SMARTLABOR

Strengthening Alliances for Policy Development and Testing in the domain of Innovation, Digitalization, and the Labour Market in the Western Balkans

National Report Serbia: What Skill Small Farmers Need and What They Get

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Editors
Branka Anđelković
Tanja Jakobi

Authors
Bojan Teofilović

Design
Sonja Lundin

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1. SUMMARY

Serbia's smallholder farming sector, while forming the backbone of rural livelihoods, faces significant structural and digital divides. The urgency for digital transformation has grown in the wake of climate-induced crop volatility and global supply chain disruptions, placing digital agriculture at the center of policy strategies aimed at climate resilience, food security, and EU market convergence. However, despite policy momentum—embodied in Serbia's Smart Specialisation Strategy and the EU's Growth Plan for the Western Balkans—the majority of Serbia's small farms remain digitally marginalized.

This report finds that digital tool usage among small farmers is largely limited to basic communication platforms like Viber and Facebook, while adoption of advanced tools such as precision farming, or online farm management systems remains negligible. Key barriers include limited digital literacy, inadequate training infrastructure, outdated educational curricula, and financial constraints.

The report identifies five interconnected pillars that shape digital knowledge transfer: the entrepreneurial sector, investment and capital providers, education and research institutions, corporate sector actors, and public institutions. However, coordination across these pillars remains fragmented. Focus group insights emphasize the need for localized, farmer-friendly, and continuous support systems. Accordingly, the training must be hands-on, visual, and timed around agricultural calendars. The importance of trust, community-based mentorship, and targeted outreach has been also highlighted.

Vocational education and training (VET) and life-long learning play a critical role but remain disconnected from real-world digital needs. Meanwhile, digital infrastructure gaps persist, particularly in remote regions, restricting access to online platforms and real-time data. Financial products for digital adoption are either inaccessible or poorly tailored to smallholders' risk profiles and cash flows.

To address these challenges, the report recommends a comprehensive strategy combining practical digital literacy training, institutional capacity building, inclusive financing mechanisms, and collaborative innovation. Agricultural advisors and VET educators must be upskilled; peer mentorship networks should be formalized; and digital solutions must be co-designed with end-users. Public-private partnerships and regional cooperation are essential to scale these interventions and foster a more equitable digital future.

Ultimately, the success of Serbia's digital agriculture transition hinges on closing the gap between supply and demand for digital skills. This will require coordinated investment across education, finance, policy, and grassroots support—anchored in the lived realities of small farmers. By aligning technical innovation with human-centered design, Serbia can ensure its agricultural transformation is inclusive, sustainable, and resilient for generations to come.

2. INTRODUCTION

Recent developments in EU candidate countries have emphasized the strategic role of digital transformation in agriculture not just as an economic imperative but also as a mechanism for climate resilience, rural inclusion, and food sovereignty. In Serbia, this conversation has gained further urgency in the aftermath of climate-induced yield fluctuations in 2024 and disruptions to global food supply chains. The convergence of digital innovation with agro-ecological practices is no longer a policy option—it is increasingly seen as a structural necessity for long-term sectoral stability.

Despite its strategic importance for the economy of Serbia, the agricultural sector continues to face persistent barriers. The average share of the agriculture sector in GDP was 6.21 % in the 2001 – 2023 period. However, of the average GDP growth rate of 3.2 % in the same period, the agricultural sector contributed only 0.11 percentage points (Institute of Economic Sciences, 2025). Structural challenges play an important role: the dominance of small-scale, family-run farms—over 99% of all agricultural holdings, with an average size of just 6.4 hectares (Agricultural Census, 2023)—means that the majority of Serbian producers operate with limited capital, outdated equipment, and minimal institutional support. These constraints are exacerbated by demographic trends, with most farm owners being over the age of 60 and possessing low levels of formal education (Agriculture Census, 2023).

At the policy level, Serbia's Smart Specialisation Strategy (2020–2027) serves as the central framework for advancing innovation and structural transformation across key sectors, with agriculture clearly identified as a strategic priority. The strategy emphasizes aligning national strengths with global market trends by promoting digitalisation, sustainability, and knowledge transfer. Within this framework, agriculture is not only seen as a traditional sector, but as a future-facing domain where digital tools can enhance productivity, environmental stewardship, and rural vitality.

In parallel, the European Commission's Growth Plan for the Western Balkans (2024) brings new momentum to this transformation. By offering closer access to EU programs and funding mechanisms, the Plan aims to accelerate convergence with the EU single market and support reforms in critical sectors—including agriculture. For Serbia, this means that digitalization of small farms and alignment with sustainability goals will likely gain additional financial and technical support. The Plan emphasizes regional integration, innovation transfer, and enhanced access to EU value chains—creating both opportunities and pressures for the domestic agri-food system to adapt. Leveraging this opportunity will require synchronized action among national institutions, local actors, and international partners.

While digital agriculture—encompassing tools such as precision farming, sensor-based monitoring, and remote advisory services—has advanced significantly in many EU member states, Serbia continues to lag in both uptake and practical application. Across Europe, digital technologies are increasingly integrated into mainstream agricultural practices, supported by targeted funding, research, and infrastructure. In contrast, Serbia faces persistent challenges: tools are often perceived as costly, interfaces are not localized, and support systems are underdeveloped particularly among small farm holders. The gap is further widened by rural-urban infrastructure disparities and the absence of strategic incentives for digital adoption. These structural differences highlight the need for Serbia to align its agricultural digitalization agenda more closely with EU best practices, ensuring that innovation reaches all producers—not just those with existing capacity or resources.

This report does not revisit these structural challenges in depth. Rather, it focuses on a less explored dimension: the mismatch between the digital skills smallholders actually need and the kinds of training and support currently available to them. By examining how skills provision aligns (or fails to align) with real-world needs, the report aims to inform better-targeted interventions that promote inclusive agricultural transformation.

3. TECHNOLOGY ADOPTION AMONG SMALL FARM HOLDERS

As recent research show, technology adoption among smallholders in Serbia remains concentrated in basic, low-cost digital tools that are accessible without formal training. To better understand the digital behavior and capacity gaps of smallholders, this section is organized by specific skill domains.

