DEMAND FOR APPLIED RESEARCH OF AGRICULTURAL ENGINEERING AND CROP MANAGEMENT IN LITHUANIA

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Abstract
Great emphasis has been placed on agriculture by the European Union (EU), considering that agricultural production provides a framework for development of the processing industry and ensures food provision. Europe 2020 Strategy presents coordinated objectives of support for the rural development for the years 2014–2020. It has been emphasized that each Member State needs to set its national headline targets. Implementation of strategic provisions of the EU and Lithuania requires adequate identification of the priorities of agricultural scientific research and experimental development. It may significantly contribute to securing competitiveness, economic and social progress of the agricultural sector. The aim of the research was to prepare proposals for the Lithuanian Programme that sets the scientific research and experimental development priorities, long- and short-term research programmes for the period until 2020 in the view of demands of economy. Individual Working Groups (WG) have been formed of specialists of Lithuanian research and educational institutions as well as the advisory services. WG have proposed prospective applied research to develop within different areas of agriculture in 2014–2020. This served as the basis for the survey aimed at identifying a general demand for applied scientific research and potential problem areas in relation to agriculture, food economy and rural development that could be addressed by prospective applied scientific research. An anonymous survey was used across the country and summary results have been presented for two areas: crop management and agricultural engineering.

Key words: applied research, experimental development, priority areas, crop management, agricultural engineering, strategy.

Introduction
The 21st century is the century of a very rapid technological, economic and climate change. This requires a prompt response to the changes, seizing all opportunities and adapting to the changes. Life and economy of the society we create must be based on the principles enabling us to courageously face new challenges. Europe 2020 Strategy prepared by the European Commission aims for smart, sustainable and inclusive growth. Five headline targets have been formulated in the Strategy: growth of jobs with the aim to increase employment; development of innovations by scientific research and experimental development funding; an efficient development of energy from renewable sources; tackling the issues of climate change with the aim to reduce emissions of greenhouse gases; educational improvements and poverty reduction among the socially excluded (Europe 2020..., 2010a). The EU is determined to achieve these targets by 2020. It has been emphasized in the document that each Member State must determine its own national headline targets. In line with the Europe 2020 Strategy, these broad objectives of support for rural development 2014 – 2020 are defined in more detail by the following EU-wide priorities: fostering knowledge transfer and innovation in agriculture, forestry and rural areas; enhancing competitiveness of all types of agricultural activity and farm viability; promotion of food chain organisation and risk management in agriculture; promotion of resource efficiency and supporting the shift towards low-carbon and climate resilient economy in the agriculture and food sectors, supporting a balanced territorial development of rural areas (Support for Rural Development..., 2011). A long-term perspective is needed in order to follow the scientific research and experimental development guidelines until 2020. Implementation of these targets depends heavily on focused cooperation between national business, research institutions and public authorities.

The Europe 2020 Strategy points out that besides other campaigns, the priority topic ‘Innovation Union’ needs to be promoted, i.e. better conditions for implementation and funding of scientific research and innovations are required to ensure that innovative ideas turn into goods and services that foster growth and job creation (The European Innovation Partnership..., 2012). The EU initiative ‘Innovation Union’ has set out the following objectives: strengthening the European knowledge base and reducing fragmentation to promote excellence in education and skills development; getting new ideas to market; pooling forces to achieve breakthroughs (Europe 2020 Flagship Initiative..., 2010b). By implementing these tasks, the benefits will be significant: according to recent estimates, achieving EU target of spending...
3% of EU gross domestic product (GDP) on scientific research and experimental development by 2020 could create 3.7 million jobs and increase annual GDP by close to €800 billion by 2025 (Zagamé, 2010).

The EU project ‘Facing sustainability: new relationships between rural areas and agriculture in Europe’ (RURAGRI) has announced the Strategic Research Agenda defining scientific priorities with the focus on ecosystems, land use, farming practices, development of new, innovative, high added value products (RURAGRI... 2012; Levidow, 2012). The need for sustainable planning and use of natural resources has been emphasized by the Agenda 21 Action Plan for Sustainable Development adopted by the Food and Agriculture Organization (FAO) of the United Nations at the United Nations Conference on Environment and Development in Rio de Janeiro (Agenda 21..., 1992).

