	22	22
Proportion in the total complying ASCSs, %	29.7	33.3	34.5	33.3	31.9	44.9	45.8

Source: authors' construction based on the LACA data

From year to year, both the total number of complying ASCSs and the total number of complying ASCSs of the dairy industry was volatile. In the period of analysis, the changes in the total number of complying ASCSs were mainly affected by amendments in the eligibility criteria the main goal of which is to ensure an efficient use of national and the EU financial support. The greatest number of complying ASCSs in the dairy industry was reported in 2012 and 2013 (i.e. 22 compared with 2007, an increase by 15.8% or 3 ASCSs), whereas, the smallest number was in 2011, 15 ASCSs. The key reason why cooperatives prefer to undergo the recognition process is the opportunity to apply for various types of support as well as the recognition of their compliance is a type of guarantee for farmers that the cooperative may be trusted.

In general, one can conclude that cooperation in Latvia's dairy farming becomes more important and, owing to it, the development of agricultural producers engaged in cooperatives is fostered. This is the main contribution of cooperatives to the development of the country and the agricultural industry.

Conclusions, proposals, recommendations

1. In dairy farming, one of the solutions to the main problems – inefficient farms (in 2012, 87.8% of farms had less than 9 cows (inclusive)), relatively low productivity (compared with other EU countries, the average milk yield in Latvia is one of the lowest), low producer prices, relatively high milk production cost (according to the LRATC estimate, it was 0.31 EUR/kg in 2011) – is cooperation.
2. The experience of the EU shows that cooperation plays a significant role in dairy farming. The market share of cooperatives in the EU's dairy sector (in terms of turnover) is approximately 57%. Cooperatives in dairy farming dominate in the Central and the Northern Europe, a strong cooperation movement exists in the Scandinavian countries, Austria and Germany.
3. In Latvia, the cooperation level in dairy farming is the highest compared with the level of cooperation in other agricultural industries, which is evidenced by the relatively high proportion of dairy cooperatives in the total cooperatives (28% in 2012), the high proportion of complying dairy ASCSs in the total ASCSs (approximately 45% in 2013), the comparatively large quantities of milk bought

ISSN 1691-3078; ISBN 978-9934-8466-1-8
Economic Science for Rural Development
No. 34, 2014

through cooperatives (26.9% of total quantity of milk produced in Latvia) and the fact that 10 are dairy cooperatives among the top 20 cooperatives (in terms of turnover).

4. An analysis of the performance of Latvia's largest dairy cooperatives shows that the assortment of services offered to their members may be very diverse (services of both economic and social nature), and it involves support to their members both at the stage of production and at the stage of sales of products; besides, the processing of milk produced by their members allows concluding that the cooperatives have experience not only in selling the agricultural commodity but also in seeking a market for their final products).
5. An analysis of the turnover of Latvia's two largest dairy ASCSs shows that it tends to increase (the turnover of ASCS Trikata KS rose by EUR 5.78 million, that of ASCS Piena cels – by EUR 5.59 million compared with 2010,). The affecting factors were milk purchase prices that were very high in 2013, the change in the membership of cooperatives, and the change in the quantity of milk purchased.
6. The further development of cooperation has to focus on consolidating the existing cooperatives (one of the options is that the weakest cooperatives merge with the strongest ones, thus, stimulating the engagement of farmers in cooperatives, attracting financial resources to modernise the park of milk collection vehicles, and expanding the assortment of services provided by the cooperatives).
7. Cooperation among cooperatives has to be fostered at the international level (e.g. among the Baltic States).