1. Basic Digital Tools

Most smallholders know how to use smartphones for calls and basic browsing, but struggle with more complex interactions such as installing or updating apps, creating strong passwords, or detecting online scams. Limited comfort with digital devices restricts their ability to explore more advanced solutions (Ilić-Kosanović et al., 2019; Čikić & Petrović, 2022). Furthermore, these skills are rarely covered in agricultural training, and older farmers often rely on family members to handle digital interactions (Andjelkovic et al., 2025). This reliance creates a vulnerability in farm management and limits independence in navigating e-governance platforms.

2. Digital Communication

Viber and Facebook Messenger are widely used for informal communication among farmers and with buyers (Dasić et al., 2022). However, few farmers use email, voice memos, or virtual forums to exchange knowledge or access advisory services. This limits their exposure to broader knowledge networks. Farmers who do engage in regional or thematic WhatsApp groups report greater access to peer learning, real-time updates on market trends (Andjelkovic at al., 2025).

3. E-commerce and Online Marketing

Some farmers use Facebook groups to sell products, but few leverage structured digital marketing or online marketplaces. Digital branding (e.g., product photos, descriptions, payment integration) is an emerging skill, particularly for younger producers aiming to scale direct sales (Dasić et al., 2022). Popularity of the Small food producers platform suggest that platforms offering simplified sales interfaces would significantly boost adoption if coupled with training.

4. Farm Management Tools and Precision Agriculture

Tools for recording inputs, yields, or managing finances are rarely used (Dimitrijević, 2023). While platforms like AgroSens exist and are free, few farmers take advantage due to unfamiliarity or perceived complexity. Precision agriculture like smart watering and technologies like drone or satellite imagery are underutilized in Serbia (Vapa Tankosić et al., 2024). Even among more innovative farmers, barriers such as lack of tailored support, absence of localized tutorials, and limited internet connectivity in the field deter adoption.

5. Using Digital Learning Platforms

While a few farmers occasionally watch YouTube tutorials or participate in WhatsApp groups, structured engagement with online training, webinars or advisory apps is rare. The absence of local-language, farmer-centric content further limits participation (Andjelkovic et al.,2025). More interactive formats—like on-demand video content or hybrid training models delivered through mobile-friendly apps—could bridge the current gap in digital education.

6. Digital infrastructure

Digital infrastructure disparities represent a critical barrier to the equitable adoption of agricultural technologies across Serbia. While urban and peri-urban regions often benefit from stable broadband access and mobile coverage, many rural and remote areas continue

to face significant connectivity challenges. According to national ICT indicators, internet penetration in rural households still lags behind the national average, limiting access to real-time data, cloud-based applications, and e-government services (Statistical Office of Serbia, 2024). This digital divide is further exacerbated by the uneven rollout of fiber-optic networks and mobile base stations, leaving some farming communities with only intermittent or low-speed connectivity.

In summary, most smallholders use digital tools for social or passive purposes. Active, strategic digital engagement remains limited due to skills gaps, cost barriers, and inadequate support ecosystems. A successful strategy for digital inclusion must address not only infrastructure and tools but also trust, and community-led learning models. Building farmer capacity across these domains is essential for unlocking the potential of digital agriculture in Serbia.

4. METHODOLOGY

The methodology is structured around three key components: desk research, focus groups, and a mapping exercise of national stakeholders. Each component plays a specific role in capturing the complex factors that affect small farmers' adoption of digital technologies and sustainable practices.

Desk research

The first phase of this study, completed in August 2024, involved an extensive review of secondary data sources, including reports, studies, and relevant literature. This foundational phase enabled the identification of challenges facing small farmers in Serbia, particularly related to digital skills, technology access, and potential pathways for sustainability improvements. By analysing these sources, the desk research highlighted gaps in current digital adoption practices and identified critical skills needed among small farm holders.

Stakeholder mapping of key actors in smart agriculture

The stakeholder mapping exercise, carried out from July to October 2024, identified five key pillars essential for vertical and horizontal knowledge transfer in digital and sustainable farming.[1] The entrepreneurial sector drives innovation through start-ups and intermediaries developing smart agricultural solutions, while investment and capital providers such as VC funds and banks support scaling through financial resources. Educational and research institutions, including vocational schools, faculties, and think tanks play a crucial role in structured skills provision and applied research. The corporate sector - agribusiness firms and technology providers- bridges market-driven innovations with industry training and partnerships. Lastly, government institutions, such as ministries and regulatory bodies, shape policies, offer financial incentives, and facilitate advisory services for farmers. This integrated five-pillar framework ensures a comprehensive knowledge transfer system, linking policy, education, finance, and market innovation to equip small farmers with essential digital and sustainability skills.

[1] https://smartlabor.repeople.rs/serbia/

Focus groups

Two focus groups were conducted in September 2024 to gather qualitative insights from key stakeholders. The first focus group included eight participants from the Smart Agriculture Council of the Serbian Chamber of Commerce, who provided expert perspectives on the state of digital agriculture in Serbia, potential advancements, and the role of policy in facilitating digital transformation among small farm holders. The second focus group, consisting of seven representatives from the Serbian Agricultural Advisory and Professional Services (AAPS), explored the practical challenges faced by small farmers, their digital literacy levels, and the specific barriers to adopting new technologies.

Research Questions

The following research questions guided the study:

1) Which educational programs are available to small farm holders to adopt digital solutions?

2) What skills do farmers and small producers need to effectively apply digital solutions and enhance sustainability and efficiency in their production?

These questions aimed to address the critical areas required to foster a sustainable and technologically advanced agricultural sector in Serbia, with implications for the broader Western Balkans region.

5. FINDINGS

I. SKILLS PROVISION FOR FARMERS IN SERBIA

A well-structured knowledge transfer system is critical for equipping small farmers with the necessary digital and sustainable farming skills. In Serbia, the stakeholder mapping exercise identified five key pillars—Entrepreneurial Sector, Investment & Capital, Education & Research Institutions, Corporate Sector, and Public & Governmental Institutions—which play distinct yet interconnected roles in knowledge dissemination, capacity building, and institutional support for smallholder farmers (see Table 1 for more details).The mapping aimed to provide initial insights into the actors who collectively form the ecosystem through which innovation, training, and resources can be mobilized and tailored to meet the specific needs of rural agricultural producers.

- The entrepreneurial sector fosters grassroots innovation, offering practical and locally adapted solutions to farmers' challenges.
- Investment and capital actors (including banks, microfinance institutions, and venture capital) are critical for funding digital infrastructure, training programs, and equipment uptake.
- The corporate sector—especially agri-tech and input companies—brings technological innovations and commercial solutions that can be integrated into training and extension services.
- Public and governmental institutions shape the regulatory and policy environment, providing frameworks for rural development, subsidy access, and technical advisory services.

