

About Governance of Agricultural Knowledge and Innovation System. The Case of Bulgaria. Part II

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Abstract

This paper is the second part of the attempt to examine the governance, efficiency, and development of the Agricultural Knowledge and Innovation System (AKIS) in Bulgaria. In the years of EU membership, the expenditures for AR&D significantly decreased absolutely and relatively as a share in the total expenditures for R&D, which indicates diminishing importance and deteriorating financial, personnel, and material potential of the agrarian knowledge and innovation sector.

The research continues the first part already published in the previous issue with the third point of view related to the governance of agrarian research in Bulgaria is unpacked; forth, the state of the system of education and training of agricultural producers in the country is analysed.

Keywords: research, training, governance, knowledge, innovation, agriculture.

JEL Classification: D83; O32; O38; Q16.

Introduction

Agricultural and related research in Bulgaria is mostly carried out by public organizations – research institutes and experimental stations of the Agricultural Academy, some institutes of the Bulgarian Academy of Sciences (e.g. Institute of Plant Physiology and Genetics, Institute of Economic Studies, etc.), some of the public and private universities (e.g. Agrarian University in Plovdiv, Trasia University in Stara Zagora, Russe University in Russe, Forestry University in Sofia, the University of National and World Economy in Sofia, High School for Agribusiness and Regional Development in Plovdiv, etc.), and to a smaller extent by the private firms and organizations, non-governmental organizations, etc. There is no official (statistical, aggregated, etc.) information about the state and development of all components of this complex system, the relationships between different structures, and implemented specific forms of organization and cooperation in AR&D.

1. The Governance of Agrarian Research in Bulgaria

1.1. Organisation of Agrarian Research

The Agricultural Academy (AA) is a key element of the system for creating, sharing, disseminating, and implementing knowledge and innovation in Bulgarian agriculture. Agriculture is the only branch of the economy for which an entire Academy¹ for scientific services, training, and consulting has been built and publicly funded. The analysis of the development of the staff of the Agricultural Academy, the organization and financing of its activity, its scientific and applied results, its relations with the other participants in AKIS, the main challenges to its development, etc. gives a good idea of the state of the main component of the national AKIS and the most general information about the state and trends in the development of the public sector of agricultural R&D in the country.

According to the Law, the present Agricultural Academy is a national autonomous budget organization for scientific research, for scientific-applied, innovative and educational activity in the field of agriculture and food (Decree of the Council of Ministers № 151, 25.06.2018). It consists of 29 scientific institutes and centers and 13 experimental stations (part of the State Enterprise "Research and Production Center")², in all main areas of agricultural research, and located in all regions of the country. The scientific institutes and centers of the Agricultural Academy are specialized or complex and carry out R&D in all main directions of agricultural research for servicing the agricultural production or its individual sub-sectors (Table 1). Experimental stations are specialized or complex for servicing agricultural production in a particular geographical area (region).

¹ The Agricultural Academy was established in 1961 and have been reorganized multiple times since then.

² This enterprise proved to be highly inefficient and there is the idea to (re)integrate these stations in Research Institutes again.

Table 1. List of scientific institutes and centers of the Agricultural Academy in Bulgaria

Specialized units		Complex units
Subject principle	Industry-product principle	
<ul style="list-style-type: none"> ▪ Agrobiointitute, Sofia; ▪ Institute of Agricultural Economics, Sofia; ▪ Institute for Food Preservation and Quality, Plovdiv; ▪ Institute of Cryobiology and Food Technology, Sofia; ▪ Institute of Soil Science, Agrotechnology and Plant Protection "Nikola Pushkarov", Sofia; ▪ Institute of Plant Genetic Resources "Konstantin Malkov", Sadovo. 	<ul style="list-style-type: none"> ▪ Institute of Ornamental and Medicinal Plants, Sofia; ▪ Institute of Animal Sciences, Kostinbrod ▪ Institute of Vegetable Crops "Maritza", Plovdiv; ▪ Institute of Viticulture and Enology, Pleven; ▪ Fruit Institute, Plovdiv; ▪ Institute of Field Crops, Chirpan; ▪ Institute of Fisheries and Aquaculture, Plovdiv; ▪ Institute of Fish Resources, Varna; ▪ Institute of Forage Crops, Pleven; ▪ Corn Institute, Kneja; ▪ Institute of Roses and Essential Oils Crops, Kazanlak; ▪ Institute of Tobacco and Tobacco Products, Markovo village, Plovdiv Region; ▪ Silkworm Science Center, Vraza. 	<ul style="list-style-type: none"> ▪ Dobrudzha Agricultural Institute, General Toshevo; ▪ Agricultural Institute, Stara Zagora; ▪ Agricultural Institute, Shumen; ▪ Institute of Agriculture, Karnobat ▪ Institute of Agriculture, Kustendil; ▪ Institute of Agriculture and Seed Science "Obraztov Chiflik", Russe; ▪ Institute of Mountain Animal Husbandry and Agriculture, Troyan; ▪ Agricultural Science Center, Targovishte; ▪ Agricultural Science Center, Sredez; ▪ Research Center for Animal Husbandry and Agriculture, Smolyan.

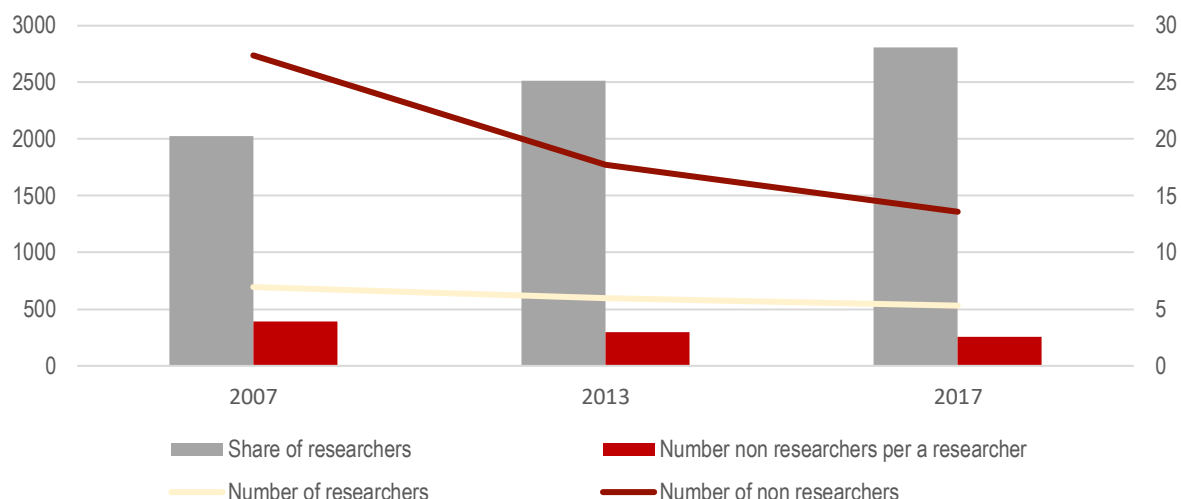
Source: author, based on Official regulation (Resolution on MS No. 151, 06/25/2018)

Some of the units of the Academy (Dobrudzha Agricultural Institute, Institute of Agriculture Karnobat, etc.) manage significant land and other resources, while the material and technical base of the majority of the units is morally and physically obsolete. The average number of researchers in the institutes is just under 20 and at the experimental stations 2.5 (Agricultural Academy, 2018). The main part of the R&D funding is on a project basis with the Agricultural Academy and other national and international organizations, from the sale of products and services, etc. The Agricultural Academy funding³ represents a different share of the total expenditures of the individual research units - from 20% for the Institute of Ornamental and Medicinal Plants to 94% for the Agrobiointitute (Agricultural Academy, 2018).

In the years after the country acceded to the EU, the number of researchers and experts employed in the Agricultural Academy has been constantly decreasing due to insufficient budget funding, regulatory constraints, restructuring and layoffs, lack of acceptable pay and working conditions, insufficiently qualified candidates in some areas, etc. For ten years, the average annual staffing in the Agricultural Academy decreased by 45% to 1890, and the number of scientists by nearly 24% to 531 (Figure 1, below in next page). At the same time, the structure of R&D employees has been improving as the share of scientists increased to just over 28% of the total at the end of the period. This shows that along with the reduction of the staffing of the Agricultural Academy and the agricultural R&D in the country as a whole, a progressive change has been taking place through a relative increase in the share of the active and highly qualified staff. Throughout the period, the habilitated staff of the Academy (Professors and Associate professors) makes up a little over half of all scientists, and doctors (Ph.D.) and doctors of science (DS) are over 70% and increasing in recent years to almost 80% (in 2017).

³ The major criteria for distribution of the Agricultural Academy support between different research institutes and stations has been the number of research personnel as budget subsidies de-facto covering the salaries and mandatory social payments of researchers and support staff while (sales, competitive grants, areal-based subsidies from EU CAP, etc.) funding of other (material, supplementary activities, etc.) expenditures being the responsibility of research unites.

Figure 1. Number and ratio of scientists and other full-time staff of Bulgarian Agricultural Academy (number, %)

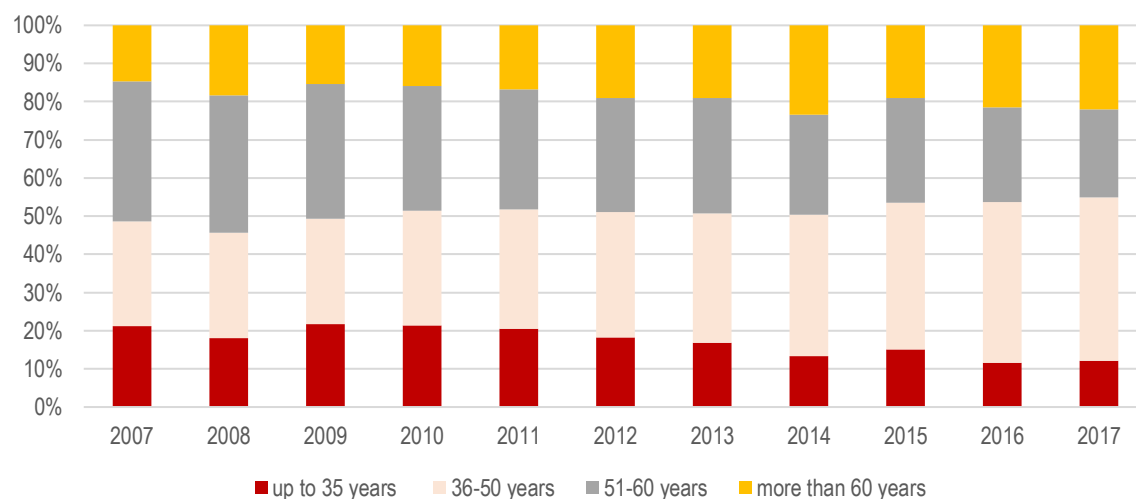


Source: Annual Reports of the Agricultural Academy

This shows that the qualification structure of staff composition is very good and adequate to meet the modern challenges of science and practice. At the same time, however, there are unfavourable trends in the development of the age structure of researchers at the Academy.

