1. Introduction

Stimulation and sharing of knowledge, innovation and digitalization is defined as one of the strategic (cross-cutting) objectives of the EU Common Agricultural Policy (CAP) during the next 2021–2027 programing period [1, 2]. Its achievement requires an effective diagnosis of the state of Agricultural Knowledge and Innovation System (AKIS), proper identification of its needs, and selection of adequate measures for public interventions [3–5]. The later can only be realized by using "new" approaches and methods of preparation and designing of the country's strategic plan, including active experts and stakeholder's involvement during all stages of the process.

The goal of this paper is to access the state, specify trends, and identify intervention needs of AKIS in Bulgaria. It only presents a new science based approach and major results of a long, multistage, multiactor, and multilevel work for assisting top level decision making of policy formation for the next programing period. In fact, this study is being used for identification of public intervention needs and measures in the 2021–2027 Program for Rural Development (PRD) [6].

STATE AND NEEDS OF AGRICULTURAL KNOWLEDGE AND INNOVATION SYSTEM IN BULGARIA

Hrabrin Bachev
Institute of Agricultural Economics
125 "Tzarigradsko shose" blvd., 1, Sofia, Bulgaria, 1113
hbachev@yahoo.com

Abstract: The goal of this paper is to access the state, specify trends, and identify intervention needs of Agricultural Knowledge and Innovation System (AKIS) in Bulgaria, and assist policy formation for the next programing period. Modern scientific approaches of SWOT, Strategic Orientation, Gap Analysis, Comparative Institutional Analysis, etc. are used to identify actors and relations, trends in development, assess Strengths, Weaknesses, Opportunities and Threats, formulate an adequate strategy, and specify overall and public intervention needs of AKIS in the country. Bulgarian AKIS demonstrates low resource endowment and efficiency, domination of outdated public institutions and undeveloped private sector, insufficient sharing of knowledge and innovations, slow and uneven application of modern technologies, varieties, production and management methods, digitalization, etc. in different types of farms, subsectors of agriculture and regions of the country. The list of specified AKIS needs is provided to the government for taking a political decision about appropriate measures for public intervention. This study demonstrates that preparation of country's RDP is (has to be) based on the comprehensive scientific approach while the research community proves that it can contribute to solving an important academic and practical problem.

Keywords: knowledge, innovation, agriculture, strategy, EU CAP, Bulgaria.

reports for AKIS state, SWOT, strategy, overall and intervention needs are publicized and broadly discussed with stakeholders as constructive suggestions timely incorporated.

3. Results

Bulgarian AKIS is composed of diverse and numerous individuals and organizations, involved in generation, sharing, dissemination and introduction of knowledge and innovations. In addition to diverse type of farmers and agricultural producers (subsistent, semi-market, market, individual, family, cooperative, corporative, etc.), this complex system includes research institutes, universities and schools, NAAS, private consultants, specialized consulting, training and innovation firms, producers organizations, suppliers of machinery, chemicals and innovations, food chains, processors and exporters of agricultural produce, government agencies, local authorities, non-governmental organizations and interests groups, media of various kind, international organizations, private individuals, etc. (**Fig. 1**).

In Bulgaria there is insufficient official (statistical, reporting, etc.) information on the status and development of this complex system, its individual components, and complex relationships of its participants, deterring its proper analysis and management.

Since 2007 R&D spending in Agricultural sciences has significantly decreased in absolute terms and as a relative share in total R&D expenditure of the country (**Fig. 2**). In recent years, the staffing of AR&D has also deteriorated due to the significant reduction in the number of R&D staff and their share in the overall R&D employed. There is also a considerable diminution of AR&D expenditures in the Gross Value Added of the sector as in 2014 it is 2.3 folds smaller than the 2007 level and slightly improving since.

The most significant AR&D sector is the Governmental accounting for over 80 % of the total R&D expenditure. The second most important sector is Private Enterprises, which share considerably varies each year (9–44 %). The third is the sector Higher Education, in which are allocated from 0.8 % to 5 % of costs in individual years.