Horizon 2020 – the EU’s new Framework Programme for Research and Innovation sets out the following main objectives: strengthening Europe’s global position as the leader in science, eliminating obstacles for bringing innovations to market, and fundamentally changing cooperation between public and private sectors by introduction of innovations (Horizon 2020..., 2011). The Programme emphasizes novel and challenging ideas that can lead to scientific breakthrough and, in particular, interdisciplinarity – both local and regional – that could promote mobility, comprehensive use of available scientific resources, and creation of common European Research Area.

Lithuania cannot avoid the effects of global changes. Lithuania’s Progress Strategy ‘Lithuania 2030’ points out that the country’s wellbeing and development are based on national security, which must be ensured to achieve sustainable national progress (The State Progress Strategy ‘Lithuania 2030’..., 2012). The Strategy further states that we need to develop technologies that would minimize adverse environmental impact and secure resource-friendly sustainable growth. Education of environmentally benign business culture and promotion of development of green economy, introduction of advanced technologies for reduction of pollution and climate change are needed.

Lithuanian Rural Development Programme 2014 – 2020 guidelines outline the main objectives to improve competitiveness of agriculture by promoting innovation, cooperation and restructuring and by creating conditions for more efficient use of resources in agricultural sector (Lietuvos kaimo plėtros 2014 – 2020 metų politikos gairės..., 2011). Sustainable territorial development in all rural areas must be secured by providing more opportunities for local residents, increasing production capacities and improving local conditions and links between rural and urban areas. All these objectives require support from science in order to ensure that added value is created not only by resource development, but also by their rational use, as well as structured and adopted scientific novelties. One of the key objectives for rural development in the period 2014 – 2020 is fostering the efficient use of resources and supporting the shift to climate resilient low-carbon technology economy in agricultural sector (Levidow 2012; Lietuvos kaimo plėtros 2014 – 2020 metų programa..., 2014; Proposal for a Regulation of the European Parliament and of the Council on support for rural development..., 2013). The analysis of strengths of agriculture and rural development usually stresses the wide network of research institutions, while the analysis of weaknesses tends to focus on a lack of scientific research and experimental development, an insufficient level of innovations and inefficient application of innovations in practice (Lietuvos žemės ūkio ir kaimo plėtros po 2013 metų strateginės kryptys..., 2012; Lietuvos kaimo plėtros 2014 – 2020 metų programa..., 2014).

Foresight of the Lithuanian Research and Higher Education System ‘Learning Lithuania 2030’ states that for natural and technical sciences particularly important are the areas where the country has been accumulating its potential for decades, i.e. biomedical research, biotechnologies, nanotechnologies, and agricultural research (Foresight on the Lithuanian research..., 2012). The Lithuanian Innovation Strategy for the year 2010 – 2020 states that the basis of the Lithuanian economy is production of high added value products and services (Lithuanian innovation strategy..., 2010). As for agriculture, the document specifically notes the need for production of ecological agricultural and food products and cooperation with business, as well as active participation in creation of the European Research Area.

Strategic documents of the EU and Lithuania show that research supporting a sustainable production of agricultural and food products and cleaner environment is needed to achieve the set targets and challenges. Besides global fundamental research, there is a particular need for applied research and innovations. Leading research knowledge and technologies must be made available to farmers, agricultural enterprises and advisory services. The aim of the research was to prepare proposals for the Programme that determine the scientific research and experimental development priorities, long- and short-term research programmes to 2020 in the view of demands of economy.

Materials and Methods

Individual WG by agriculture and food areas have been formed of specialists from Lithuanian research and educational institutions as well as the advisory services on the basis of the above review of strategic
documents and analysis of previously applied research. These WG have proposed prospective applied research to develop within different areas of agriculture in 2014 – 2020. This served as the basis for the survey aimed at identifying general demand for applied scientific research and potential problem areas in relation to agriculture, food economy and rural development that could be addressed by prospective applied scientific research. Another aim of the survey was to include potential consumers of the research results into decision making process, thus encouraging them for closer cooperation in future.