Although the average age increased slightly during the period (from 48.4 in 2007 to 49 in 2017), the share of young scientists decreased relatively, at the expense of an increase in those over 60, see Figure 2. The main reason for this is the lack of enough young candidates ready to pursue a career in science, due to lower pay compared to private businesses, public institutions, or foreign academic and other organizations. If this trend continues, the Agricultural Academy will have serious problems shortly in securing the needed qualified staff to carry out its mission and research program.

Figure 2. Age structure of researchers of the Agricultural Academy in Bulgaria



Source: Annual Reports of the Agricultural Academy

1.2. Funding of Activity of the Agricultural Academy

The budgetary "institutional" support of the Agricultural Academy is essential for the R&D activity of research institutes and centers (Activity 163). It is distributed mainly on a "project" basis, in which teams from the Academy units make proposals for research projects, which, after evaluation by specialized Expert Councils, are approved by the management of the Academy.

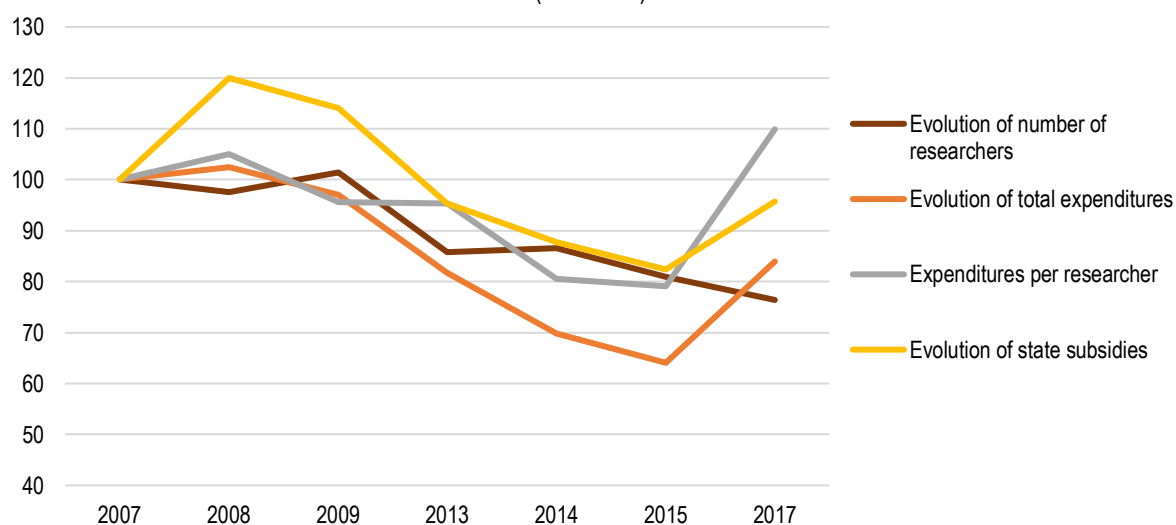
The main research priorities in the Agricultural Academy are four and are in line with the national and European priorities in this area: Sustainable development of competitive knowledge-based agriculture; Preservation of natural and genetic resources to mitigate the impact of climate change; Safe, quality and healthy

agricultural raw materials and food; Improving the quality of life in rural areas through competitive agriculture and increasing incomes. In the Agricultural Academy are carried out projects under 8 scientific programs:

- Collection, research, storage, and management of plant genetic resources. Improving the varietal composition of the main agricultural crops and production of quality pre-basic and basic seeds and planting material.
- Comprehensive ecological and economic assessment of soil resources and new technologies to increase soil productivity.
- Problems related to the resilience and tolerance of agricultural crops to water deficit and extreme temperature effects of the environment. Optimization of irrigation techniques and technologies in the conditions of water deficit.
- Technologies for organic production of plant and animal products. Development of integrated plant protection systems as a basis for safe food production and ecosystem protection.
- New economically and energy-efficient technologies for competitive production of plant and animal products that meet EU requirements.
- Systems for storage of the national gene pool and creation of highly productive breeds and lines of farm animals for the production of animal products, meeting EU standards. New feed sources and feed additives.
- New methods and technologies for production and storage of safe food, beverages, and organic products. Extending the period for supplying the domestic market with fresh fruit and vegetables.
- Assessment of the agro-ecological potential of the agricultural regions and diversification of the agricultural production. Development of organizational and economic structures in farming and their improvement. Socio-economic problems of rural development.

In addition to the direct subsidies from the state budget (until 2018 from the Ministry of Agriculture, and since then from the Ministry of Finance), the Agricultural Academy units receive budget funds for R&D from other public institutions (Ministry of Education and sciences, Ministry of Waters and Environment, etc.) mainly on a project basis. The Agricultural Academy also receives significant budgetary resources under other national and European programs - Human Resources Development, Program for Rural Development, and direct payments based on utilized agricultural area, defence and mobilization preparedness, etc. A good portion of all these funds is practically used for the maintenance of scientific units and R&D activity. For the analysed period, there is a significant reduction in total expenditures and budget subsidies for research institutes and centers of the Academy (Figure 3). The level of expenditures in 2015 was almost 36% lower than in 2007, after which there was a significant increase in expenditures and activity below the levels at the beginning of the period. The decrease in the budget expenditures has been relatively smaller than the overall decrease in expenditures, which demonstrates the growing importance of the budget financing of the activity during the period.

Figure 3. Evolution of the general and budgetary financial endowment of scientists of Bulgarian Agricultural Academy (2007=100)

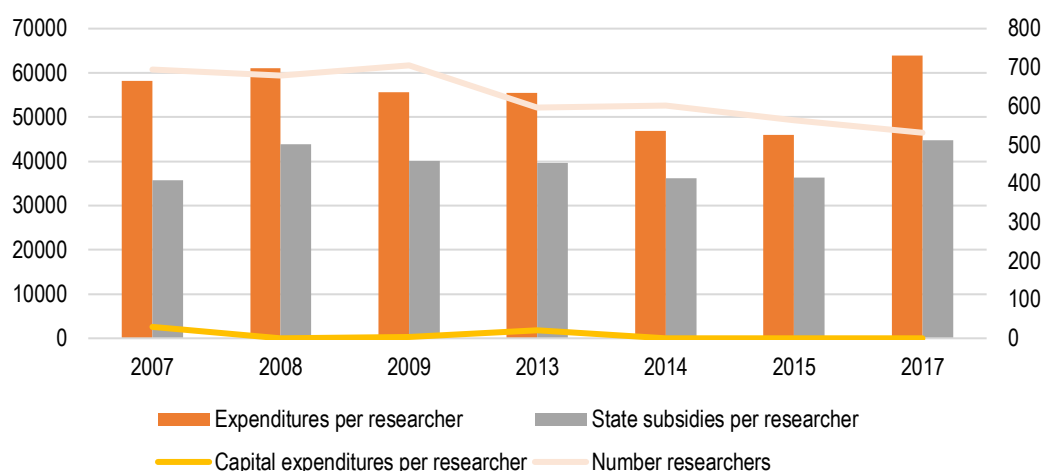


Source: Annual Reports of the Agricultural Academy

Despite the reduction in the total number of scientists, the financial and material endowment per scientist decreased after 2007 by 20% (2015), after which it increased at the end of the period by almost 10% above the initial level, see Figure 3 and Figure 4. During the period, the size of the budget expenditures per one scientist fluctuates significantly in levels above the base one, and in 2017 their size is with a quarter higher than in 2007. This confirms the crucial role of the budget funding for maintaining and increasing the provision of researchers with salaries, social insurance, material resources, etc. This is accompanied by a stronger orientation of the overall R&D towards the strategic state priorities (the financing organization) rather than towards the immediate needs of the market and the end-users of knowledge and innovation.

However, the capital expenditures for R&D during the period are insignificant in size, carried out only in individual years and with a decreasing amount per scientist. Their maximum share in the total costs is a little over 4% in the first two years of the period, while in the last few years it is negligible or zero. The latter deters modernization of the material and technical base and the resource endowment of scientists and reduces the efficiency of R&D.

Figure 4. Evolution of the number of scientists and their financial endowment in Bulgarian Agricultural Academy (no, BGL)

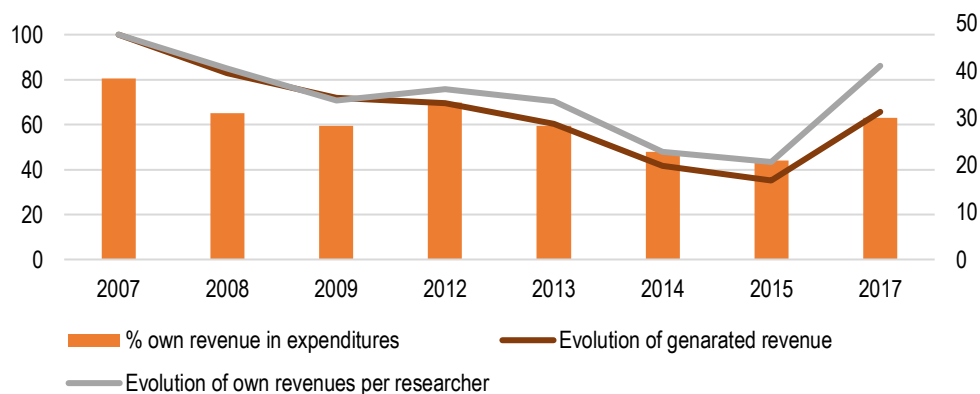


Source: Annual Reports of the Agricultural Academy

Own generated revenues account for 21-38% of the total expenditures for research institutes and centers the Agricultural Academy in individual years, and their size varies greatly and decreases over the period (Figure 5). The sale of services, goods, and products is the main source of R&D revenue (almost 100%) and gives an idea of the degree of market orientation and commercialization of the activity, and the practical dissemination and implementation of the results of the research activity.

In 2017, the own revenues (sales, rents, donations, etc.) from the country finance 30% of all R&D expenditures of the Academy. The total amount of income from own activities and the amount of income per scientist decreased significantly by 2015 (by three quarters and 57% respectively) and reached 86% of the initial level in 2017. This is an indicator that the importance of market orientation and funding in the management of the activity, and direct relations with consumers of knowledge and innovation, relatively decreased during the period.