- Among these, education and research institutions play a particularly foundational role. They act as the knowledge engines of the ecosystem, responsible for designing curricula, generating context-relevant research, and training the farmers as well as trainers who interface directly with farmers. These institutions ensure that knowledge is not only created but also translated into usable formats for different farmer profiles, particularly smallholders. Their capacity to embed digital agriculture and sustainability themes into vocational education, lifelong learning programs, and agricultural extension services is essential to ensure that farmers are equipped with future-proof skills. Furthermore, their collaboration with farmer cooperatives, NGOs, and local advisory services enhances the reach, credibility, and adaptability of training initiatives.

In sum, while all five pillars are indispensable, educational and research institutions serve as a backbone for sustainable skill provision, ensuring the continuity and relevance of digital and agroecological knowledge transfer systems across Serbia's agricultural sector.

Table 1: Detailed Stakeholder Breakdown

Stakeholder Type	Subcategory	Number of Stakeholders
Pillar One – Entrepreneur Sector		**56**
Entrepreneurial Sector	Startup	30
Entrepreneurial Sector	Hubs and incubators	3
Entrepreneurial Sector	Startup centers	23
Pillar Two – Capital		**29**
Capital	Bank	12
Capital	VC Fund	11
Capital	Fund	3
Capital	Insurance	3
Pillar Three – Education and Research		**69**
Education and Research	Ministry of Education	
Education and Research	Government Office for Dual Education	1
Education and Research	Qualification Agency	1
Education and Research	Secondary VET schools	42
Education and Research	Faculty	7
Education and Research	Institute	9
Education and Research	Associations and think tanks	9
Pillar Four –Corporate Sector		**53**

Corporate Sector	Business	50
Corporate Sector	Chambers of Commerce Serbia	1
Corporate Sector	Support agencies	2
Pillar Five – Public, government and intergovernmental Institutions		**226**
Public institutions	Development agencies	1 plus 16 branch offices
Government institutions	National Agricultural and Advisory Services	1 plus 23 regional offices
Government institutions	Science and technology parks	4
Government institutions	Ministry	6
Government institutions	Government Office	1
Government institutions	Government Funds	2
Government institutions	National Bank of Serbia	1
Intergovernmental institutions	World Bank, European Investment Bank, etc.	4
Local self- government, cities and towns		174
Intergovernmental institutions	Development programs	3

Source: Author, based on collected data

(1) Entrepreneurial Sector

The mapped entrepreneurial ecosystem in Serbia comprises 56 stakeholders, including 30 start-ups, 3 hubs and incubators, and 23 start-up centers. These entities are at the forefront of agri-tech innovation, contributing significantly to the development and promotion of digital tools for farm management, e-commerce, precision agriculture, smart irrigation, and supply chain optimization. Many of these entrepreneurial actors provide training, mentoring, and demonstration workshops for farmers, agronomists, and agricultural advisors. These capacity-building initiatives often include:

- Digital literacy training (e.g., using mobile apps and IoT-based tools for field data collection)
- Workshops on precision farming techniques (e.g., sensor integration, data-based fertilization)
- Hands-on use of farm management software (e.g., platforms to monitor input-output records, cost tracking)
- Webinars and field demonstrations on emerging technologies such as drones for crop monitoring or automated irrigation systems.

However, as the mapping and literature (ETF, 2022) indicate, the engagement of these start-ups and centers with smallholder farmers remains limited. Many of the innovations and trainings are designed with medium and large-scale producers in mind, often assuming pre-existing levels of infrastructure, digital literacy, and capital investment that are not typical of small family farms.

Despite this gap, some good practices have emerged:

- Digital Serbia Initiative and BioSens Institute have collaborated on pilot programs to introduce low-cost sensors and mobile-based advisory services for smallholders, particularly in Vojvodina.
- Startups such as Agremo have developed user-friendly tools—like drone-assisted mapping or pest prediction systems—that require minimal training and are scalable for smaller farm plots.

To maximize their impact on digital transformation in agriculture, these entrepreneurial stakeholders need to intensify outreach to smallholder farmers, adapt their solutions to resource-constrained contexts, and collaborate more closely with extension services, farmer cooperatives, and vocational schools.

(2) Investment & Capital

Financial institutions play a key role in facilitating access to funding for technology adoption. The stakeholder mapping identified 30 capital providers, including 12 banks, 11 VC funds, 3 investment funds, and 3 insurance companies. These entities are crucial for enabling investments in agri-tech equipment, digital farm management systems, renewable energy solutions, and climate-resilient agricultural infrastructure.

Despite this strong institutional presence, the World Bank (2024) highlight persistent barriers that small farm holders face in accessing financing. These include low levels of financial and digital literacy, lack of collateral, and the perceived riskiness of small-scale agriculture among traditional lenders. Moreover, many existing financial products are not tailored to the specific cash flow patterns or investment timelines of small farms, making it difficult for them to engage in long-term technological upgrades. Financial mechanism gaps include: complex and rigid loan application procedures; insufficient grant options for first-time adopters; low penetration of crop or weather-based insurance products; lack of bundled products (finance + training + technology**).**

Some successful financing mechanisms and good practices such as IPARD II Programme (EU Pre-accession Funds for Rural Development) emerged in Serbia over time.
Serbia has successfully implemented this grant-based support scheme, which offers co-financing for agricultural equipment and other. Although uptake among smallholders remains uneven, targeted outreach and advisory support have helped increase participation in some regions.

The Ministry of Agriculture also provides loan guarantees to banks issuing credit to small and medium-sized farms. The fund is part of a broader effort to mitigate credit risk and stimulate bank lending to farmers, especially those who lack collateral or stable credit histories. However, it is primarily focused on general agricultural investments, including machinery, inputs, and infrastructure—but digital investments are not explicitly listed as a priority category in publicly available documentation. Furthermore, while ProCredit Bank

Serbia is one of very few actors playing a meaningful role in green financing, its current agricultural financing approach appears better suited to mid-sized or commercially-oriented farms, rather than subsistence-level or very smallholder farms.

In sum, most of the interventions are not tailored to reach smallholder farmers and actively support their transition to a digital and sustainable agricultural economy.

