

Agriculture knowledge and information system in Republika Srpska

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Abstract

We define Agriculture Knowledge and Information System – AKIS, as a system that connects people and organizations to promote mutual learning, generation, sharing and use of technology, knowledge and information related to agriculture. The AKIS includes institutions and organizations that create and disseminate knowledge and information to support agricultural production, marketing and post-harvest handling of agricultural products, and natural resource management. Most projects support agricultural research, advisory or educational activities, which are increasingly seen as components of an interconnected system. The system may include actors such as farmers, agricultural workers, agricultural educators, researchers, non-academic experts, public and private advisors, supply chain actors and other actors in the agricultural sector. The aim of the research in this paper was to collect data on how much the AKIS system has an impact on the development of the agricultural sector in the territory of the Republika Srpska and to determine the current situation regarding the use of knowledge and information in agriculture. The methods used in the research are: content analysis method, analytical-synthetic method, description method, and survey method. The research identified a weak connection between the participants in the chain, especially between scientific institutions (universities and institutes) and organizations of agricultural producers, weak capacitation of the advisory service, and a low level of application of modern technologies, especially related to digitization and automation of processes. On the other hand, the respondents confirmed the importance of the application of knowledge and innovations for improving the competitiveness of agricultural production, strengthening the market orientation of agricultural farms and attracting young people to engage in agriculture. The improvement of functional links between the links in the system of knowledge and information in agriculture could contribute to overcoming structural limitations in the development of the agricultural sector of Republika Srpska.

Key words: system, knowledge, information, innovation, agriculture

INTRODUCTION

According to Rolling and Engel (1991) AKIS is a set of agricultural organizations and/or persons, and the connections and interactions between them, engaged in processes such as generation, transformation, transmission, retrieval, storage, integration, diffusion and the use of knowledge and information in order to work synergistically to support decision-making, problem-solving and innovation in the agriculture of a given country or its domain. The system includes farmers, specialists in agricultural education, researchers and consultants - for the establishment of comprehensive knowledge and information from various sources for more successful agriculture and improvement of living conditions (FAO and World Bank, 2000). Looking at knowledge in agriculture as a system, the AKIS model indicates to the effectiveness of participants in agriculture. Policymakers are beginning to recognize the importance of knowledge among farmers, whereby the expertise of farmers becomes one of the development priorities. AKIS analyses who and what types of knowledge and information contribute to decision-making in agriculture and what are the relationships between the various actors in this system. To be able to manage

AKIS in a way that contributes as much as possible to the creation, dissemination, use of transformation, storage and retrieval of knowledge and information that is useful for the development of agriculture, it is useful to study this system. The basic assumption in the study of AKIS is that information relevant for decision-making is generated by different actors and reaches farmers in many different ways. Often, in order to solve a problem, research findings from different disciplines generated by researchers at different institutions must be combined. Following the AKIS literature, research continues to be the main driver of innovation. Researchers, as the first of the three basic actors in AKIS, have the task of investigating and researching existing problems and bringing new theories and knowledge by solving some of the problems or new scientific knowledge (Nagel, 1980). The development of new agricultural technologies usually requires close cooperation between researchers, advisors and farmers. Extension services and research institutes should develop technical knowledge that farmers apply on farms. Agricultural consultants help farmers develop technical and organizational skills, management skills and practices to improve their living conditions. Essential researchers are not the only ones who generate information, very important information is generated by farmers. Farmers get information on their farm, using their resources and abilities, as well as their willingness to bear risks on the quality of their land (farm). They usually do not get information from other farmers, who have tried and modified innovations, who make their experiments and develop new farming systems and which have been collected over generations. Innovations are considered a key factor in the growth and development of companies and are the main driving force in every company, including in agriculture. Every enterprise (farming in agriculture) must introduce innovations if it wants to operate profitably and achieve success in its enterprise (property).

Agricultural extension service has a key role in connecting food and agricultural innovation models. The role of agricultural extension services goes far beyond technical and production functions, and includes the entire social and cultural life. Agricultural consultancy is, simply put, working with others (GFRAS, 2012). The education system often has strong links with the agricultural information system. Openness to innovation within the educational system is a key factor that allows actors to understand and transform knowledge and thus build projects (EUSCAR, 2012). In terms of the application of knowledge, developed countries are far ahead of others, because it is about organized actions of the state and the private sector to expand the use of modern technologies in agribusiness (Ristic, 2018). The goal of the research in this paper was to collect data on how much the knowledge and information transfer system has an impact on the development of the agricultural sector.