The survey was anonymous and was carried out during the period from April 11, 2013 to May 19, 2013 across the country. The questionnaire of the survey comprised two sections: a general section – data about the respondents, and special section – questions on individual aspects of applied research.

863 respondents participated in the survey; however, a share of questionnaires was rejected (as incomplete, non-validated). 489 respondents, 393 of whom were engaged in an agricultural activity, filled out the questionnaire properly. Summary analysis was carried out based on the information provided by the respondents.

Representatives of the Chamber of Agriculture of the Republic of Lithuania and agriculture- and rural development-related associations (33), consultants at the Lithuanian Agricultural Advisory Service, and farmers were chosen as respondents for the survey.

Due to the diversity of areas in applied scientific research, a single article cannot accommodate all aspects. For this reason, summary results of the survey have been presented for two areas: crop management and agricultural engineering. Special section questions on crop management were answered by 317 respondents, agricultural engineering – 155 respondents.

Distribution of respondents by the activities they were engaged in was determined by analysis of the general section of respondents’ questionnaires (Figure 1). The majority of the respondents (78%) were engaged in farming, 61% of whom were farmers on their own farm.

![Figure 1. Distribution of respondents by the activities.](image)

Distribution of respondents by age and education is presented in Figure 2. The majority of the respondents (78%) were engaged in farming, 61% of whom were farmers on their own farm.

![Figure 2. Distribution of respondents by age (A) and education (B).](image)
Distribution of respondents by age and education is presented in Figure 2. The majority of the respondents were at the age of 41 to 50. About 23 – 24% of the respondents were at the age of 31 to 40 and 51 to 65.

With modernisation of agriculture, introduction of new crop management and smart agricultural engineering technologies, farmers’ educational background has become particularly important. Most of the respondents (45%) indicated that they had a completed higher education. 25% of the respondents had a completed college education. 9% of the respondents neither clearly identified their educational background from the list of available options, nor responded to the question, or chose ‘Other’ and provided details (e.g. an incomplete higher education, basic education etc.). All responses by the survey respondents indicated that 54% of the respondents were males, 38% – females, while 8% of the respondents did not indicate their gender.

Results and Discussion

The EU has put great emphasis on agriculture in the time period until 2020, including crop management, as crop production by agricultural enterprises form the basis for processing industry and ensures national supply of food products. In light of the current situation in national agricultural sector of crop management, the anticipated development of production, internal market and export, crop structure could be expected to remain similar to the current structure regarding the time period until 2020. Farms are expected to focus on wheat (Triticum aestivum L.), barley (Hordeum vulgare L.), rape (Brassica napus L.) and sugar beet (Beta vulgaris L.) cultivation. With the growing awareness among population of the country and prospective export regions on healthy nutrition, oat (Avena sativa L.) and protein crops consumption will exceed current levels, and such non-traditional crops as amaranths (Amaranthus spp.), lentils (Lens esculenta Moench) and less popular buckwheat (Fagopyrum esculentum Moench) might become in greater demand. The demand for precise parameters for raw material as well as wheat, barley and potatoes (Solanum tuberosum L.) cultivated for processing will be growing. Greater importance will be placed on qualitative characteristics of raw material both for food and feed or unprocessed food purposes. Cutting of production costs, higher crop yield, precision farming technologies will be needed as the farms will continue to concentrate and modernize. Considering the increasing health and environmental requirements, natural resistance of crops to harmful organisms and maximum consumption safety meaning minimal use of chemical substances will be of greater concern. Among other aspects, the notion of food safety also involves stability of national annual crop production by avoiding losses caused by adverse growing conditions. Prudent use of natural resource, possibility for crop growers and the country to receive greater benefit using fewer resources in light of growing potential biocapacity and by increasing potential biocapacity, as well as national development of competitive plant species will always remain on the agenda.