(3) Education & Research Institutions

Educational and research institutions form the largest stakeholder group, with variety of actors, including 42 secondary VET schools, faculties, 9 institutes, and 9 think tanks, etc. This section highlights a selection of relevant stakeholders; however, due to space limitations, it does not encompass the full spectrum of actors.

The most important academic and scientific institutions in the field of agriculture and food processing are the Faculty of Agriculture at University of Belgrade, Faculty of Agriculture at University of Novi Sad, Faculty of Agronomy in Čačak at University of Kragujevac, and Faculty of Agriculture in Kruševac at University of Niš.in Backa Topola, etc. Private faculties include the Faculty of Eco-Agriculture in Svilajnac, Bio-Farming Faculty in Bačka Topola, etc. However, among graduates, profiles related to the agri-food sector are not very popular. For example, in the period 2017-2021, the number of students educated in the field of agriculture, manufacturing and food processing was only about 5-6% of the total number of students in the secondary education system in Serbia (ETF 2022). The decreasing number of agricultural workers, resulting from these trends, was pointed out be the focus groups discussants as one of the main concerns for the future of agri-food sector in Serbia.

In addition to universities, there are 16 research institutes specialised in supporting agri-food producers. The most important institutes are the Fruit Research Institute Čačak, Institute for Agricultural Economics, Institute for Science Application in Agriculture, Institute for Vegetable Crops Smederevska Palanka, Institute of Fields and Vegetable Crops Novi Sad, Institute for Animal Husbandry, and Food Institute Novi Sad.

In this context, The **Institute for Science Application in Agriculture (IPN)** in Belgrade serves as a central institution in Serbia's agricultural knowledge and extension system. Functioning as a public research and development body, IPN is tasked with bridging scientific knowledge and practical agricultural needs, particularly through the training and upskilling of agricultural advisers. In cooperation with the Ministry of Agriculture, the institute regularly organizes seminars, workshops, and field-based training sessions focused on contemporary agricultural practices, digital farming technologies, and the requirements of EU-aligned policy frameworks, including IPARD-related standards. The training modules are designed to support the effective dissemination of knowledge to small and medium-sized farms, which often rely heavily on state extension services. Through its educational role, IPN enhances the institutional capacity of Serbia's Agricultural Advisory and Professional Services and plays a strategic part in advancing the country's broader agricultural modernization and digitalization goals.

Vocational education in agriculture, agriculture and veterinary medicine and food processing educational programs can be realised at the four-year VET programmes leading to studies at university level and the three-year VET programmes not allowing this access. Approximately 80 % of students enroll in four-year VET programmes (ETF, 2022). The Government Office for Vocational Education and Training (VET Office) in 2023 was formed in 2022 and officially launched in January 2023 with the aim to enhance cooperation between businesses and schools within the framework of the Smart Specialisation Strategy. The goal of these reforms is to increase the relevance of vocational education to labour market needs.

VET schools in the agricultural and food sector in Serbia include 24 secondary schools across the country, located in towns such as Zrenjanin, Subotica, Sombor, Novi Sad, Belgrade, Niš, Vranje, and others. These schools offer vocational profiles relevant to agriculture and the food industry, including food technician, baker, butcher, agrotechnician, winegrower-winemaker, operator in the food industry, and agro-mechanical technician. Participating schools operate within the dual education system, where students acquire practical skills through in-company training in addition to classroom instruction. The system is designed to strengthen the alignment between vocational education and the specific needs of the local agri-food economy, particularly in rural areas and smaller towns, where traditional sectors remain vital to employment and development.

However, these VET schools are performing in parallel with the schools offering dual education in the fields of electrical engineering, automation, and mechatronics. This second list includes 20 technical and vocational schools located in cities such as Belgrade, Kragujevac, Valjevo, Vranje, Čačak, Zrenjanin, Trstenik, and others. The educational profiles offered focus on modern, industry-driven occupations, including mechatronics technician, CNC (Computer Numerical Control) machine technician, electrical technician for information technology, and CAD mechanical technician. These profiles prepare students for employment in high-tech sectors aligned with the principles of Industry 4.0, placing a strong emphasis on digital competencies, automation, and advanced manufacturing.

This illustrates a sectorally differentiated approach to dual education in Serbia, decoupling traditional vocational pathways from future-oriented technological disciplines. In this regard, the incorporation of precision agriculture tools into high schools specialised in agriculture is still in its early stages. Since 2020, BioSens has been making efforts to underscore the importance of using information and communication technology (ICT) in agriculture and encouraging high school students to adopt new trends and innovations. This experiment was conducted at the secondary agriculture school in Futog.[2]

According to the focus groups participants, many training programs still emphasize traditional farming techniques, leaving a gap in knowledge transfer related to digital solutions that enhance sustainability. Existing curricula remain theory-heavy and lack hands-on digital agriculture training. Precision agriculture tools, such as sensor-based irrigation systems, automated fertilization tools, and remote pest monitoring, are underutilized by small farmers due to limited access to training on how to use them effectively. Focus group discussions highlighted the need for customized, practical courses, integrating smartphone literacy, farm management software, and sustainable agronomic practices.

Continuous and life long learning

Non-formal adult education includes all programmes beyond the school system This includes vocational training, short-term courses, and workshops. These programmes are offered by various institutions, including agricultural schools, agricultural extension services, and private training providers. This type of education aims to provide learners with skills, knowledge and abilities essential for professional development, which is documented by a certificate as proof of acquired qualifications. Non-formal education is intended for people who have, partly or entirely, completed formal education and who need to improve their skills or requalify for another vocation. Some of the popular training courses in this field include fruit production, animal breeding, and organic farming. There are several types of providers of non-formal education in the agri-food sector in Serbia [1]

1. General and vocational education schools, which can be either regular schools licensed for work with adults or schools specialised for adult education (Primary schools, General secondary schools, Vocational secondary schools. The latter often provide vocational

[2] Serbian Society for Informatics (2023). Higher Schools of Information and Communication Technology (ICT). Retrieved from: https://dis.org.rs/it-zanimanje/visoke-skole-za-ikt/.

training programmes, short-term courses, and workshops in various aspects of the agri-food sector.

2. Public services are institutions founded by the Government and/or local authorities, which, alongside other goals and activities, offer some kind of training for adults. Some of the institutions of this type are the National Employment Service with its departments in 30 towns all over Serbia; the Education Centre within the Chamber of Commerce and Industry of Serbia offering continuous adult education in the business and entrepreneurship areas; The Centres for the Professional Development of Adults are located in 12 towns in various parts of Serbia, etc.