The subject of the research is related to the system of knowledge and information in the agricultural sector of Republika Srpska (RS), because the analysis of the actors of the system, the analysis of the indicators of the development of the system and the analysis of the links between the actors refer to Republika Srpska. Republika Srpska is one of the entities in Bosnia and Hercegovina with competences over agriculture policy development and implementation.

MATERIAL AND METHODS

The following scientific methods were used during the research:

- Method of content analysis - this method was used to analyse the results of previous research, collect data from secondary sources and analyse professional literature. In this context, a review of literature sources related to the definition of the term knowledge and information system in agriculture was carried out.
- Description method - the process of describing the facts that was applied in the presentation of the research results, in which the facts related to the set of qualitative and quantitative indicators that were selected for the analysis of the knowledge and information system in agriculture in the territory of Republika Srpska are presented.
- Analytical-synthetic method - with this method, conclusions are reached by proceeding from the general to the individual (analysis) and vice versa, from the individual to the general (synthesis). This method was applied in the part of the paper that refers to the discussion of the research results, in which the results are connected with the set hypotheses and the conclusions drawn.
- Survey method - a process that included a survey sample of 30 experts (experts) and 20 representatives of producers association.

The analysis of primary data was obtained by the questionnaire method of a selected group of 30 experts from various institutions in the research, educational and advisory sectors as well as 20 representatives of umbrella producer organizations in dairy, poultry, fruit, vegetable and crop sector. The research was conducted during 2022. Primary data related to the following set of indicators were analysed: the level and efficiency of public expenditures, the importance of individual participants in AKIS, the financial, human and technical resources of AKIS, the effectiveness of cooperation between stakeholders in AKIS, the extent of the use of advice and the introduction of innovations in sector, factors and prospects for improving the spread of knowledge and innovation. At the end, the research results were presented graphically and processed using basic statistical indicators.

RESULTS AND DISCUSSION

Agriculture in Republika Srpska occupies an important place in its economic structure. The share of agriculture in the gross domestic product is 8.9% (Institute of Statistics, 2022). Although it formally employs only 3,000 workers, informal, i.e. permanent or occasional, employment in agriculture is much higher. At the end of 2020, 41,412 agricultural farms were registered in the Farm registry, of which 752 were legal entities, and the remaining 40,660 were family farms. In principle, behind each of those 40 thousand family farms stands at least one person who is an agricultural producer, that is, a food producer (MOFTER, 2023). The 2013 population census showed that there were slightly more than 140,000 (more precisely, 140,960) such farms in the RS. Rural areas occupy about 95% of the territory of Republika Srpska and about 83% of its population (MAFWM, 2021). According to information from the European Commission's annual report on BiH's progress in the process of stabilization and association, it is stated that Bosnia and Herzegovina is in the early stages of preparations in the field of agriculture and rural development (European Commission, 2022). The number of PhDs in the field of agricultural sciences is modest and ranges from 2 to 4 per year. In Republika Srpska, 3.71% of the total number of students study agriculture, with a decreasing number of students. Researchers have problems accessing sources of new knowledge (subscriptions to scientific databases, reference scientific journals, etc.). The scientific productivity of researchers is weak (registration of patents, publication of books, publication of papers in indexed scientific journals, participation in international scientific conferences), but it is often correlated with limited financial resources. Scientific research and its application today largely rely on the application of IT technology, but the level of information literacy, especially among the rural population, is low (Vaško, 2022). The share of expenditure on research and development in total GDP in Republika Srpska was 0.20% and in the period from 2009 to 2021 reached the highest share in 2013 with the level of 0.56% (Institute of Statistics, 2022). In comparison with EU, where the level of research and development expenditure relative to GDP was 2.27% in 2021 (EUROSTAT, 2022), Republika Srpska is far from reaching this level.

The respondents confirmed the weak level of cooperation that exists between the links in the AKIS (Figure 1), especially between scientific institutions (universities and institutes) and producers organizations, and on the other hand, they confirmed the importance of the application of knowledge and innovations for improving the competitiveness of agricultural production, strengthening the market orientation of agricultural holdings and attracting young people to engage in agriculture.