Figure 5. Amount and share of own revenues of the Agricultural Academy (2007=100)

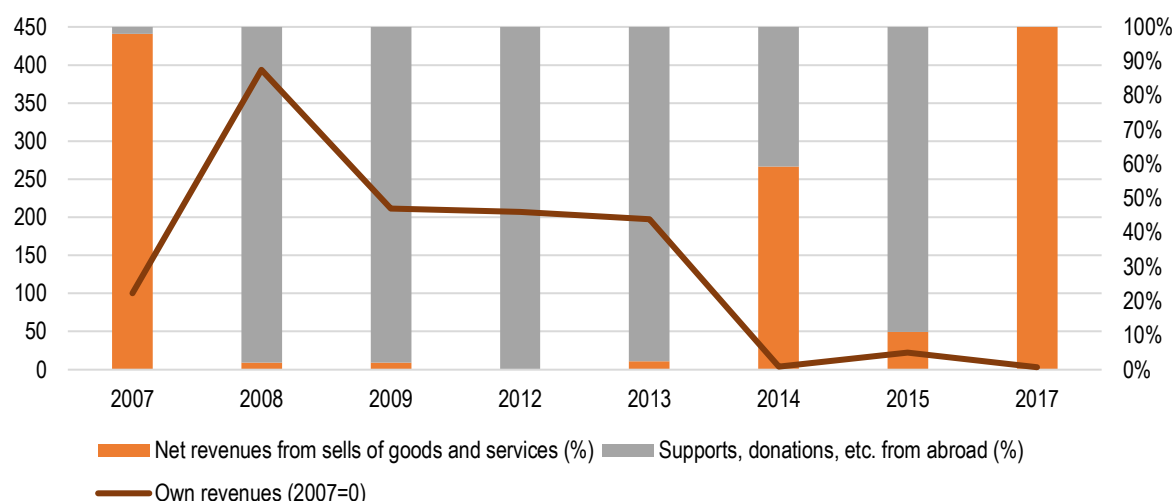


Source: Annual Reports of the Agricultural Academy

The Agricultural Academy also receives funds from international programs and agreements, donations and grants from abroad, revenues from sales of products, goods, and services abroad, etc. In some years, their level varies widely and decreases in recent years, as they account for a different share of the total own revenues of the Academy - from 0.2% (2017) to 18% (2008), see Figure 6.

The amount of this source of funding is almost entirely formed by grants, donations, and other grants received as well as sales of services, goods, and products, which have different significance in the individual years. The size, dynamics, and share of the international programs and markets for intellectual property and sharing of scientific knowledge give an idea of the degree of inclusion of the Agricultural Academy in the international division and cooperation of labour in the generation, transfer, and dissemination of knowledge and innovation.

Figure 6. Level and share of own revenues from international programs and agreements, donations and grants from abroad, and sales of products, goods and services of the Agricultural Academy in Bulgaria



Source: Annual reports of the Agricultural Academy

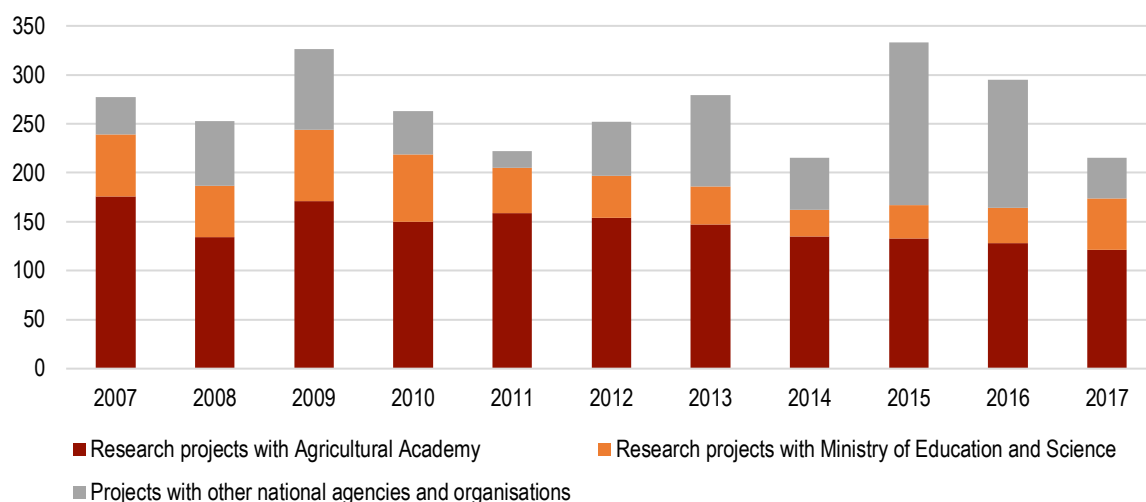
1.3. Production and Productivity of the Agricultural Academy

Research units and teams of the Agricultural Academy work on a large number of research projects funded by the Agricultural Academy, Ministry of Education and Science, and other national agencies and organizations (Figure 7). Projects are a form of organization of research and cooperation of researchers and stakeholders from different fields and disciplines, and often organizations (institutes of Agricultural Academy, Bulgarian Academy of Sciences, Medical Academy, universities, National Agricultural Advisory Service, farmers, and farmers' organizations, etc.).

The total number of national projects varies from year to year, and for most of the period the share of the Agricultural Academy projects predominates. In 2015-2016, the projects funded by foreign agencies and organizations are more. The latter demonstrates higher activity in the preparation and winning of projects on a competitive basis and the efficiency of participation in the "national market" for research projects. In addition, the Agricultural Academy teams work on a significant number of bilateral and multilateral international projects, which in different years represent from 34.5% (2015) to 46.4% (2014) of the total number of projects. Moreover, most international projects are multilateral - from 27.2% (2014) to 35% (2009) of all of them.

These data are an expression of the active involvement of the Agricultural Academy in international cooperation for the joint generation, transfer, and dissemination of knowledge and innovation.

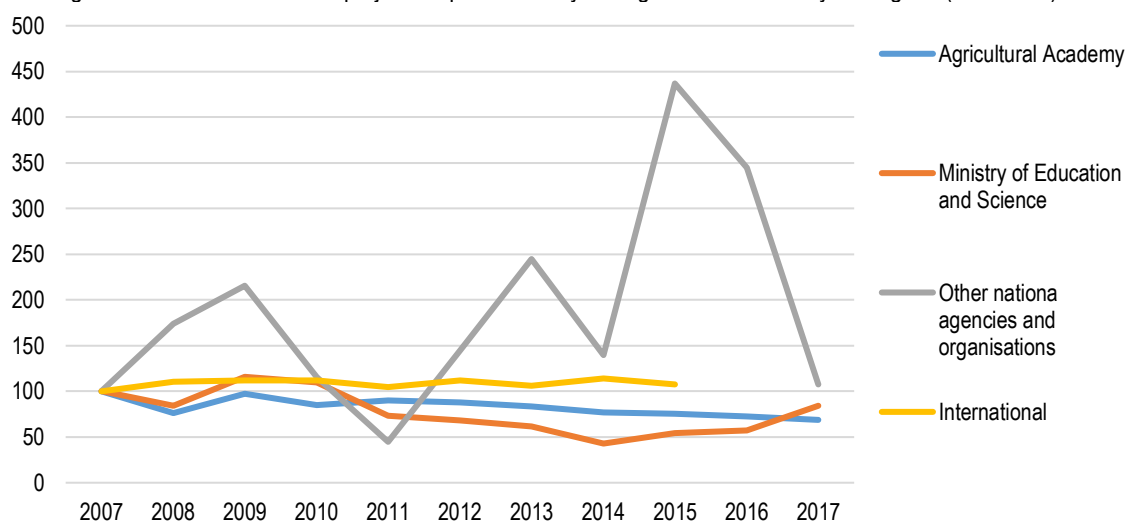
Figure 7. Number of current and completed research projects funded by the Agricultural Academy and other national agencies and organizations carried out by the units of the Agricultural Academy in Bulgaria



Source: Annual Reports of the Agricultural Academy

The number of carried-out projects funded by the Agricultural Academy and the Ministry of Education and Science decreased during the period, while the number of projects contracted with other national agencies and organizations varied widely (Figure 8). This is accompanied by an increase in the national projects implemented by one scientist from 0.4 to 0.6. The number of carried international projects throughout the period is higher than in 2007 and relatively stable, together with an increase in the number of projects (productivity) per scientist - from 0.2 to 0.3.

Figure 8. Number of research projects implemented by the Agricultural Academy in Bulgaria (2007=100)

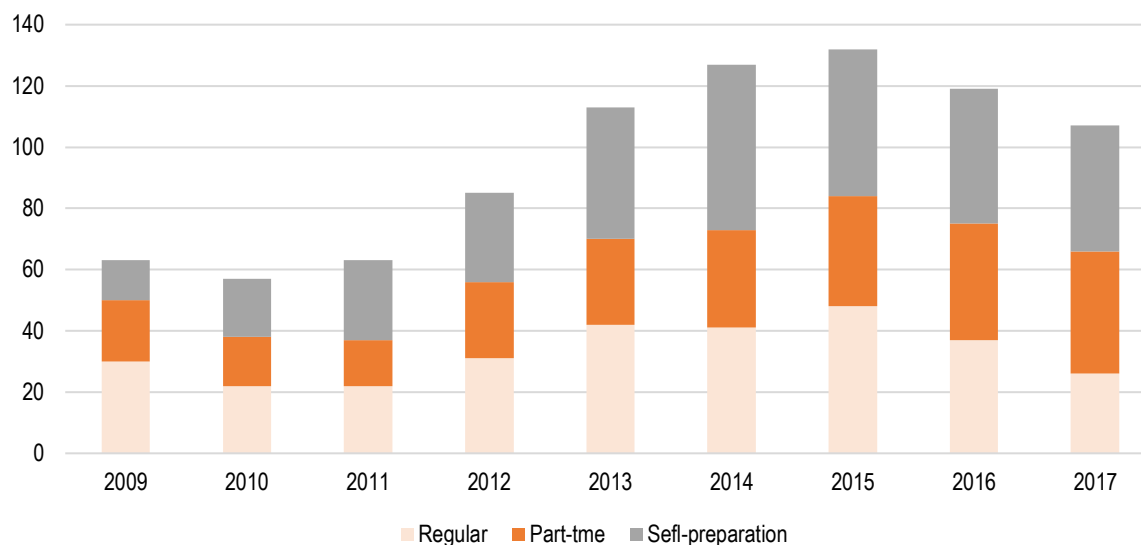


Source: Annual Reports of the Agricultural Academy

Along with the research activity, the Agricultural Academy also trains doctoral students in the field of agricultural sciences, for the needs of the Academy and other state and private organizations. Doctoral studies are on current issues of science and practice, which are integrated into the programs of scientific units, which increases both the efficiency of training and the effectiveness of the work of the Agricultural Academy.

Throughout the period there is a tendency to increase the number of successfully defended dissertations. By 2015, the total number of doctoral students is increasing, which has decreased in the last two years (Figure 9). At the same time, the relative share of full-time doctoral students decreases, and that of part-time and self-study increases. The latter groups include researchers and experts in the Agricultural Academy units and other public and private organizations. All this shows that the role of the Academy in training highly qualified specialists for the needs of scientific and other organizations in the country has been increasing.