   Already mentioned Agricultural advisory and professional service (AAPS) under the auspices of the Ministry of Agriculture, Forestry and Water Management is one of the key supporting services to farmers in Serbia in terms of knowledge transfer. Expert and advisory services advisors are available to agricultural producers in around 450,000 farms in order to improve agricultural production. The AAPS is one of the most important channels for providing training to famers, including digital solutions. However, the advisers also need tailor-made training to advance their skills, particularly in the digital sphere. The Programme Committee assess the needs and defines the training curricula for advisors with the aim to ensure knowledge transfer to farmers. In order to keep their license, the AAPS advisers have to undergo regular training. The Serbian Association of Agricultural Economists and Agribusiness Professionals (SAEAP) also offers training, networking opportunities, and information resources to its members.

3. Publicly recognised providers may include nongovernmental organisations, cultural institutions, associations, open universities, career centres, consulting and training centres, private schools or any other institutions registered for educational programmes implementation, which means they have to be approved by the Ministry of Education, Science and Technological Development, as well as fulfil adult education standards as prescribed by the Law on Adult Education. When such standards are met, the institution receives a license which has to be renewed every 5 years.[2] However, there are no available structural statistics on such trainings delivered. Currently, professional development courses and non-formal courses are not mandatory in the professions within the agri-food sector and there is little interest in following the courses in the area.

(4) Corporate Sector

The mapping of corporate sector identified 53 stakeholders, including 50 businesses, 1 chamber of commerce, and 2 support agencies. Among business intermediary bodies, the Chamber of Commerce and Industry of Serbia (CCIS) has a significant role in connecting companies from different sectors and providing support to them in various fields from digitalisation to promotion.[3] The members are organised in 18 branch associations. Two associations and one service belong to the agri-food sector: Association of Crop Farming and Food Industry, Association of Stockbreeding and Livestock Product Processing and Service for organic production. Centre for Digital Transformation which works under CCIS has a significant role in supporting digitalisation of SMEs in Serbia including those in the agri-food sector. Nevertheless, the provision of training is targeting SMEs and not commercial or non-commercial small farms with a huge gap regarding the training for digitalisation in agri-food. As a response to this gap, the Chamber established Smart Agriculture Council aimed at fostering digital transformation and innovation in the agricultural sector. Purpose of the Council is to serve as a strategic and advisory body promoting the development of smart, digital, and sustainable agriculture and to connect agri-tech

[3] CCIS represents an association of business companies, organised in the sectors of agriculture, industry, and services, which are further grouped into 18 branch associations. CCIS has a headquarter in Belgrade and 16 regional chambers of commerce (Kikinda, Kragujevac, Kraljevo, Kruševac, Leskovac, Niš, Novi Sad, Pančevo, Požarevac, Sombor, Sremska Mitrovica, Subotica, Užice, Valjevo, Zaječar, Zrenjanin).

companies, farmers, research institutions, and policymakers to facilitate knowledge exchange and accelerate the adoption of digital tools in agriculture. The Council supports Serbia's broader Smart Specialization Strategy and EU Green Deal alignment, and the goals of the Digital Serbia.

Business clusters and associations are important players in the efforts of modernisation and digitalisation of traditional agriculture and food industry. Among them are the Vojvodina Organic Agricultural Cluster, Vojvodina ICT Cluster, Serbia Organica, Business Association ICT Cluster of Central Serbia in Kragujevac, Panonian Bee Cluster in Novi Sad, etc. Based on the list of the most active clusters, it can be concluded that the greatest potential for association in thematic areas is in the sectors of information and advanced technologies, agriculture, and food.

These actors contribute to market-driven knowledge transfer, particularly in areas such as precision agriculture, sustainable input usage, and supply chain digitalization. However, research suggests that small farmers have limited engagement with private sector training programs, often due to cost barriers and accessibility challenges. Incentivizing public-private partnerships in training programs could address these gaps.

(5) Public & Governmental Institutions

Public institutions play a fundamental role in shaping policy frameworks, providing financial assistance, and ensuring advisory support. The mapping exercise identified 39 governmental and intergovernmental institutions, including 17 development agencies, 6 ministries, 4 science and technology parks, and the National Agricultural Advisory Service (AAPS) with 23 field offices. The list also includes local governments that also ensure a variety of support services to agricultural and food producers.

The Ministry of Agriculture, Forestry and Water Management sets the strategic goals and the policy framework for the development of the agri-food sector. The Directorate for Agrarian Payments, as an administrative body within the Ministry of Agriculture, Forestry and Water Management plays an important role in supporting the farmers and agricultural production through various financing mechanisms.[4] However, small farmers often struggle with accessing government funding schemes due to a lack of knowledge on how to navigate digital application systems for subsidies and grants. In this regard, **The Agricultural advisory and professional service** (AAPS) under the auspices of the Ministry of Agriculture, Forestry and Water Management is one of the key supporting services to farmers in Serbia.[5] E-Agrar online platform was introduced in 2023, and advisers played a pivotal role in educating farmers and explaining how to register and use that digital platform. Hower, this endevour showed that majority of farmers in Serbia lack basic digital skills.

To support innovative activities and manage funding for stimulating **innovation, the Innovation Fund of the Republic of Serbia operates under the a**uspices of the Ministry of Education, Science and Technological Development. Programmes of the Innovation Fund

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[4] Selecting procedures in accordance with the criteria, mechanisms and rules established by the regulations for awarding incentives; announcing a tenders for awarding incentives; publishing a public call for submission of applications for exercising the right to incentives with the conditions for using the right to incentives; verifying the fulfilment of the conditions for the approval and payment of funds upon the request for exercising the right to incentives in accordance with the regulations and conditions of the competition and, where necessary, according to the rules of public procurement; preparing the contract on the use of incentives between the Directorate the beneficiary of the incentives; deciding on the right to incentives; making a payment based on the realized right to incentive; conducting the procedure for the return of funds in case of non-fulfilment of obligations by the user or unjustified payment of funds; providing administrative control and on-site control; maintaining accounting records of obligations and payments; implementing programmes of international agricultural policy incentives in the Republic of Serbia; managing the Register of Agricultural Holdings; performing an independent internal audit; submitting reports and analyses to the Minister; as well as other jobs.