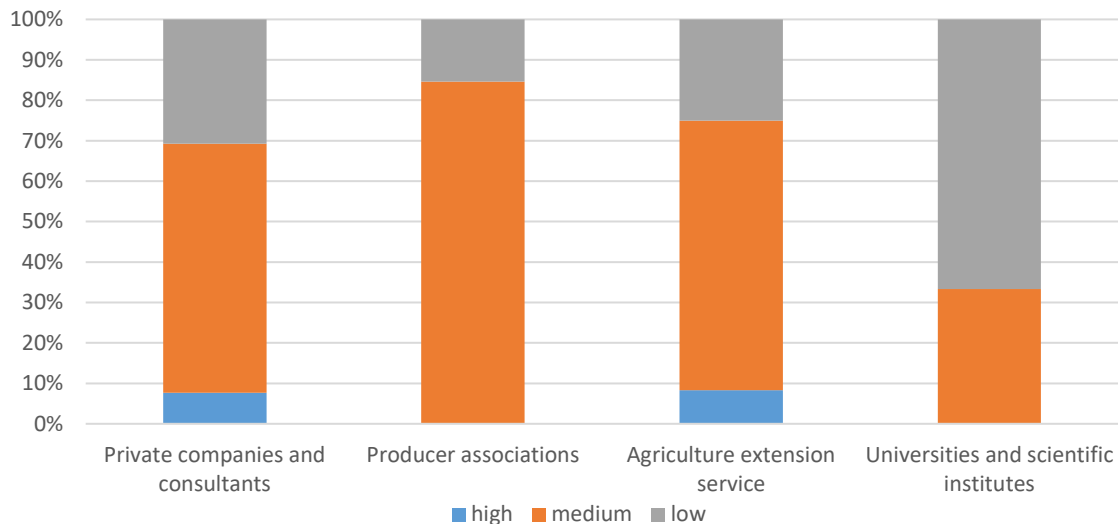


Figure 1. The level of cooperation between the association of farmers and other links in AKIS

The lack of a higher level of allocation of public funds for these purposes may also be one of the reasons for the weak cooperation between the links in AKIS (Figure 2). Universities and institutes are primarily oriented towards European funds, in the absence of domestic funds, which results in abandoning research of local importance and seeking solutions for global problems and priorities defined at the level of the European Research Area (ERA).

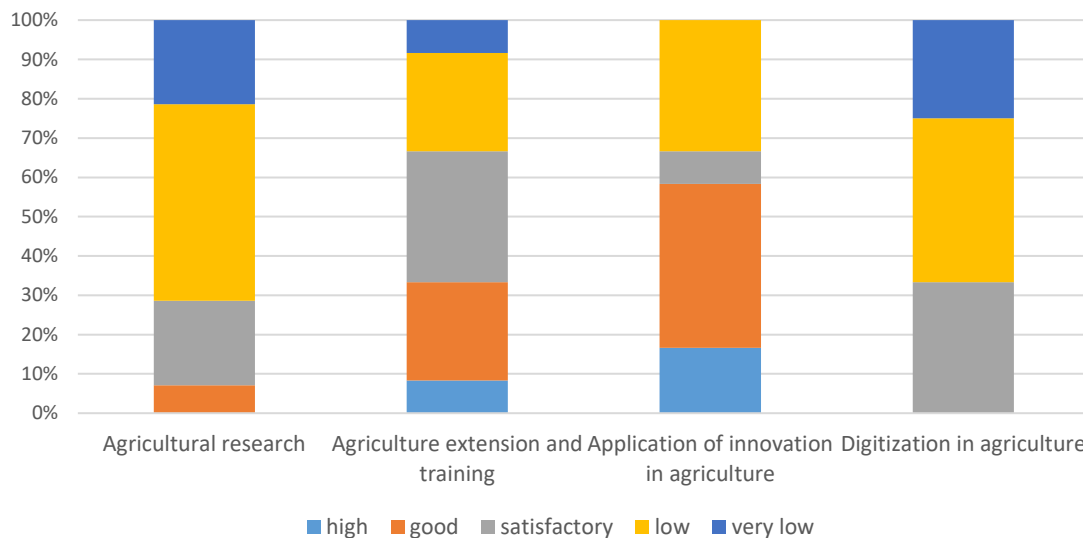


Figure 2. The level of public spending and investment in agriculture research, extension, innovation and digitalisation