AR&D is mainly financed by the state budget, and the later role has been increasing. At the same time, there is a fall in the share of budget appropriations for AR&D in the total budget R&D appropriations. A share of funding of AR&D from the national budget is quite fluctuating (23–13.9 %). Expenditures of business enterprises for AR&D comprise a little share of the total (0.35 % to 2.5 %) and a tiny portion (0.05–0.31 %) of the total business investments in R&D. Business investments in AR&D accounts for 7.5–20 % of R&D expenditures of involved firms confirming that high incentives and benefits induce the private sector in ARD funding and execution.
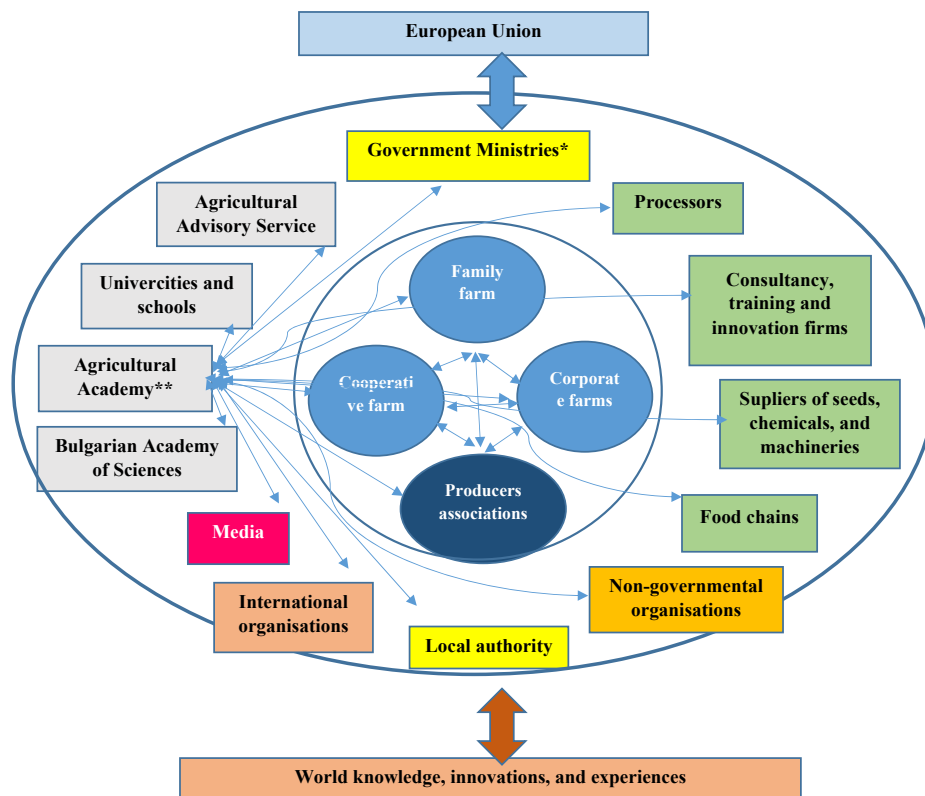
2. Materials and Methods

A methodological framework, suggested by EC [1], is applied and ameliorated through inclusion of Strategic Orientation [7], Gap Analysis [8], and Comparative Institutional Analysis [9] for better formulation of intervention needs. Initially, actors and links in Bulgarian AKIS are identified. After that the state and trends in AKIS evolution are assessed using official statistical, report, etc. data [10, 11] and evaluations of 32 experts from research institutes, universities, National Agricultural Advisory Service (NASS), and producers' organizations. Next Strengths, Weaknesses, Opportunities and Threats of AKIS are formulated using SWOT analysis [12] and participation of stakeholders' representatives. Next Strategic Orientation for AKIS development is specified by building SO matrix, determining the importance of S, W, O and T (by experts), and confronting scores of S and W with O and T. The quadrant with the highest scores indicates the principle type (Reform, Attack, etc.) of the most effective strategy for AKID development. Subsequently, an effective strategy, which let profiting from S and exploring O while overcoming W and protecting from T, is formulated. The most important needs of AKIS development for achieving the specified strategy are identified using GAP analysis. After that, most appropriate needs for public intervention are determined by applying Comparative Institutional Analysis of feasible modes of public involvement (PRD measures, R&D policies, credit and tax instruments, etc.), and potential of the market and private sector to fulfill existing needs. Preliminary