[5] Their role is in more detail explained through the Agriculture and Rural Development Strategy 2014-2024. Government of the Republic of Serbia. (2014). *Strategy of agriculture and rural development for 2014–2024*. Available here.

are designed to support priority areas of the Serbian Smart Specialisation Strategy including vertical priority areas such as: ICT, Food for Future, Creative industries and Future Machines and Manufacturing Systems, and horizontal priority areas: Key Enabling Technologies (KET), and Energy Efficient and Eco-Smart Solutions. It is financially supported through the funding of the European Union and the World Bank. By encouraging innovative entrepreneurship and strengthening the link between science and businesses, the Innovation Fund strives to create positive environment and support development of the knowledge-based economy. For example, AgTech Lab at the Science and Technology Park Belgrade has launched training series aimed at young agri-entrepreneurs, encouraging digital start-ups to design solutions for marginal and rural communities. However, the Fund's initiative are only indirectly reaching farmers in Serbia.

Four regional units of **Science and Technology Parks (STP)** – in Belgrade, Novi Sad, Niš, and Čačak – are the focal points for supporting knowledge and innovative ideas, i.e. small companies and start-ups, throughout Serbia. The main role of the STP is to promote innovations and support entrepreneurship in a broad field of economy, including agriculture and food processing. STP Čačak formally fits the profile of the STP which would be the most oriented on agri-food, since it was founded by the relevant organisations, including the Faculty of Agronomy and the Institute of Fruit Growing.

Development Agency of Serbia (RAS)[6] with 16 regional offices is a government organisation offering a wide range of services including support to direct investments, competitiveness, and export promotion, leading the implementation of projects aiming to improve Serbia's attractiveness and reputation and increase economic and regional development. It operated under the Ministry of Economy and supports micro, small and medium enterprises, and entrepreneurs, as well as domestic and foreign investors seeking to set up or expand their business in Serbia, RAS strives to raise Serbia`s position in the region and globally. RAS itself is not the primary institution tasked with farmer digital education but may indirectly support such initiatives, especially when tied to entrepreneurship in agri-tech or rural innovation projects, but explicit, broad-based digital training for farmers is not a core area of their public programming.

The Instrument of Pre-Accession Assistance for Rural Development (IPARD III) 2021-2027. The instrument represents an important incentive programme that will last at least by 2027. It envisages three key measures: Measure 1 – Investments in physical assets of agricultural holdings; Measure 3 – Investments in physical assets related to the processing and sale of agricultural and fishery products; Measure 7 – Diversification of agricultural holdings and business development. In general, it focuses on improving physical infrastructure of farms and producers. IPARD II and III helped farmers to access funds to upgrade machinery and infrastructure but was not aimed at enhancing the application of digital solutions.

While these institutions are central to digital transformation efforts and/or supporting farmers, bureaucratic inefficiencies and inadequate outreach limit their impact. Expanding peer-learning models, localized advisory services, and targeted government subsidies can enhance adoption among small farmers.

To conclude, the comprehensive mapping of Serbia's digital agriculture ecosystem reveals a growing but uneven landscape of actors and initiatives across five interrelated domains: entrepreneurial activity, access to capital, corporate engagement, public institutions, and education and research. Each domain contributes uniquely to digital knowledge transfer and

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[6] RAS has 16 accredited regional development agencies (ARPA) in its network, as follows: in Belgrade, Novi Sad, Subotica, Zrenjanin, Pančevo, Ruma, Požarevac, Loznica, Kragujevac, Zaječar, Užice, Kraljevo, Kruševac, Niš, Novi Pazar and Leskovac.

agri-tech innovation, yet smallholder farmers—who form the backbone of Serbian agriculture—remain largely underserved.

Start-ups and innovation hubs are driving technological advancement, offering practical tools and targeted training, but often fail to reach resource-constrained small farms due to assumptions about infrastructure, literacy, and scale. Financial institutions and public funding mechanisms provide critical support but still lack tailored instruments adapted to the cash flow realities and risk profiles of smallholders. Educational and research institutions offer a strong foundation of technical knowledge, but dual education systems remain fragmented and insufficiently aligned with the emerging demands of digital agriculture. Corporate actors, including business clusters and chambers of commerce, promote modernization and sustainability but primarily target SMEs and larger producers. Finally, public institutions are key to enabling access and outreach, yet bureaucratic complexity and limited perception of the importance of digital transformation and digital readiness constrain their impact.

Ultimately, scaling digital transformation in Serbian agriculture requires building an enabling ecosystem: one that integrates policy incentives, inclusive training models, and cross-sectoral collaboration to empower smallholders as active participants in the agri-digital future.

II. BRIDGING THE DIGITAL CAPACITY GAP: SKILLS, SUPPORT, AND LEARNING PATHWAYS

Recent research from Serbia (Andjelkovic et al., 2025; Kovljenic et al., 2023; Čikić & Petrović, 2022) points to the digital skills deficit in agriculture. Fewer than half of surveyed farmers report using digital technologies in their daily work, with many expressing unfamiliarity with how such tools can support agricultural productivity and sustainability. Compounding this issue, over 50% of respondents stated they had never received any formal training related to digital technology in agriculture. The primary obstacles identified include insufficient education, limited awareness, and a lack of tailored training opportunities

One study (Čikić & Petrović, 2022) found that nearly two-thirds of farmers surveyed had no formal exposure to digital tools, despite acknowledging their relevance. These findings underscore that the challenge is not resistance to innovation, but rather a lack of enabling conditions. As Nikolić et al. (2022) emphasize, although the volume of agricultural information has grown significantly, time constraints and a lack of user-friendly platforms make it difficult for farmers to navigate and apply that information meaningfully. This disconnect between information availability and practical usability highlights the urgent need for streamlined, time-efficient support mechanisms.

Focus group discussions reinforced these findings. Several participants highlighted that different categories of digital skills are required for different daily tasks. For example, participants emphasized that basic smartphone operations, such as connecting to Wi-Fi, downloading apps, and updating operating systems, are foundational yet frequently assumed to be understood.

Others stressed the importance of digital communication tools. Messaging platforms like Viber, WhatsApp, and Facebook Messenger are widely used, but less so for professional purposes. Participants pointed out to the need to organize training on how to use these apps for professional communication with cooperatives, extension workers, or buyers. “Simple skills could have immediate professional impact”, suggested one participant.