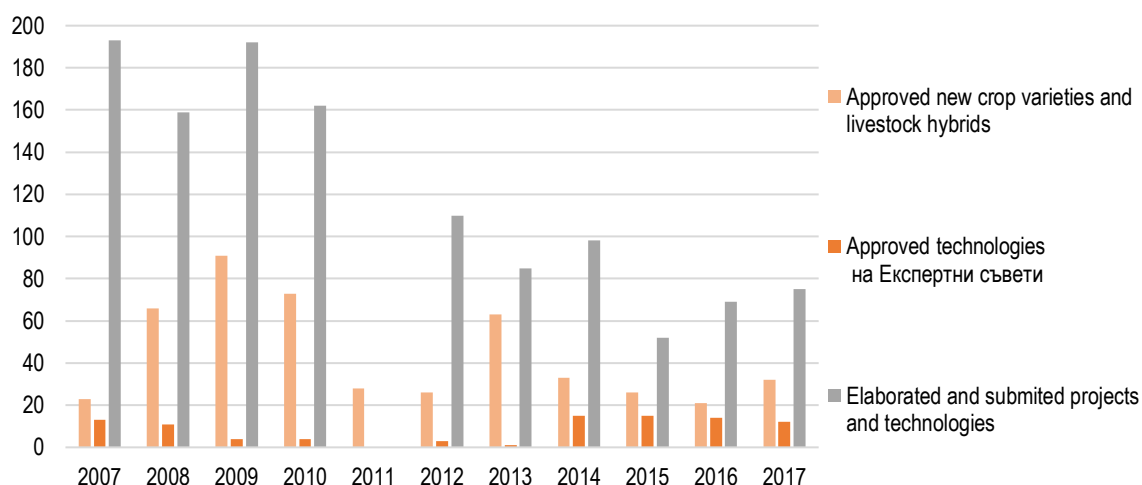
Figure 9. Number of doctoral students trained in the Agricultural Academy in Bulgaria



Source: Annual Reports of the Agricultural Academy

As a result of the R&D of the Agricultural Academy, a large number of new scientific products are created, which after approval (certification, etc.) by the relevant institutions are provided for implementation in practice through a direct transfer, contracts, and licensing agreements with the private sector and others. The number of approved new varieties and hybrids of plants, as well as animal breeds, established technologies and works, and presented projects and technologies are significant during the period (Figure 10). The variations in the amount of scientific production in the individual years arise from the nature of the R&D performance (long period of creation and formalities for approval of varieties and breeds, uncertainty, cyclicity, etc.).

Figure 10. Number of officially approved new varieties and hybrids of plants, animal breeds and works, and approved technologies from the Agricultural Academy in Bulgaria



Source: Annual Reports of the Agricultural Academy

The Agricultural Academy maintains 350 certificates of protected products issued by the Patent Office, including the largest number (about 85%) of all issued and maintained certificates for plant varieties and animal breeds. Of these, the largest share is of cereals (151); beans (7); oilseeds and industrial crops (39); forages (30); vegetables (48); tobacco (22); vines (22); fruit (2); breeds of animals (14) and flowers (15). In addition, 12 technologies and instructions for production, and processing of tobacco are included; as well as oil rose picking machine; 2 useful models in cryobiology and food technologies; a device for express diagnosis of the degree of infestation of bee families with varroosis, etc. The official variety list of the country includes a total of 285 varieties of the Agricultural Academy, as in list A (cereals, fodder, oilseeds, and industrial crops, beets, potatoes, and fruit plants) are included 226 varieties, and in list B (vegetable, ornamental, medicinal and aromatic crops and vines)

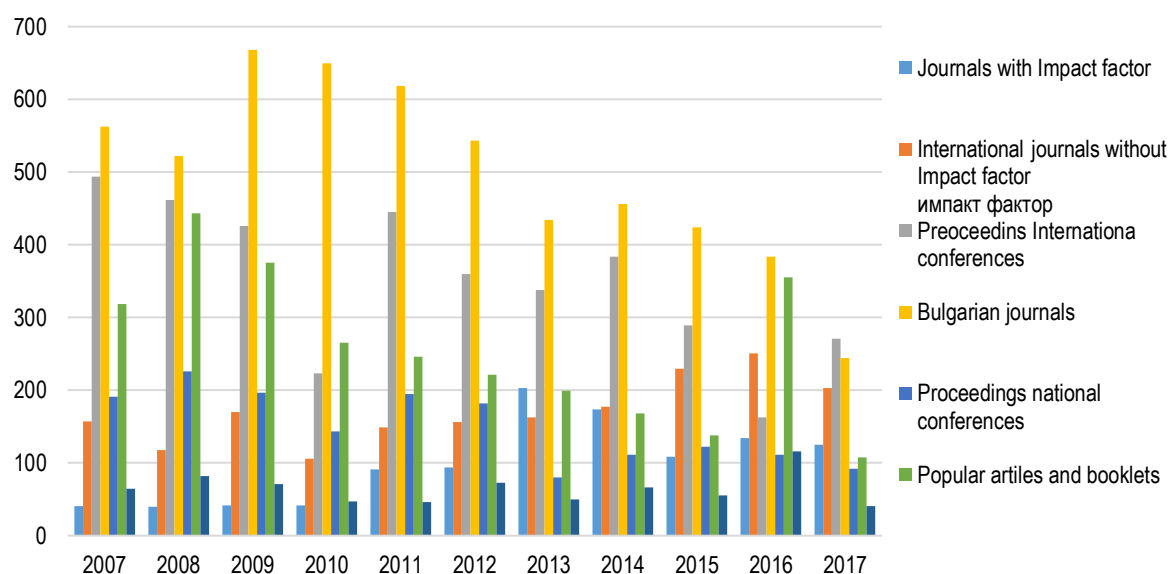
59 varieties (Agrarian Report, MAF, 2018). New scientific products often outperform old ones and are quickly implemented in practice. The possibility to register rights and grant licenses creates an economic incentive to increase the efficiency and commercialization of intellectual agricultural products. However, in the country, there is no official information and reliable methods for establishing the degree of implementation of the developed new varieties and hybrids of plants, animal breeds, and technologies due to lack of effective regulations or willingness to sanction intellectual property rights, mass piracy of varieties, the impossibility of effective control and insufficient incentives and sanctions, etc. For example, in 2017, out of the total number of Agricultural Academy certificates (350), only 19.7% have concluded license agreements. All this slows down the commercialization of intellectual agricultural property and market management of R&D in the country.

1.4. Dissemination of Research Output of the Agricultural Academy

The Agricultural Academy and its units use a variety of forms to disseminate and share knowledge, provide scientific services, and support innovation in agriculture. Publishing in the publications of the Agricultural Academy and its units (magazines, books, collections, brochures, etc.) and other national and international academic and scientific-applied publications are the main channel for dissemination of the results of scientific and scientific-applied activities of the Academy. The number of different types of publications during the period is huge and evidence of the high productivity of researchers (Figure 11).

There is a tendency to increase the number of publications in prestigious magazines with an impact factor and foreign magazines. This is an indicator of the international recognition of the Academy's R&D performance and the growing contribution to the global sharing of knowledge and scientific development.

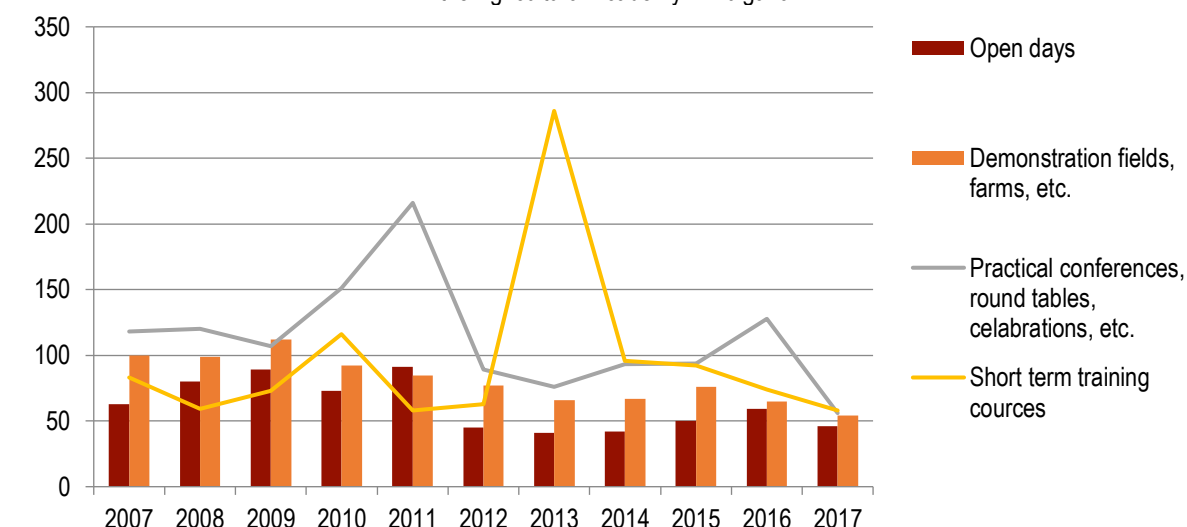
Figure 11. Number of publications of the Agricultural Academy in scientific and popular science magazines, brochures, proceedings and books



Source: Annual Reports of the Agricultural Academy

One of the most popular and widely used forms for sharing and disseminating knowledge and supporting innovation in agriculture are holding open days for farmers and stakeholders, creating demonstration fields, farms, etc., organizing scientific and practical conferences, seminars, symposia, round tables, anniversary celebrations, etc., and conducting short-term training courses. During the different years of the period, a large number of all these forms take place in the Agricultural Academy units, with the participation of many farmers of different types and other stakeholders (Figure 12).