The WG have identified prospective fields of applied research by 2020 in the following areas of crop management: agrotechnology (soil preparation, crop care, identification and improvement of soil quality, crop rotation and other issues); crop protection (developmental biology of plant diseases and pests, use of chemicals and other measures, and other issues relevant to crop protection); crop nutrition (specifics of plant nutrition using macro- and micronutrients, optimization of use of mineral and organic fertilisers, nutritional balance); grassland management (use of grass plants for feed production, bio-energy, planting, establishment and use of grazing and pastures, perennial grass crop growing for seeds); seed production and plant breeding (development of crop species adapted to local conditions and special market demands, research on improvement of seed matter); plant raw material quality (research and improvement of nutritional and feed value of plants, determination of chemical composition and technological parameters of plants).

Considering the perspectives of agriculture in Europe and Lithuania, modernisation of agricultural engineering systems, robotisation of agricultural equipment in crop management, husbandry, horticultural and food processing sectors, new demands for engineering and research in agriculture will emerge. One of the possible research programmes is environmentally friendly and resource-conserving innovations in agricultural engineering. Such a programme would be aimed at developing and introducing engineering solutions into agriculture that would minimize the use of natural resources, mitigate adverse effects on humans, animals, environment and climate change, ensure efficient and safe production, processing, storage and use of agricultural products. Renewable energy innovations in agriculture could be included into another research programme.

The WG on agricultural engineering has estimated that in the coming funding period 2014 – 2020, it would be reasonable to develop applied research in the following areas: crop production engineering (engineering issues related to tillage, sowing, planting, crop care, harvesting and other machinery, cutting man-hour and energy costs); feed preparation engineering (cutting, milling, pressing, loading, transportation, drying, storage and other engineering issues, cutting man-hour and energy costs); husbandry engineering (low-waste production, cutting pollution and
energy costs, organic waste collection and recovery, automation/robotisation, creation of favourable conditions for livestock, control and management of technological processes, and other engineering issues; precision farming engineering (automated vehicle driving; installation of the satellite system in tillage, sowing, fertilisation, spraying, harvesting machinery; ISOBUS system (international standard for electronic communication between implements, tractors and computers); soil, fertilization and spraying maps and other related issues); engineering of biomass preparation for energy production (energy crops growing, harvesting, milling, drying, storage, pelletizing, briquetting, transportation, combustion, and other engineering issues); operation and servicing of agricultural machinery (cutting operating costs, increasing service life, development and installation of lubrication systems, mitigating adverse effects by tractors, combine harvesters and other machinery on humans and environment).

Survey respondents were asked questions related to agriculture and applied research. In their responses to the question ‘Do you take interest in information related to agriculture?’, 71% of the respondents answered that they took regular interest (Figure 3). In case of specific question ‘Do you take interest in applied research?’, 23% of the respondents answered that they took regular interest in applied research. However, more respondents answered that their interest in applied research was of general nature, i.e. they took occasional interest or when needed only.

32% of the respondents indicated that innovations were introduced into their farms, i.e. new modern agricultural equipment was purchased; buildings were reconstructed; agricultural technologies or their parts were replaced and improved; new species of crops and livestock were purchased; new crop protection and fertilisation products were used; innovative management, disposal of the production and other methods were applied.

Respondents were asked what innovations were introduced into the farm and what obstacles to introduction of innovations were faced (Figure 4). Innovations were classified under four headings: product innovations – development, production or use of new goods and/or services; technological innovations – development or application of new technologies in various areas of economic activity;

![Figure 3. Respondents’ answers to questions ‘Do you take interest in information related to agriculture?’ (A); ‘Do you take interest in applied research?’ (B) and ‘Does your farm, agricultural company (enterprise) apply novelties (innovations)?’ (C).]
social innovations – development and introduction of new management, organisational and other structures and forms in various areas of economic activity; integrated innovations (a set of product, technological and social innovations) – a complex of product, technological and social innovations. Most of the respondents (46%) indicated that their farms adopted technological innovations, 29% – product innovations.

The survey demonstrated that the main obstacle (37%) to introduction of innovations into a farm or rural area was the lack of financial resources. Some of the respondents indicated insufficient cooperation between science and agricultural business (12%), insufficient focus of science on solution of specific problems of farms and enterprises (12%), slow acknowledgement (introduction to production) of innovations (11%), and lack of qualified specialists (10%). 8% of the respondents indicated that farmers/enterprises were not ready for innovations.