Skills related to accessing and interpreting information also stood out. One participant explained, “Even if they find a site, they don’t know which part is relevant to them, or how

often it updates." Several participants pointed out to the assistance required for distinguishing between trustworthy and irrelevant digital content.

Some participants mentioned digital financial tools, including mobile banking and accessing subsidies through platforms like eAgrar. However, fear of making a mistake or submitting incorrect information discouraged many from using these services. "Many farmers couldn't register to the eAgrar platform as they didn't know how to do it. Also, applications for subsidies are prepared by the agricultural advisers. Without them, many farmers would be lost," said one participant.

One of the most prominent barriers identified in the mapping process is the lack of structured digital literacy programs tailored specifically for small farmers. Several participants emphasized the need for digital tools to be both user-friendly and accessible to support food security efforts. As one expert pointed out, "If these technologies are simple to use and affordable, more farmers will adopt them, which could help us improve food security."

Participants consistently stressed the need for practical, hands-on training—not theory-heavy courses, but real-time demonstrations of how to use mobile phones, find market prices, or apply for subsidies online. "Farmers need someone who can sit next to them and show them what to press," one participant explained. Another emphasized that current training does not match farmers' daily realities, noting that small farm holders have different needs than big farms. Participants also raised the importance of visual literacy for navigating platforms and apps. Icons, navigation menus, and security warnings were described as confusing. "You need to be trained not just in words, but in recognizing signs and symbols," one participant explained. Suggestions for video demonstrations were also frequent.

In addition to these baseline concerns, participants raised the issue of the importance of continuity in support. Several noted that training was often delivered as one-off events without follow-up or on-demand guidance. "It's not enough to come once a year —farmers need someone we can call or message when they are stuck," said one participant. Others underlined the importance of village-based digital mentors or local champions who could serve as constant points of contact.

Gender dynamics also surfaced in several discussions. Women farmers—who are often responsible for day-to-day farm administration and are often digitally savvier than men should be included more in outreach and be more represented in workshops. This suggests that designing inclusive training programs that account for both gender roles and schedules could improve reach and impact.

Participants also called attention to seasonal timing. They emphasized that training schedules should avoid peak agricultural cycles. "If the trainings are organized in May, that's when farmers are in the field 12 hours a day," one participant noted. Flexible formats—such as evening sessions, weekend options, or short video modules—were frequently recommended.

The format and language of trainings were noted as potential barriers. Participants stressed the need for simple, jargon-free communication delivered in local dialects. Several highlighted the usefulness of visual content and recommended simple printed guides they could keep on hand when internet access was unreliable.

Participants also pointed to the untapped potential of peer learning. "If a farmer sees another farmer using a new tool, they're much more likely to try it themselves," one participant said. The sense of trust and familiarity that comes with community-based knowledge sharing emerged as a recurring theme, with multiple participants endorsing the value of local mentorship networks

Participants also emphasized the role of agricultural advisors, arguing that they should serve as the first line of digital support. In order to do so, the advisors themselves need the digital

competencies to fulfill that role. Investing in their training could create a multiplier effect, expanding access to digital tools far beyond the reach of isolated workshops.

Financial barriers compound the skills gap. Multiple participants called for subsidies—not only for equipment but also for training costs. Without financial support, digital adoption remains out of reach for many. One participant noted, “Policy support is crucial; without financial incentives and guidance, digital adoption among small farms will remain limited.” Another expert highlighted the need for a strategic policy focus, saying, “It’s not just about giving farmers technology, but about creating an ecosystem that supports digital tools and knowledge transfer.” These focus groups participants emphasized the importance of both technological and policy support to make digital transformation accessible for small-scale farmers.

Additionally, as highlighted, regional cooperation could enhance the knowledge exchange on sustainable and digital farming. Agricultural VET schools and demonstration farms could serve as training hubs, where farmers can physically engage with new sustainable technologies before implementing them on their farms.

Finally, a promising avenue emerged from intergenerational exchange. Younger family members often serve as informal tech facilitators, helping parents and grandparents navigate devices and apps. Encouraging youth to take on roles as digital ambassadors could serve both digital literacy goals and broader efforts to retain young people in rural communities.

As focus groups participants point out, inadequate educational structure of farmers and related lack of digital skills, limit the access to modern technology. At the same time these challenges are enforced by the perception that ICT is not essential for small-scale operations by both farmers themselves but also by the government, which does not provide sufficient support for the application of digital technology in agriculture.

In conclusion, the insights from focus groups reveal that bridging the digital divide in Serbian agriculture will require a holistic strategy that incorporates accessible, customized training, financial support, community-based knowledge sharing, and the engagement of younger generations.

These findings point to a clear path forward. Serbia must invest in a multi-layered approach that combines accessible, localized training with financial support and peer learning infrastructure. Training should be embedded in farmers’ real-life routines and designed for their tools—not theoretical concepts or desktop-only platforms. Only by addressing the human side of digital transformation can Serbia close the skills gap and unlock the full potential of its agricultural sector. These efforts can pave the way for a more digitally literate, technologically equipped agricultural sector that aligns with sustainability goals and economic resilience.

6. CONCLUSION - MATCHING THE DEMAND AND SUPPLY

The digital transformation of agriculture is no longer a future consideration but an urgent necessity for Serbia’s smallholder farmers. However, a significant gap persists between the digital competencies farmers need to adopt innovation and the support systems currently in place to deliver those skills. This report reveals that while some progress has been made—most small farmers remain marginalized from the digital transition. Their use of technology is often limited to informal communication tools, with more advanced applications such as e-commerce, farm management systems, or precision agriculture tools rarely adopted.

The reasons for this underutilization are manifold. Many small farmers lack even basic digital literacy, and the educational system has not adapted sufficiently to meet this need.

Extension services, while critical, are not consistently equipped to train farmers in digital tools. Other actors such as non-governmental organisations provide training for farmers, but this training is random, lacks continuity and relies heavily on donor funding. At the same time, business intermediaries do not actively provide necessary skills, and financial constraints further hinder famers to adopt digital tools. Financial support for training is lacking, and cooperation with hubs and institutions is limited.

Moreover, public policy frameworks—although increasingly aligned with EU standards—fail to translate into practical, on-the-ground support that is accessible to the most vulnerable farming communities.