Fig. 1. Main actors and relationships in the AKIS of Bulgaria: * – Ministry of Agriculture and Food, Ministry of Education and Science, Ministry of Industry, etc.; ** – For greater clarity only relationships of the Agricultural Academy are highlighted
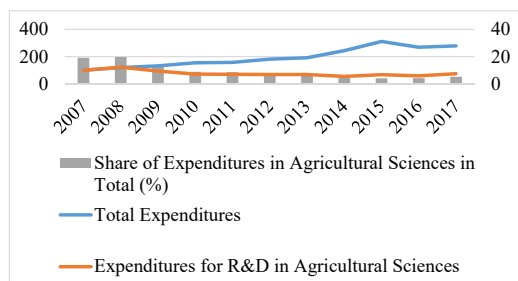

Fig. 2. Evolution of R&D expenditures Total and for Agricultural Sciences (2007=100)

Agriculture is the only sector, for which a special scientific service structure Agricultural Academy (AA) is established and publicly funded. Some of AA institutes manage significant resources, but the material and technical base of most of them is outdated, while some have no a "critical" mass of resources for modern research. AA own and external revenues vary widely and decrease in past years. Despite many "reforms", still there is no effective structure for organization of AR&D and systems for public funding, coordination and evaluation of research, evaluation and stimulation of researchers and organizations, and protection of agrarian intellectual property.

Agrarian vocational education is carried out in a large number of secondary and higher schools. Discussions for quality of education and inefficient adaptation of schools to business needs continue. A proportion of managers completed full agricultural training has increased, but almost 93 % of them are still with practical experience only.

Maintaining NAAS is a top priority for the country with all consultations free of charge to farmers. The number of con-

sultants significantly falls as a result of improving the farmers' qualification level and evolution of alternative forms of services. Subjects of consultations are evolving, with those assisting farms with PRD measures dominating. New forms of information dissemination through on-farm consultations, field offices, "farmer circles" and more are emerging. Universities, Academies, producer organizations, various private and NGOs, etc. also provide training and a wide range of advices. Part of AKIS are Local Initiative Groups, partnerships around them and the National Rural Network, but their great potential not yet been fully realized.

In Bulgaria there is a retard in the "average" technological level from the world standards. There is insufficient information among farmers on the "innovations" of Academies and universities. Most of the innovations, implemented in the country, are "imported" from abroad due to the lack of effective solutions in the local institutions.

Modernization of farms is an important area of the public support. The extent of introduction of new produc tion methods, forms of organization and marketing, precis i on technologies and process automation is low. There is a significant differentiation in application of innovations in different sub-sectors, in farms of different types and sizes, and in different regions. There is a great unrealized potential for organizational, technological and product innovations and needs for public support.

There has been a significant improvement in Internet access of households, but large regional differences prevail. The number of people, using Internet to interact with public institutions and e-commerce, is insignificant. A half of farmers are unaware of the nature of digital agriculture, and only 14 % of them use modern digital technologies.

According to the experts, some important links in AKIS are not efficient – between individual universities, universities with farmers and private companies and consultants, research institutes with farmers and private companies and consultants, NAAS with private companies and consultants, producers' associations among themselves and with private firms and consultants, between private firms and consultants, and between farmers themselves.

On the base of diagnosis of the AKIS state and trends, SWOT for AKIS is formulated (**Table 1**), and a Strategic Orientation matrix built (**Fig. 3**).