Figure 12. Number of created demonstration fields, open days, scientific-practical conferences and short-term courses from the Agricultural Academy in Bulgaria

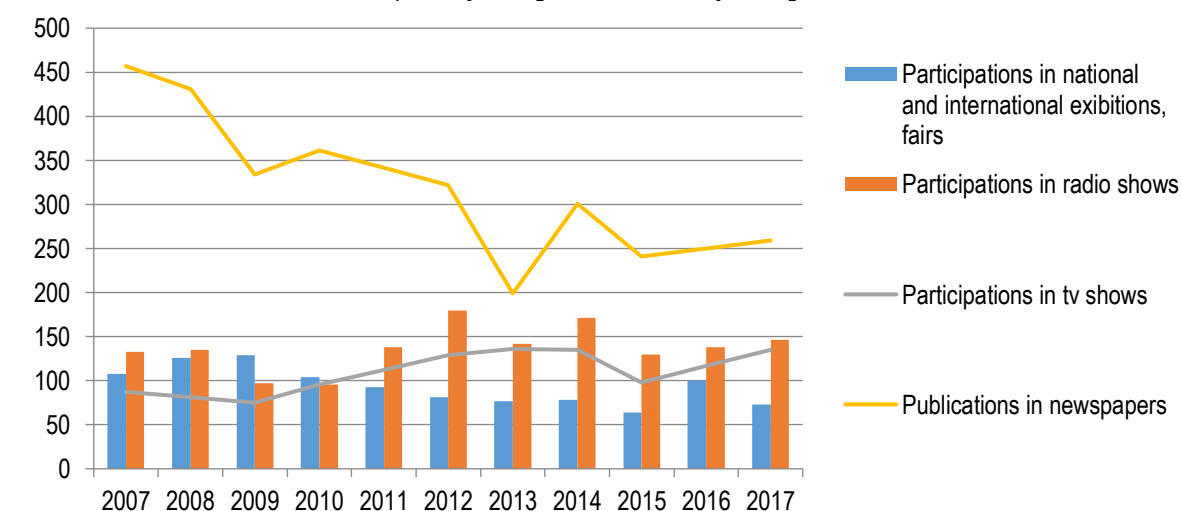


Source: Annual Reports of the Agricultural Academy

After the country acceded to the EU, the Agricultural Academy's participation in the training of farmers and specialists of various types has improved. For example, during the period 2011-2015 in the Center for Vocational Training and the scientific institutes of Agricultural Academy 2203 agricultural producers and specialists were trained, including 46% under Measure 111 in the specialty's animal husbandry, plant growing, ecology, perennials, etc. (Agricultural Academy). In 2017 alone, 265 agricultural producers were trained in the courses of the Center for Vocational Training in the professional fields "Farmer", "Agroecologist", "Livestock Breeder", and "Plant Technician". The training was also conducted for over 100 people under Ordinance 2 of 23.07.2017 on the specific requirements for production, collection, transportation, and processing of raw milk, the marketing of dairy products and their official control, and for the purposes of self-control. In addition, Agricultural Academy research units and experts participate in many joint training and dissemination initiatives with other organizations such as National Agricultural Advisory Service, universities, private and professional organizations, and others.

Other effective forms for popularizing the scientific achievements of the Agricultural Academy and disseminating knowledge are participation in exhibitions and fairs at home and abroad, participation in national, regional, and local radio and television programs, as well as publications in the press. The use of modern media such as radio and television has tended to increase over the period, enabling to reach many users at a low-cost (Figure 13).

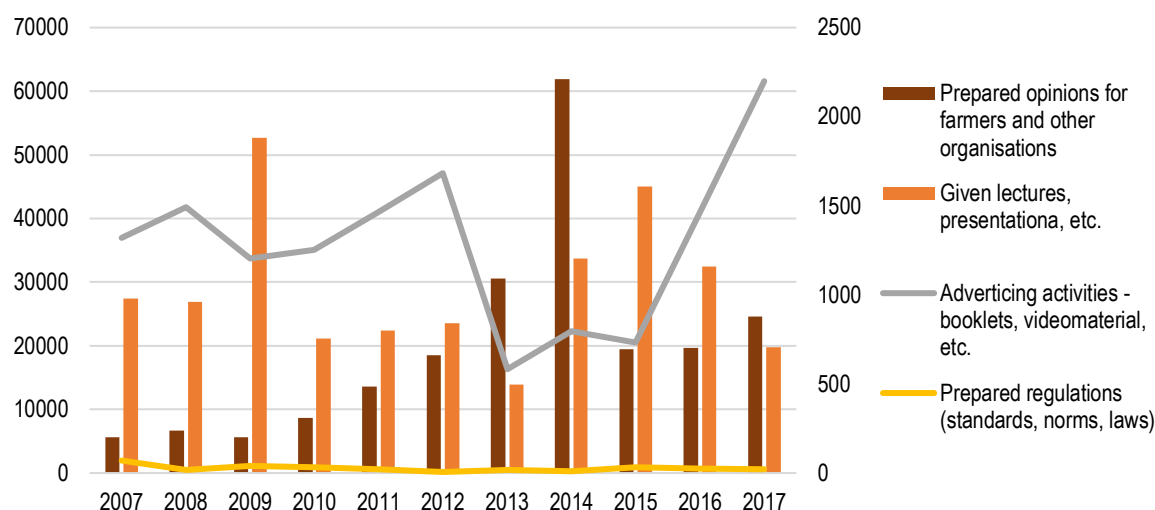
Figure 13. Number of participations in exhibitions and fairs, in radio and television broadcasts, and materials published in the press by the Agricultural Academy in Bulgaria



Source: Annual Reports of the Agricultural Academy

Also, Agricultural Academy researchers take an active part in the development of many official documents (standards, norms, laws), opinions for farmers, cooperatives and agencies, advertising materials (brochures, newsletters, leaflets, videos, etc.), and in lecturing and reporting. The growth of this type of activity shows that the diverse expertise of the Agricultural Academy is widely sought after by various agents making management decisions at different levels and all stakeholders (Figure 14).

Figure 14. Number of prepared opinions for farmers, cooperatives and agencies, developed official documents, delivered lectures, reports and advertisements from the Agricultural Academy in Bulgaria



Source: Annual Reports of the Agricultural Academy

The dynamics of all these indicators give an idea of the changing possibilities (qualification, financial and organizational capacity) for organizing and participating in such forms, the efficiency, and complementarity of the individual forms, as well as the adaptation to different needs (demand) of various participants in the system for sharing knowledge and innovations in the country. In addition to all this, the Agricultural Academy performs other important functions related to the scientific service of the industry, such as maintenance of plant and animal gene pool, performing analyses of soil, plant and animal products, information services, independent expertise, etc. In this way, it contributes to improving the scientific and technical level in agriculture, preserving the "accumulated" biological potential, as well as disseminating knowledge and innovation in the sector.

Over the last three decades, various "reforms" of the country's agricultural research system, and in particular the Agricultural Academy, have been undertaken. However, despite certain success in some areas in recent years, still, there is not established an effective structure for the organization of R&D, and systems for public funding of activities, coordination, and evaluation of research, evaluation, and incentives for researchers and teams, as well as protection of intellectual agricultural property. Some of the research institutes and centers do not have or are on the border of the "critical" mass of human, financial and material resources necessary for effective conducting of modern research: Institute of Roses and Essential Oils Crops (6), Institute of Fisheries and Aquaculture (7), Institute of Ornamental and Medicinal Plants (9), Institute of Fish Resources (9), etc. The organizational separation of the experimental stations, on the other hand, does not allow the effective integration of their "significant" resources in the R&D coordinated by the scientific institutes and centers. All this does not allow to fully realize the great potential of the Agricultural Academy to improve the scientific and technological level of the agricultural sector in the country.

1.5. State of Agrarian Research Conducted in Other Organisations

The general tendencies, efficiency, and problems in the development of agrarian research in the universities and Bulgarian Academy of Sciences are similar to those in the Agricultural Academy. Many of the universities traditionally have no strong research programs due to lack of researchers' time, financial and material resources, sufficient capacity to win and implement projects, etc. Universities receive insignificant subsidies from the Ministry of Education and Science for "internal" projects, which are usually "fundamental", small in size, and include part of the academic staff. In recent years, additional weight has been given to the distribution of the state subsidies according to science-metric indicators, on which only a few universities have comparative advantages mostly outside of "agrarian" programs. In addition, universities compete for funding from research programs of the National Science Fund of the Ministry of Education and Science and other national and international organizations, making contractual research for business and other organizations.

In 2017 the share of the budget for funding from National Science Fund projects in "Agricultural Sciences" was 17%, which is extremely insufficient (REPORT of the Commission for Monitoring, Evaluation, and Analysis of the activities of the Research Fund at the Ministry of Education and Science, 2018). Moreover, the share of public higher education institutions in the total funding of the National Science Fund was only 42%, which shows that only part of the projects in "Agricultural Sciences" are in universities.

The financing of agricultural research in the country by the European programs such as FP7, HORIZON 2020, and others is also insignificant. The total funding of Bulgarian science from these funds is significant, nevertheless among the lowest in Europe - for example, funding from HORIZON 2020 for Bulgarian organizations is "significant" (105.5 million euros), but only 0.25% of the total budget of that Program, the number of participants from Bulgaria is 0.58% of all, with only one leading organization from the country, etc. (HORIZON 2020). At the same time, in the ten most active organizations in the country for winning projects from the main EU programs such as FP7 and HORIZON 2020, there is none in the agricultural field.

The main universities in which research in the field of agriculture and food technology is carried out are the Agricultural University, Plovdiv; Thracian University, Stara Zagora; University of Forestry, Sofia; University of Food Technology, Plovdiv; and University of Ruse, Ruse.⁴ In recent years, other "non-specialized" fields of agriculture universities and institutes of the Bulgarian Academy of Sciences are also quite competitive to enter the field of agricultural and related research such as bioeconomics, food security, ecology, AKIS, socio-economic and other projects. There is no aggregated information in the country about the nature and volume of agricultural research conducted by Bulgarian universities. The situation is similar to the available information on agricultural research in the institutes of the Bulgarian Academy of Sciences, given the more fundamental and multidisciplinary nature and the diverse goals of research that often go beyond the agricultural field. It is also difficult to find information on agricultural research carried out in the private sector. All this hinders the analysis and management of AKIS in the country and requires the collection of similar information in the future.

The conclusion in the RDP 2014-2020 is also relevant for the agricultural universities and the Bulgarian Academy of Sciences: "the provision of consulting services and knowledge transfer in the country are not systemic. The results of research, such as innovations for introduction into agricultural holdings, are presented mainly at academic conferences or exhibitions without being promoted among potential users. The Agricultural Academy, due to its limited budget, presents results only on demonstration fields. On the other hand, research topics, although they generally cover key problems in agriculture, are not linked to the specific problems of specific farms or specific sectors".

In Bulgaria, there is no summary information on the degree of implementation of different types of innovations in agriculture. There are good examples of implemented science and technology achievements in all sub-sectors. These innovations are implemented by innovative entrepreneurs who manage to study, transfer and adapt the highest achievements in the respective field, providing the necessary organization, financing, consulting, and know-how in a private way. However, the overall level of innovation implementation in the country is far below the world and EU levels, with significant differences in the technological level of the "leading" farms and the average level in most holdings of the country.

Our 2019 survey among farmers' organizations and innovative farmers found that there is not enough information about the achievements and "ready" innovations of the institutes of Agricultural Academy, Bulgarian Academy of Sciences, and universities. Moreover, the majority of the implemented innovations in the country are "imported" from abroad, due to the lack of effective solutions in the local institutes and universities for the contemporary needs and actual conditions of the Bulgarian economies.