Importantly, the challenge is not only technological but also social. Farmers require trust, relevance, and community-based learning structures. The research demonstrates that peer mentorship, localized demonstrations, and gender-inclusive approaches can greatly enhance adoption. Similarly, financial and digital inclusion must go hand-in-hand. Without bundling digital tools with subsidies or micro-loans, digital uptake will remain concentrated among better-resourced producers.

What emerges clearly from this study is that aligning supply and demand in digital agriculture skills requires a whole-system response. Policies must move beyond rhetorical commitments to tangible investment in curriculum reform, advisory systems, public-private partnerships, and community engagement. Equipping small farmers with digital competencies is not simply a technical fix—it is a structural lever for social equity, climate adaptation, and economic modernization.

7. POLICY RECOMMENDATIONS

This report presents targeted recommendations to address the digital skills gap among smallholder farmers in Serbia. The insights are based on research findings from stakeholder mapping, focus group discussions, and analysis of digital adoption trends in the agricultural sector. The objective is to align training supply with the real-world digital needs of small farms, facilitating inclusive, sustainable, and innovation-driven growth in line with Serbia's Smart Specialisation Strategy and EU accession priorities.

1. Empower farmers through education and training

Develop farmer-centric digital literacy programme and training prioritising practical, hands-on digital skills. Training should be available via hybrid models including video tutorials and community workshops. Community-based mentorship networks can be created by training tech-savvy youth. Additionally, peer-to-peer knowledge exchange programs—where farmers who have successfully adopted digital solutions mentor others—could help overcome resistance to technological change. Training schedules must consider the farming calendar, offering flexible, off-season or evening-based learning options to maximize participation.

2. Further strengthen Agricultural Advisory and Professional Services

Enhance the capacity of Agricultural Advisory and Professional Services (AAPS) to deliver digital support. Require continuous professional development in digital tools and create incentives for digital mentorship outreach among advisors. Moreover, AAPS and vocational education institutions should collaborate to create hands-on digital training workshops that focus on real-world applications of digital tools in farming. Long-term

strategy for digital agriculture should further strengthen digital advisory services and promote smart farming through education and awareness campaigns. A national e-learning platform could be established to provide mobile-accessible, on-demand training.

3. Enhance innovation and private sector engagement

Public-private partnerships should be leveraged to co-create digital solutions tailored for smallholder needs. Start-ups should expand outreach to rural communities through demonstration projects. To maximize their impact on digital transformation in agriculture, these entrepreneurial stakeholders need to intensify outreach to smallholder farmers, adapt their solutions to resource-constrained contexts, and collaborate more closely with extension services, farmer cooperatives, and vocational schools.

Corporate sector actors must be incentivized to support smallholder training in areas like precision agriculture, supply chain digitalization, and sustainable input use. Digital education must also be inclusive, with formats that cater to the needs of women farmers and actively promote their participation as leaders in digital adoption. Expanding inclusive training models and promoting co-creation of tools with end-users could significantly boost their effectiveness in bridging Serbia's agricultural digital divide. Public-private partnerships should be promoted to expand digital infrastructure which is also vital and important.

4. Enhance development of customised digital tools for small farmers

Research institutions should develop customized digital tools for small farmers, ensuring they are cost-effective and user-friendly. Many current digital farming solutions are designed for large-scale agribusinesses, making them financially and operationally inaccessible for smaller farms. By promoting simplified farm management apps and peer-to-peer digital learning platforms, small farmers can be empowered to gradually integrate digital solutions into their workflows. Also, grants for affordable digital solutions should be introduced by the local governments with high agriculture share. Offer co-development grants to design user-friendly apps and services tailored to small farms with low capital and digital literacy.

5. Reform agricultural Vocational Education and Training (VET)

Agricultural VET institutions should reform their curricula to embed digital farming modules, while also collaborating with ICT-oriented schools. Support teacher training in digital tools for agriculture.

6. Implement real-time monitoring and feedback systems

Develop systems to track digital adoption, gather farmer feedback, and adapt training programs dynamically based on needs.

7. Facilitate Financing and Access to Tools

Existing agricultural financing mechanisms should be adjusted to include digital technology as a key investment category. New instruments such as vouchers and micro-loans must be introduced to support first-time digital adopters. Integrated financing models that combine credit access, equipment provision, and digital training have proven effective

and should be scaled up. Financial literacy programs delivered through cooperatives and extension networks can help farmers better navigate financial systems and utilize digital financial tools.

To scale these efforts and bridge the financing gap policies should also focus on simplifying credit mechanisms, offering grants, and incentivizing private sector investments to encourage digital and sustainable agriculture practices. Incentivize private-sector investments in rural areas through tax relief, blended finance, or impact investment frameworks.. Encourage the development of integrated financing models that combine credit, training, and technology—a model shown to be effective in pilot programs run by development organizations and social enterprises.

8. Embed Sustainability into Serbia's Smart Specialization Strategy (S3)

Training programs should not only focus on immediate skill-building but should also encourage systemic thinking, where farmers understand the long-term economic and environmental benefits of digital and sustainable farming. Government subsidies and grants should be directly linked to participation in these training programs, incentivizing farmers to continuously upgrade their skills.

In conclusion, a holistic approach to skills development—where digital adoption and sustainability are taught hand in hand—will be essential for the future of Serbian small-scale farming. By aligning educational curricula, corporate expertise, government initiatives, and farmer-driven learning networks, a resilient and technologically empowered agricultural sector can be built, ensuring economic and environmental sustainability for generations to come.

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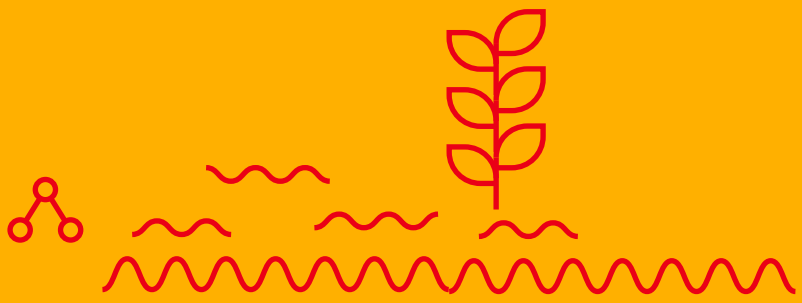

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Civil Society for Shared Society in the Western Balkans
CPCD
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Institute for Democracy and Mediation
CRPM
Center for Research and Policy Making
...policy impact since 2004
CENTAR
PUBLIC POLICY RESEARCH
[re:]people
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IMPETUS
CIDGG