The other authors also reached similar results in many countries of the European and non-European continents. Thus, Ristić (2018) in his research on knowledge as a prerequisite for technological modernization and development of agribusiness in Serbia, notes that small farms very rarely use the most modern technologies, due to the lack of their own financial resources, the disadvantage of loans intended for agriculture and insufficient subsidies from the state. Also, Bachev (2022) in his research on the management of the system of knowledge and innovation in agriculture in Bulgaria concludes that AKIS shows low resource capacity and efficiency, dominance of outdated public institutions and underdeveloped private sector, insufficient exchange of knowledge and innovation, slow and uneven application of modern technology, varieties, methods of production and management, digitization, etc. on different types of farms, sub-sectors of agriculture and regions of the country. Adolwa et al. (2017)

conclude that a well-connected knowledge network in terms of organizations engaged in research and dissemination of knowledge and innovation is crucial not only for the diffusion but also for the learning of complex innovations, and that the integration of formal and informal agricultural knowledge systems can be enhanced by fostering functions of informal and formal mediators in the spread of innovations. Kabirigi et al. (2022) emphasize the importance of social ties and conclude that they play an important role in knowledge dissemination, and farmers use their personal networks to improve their ability to adapt to market, climate and other shocks.

Strengthening research and improving the exchange of knowledge between the scientific community and the business sector is the goal of AKIS in the field of research. The research confirmed the weak capacity of the advisory service in terms of the ratio of the number of employees to the number of agricultural holdings, the weak development of private advisory services, and the weak level of application of modern technologies, especially related to digitization and automation of processes, which points to a lack of adequate knowledge transfer methods in that area. On average, one advisor serves 652 active farms and 3,725 ha in Republika Srpska. If all registered farms are taken into account, and not only those that are active users of incentives, then their relationship to the number of advisers is even more unfavourable, 1,250 farms to one adviser and 5,894 ha of agricultural land. Of methodological procedures, more or less clearly defined individual or group work methods are applied. Private agricultural advisory services have not taken root in the RS as formally organized and institutionalized services. Their activities are reduced to the private services of agricultural engineers who work without a license (because they are not required by law), who are self-employed or employees of trading companies. Private service providers work as commercial consultants, i.e. they are only available to agricultural enterprises and larger farms willing to pay for their services, either directly or through the purchase of inputs or equipment (Vaško, 2022).

Rijswijk et al. (2019) in their research on the digitization of AKIS in New Zealand also state that it is taking place in an ad-hoc approach since digital agriculture is in the early stages of development. This indicates that the agricultural knowledge and innovation system should better support advisors in understanding digitization in agriculture and developing a digitization strategy, anticipating possible futures and thinking about the consequences of this on business models and the organization of extension services. Zahran et al. (2020) in research on the functionality of AKIS conclude that legal and regulatory frameworks, lack of infrastructure and the weak role of intermediary organizations are the main obstacles that AKIS faces. Contracting and public-private partnership links were seen as the main interactions needed to strengthen AKIS. The analysis also explores the availability of innovation requirements of each actor, as well as distribution technologies, which should be encouraged to build the capacity of the agricultural sector.

The research confirmed that the level of application of innovations is different in various sectors. In sectors that are more intensive and with a larger number of big size farms and legal entities, the level of application of innovations is good or satisfactory, and this is the case with the poultry and dairy sectors. Also in these sectors, a high level of automation of the work process is noticeable, which is a direct response to the problem of labour shortage. In other sectors, apart from the application of advice and innovations in production, there is no application of automation, digitization, precision agriculture, etc. Especially in this respect, the crop production sector lags behind, but unfortunately also more profitable sectors such as the fruit and vegetable sector. This confirms the dominance of small farms in the structure of farms at the level of Republika Srpska, which, due to the small volume of production, cannot achieve a threshold of productivity and economy sufficient to invest in process of automation and the application of new technologies, but are still facing the problem of low marketability and productivity.