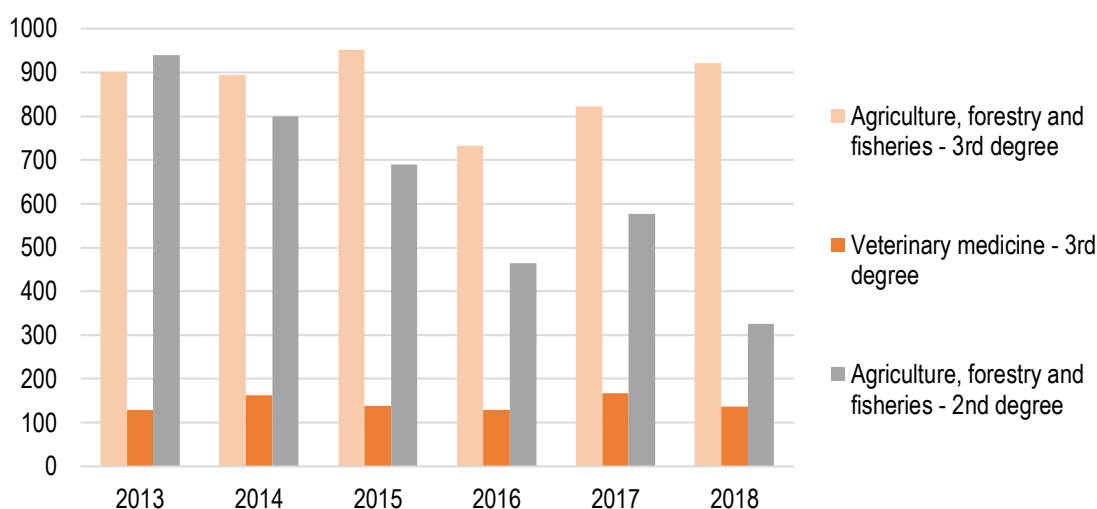
2. System of Education and Training of Agricultural Producers

In 2014 professional education in the field of agriculture and forestry covers 92 institutions (technical schools, high schools, etc.) and more than 880 vocational training centers with licensed professions and specialties for vocational education and training in the fields of agriculture, veterinary medicine, forestry and food technologies (ПРСП 2014-2020, МЗХГ). Subsequently, some of them were closed due to the low interest in the specialties, the number of students enrolled and dropped out, etc. During the period 2013-2018 on average annually 870 persons receive a Level-3 qualification in the field of agriculture, forestry, and fisheries, and 144 in veterinary medicine. For the same period, 633 people also receive a Level-2 qualification in agriculture, forestry, and fisheries. agrarian graduates represent 6.14%, 1.08%, and 16.25% respectively of the total professional qualifications in the country. The number of persons acquiring in 2018 the professional qualifications Level 3 in the fields of agriculture, forestry

⁴ None of them is classified as a "research" university during the 2021 multicriteria assessment by the Ministry of Education, Science, and Technologies.

and fisheries and veterinary medicine is higher than the beginning of the period by 2% and 6% respectively (Figure 15), with a decrease in the total level of qualifications acquired in the country by 13%. The number of graduates with vocational qualifications of Level 2 in general and in the field of agriculture, forestry, and fisheries has been significantly reduced since 2013, as the reduction in agrarian sphere is less than the overall graduates in that level.

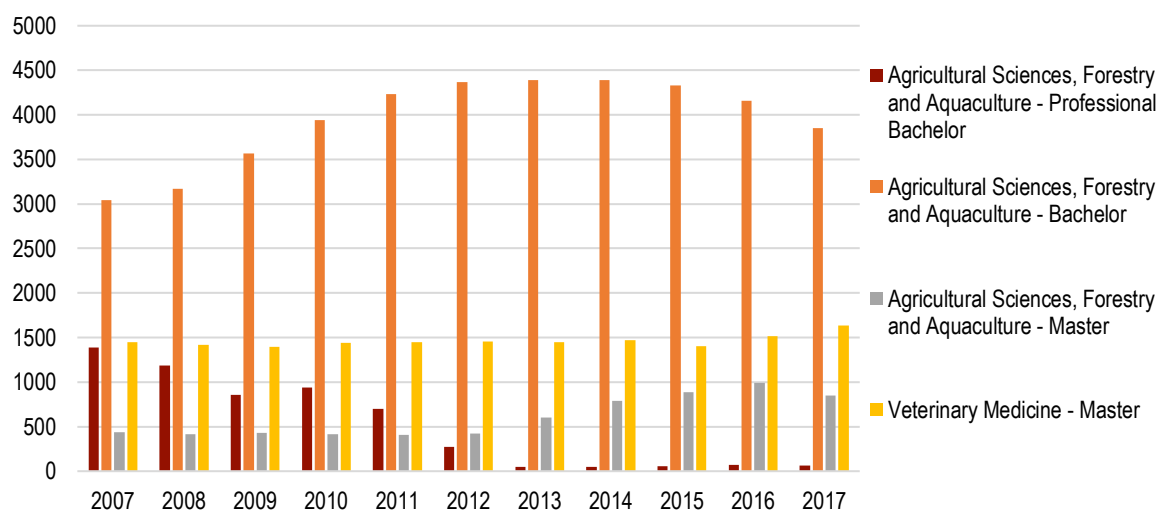
Figure 15. Graduates of the II and III Levels programs for professional qualification in different fields of education (number)



Source: NSI

The higher education in agrarian specialties is carried out at several universities offering similar qualifications and competing for a limited number of students e.g., Agronomy and Agrarian Economics is offered in 6 universities and colleges, etc. The number of undergraduate students in Agrarian Sciences, Forestry, and Aquaculture, and Veterinary Medicine in 2017 is well above the 2007 levels for Bachelor's and Master's degrees (Figure 16). Moreover, the relative share of these two branches of agricultural education relatively increased in the total number of students in the country during the period - for Bachelor's Degree in Agrarian Sciences, Forestry and Aquaculture from 1.89% to 2.48%, for the Master's Degree Program in Agricultural Sciences, Forestry, and Aquaculture from 0.67% to 1.1%, while for the Master's Degree in Veterinary Medicine it is relatively stable (HCU). This confirms the aspirations of many young people to increase their education in the agrarian sphere. However, there is no information on how many of the graduates of agricultural specialties in vocational and higher education institutions work in the agricultural sector. It is well known, for example, that a small number of university graduates work subsequently in their fields of education. Moreover, discussions regarding the (low) quality of education and the efficiency of school's adaptation to the needs of the business have been constantly on the agenda.

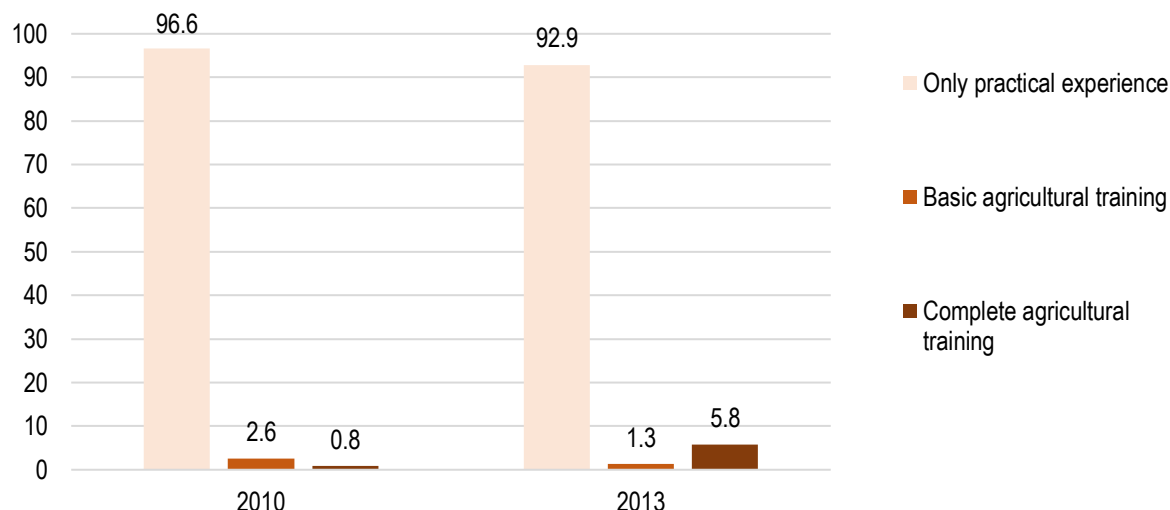
Figure 16. Number of undergraduate and graduate students and fields of education



Source: NSI

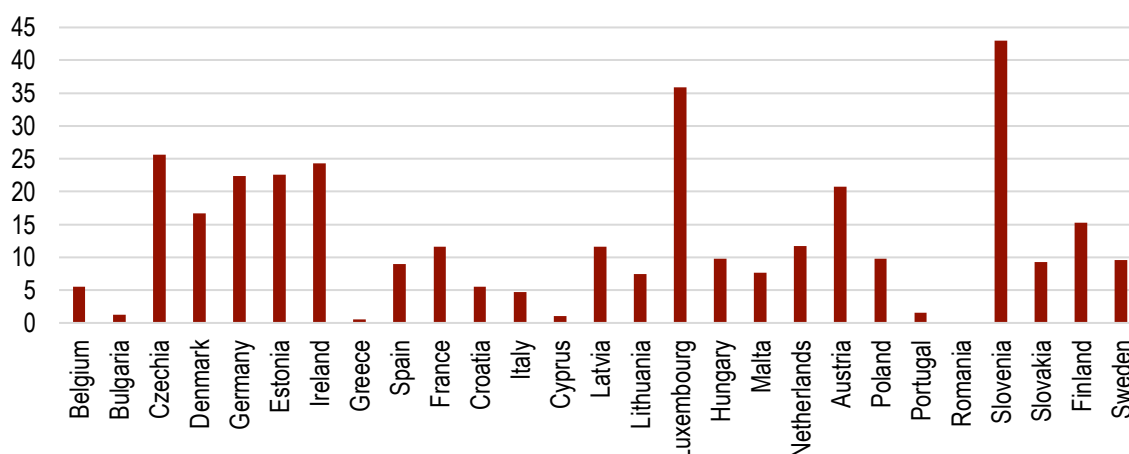
Available data on the agricultural training of the managers of agricultural farms in Bulgaria show that in the first years after the accession to the EU, only a small number of them have basic or full agricultural training, most of them being only with practical experience (Figure 17). Moreover, in 2010, only 1.3% of the farm managers had undergone some form of training in the last 12 months (Figure 18). By this indicator, Bulgaria is among the most lagging behind countries in the EU, along with Romania, Greece, and Cyprus.