Table 1
SWOT for AKIS in Bulgaria

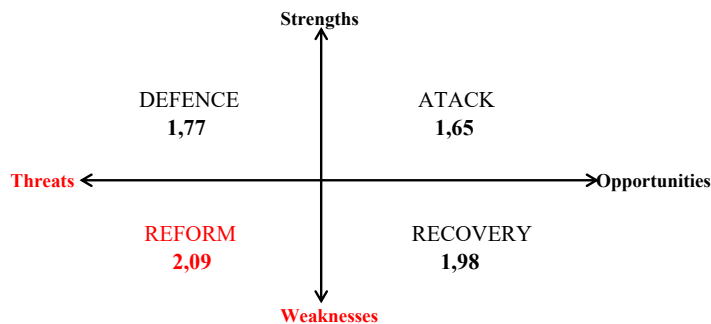| STRENGTHS	WEAKNESSES
- AKIS of the country includes diverse and well-developed scientific, university, private and professional organizations - Agriculture is the only sector, for which special service structures (AA and NAAS) are built and publicly funded - The relative share of scientists, doctors and doctors of science in AR&D is increasing - The number of recognized new varieties and hybrids of plants and animal breeds, and approved technologies is considerable - Vocational education in the field of agriculture and forestry is provided in a large number of secondary and higher schools - The number of consultations, provided to farmers, has increased and the subjects expanded - Availability of free and affordable support to farmers through NAAS - Opportunity for farmers to participate in diverse events for transfer and dissemination of knowledge and innovation - Private consultancy organizations are active in preparing business plans and projects for investment measures - There is a growing interest in implementation by producers for all types of innovations - Numerous activities taking place, related to digitization of agriculture, including Digital Innovation Hub - Significant measures, taken to digitize agricultural administration, increasing efficiency and improving services	- There is insufficient official or other reliable information on AKIS in the country - The share of the university and private (business) sectors of AR&D is negligible - Poor staffing and age structure of AR&D - Material endowment of AKIS lags behind world standards - Obsolete facilities and reduced, on the border of the "critical" mass, personnel, financial and material resources in some of the AKIS units - Low quality of education and insufficient adaptability of schools to the business needs - Most farm managers are only with practical experience and no agricultural training. - Lack of financial resources, unwillingness to take risks and insufficient training of farmers make it difficult to innovate - In many areas, a limited number of private organizations is providing consultancy - Only 5 % of producers in mountainous regions use computer programs in farm management - There is considerable variation in internet access of households in densely populated and rural areas - Much of the links in AKIS are not efficient - The degree of introduction of new production methods, forms of organization and marketing, precision farming technologies and process automation is unsatisfactory - There is considerable differentiation in the use of advice and consultations and introduction of innovations in different sub-sectors of agriculture, in farms of different legal types and sizes, and in different regions - There is insufficient information among farmers and producers' organizations on the achievements and innovations of local institutions - Few publicly supported farms introduce new technologies or product - Nearly half of farmers are unaware of the nature of digital agriculture, and only 14 % use modern digital technologies
OPPORTUNITIES	THREATS
- The role of budgetary funding for AR&D is relatively increasing - With sufficient incentives and benefits, the private sector is actively involved in AR&D - Existence of significant public support and funding for "Transfer of Knowledge", "Consultancy Services, Farm Management and Replacement Services" and "Cooperation" - Modernization of agricultural holdings is an important area of public support for Bulgarian farms. - Adopted Strategy for Agriculture and Rural Digitization, aiming to turn agriculture into a highly technological, sustainable, productive and attractive sphere - There is great potential for increasing efficiency with adequate support and modernization of AKIS - European and world AKIS offer great opportunities for rapid and efficient transfer of knowledge and innovations	- Expenditures for AR&D are significantly reduced in both absolute and relative terms - Significant reduction in AR&D expenditure in the Gross Value Added of agriculture - Share of AR&D budget expenditures in the total budget expenditures is decreasing while the share of AR&D funding from the state budget is variable - Costs of innovations are high, leading to high prices for innovative technologies and products - There is no effective organization of AR&D, and systems for public funding, coordination and assessment of activity, evaluation and stimulation of researchers and teams, and protection of intellectual agrarian property - Most innovations implemented are "imported" from abroad due to the lack of effective solutions in the local institutes and universities - Regulatory restrictions for implementing public-private partnerships between research centers and agribusiness - Bulgaria lags far behind EU in terms of entry of digital technologies in economy and society - Implementation of measure 16.1 of the RDP 2014-2020 is lagging behind, comparing to EU - Competition with global suppliers of new knowledge and innovations in the agricultural sector is increasing

Fig. 3. Strategic orientation for AKIS development in Bulgaria (Scale 0–3)

4. Discussion

The summary of experts' assessments found out that the scores in quadrant IV are the highest (**Fig.3**), which means that Weaknesses of AKIS in Bulgaria prevent from confronting the Threats of the socio-economic, market, and natural environment. This calls for selection of a general REFORM strategy. The scores in Quadrant III are close to the highest one, indicating that AKIS in the country has many Weaknesses and not able to take advantage of the existing options of the environment. That also calls for a need to launch a global RECOVERY type strategy.