Bibliography

1. Agricultural Data Centre. (2014). Unpublished information.
2. Arla Food (2014). Consolidated Annual report 2013. Retrieved: http://www.arla.com/Images/arla.com/2014/annual-report-and-csr/pdf/Consolidated-Annual-Report-2013.pdf. Access: 27.03.2014.
3. Bugina, V., Piksena, B., Pucure, I., Belovs, M., Lescevica, M. (2002). Analysis of the Economic Efficiency of Agricultural Cooperatives, as Compared with the Traditional Management Methods for Farms and Statutory Companies (in Latvian): Research project. Jelgava, p. 71.
4. Central Statistical Bureau (2014). Purchase Prices of Agricultural Products (euro per tonne). Retrieved: http://data.csb.gov.lv/Table.aspx?layout=tableViewLayout1&px_tableid=LI0112_euro.px&px_path=lauks__Ikgad%c4%93jie%20statistikas%20dati__01Lauks_visp&px_language=lv&px_db=lauks&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0. Access: 15.02.2014.
5. Central Statistical Bureau (2014). Number of Cattle, Pigs and Sheep Increased, the Number of Horses and Goats Decreased Last Year. Retrieved: http://www.csb.gov.lv/notikumi/pern-liellopu-cuku-un-aitu-skaita-pieaugums-mazak-zirgu-un-kazu-39604.html. Access: 24.03.2014.
6. Cooperative Societies Law (1998). Retrieved: http://likumi.lv/doc.php?id=47009. Access: 16.11.2013.
7. Diezina ,S. (2014). TOP 20 of Latvia's Largest Agricultural Cooperatives (in Latvian). Retrieved: http://www.db.lv/foto-video/foto-stasts/latvijas-lielako-lauksaimniecibas-kooperativu-top-20-411868. Access: 20.03.2014.
8. European Commission (2014). InforEuro. Retrieved: http://ec.europa.eu/budget/contracts_grants/info_contracts/inforeuro/inforeuro_en.cfm. Access: 27.03.2014.
9. Firmas.lv (2013). Latvian Business Report. Sector. Dairy product wholesales, food. Retrieved: http://www.firmas.lv/lbgpp/2013#1000000440522. Access: 06.03.2014.
10. Firmas.lv (2013). Latvian Business Report. Sector. Milk processing, food. Retrieved: http://www.firmas.lv/lbgpp/2013#1000000440520. Access: 06.03.2014.
11. FrieslandCampina (2014). Annual Report. Retrieved: file:///C:/Users/User/Downloads/Presentation%20Annual%20Figures%202013%20EN.pdf. Access: 27.03.2014.
12. Hanisch, M., M. Müller, and J. Rommel (2012). Support for Farmers' Cooperatives; Sector Report Dairy. Wageningen: Wageningen UR.

13. Latvian Agricultural Cooperatives Association (2011). Thematic Working Group "Promotion of Cooperation in Agriculture" is Finished (in Latvian). Retrieved: http://www.llka.lv/lv/top-noderigainfo/22-kooperacijas-attistiba/938-darbagrupa.html. Access: 01.03.2014.

14. Latvian Agricultural Cooperatives Association (2012). Conference Development Possibilities for Farmers' Cooperation the Baltic Sea Region after the EU's CAP Reform in the Period OF 2013-2020. Presentations. Retrieved: http://www.llka.lv/lv/top-noderigainfo/22-kooperacijas-attistiba/972-konference.html. Access: 26.02.0214.

15. Latvian Agricultural Cooperatives Association (2012). Conference Development Possibilities for Farmers' Cooperation the Baltic Sea Region after the EU's CAP Reform in the Period 2013-2020. Presentations. Retrieved: http://www.llka.lv/lv/top-noderigainfo/22-kooperacijas-attistiba/972-konference.html. Access: 05.01.2014.

16. Latvian Agricultural Cooperatives Association (2012). Development of Cooperation in Agriculture and the Strategy for 2013-2020. Thematic assessment (in Latvian). Retrieved: http://www.laukutikls.lv/pielikumi/3440_Kooper%C4%81cijas_att%C4%ABst%C4%ABba_lauksaimniec%C4%ABb%C4%81_2012_LLKA.pdf. Access: 31.11.2013.