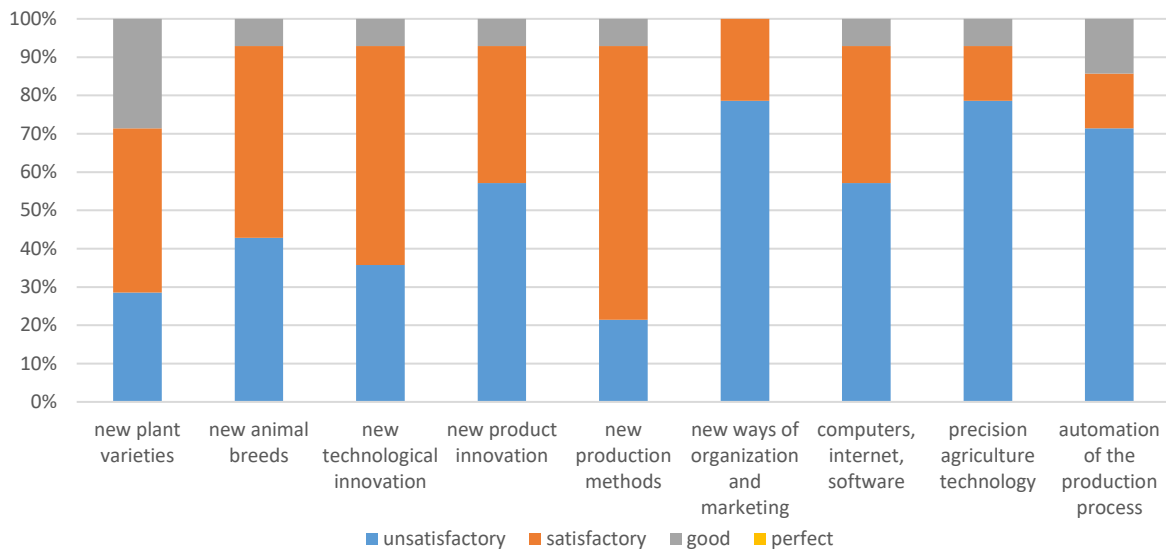


Figure 3: The extent of the introduction of various innovations by agricultural producers in Republika Srpska

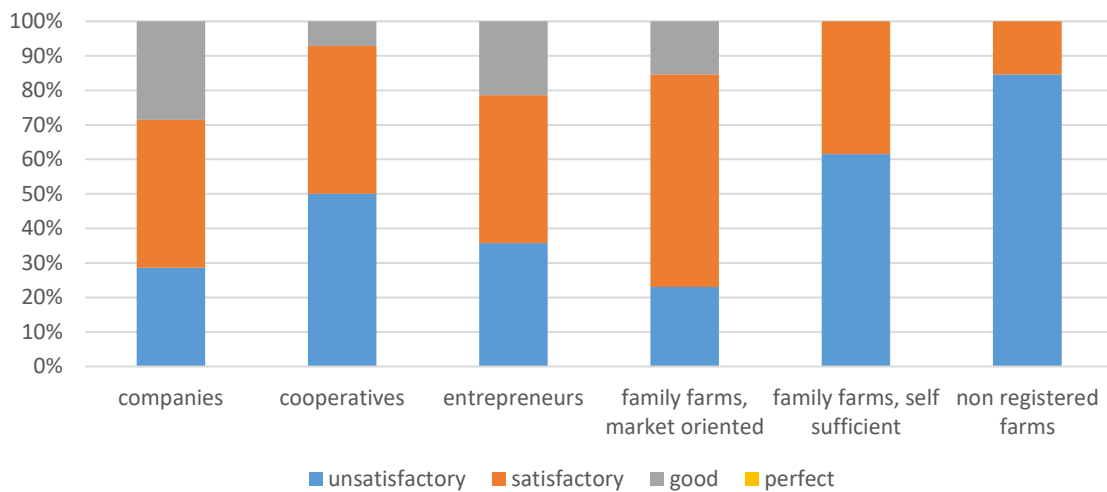


Figure 4. The extent of the introduction of various innovations by agricultural producers in Republika Srpska by the type of the registered farm