Therefore, the specific strategy, suggested for AKIS development during next programing period, is: *"Improving the level and forms of agriculture through stimulating knowledge sharing, innovation and digitization"*. Following major needs and sub-needs for intervention for realization of the defined strategy are specified:

I. Collecting complete and reliable information on the state and development of the System of Sharing of Knowledge and Innovations and Digitization in agriculture

a. Collecting information on the status and development of research, consultancy and innovation, introducing activities of universities;

b. Collecting information on the status and development of research, consultancy and innovation, introducing activities of the private sector;

c. Collection of information on the digitization of agriculture and rural regions.

II. Significant modernization of the AKIS of the country

a. Significant increase in investment for R&D activity and for introduction of innovations in agriculture;

b. Support and stimulation of private investment in R&D activity and introduction of innovations in agriculture;

c. Supporting and stimulation of public-private partnerships and co-operation in financing and organizing R&D activity and introduction of innovations in agriculture;

d. Improvement of the system of registration, protection and commercialization of intellectual agricultural products (new varieties, breeds, technologies, production methods, etc.).

III. Significant expansion of the AKIS of the country

a. Sustainable growth of budgetary investments in R&D activity and introduction of innovations in agriculture;

b. Improving the incentives for retaining and attracting highly qualified staff for research and development activity in agriculture;

c. Improvement of the material and technical base, and the resource, financial and human endowment of the public scientific, educational and consulting organizations in the agricultural sphere.

IV. Improving the educational and qualification level of managers, specialists and workers in the agricultural sector

a. Encouragement and support of all forms of training and upgrading of the employees in the agricultural sector;

b. Encouragement and support for improving the educational and qualification level of managers and workers in agricultural holdings and rural residents;

c. Expanding the training and qualification of the AKIS participants in priority areas, including the organization of networks for sharing of knowledge and innovations;

d. Adapting the training system to the contemporary needs of farmers and businesses.

V. Promoting and supporting the various forms of dissemination of knowledge and innovations in agriculture

a. Encouraging and supporting joint initiatives of scientific, business, non-governmental and professional organizations, and farmers for dissemination of knowledge and innovations in agriculture;

b. Accelerating the setting up of operational groups of interested farmers, researchers, consultants and business (EIP) in agriculture to solving specific problems;

c. Free, easily accessible, tailored to the needs and diverse in forms and subjects consultations and information for agricultural producers.

VI. Overcoming the big differences in the technological level and production efficiency in different types of farms, subsectors of agriculture and regions of the country

a. Enhanced support for sharing and transfer of knowledge and digitization in lagging areas;

b. Enhanced support and incentives for the introduction of new production methods and technologies for precision agriculture, processes automating, and implementation of digital technologies, software and other innovations in perspective areas.

VII. Supporting and stimulating the digitization of agrarian management, agricultural production and rural areas

a. Expanding the use of digital technologies in the management of the sector and in the relationships with producers;

b. Expanding access to and use of computers and digital technologies in agriculture and rural areas;

c. Supporting the introduction of digital technologies in small and medium-sized agricultural producers and their organizations;

d. Supporting innovative initiatives for the creation, adaptation and introduction of digital technologies in the management and production of small and medium-sized enterprises.

The list of AKIS needs is provided to government officials for taking a political decision about appropriate measures for public intervention - direct supports from PRD, modernization of regulatory framework, reorganization and improvement of management of public agencies, public-private partnerships, etc.

Strategies development has been an important part of the university curriculum in the country [13]. However, for the first time preparation of RDP in Bulgaria is being done on the base of the comprehensive scientific approach and immediate involvement of leading academic institutions (IAE, UNWE, AU) rather than consultancy firms.