Figure 17. Agricultural training of the managers of agricultural farms (%)



Source: Eurostat

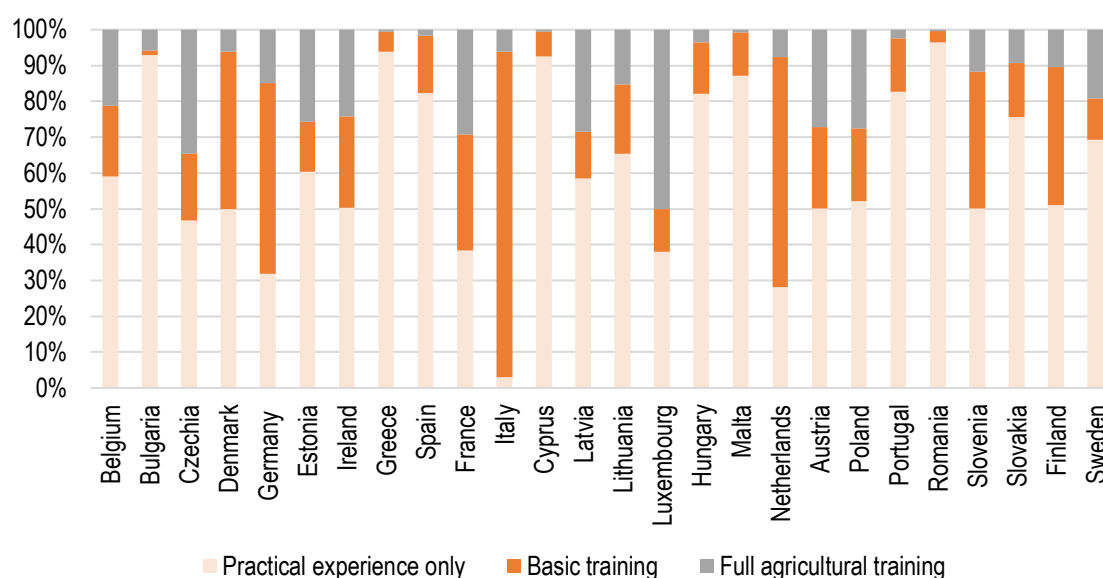
Figure 18. Share of holdings with vocational training by manager in last 12 months in EU member states in 2010 (%)



Source: Eurostat

As a result of the undertaken measures for public support during the period, 2010-2013 the share of managers having completed full agricultural training increased from 0.83% to 5.8%, while those with basic agricultural training and only practical experience decreased slightly. At the end of the First programming period for the implementation of the CAP in the country almost 93% of all farm managers are only with practical experience and without any agricultural training. The relatively small proportion of the farm managers who have completed basic or full agricultural training (7.12%) requires significant public intervention for training and consultations of agricultural producers. Except for Romania, Greece, and Cyprus, all other EU countries far outperform Bulgaria in the extent of training of farm managers (Figure 19).

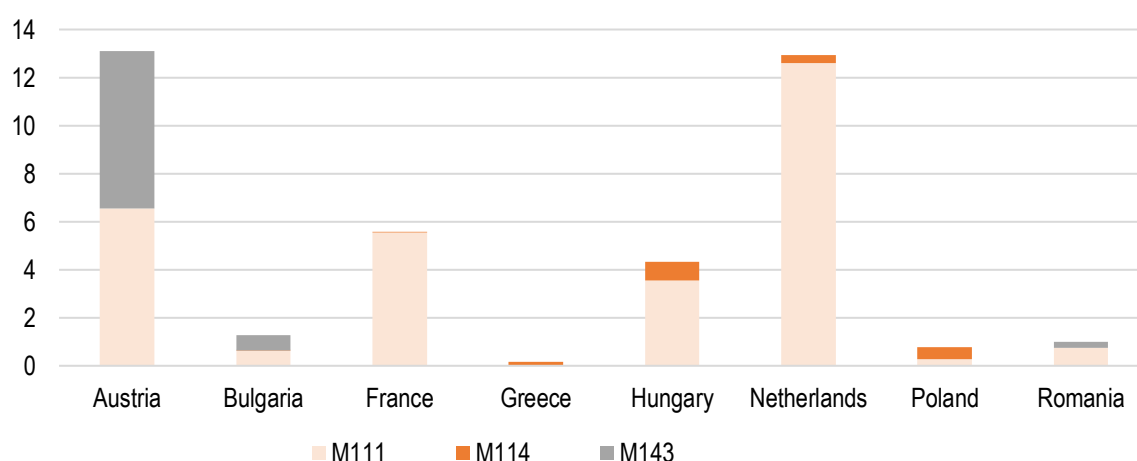
Figure 19. Agricultural training of farm managers in EU member states in 2013



Source: Eurostat

Since 2007, agricultural and rural development programs have been a major tool for public support for the training and consultations of farmers to successfully adapt to the ever-changing economic, market, institutional and natural environment. The total amount of public funds spent under the RDP 2007-2013 under Measure 111 "Vocational training, information activities and dissemination of scientific knowledge", Measure 114 "Use of advisory services by farmers and forest owners" and Measure 143 "Provision of advice and agricultural consultancy in Bulgaria and Romania" amounts to 15 236 905 Euro (MAF, 2018). It represents 1.65% of the total amount of the public expenditures under Axis 1 and 0.5% of the total budget of the program. Bulgaria is in the group of EU countries (along with Greece, Poland, and Romania), in which these three measures account for the smallest share in the total expenditures of Axis 1 and of the RDP 2007-2013 as a whole (Figure 20). Developed European countries such as Austria, Netherlands, France, etc. attach greater importance to farmers' consultations and training and devote a much larger share of the Axis 1 and RDP budgets to these activities, as the majority implement more measures related to them.

Figure 20. Share of public expenditures for Measures 111, 114 and 143 in total public expenditures for Axis 1 of Rural Development Programmes 2007-2013 in selected EU countries (June 2015)



Source: ENRD

Measure 111 represents 0.99% of the public expenditures in Axis 1 and 0.3% of the budget of the PRD. For the entire period of implementation (2008-2015), 91 contracts were concluded under the measure with various training organizations for financial assistance, totaling BGN 30 685 570. The training is provided by the AA, NAAS, universities, private and professional organizations, etc. To increase the efficiency of the RDP, vocational training

was introduced as a prerequisite for the participation of farmers without agricultural education in some of the other public support measures - Measure 112 "Setting up farms for young farmers" and Measure 214 "Agri-environment payments". During the implementation of the measure, the initial budget was reduced four times, which is due to greater initial interest and unrealistic planning, lack of training providers, insufficient promotion of the activity, and the reluctance of the producers to study away from the farm. In the course of implementation of Measure 111 "Vocational training, information activities and dissemination of scientific knowledge", a total of 40 062 farmers were trained, with an average training duration of 5.1 days (Table 2). This represents almost 16% of the total number of farms in the country and just over 52% of the number of registered farmers in 2013. This is a significant success given a large number of farmers in the country and their (low) qualification level.

Table 2. Implementation of Measure 111 of the RDP 2007-2013

Area of training	Total trained participant	No. of days of training	Public funds paid, thousand EUR	Duration of training per student, days	% in total trained	% in total days	% of total cost
Administrative, management and marketing skills	5.892	32.020	1.347	5,4	14.71	15.70	14.70
ICT in agriculture	233	1.921	53	8,2	0.58	0.94	0.58
Technical knowledge and skills - new technological processes and machines, innovative practices	14.898	85.500	3.407	5,7	37.19	41.93	37.19
New standards	170	2.247	39	13,2	0.42	1.10	0.43
Quality of production	100	2.163	23	21,6	0.25	1.06	0.25
Sustainable management of natural resources and environmental protection	17.157	75.874	3.923	4,4	42.83	37.21	42.82
Others	1.612	4.184	369	2,6	4.02	2.05	4.03
TOTAL	40.062	203.909	9.161	5,1	100	100	100

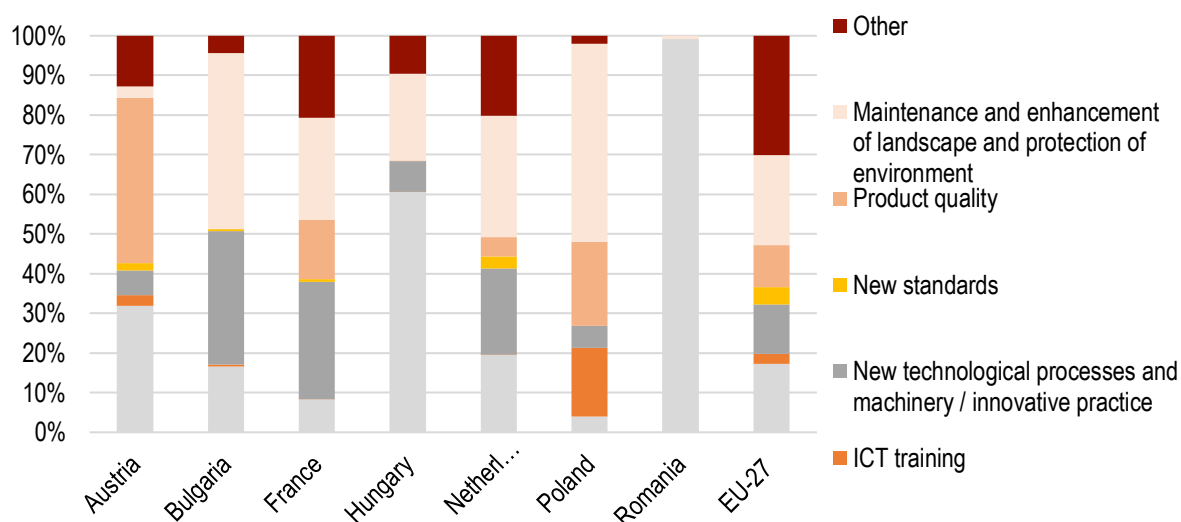
Source: Ex-post evaluation of the 2007-2013 RDP, M3X, 2018

The public cost per trained person is EUR 228.7 and one-day training EUR 44.9, which demonstrates the high efficiency of this public intervention. The over-passing of the planned indicators is high - by 158% for the indicator number of participants and by 54% for the number of training days. The participation of farmers in the training under this measure is high given the opportunity to acquire new knowledge, improve qualifications, transfer knowledge and experience, as well as the mandatory requirements for participation in other measures of the program.

A positive result in the implementation of the activities under that measure is the high participation of young people up to 40 years and women. Trainees between the ages of 18 and 40 are 60% of all trainees (M3X). In 2013, the number of farm managers under 40 is between 30-35000, which means that over 70% of them have received training. Women enrolled in the training are 35% of all trained, indicating that one-quarter of women managers in the country have received training during the period.

The biggest number of participants in the training and information events are in the thematic area "Sustainable management of natural resources and environmental protection" (Table 1). This area represents 42.8% of all trained persons and expenditures and 32.7% of all training days, with an average of 4.4 days of training. The second most popular topic is "Technical knowledge and skills - new technological processes and machines, innovative practices", which represents 37.2% of the number of trainees and total expenses and 41.9% of the training days, with an average length of training of 5.4 days. The third topic that farmers are most interested in is "Administrative, Management and Marketing Skills", in which 14.7% of the participants are trained, 15.7% of the training time is engaged, with an average duration of 5.4 days. On average for the EU countries, these three thematic areas also dominate, along with "Others", but take a different relative share than in Bulgaria (Figure 21).