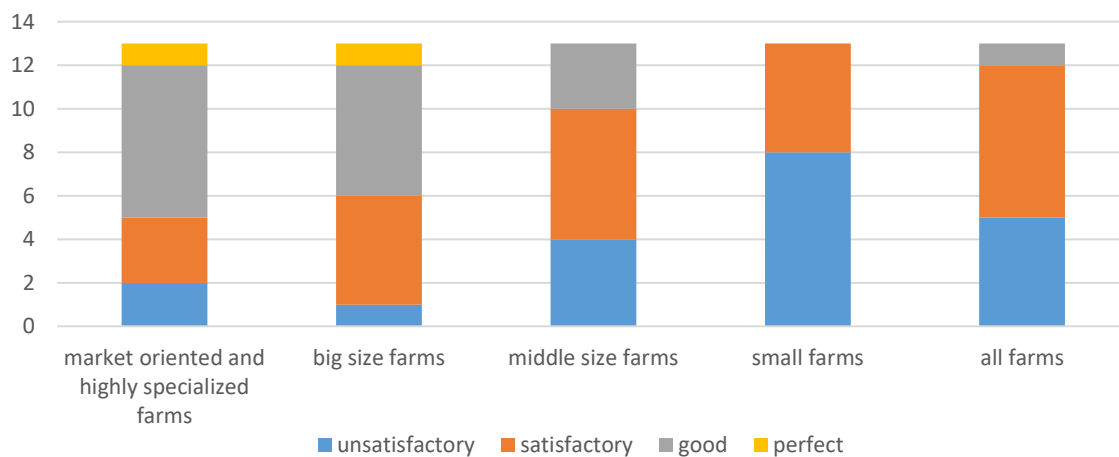


Figure 5. The extent of the introduction of various innovations by agricultural producers in Republika Srpska by the size of the farm

Pascucci and de-Magistris (2011) in their research on the effects of the application of the regional approach in the organization of AKIS on the development strategies of the agricultural sector in Italy indicate the need to adapt strategic measures in the field of agricultural consultancy and agricultural development in general according to the local circumstances of the given area and in that context to support interaction between farmers, rural actors and local networks. Zahran et al. (2020) believe that innovation systems rely on management, and a need for a coordination unit in charge of AKIS. This unit could improve policy coordination, which concerns the determination of priorities, the development of a clear, consistent and agreed set of policies and the implementation of these policies in practice. On the other hand, Potters et al. (2022) emphasize the importance of innovative approaches such as the approach that is currently receiving a lot of attention from policy and investment in the EU called "Living labs" that bring together public and private stakeholders to jointly create, validate and test new services, business ideas, markets and technologies. Also "the Multi-Actor Approach" developed under the HORIZON 2020 program of the European Union is recommended as an approach that aims to make innovation more demand-driven to increase the impact of research. Vaško (2020) also states that the opportunity for the agricultural sector is EU pre-accession funds, as better use of other EU programs to support research and development activities (HORIZON, Life, ERASMUS+) and SMEs (COSME, Innovation Fund, etc.). In addition, there are many bilateral programs of developed countries that provide assistance to BiH through a combination of different interventions, with the expectation that their interest in being present in BiH will not disappear.

CONCLUSION

The research resulted in the conclusion that in Republika Srpska there are all the links, that is, institutions and organizations, that make up the system of knowledge and information in agriculture: research, education, consultancy, and production. However, the research confirmed at the same time the low level of inter-connectivity of the links in the system, and partly the low capacity of certain parts of the system. The research also includes an analysis of the degree of application of knowledge and innovation in the agricultural sector, in various production branches. The research results confirmed the different levels of application of new knowledge and technologies in certain sectors, as well as the different levels of application of digital solutions and automation of work processes. The technologies that represent the concept of "smart agriculture" are least applied in the production sectors, and the following are identified as the causes of that situation: fragmentation of production, dominance of small, non-commercial farms, structure of production and weak capacity of the advisory service. The improvement of functional links between stakeholders in the system of knowledge and information in agriculture could contribute to overcoming structural limitations in the development of the agricultural sector of Republika Srpska, and by investing in knowledge and the application of knowledge in production, contribute to the improvement of productivity and the competitiveness of the sector as a whole. The main challenge of AKIS is to face the future changes that European agriculture requires, is in three specific issues. First, it becomes necessary to implement institutional coordination that engages both public/private institutions and research structures within a joint strategic agenda that deals with priorities and approaches and verifies the necessary financial resources with a short- and med-term perspective. Secondly, it is necessary to analyse the demand and assess the impact of certain professional services provided and, thirdly, a stronger investment in human resources is needed. It is important that public initiatives become more connected to a more structured system of monitoring and evaluation, and that researchers and technicians use more effectively a system of 'continuous training' especially when it comes to choosing the right working methods that meet the needs of farmers.