Moreover, identifications of needs of the agricultural sector has not been arbitrary (like in previous national programs), but based on a holistic scientific methodology and intensive public (stakeholder) consultations at all stages of the process. In addition to the dominating traditional framework, including diag-

nosis and SWOT [14] and standard EU guidance [1], a number of new interdisciplinary approaches have been incorporated, such as Strategic Orientation, Risk Management, GAP and Comparative Institutional Analysis.

An entirely "new" concept of AKIS [2] has been incorporated, its importance for realization of other EU CAP goals specified, and "common" development and needs identified (rather that separate analysis of individual components – research, training, consultation, information sharing, digitalization, etc. systems).

Furthermore, the identification of requirements and intervention needs has not been only an academic exercise and textbook topic [15], but also practically applied in the real process of RDP preparation in the country. Consequently, the scientific community has demonstrated that it can contribute substantially to solving an important academic and practical (policies forwarded) problem, while Government officials have "discovered" the critical role of researchers for effective decision-making.

References

1. European Commission (2018). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing rules on support for strategic plans to be drawn up by MS under the CAP. European Commission. Brussels.
2. EIP-AGRI EU SCAR (2012). Agricultural knowledge and innovation systems in transition – a reflection paper. Brussels.
3. Bachev, H. (2020). State and Evolution of Public and Private Research and Development in Bulgarian Agriculture. International Journal of Sustainable Development & World Policy, 9 (1), 10–25. doi: http://doi.org/10.18488/journal.26.2020.91.10.25
4. Bachev, H., Mihailova, M. (2019). Analysis of the State of the System of Sharing of Knowledge and Innovations in Bulgarian Agriculture. EconPapers. Available at: https://econpapers.repec.org/paper/pramprapa/94230.htm
5. Chartier, O., Doghmi, M., Fourcin, C., Broek, M., Midmore, P. (2015). Investment in Agricultural Research in Europe: Synthesis Report. IMPRESA project. EC 7th Framework Programme.
6. Yvanov, B., Popov, R., Bashev, Kh., Koteva, N., Malamova, N., Chopeva, M., Todorova, K., Nacheva, Y., Mytova, D. (2020). Analyz na săstoianyeto na selskoto stopanstvo y KhVP, YAY. Sofyia. Available at: https://www.mzh.government.bg/media/filer_public/2020/01/21/analiz_na_sstoianieto_na_selskoto_stopanstvo_i_khranitelno-vkusovata_promishlenost_izgotven_ot_institut_po_agrarna_ikonomika.pdf
7. Gellynck, X., Vermeire, B. (2008): Strategic Orientation – Step by Step, in Reinforcement of the WBC Research Capabilities for Food Quality Characterization, EC 7FP.
8. Gap analisis (2015). Wiley Encyclopedia of Management. Publisher John Wiley & Sons, Ltd.
9. Bachev, H. (2013). New Institutional Economics Framework for Assessing and Improving Agrarian Organizations. Bulletin of Taras Shevchenko National University of Kyiv-Economics, 9 (150), 5–17. doi: http://doi.org/10.17721/1728-2667.2013/150-9/1
10. National Statistical Institute. Available at: https://infostat.nsi.bg/infostat/pages/module.jsf?x_2=12&lang=bg
11. Eurostat. Available at: https://ec.europa.eu/eurostat/data/browse-statistics-by-theme
12. SWOT Analisis. Wikipedia. Available at: https://en.wikipedia.org/wiki/SWOT_analysis
13. Osnovy na stratehycheskoto upravlenye. Available at: http://st.merig.eu/index.php?id=71&L=3
14. Preparation of an Agricultural Strategy (2018). Forbes Shire Council. Available at: https://www.forbes.nsw.gov.au/f.ashx/docs/Exhibited/RFQ-Preparation-of-an-Agricultural-Strategy-February-2018.pdf
15. Minimum Guidelines for Agricultural and Livelihood Interventions in Humanitarian Settings (2010). Inter-Agency Standing Committee. Available at: https://reliefweb.int/sites/reliefweb.int/files/resources/Minimum%20Guidelines%20for%20agriculture%20and%20livelihoods%20interventions%20in%20humanitarian%20settinngs.pdf