Figure 21. Measure 111 Vocational training and information actions of Rural Development Programmes 2007-2013 of selected EU countries (June 2015)

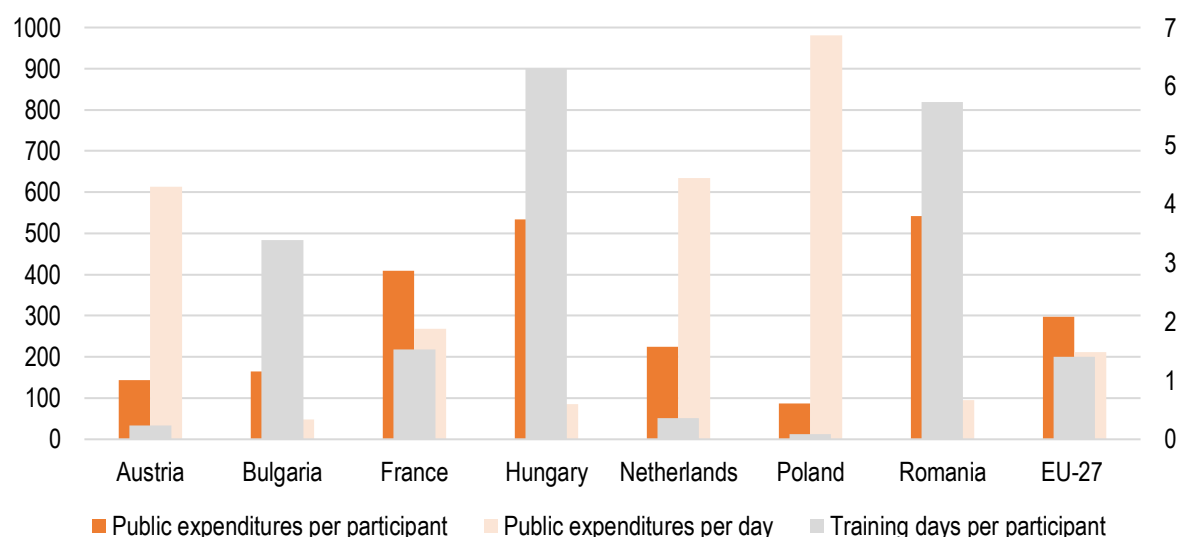


Source: ENRD

In more developed countries such as Austria, France, and Poland, and the Union as a whole, product quality training has a significant share. In some countries in Eastern Europe, such as Romania and Hungary, the vast majority of participants in the training have preferred "Administrative, management and marketing skills".

In terms of the number of training days, Bulgaria is 2.4 times above the EU average, well above that in developed countries such as Austria, the Netherlands, and Poland, and well below the duration in Hungary and Romania (Figure 22). At the same time, the public expenditures of one participant and one day of training in the country are significantly lower than the average for the Union and some of the compared countries. This is an indicator of the higher (economic) efficiency of the organization of training compared to other European countries.

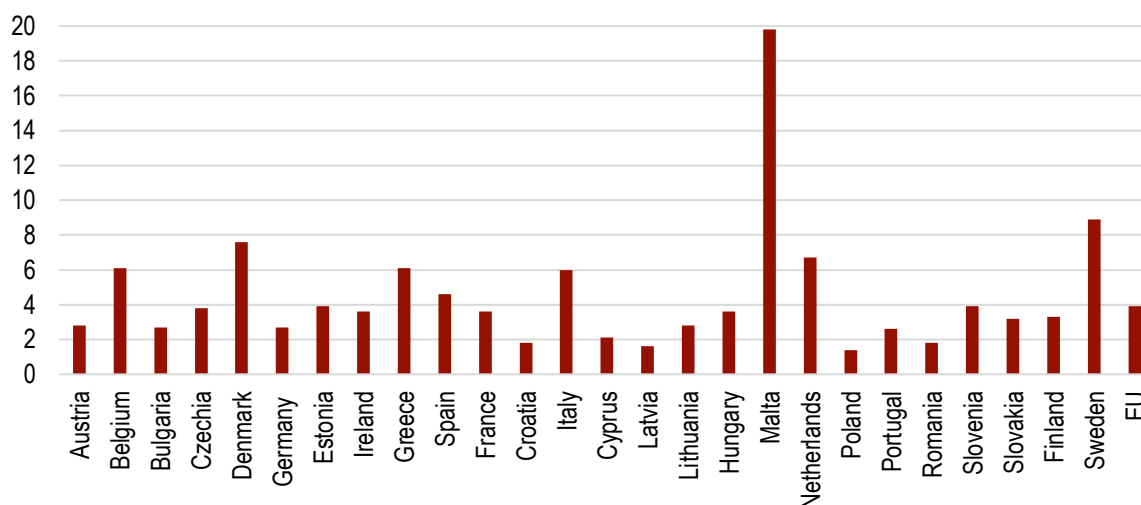
Figure 22. Number of training days received and Public Expenditure per participants and training day of Measure 111 in EU countries, June 2015 (Number, Thousand Euro)



Source: ENRD

The RDP 2014-2020 also gives a priority for the "Knowledge transfer and information actions" (Measure 1), "Consultation services, farm management, and transfer of farms" (Measure 2), and "Cooperation" (Measure 16), which respectively represent 0.87%, 0.15% and 1.12% of the total budget of public funds. Compared to the EU average and most Member States, the relative share of expenditures for co-operation, knowledge transfer, and advisory services is significantly lower in Bulgaria (Figure 23). The part of this component of the budget in the country is similar to Germany and exceeds only that of a few countries (Croatia, Latvia, Romania, and Cyprus).

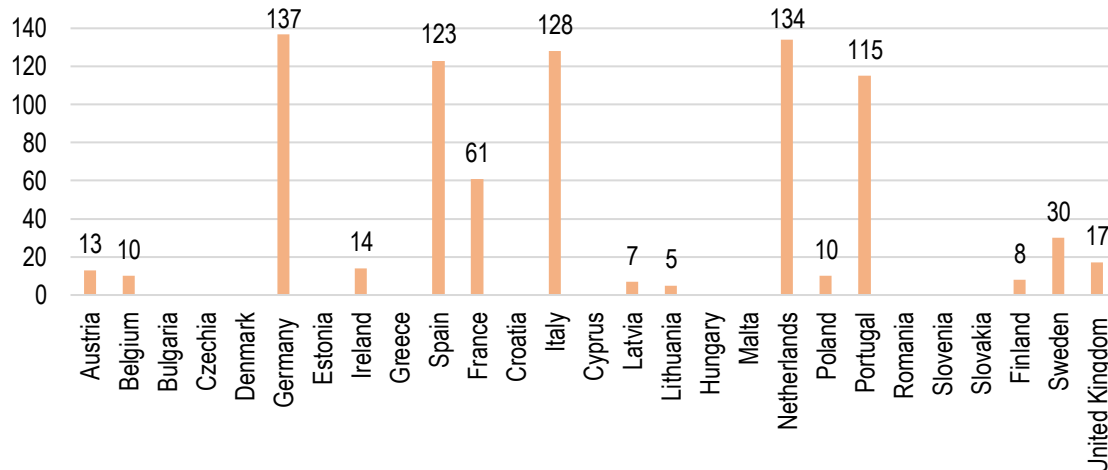
Figure 23. Percentage of expenditure under Measure 1, Measure 2 and Measure 16 in relation to the total expenditure for the RDP 2014-2020 in EU countries



Source: ENRD

The implementation of the main activities under the individual measures in the country is significantly behind in comparison with other European countries. For example, due to the delay of competitions, training has not been supported so far. There are also no funded EIP projects of stakeholder groups, researchers, consultants, and businesses within the European Innovation Platform⁵. At the same time, many of these promising forms of knowledge sharing and innovation have already been established and are successfully operating in 15 other EU countries. With the largest number of EIP operational groups in place, are the older developed member states - Germany, the Netherlands, Italy, and Spain (Figure 24).

Figure 24. Number of EIP Operational Groups in EU countries (November 2018)



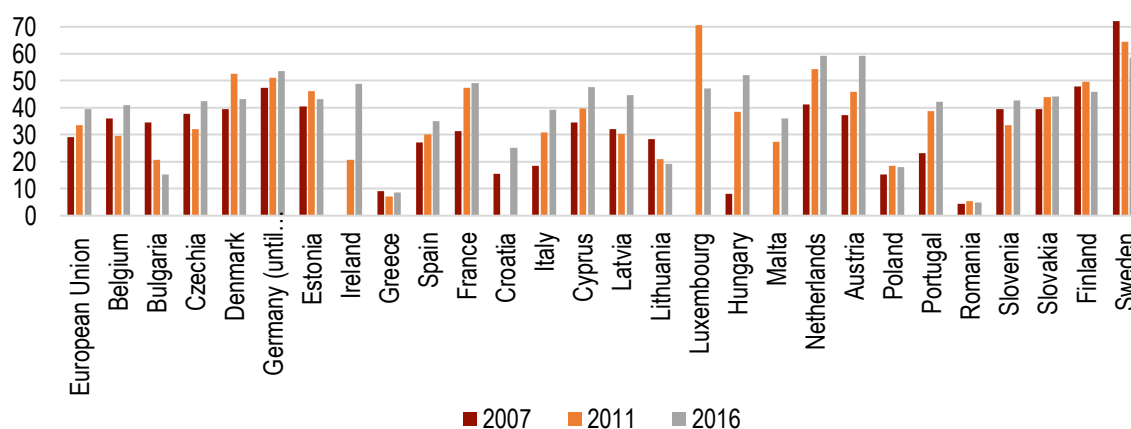
Source: DG AGRI

In Bulgaria there is no information about the total number of PhD students in the agrarian and rural sector. We can only presume that the similar trends like in Agricultural academy exist in other organizations involved in PhD training in agrarian and rural sector like public and private universities, institutes of BAS, foreign and international (like EU JRCs) organizations, etc. Nevertheless, in the country there is no any information about the number of employed in agriculture out of total completed PhD studies in the agrarian, rural and related fields. Despite the various forms of education and training offered and the considerable amount of public money spent, the participation rate in rural areas remains weak and steadily decreasing in the years after accession of the country

⁵ The first call for applications for the Sub-measure 16.1. "Support for the formation and functioning of operational groups within the EIP" under measure 16 "Cooperation" of the RDP 2014-2020 was published on 17.10.2019. There have been a good number of proposals submitted and since 2020 there are dozen selected projects for funding.

to the EU (Figure 25). This trend is the opposite of that in most EU Member States except Romania and Greece. In terms of formal and non-formal education and training in rural areas, Bulgaria is also much worse than most of the EU countries (Eurostat).

Figure 25. Participation rate in education and training in rural areas in EU (%)



Source: Eurostat

Conclusion

However, the lack of data can only partly be offset by the expert evaluations and it is, therefore, necessary to carry out further expert-based analyses, in-depth and representative studies of the individual components, factors, and efficiency as well as AKIS as a whole. It is also necessary to institutionalize and regulate the collection of official statistical, reporting, and other information on the status and efficiency of this important system. Further research will be approach in the part III of this extensive study with the fifth point of view related to the governance of the system of advice and consultations in agriculture is assessed; sixth, results of an expert assessment on the governance of AKIS in Bulgaria are presented.

Acknowledgments

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