REFERENCES

Adolwa, I.S., Schwarze, S., Bellwood-Howard, I., Schareika, N., & Buerkert, A. (2017). A comparative analysis of agricultural knowledge and innovation systems in Kenya and Ghana: sustainable agricultural intensification in the rural–urban interface. *Agriculture and Human Values*, 34, 453-472. DOI: <https://doi.org/10.1007/s10460-016-9725-0>

- Bachev, H. (2022). Governance of agricultural knowledge and innovation system (AKIS) in Bulgaria, Munich Personal RePEc Archive, Paper No. 112253. Online at <https://mpra.ub.uni-muenchen.de/112253/>
- European Commission (2022): Bosnia and Herzegovina 2022 Report, Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 2022 Communication on EU Enlargement policy, https://neighbourhood-enlargement.ec.europa.eu/bosnia-and-herzegovina-report-2022_en
- EUROSTAT (2022). Gross Domestic Expenditures on Research and Development, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R%26D_expenditure&oldid=551418
- FAO&World Bank (2000): Agricultural Knowledge and Information Systems for Rural Development - Strategic Vision and Guiding Principles. FAO/World Bank, Rome.
- GFRAS (Global Forum for Rural Advisory Services) (2012): Building knowledge systems in agriculture: Five key areas for mobilising the potential of extension and advisory services, Position Paper.
- Kabirigi, M., Abbasiharofteh, M., Sun, Z., & Hermans, F. (2022): The importance of proximity dimensions in agricultural knowledge and innovation systems: The case of banana disease management in Rwanda. *Agricultural Systems*, 202, DOI: <https://doi.org/10.1016/j.agsy.2022.103465>.
- Nagel, U.J. (1980). Institutionalization of knowledge flows, An analysis of the extension role of two agricultural universities in India. *Quarterly Journal of International Agriculture* (Special Issue), DLG-Verlag.
- Pascucci, S., & de-Magistris, T. (2011). The effects of changing regional Agricultural Knowledge and Innovation System on Italian farmers' strategies. *Agricultural Systems*, 104(9), 746-754.
- Potters., J, Collins, K., Schoorlemmer, H., Stræte, E. P., Kilis, E., Laneand, A., & Leloup H. (2022). Living labs as an approach to strengthen agricultural knowledge and innovation systems. Euro Choices published by John Wiley & Sons Ltd on behalf of Agricultural Economics Society and European Association of Agricultural Economists.
- Rijswijk, K., Klerkx, L., & Turner, J.A. (2019). Digitalisation in the New Zealand agricultural knowledge and innovation system: Initial understandings and emerging organisational responses to digital agriculture. *NJAS - Wageningen Journal of Life Sciences*, 90-91. DOI: <https://doi.org/10.1016/j.njas.2019.100313>.
- Ristic, L. (2018). Znanje kao preduslov tehnološkog osavremenjavanja i razvoja agrobiznisa u Republici Srbiji, Implikacije ekonomije znanja za razvojne procese u Republici Srbiji. Zbornik radova, Univerzitet u Kragujevcu, Ekonomski fakultet, str. 135-151
- Rolling, N.G., & Engel, P. (1991). The development of the concept of agricultural knowledge and information system (AKIS): Implications for extension, in W.M. Rivera and D.J. Gustafson, *Agricultural extension: Worldwide institutional evolution and forces for change*, Elsevier, 125-139.
- Institute of Statistics (2022). Indicators of sustainable development of the Republic of Srpska, Statistical Bulletin, December, 2022. https://www.rzs.rs.ba/front/article/5731/?left_mi=291&add=291
- Institute of Statistics, (2022). National Accounts, Statistical Bulletin, 2022, https://www.rzs.rs.ba/front/article/5692/?left_mi=22&up_mi=12&add=22
- Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina (2023): Strategic plan for rural development of Bosnia and Herzegovina for the period from 2023 to 2027. framework document, http://www.mvteo.gov.ba/data/Home/Dokumenti/Poljoprivreda/BOS_SPRR_2018-2021_-_korekcija.pdf
- Vaško, Ž. (2022). Agricultural Knowledge and Innovation Systems (AKIS) in the Republic of Srpska, BiH National Report and Proposed Draft Action Plan, <https://seerural.org/wp-content/uploads/2022/10/AKIS-report-Republic-of-Srpska-BiH.pdf>
- Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska (2021). Strategy for the development of agriculture and rural areas of the Republic of Srpska 2021-2027. <https://vladars.rs/sr-SP-Cyrl/Vlada/Ministarstva/mps/Documents/strategija%202021%202027.pdf>
- Zahran, Y., Kassem, H.S., Naba, S.M., & Alotaibi, B.A. (2020). Shifting from fragmentation to integration: A proposed framework for strengthening agricultural knowledge and innovation system in Egypt. *Sustainability*, 12(12), 5131. DOI: <https://doi.org/10.3390/su12125131>