17. Latvian Agricultural Cooperatives Association (2013). ASCS Piena cels Executive Board Chairwoman Ilze Aizsilniece Receives the Highest Award of the Ministry of Agriculture. Retrieved: http://www.llka.lv/lv/top-aktuali/top-aktualitates/1162-lpks-piena-ce-valdes-prieksdtja-ilze-aizsilniece-saem-zm-augstko-apbalvojumu.html. Access: 05.01.2014.

18. Latvijas Piens (s.a.). About us. What is Latvijas Piens (in Latvian). Retrieved: http://www.lvpiens.lv/par-mums/kas-ir-latvijas-piens/. Access: 26.02.2014.

19. Latvian Rural Advisory and Training Centre (2013). Farmers Make Milk Production Efficient and do not Feel Gains from Price Increases in Stores (in Latvian). Retrieved: http://www.llkc.lv/lv/raksts/zemnieki-efektivize-piena-razosanu-ieguvumu-no-cenu-kapuma-veikalos-nejut. Access: 03.02.2014.

20. Latvijas Piens Ltd Doubled its Market Share in Latvia and Increased Exports Last Year (2014). Retrieved: http://www.lvpiens.lv/sia-latvijas-piens-aizvaditaja-gada-dubultojis-tirgus-dalu-latvija-un-audzejis-eksportu/. Access: 26.02.2014.

21. Livestock and Breeding Division of the Department of Agriculture, Ministry of Agriculture (2013). Retrieved: http://www.laukutikls.lv/pielikumi/3871_2013_05_09_LA_Prezentacija_ZM.pdf. Access: 10.02.2014.

22. Lursoft (2014). Multi-report. Profit/Loss Statement. Latvijas Piens, Limited Liability Company. Retrieved: https://www.lursoft.lv/gada-parskatu-multi-atskaite/?&print=y&aid=047541E7YS&lang=LV&lcurr=EUR. Access: 06.03.2014.

23. Lursoft (2014). Multi-report. Profit/Loss Statement. Piena cels, Agricultural Services Cooperative Society. Retrieved: https://www.lursoft.lv/gada-parskatu-multi-atskaite/?&print=y&aid=974200VN51&lang=LV&lcurr=EUR. Access: 06.03.2014.

24. Lursoft (2014). Multi-report. Profit/Loss Statement. Trikata KS, Agricultural Services Cooperative Society. Retrieved: https://www.lursoft.lv/gada-parskatu-multi-atskaite/?&print=y&aid=956840RHNW&lang=LV&lcurr=EUR. Access: 06.03.2014.

25. Ministry of Agriculture of the Republic of Latvia (2012). Agriculture in Latvia 2012. Retrieved: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/18/27/LS_2012.pdf. Access: 05.01.2014.

26. Ministry of Agriculture of the Republic of Latvia (2013). Agriculture in Latvia 2013. Retrieved: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/29/28/LS_ZINOJUMS_2013.pdf. Access: 05.01.2014.

27. Ministry of Agriculture (2012). Latvia's Dairy Industry: Problems, Development Directions and Opportunities. Retrieved: www.losp.lv/sites/.../29.../aizkraukle_piena_strategija_22112012.ppt. Access: 26.11.2013.

28. Rural Development Programme of Latvia for 2014 -2020. (2014). Retrieved: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/38/25/LAP_2014_20_pr.pdf. Access: 28.02.2014.

29. Spogis, K. Specialisation, Cooperation and Unification of Agricultural Enterprises. Business Studies (in Latvian). Riga, 1999, p. 236.

30. Trikatas siers (s.a.) Activity Directions. Retrieved: http://www.trikatassiers.lv/lv/kooperativs/25.darbibas-virzieni/. Access: 25.02.2014.

31. Trikatas siers (s.a.). About Us. Cooperatives. Retrieved: http://www.trikatassiers.lv/lv/kooperativs/25.darbibas-virzieni/. Access: 25.02.2014.

32. Trikatas siers (s.a.). About Us. Retrieved: http://www.trikatassiers.lv/lv/kooperativs/19.par-mums/. Access: 25.02.2014.