The results of the survey (Table 1) support the demand for applied research and innovations in crop management and agricultural engineering. 68 – 85% of the respondents agreed fully and 11 – 21% agreed partially to the idea that applied research was needed.

### Table 1

Summary of results supporting the demand for applied research and innovations in crop management and agricultural engineering

<table>
<thead>
<tr>
<th>Areas and topics</th>
<th>Agree</th>
<th>Partly agree</th>
<th>Disagree</th>
<th>Total number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CROP MANAGEMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop protection</td>
<td>263</td>
<td>85</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Agrotechnology</td>
<td>254</td>
<td>81</td>
<td>44</td>
<td>14</td>
</tr>
<tr>
<td>Crop nutrition</td>
<td>239</td>
<td>78</td>
<td>53</td>
<td>18</td>
</tr>
<tr>
<td>Seed production and plant breeding</td>
<td>222</td>
<td>74</td>
<td>51</td>
<td>17</td>
</tr>
<tr>
<td>Plant raw material quality</td>
<td>201</td>
<td>68</td>
<td>63</td>
<td>21</td>
</tr>
<tr>
<td>Grassland management</td>
<td>201</td>
<td>68</td>
<td>55</td>
<td>19</td>
</tr>
<tr>
<td><strong>AGRICULTURAL ENGINEERING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop production engineering</td>
<td>120</td>
<td>79</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>Operation and servicing of agricultural machinery</td>
<td>108</td>
<td>75</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Feed preparation engineering</td>
<td>102</td>
<td>75</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Precision farming engineering</td>
<td>107</td>
<td>74</td>
<td>27</td>
<td>19</td>
</tr>
<tr>
<td>Husbandry engineering</td>
<td>99</td>
<td>72</td>
<td>26</td>
<td>19</td>
</tr>
<tr>
<td>Engineering of biomass preparation for energy production</td>
<td>96</td>
<td>69</td>
<td>26</td>
<td>19</td>
</tr>
</tbody>
</table>
in separate areas of crop management, whereas 4 – 13% of the respondents did not see any necessity in such research. The majority of respondents (over 80%) indicated that the areas of crop protection and agrotechnology needed applied research most.

The survey showed that 69 – 79% of the respondents agreed that applied research in various areas of agricultural engineering was needed, while 14 – 19% of the respondents agreed partially, and 7 – 12% did not agree to the idea. The majority of the respondents (79%) agreed that applied research was needed in the area of crop production engineering. Only a minor share of the respondents (7%) believed that research in precision farming engineering was not necessary.

Conclusions
Implementation of strategic provisions of the EU and Lithuania requires adequate identification of the priorities of agricultural scientific research and experimental development. It heavily depends on focused cooperation between national business, research institutions and public authorities. Besides global fundamental research, there is a particular need for applied research and innovations that would be adopted by agricultural enterprises and farms.

Based on the review of strategic documents and analysis and synthesis of previously applied research and survey were representatives of the Chamber of Agriculture of the Republic of Lithuania and agriculture- and rural development-related associations, consultants at the Lithuanian Agricultural Advisory Service, and farmers were chosen as respondents, prospective fields of applied research for the period until 2020 in Lithuania in the following areas of crop management and agricultural engineering have been identified.

Topics identified in crop management: agrotechnology, crop protection, crop nutrition, grassland management, seed production and plant breeding, plant raw material quality. 68 – 85% of the respondents agreed to the need for applied research in individual areas of crop management. The majority of the respondents (over 80%) indicated that the areas of crop protection and agrotechnology needed applied research most.

Topics identified in agricultural engineering: crop production engineering, feed preparation engineering, husbandry engineering, precision farming engineering, engineering of biomass preparation for energy production, operation and servicing of agricultural machinery. The survey showed that 69 – 79% of the respondents agreed that applied research in various areas of agricultural engineering was needed. The majority of the respondents (79%) agreed that applied research was needed in the area of crop production engineering.

Acknowledgements
The paper presents research findings, which have been funded by The Ministry of Agriculture of the Republic of Lithuania under the project ‘Scientific Recommendations on the Agricultural, Fisheries and Rural Development Applied Research and Innovation Development for 2014 – 2020’.

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