Perceived Benefits and Barriers to Cooperation Between Small Farms and Clusters—A Case Study of Poland

Elżbieta Zysk

Abstract Current climate risks, increasing urbanization, decreasing availability of arable land for food production, and the risk of flooding can be seen as potential risks to future global food security. The increase in the global population is yet another challenge facing humanity in the twenty-first century. Urgent steps should be taken to pursue a sustainable agricultural policy and achieve food security, including the cluster policy. Clusters are created to enhance efficiency, competitiveness, environmental sustainability, and enterprise development. A model of linkages between the academia, industry, government, and citizens should be implemented to achieve this goal. Cooperation between clusters and farmers is key to implementing innovative business solutions for smart specialization and sustainable development of regions, to provide modern support solutions for efficient management in agricultural production, implement environmentally friendly technologies, and foster innovation. The aim of this study was to develop a conceptual framework for enhanced cooperation between farmers and clusters and to survey Polish farmers' and experts' perceptions of the benefits and barriers to such collaboration. The final result was a set of competences for cooperation between farmers and clusters, including the specification of agro-clusters. Farmers should have the opportunity to cooperate with agricultural enterprises to implement innovations, improve the efficiency of agricultural production, improve their skills through training, and foster the growth of farms through cluster activities. The present research is a case study of Poland which is one of the largest food producers in the European Union. The research assumptions were validated by analyzing the existing agricultural clusters in Europe and Poland based on a review of the literature, reports, interviews with experts in agriculture, and rural area development, as well as direct research involving small farms (with an area of less than 20 ha). The foundation of the Sustainable Development Goals (SDGs) is blueprint for peace and prosperity for people and the planet, now and into the future. An integral part of the SDGs is the implementation of state-of-the-art innovation, especially in the least developed areas. The discussed concept is fully consistent with the Sustainable Development Goals (SDGs) addressed by European policies,

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in particular Goal 9: Industry, Innovation and infrastructure because cooperation between society/farmers and stakeholders/clusters is key to the implementation of innovation in rural areas and the creation of infrastructure that will support regional economic development with active social participation.

Keywords Small farms · Farmers · Sustainable agricultural policy · Agro-clusters · Agricultural policy

Introduction

The key global challenges of the twenty-first century include growing urban population (Kalnay and Cai 2003; Antrop 2004; Cohen 2006) globalization (van Meijl et al 2006), rapidly growing demand for food (FAO 2012), decreasing availability of cultivable land for food production (Benayas et al 2007; Renwick et al 2013; Olesen and Bindi 2002; Dimitri et al 2005), environmental and climate pressures that threaten agricultural productivity, and current land use practices (IPCC 2014). According to current estimates, food production has to increase by 50–70% by 2050 to meet rising demand and changing food preferences of a growing population, especially the urban population (Boserup 2011) (Table 1). Much of the additional demand for food will originate in regions with high population growth, in particular Sub-Saharan Africa, India, the Middle East and North Africa (OECD/FAO 2019).

By 2050, the world's population will grow to around 9.6 billion people. According to estimates, the global population will increase by 1 billion every 12 years (UN DESA 2018). A growing global population will continue to use increasing amounts of agricultural products for food, feed, and industrial purposes. Many of the world's poorest people will continue to live in rural areas and will depend on agriculture for an important share of their incomes (OECD/FAO 2019). The increase in food production must be achieved from a natural resource base that is declining in quantity and quality (EC 2018) and contributes to climate change (Abson et al 2014) by inducing chemical, physical, and biological processes (Lal 2006) that increase the levels of atmospheric CO_2 (Chase et al 2001) and speed up soil erosion. These processes exert a negative impact on the environment (Pimentel et al 1995). Unsurprisingly, there are now mounting pressures on agriculture to reduce its carbon footprint, and to help mitigate climate change (OECD/FAO 2019).

Table 1 World population

Year	1961	1991	2020
World population	3.073 billion	5.375 billion	7.753 billion
Urban population growth (annual %)	34.12	43.40	56.15
Rural population growth (annual %)	65.87	56.60	43.85

Source The World Bank Group (2021)

International norms such as the Millennium Development Goals (UN 2000) and Sustainable Development Goals (UN 2015a, b) (FAO 2012a, b) postulate sustainable rural development. The Common Agricultural Policy postulates that sustainable rural development can be achieved by focusing on a limited number of key priorities relating to the transfer of knowledge and innovation in agriculture at the EU level (Regulation (EU) No 1305/2013). The transfer of knowledge and innovation in agriculture can be facilitated through clustering and data and experience sharing. Clusters are created to increase efficiency, competitiveness, environmental sustainability, and enterprise development. They enhance the effectiveness of agricultural production through innovation and the implementation of smart specialization. A model of linkages between the academia, industry, government and citizens should be implemented to achieve this goal. The framework of action should be organized around citizens-farmers and clusters.

The aim of this study was to develop a conceptual framework for enhanced cooperation between farmers and clusters and to survey Polish farmers' and experts' perceptions of the benefits and barriers to such collaboration. Farmers should have the opportunity to cooperate with agricultural enterprises, implement innovations, improve the efficiency of agricultural production, improve their skills through training, and foster the growth of farms through cluster activities. Cooperation between clusters and farmers is crucial for implementing innovative business solutions for smart specialization and sustainable development of regions, to provide modern support solutions for efficient management in agricultural production, implement environmentally friendly technologies and foster innovation.

A review of the literature indicates that cooperation between institutions and local communities fosters technological progress and contributes to policies that support the sustainable development of regions. This is an important objective because agriculture needs guidance for improved cooperation under Goal 9 of the Sustainable Development Goals formulated by the United Nations General Assembly in 2015 (UN 2015a, b). The foundation of the Sustainable Development Goals (SDGs) is blueprint for peace and prosperity for people and the planet, now and into the future. An integral part of the SDGs is the implementation of state-of-the-art innovation, especially in the least developed rural areas.

Cooperation between society/farmers and subjects/clusters is key to implementing innovation in rural areas and the creation of infrastructure that supports the economic development of regions with active social participation. Clusters enable farmers to improve the efficiency of agricultural production through innovation and the implementation of smart specialization. A model of linkages between the academia, industry, government, and citizens should be implemented to achieve this goal.

The progress made in the implementation of the above goals will be assessed based on an analysis of the existing clusters in Europe and in Poland in view of published reports and a review of the literature. The existing clusters will be analyzed to obtain background information, identify the main clusters and their area of activity in Europe and Poland. Agricultural cluster policy at the regional level and the relevant solutions and barriers will be identified based on a literature interview and interviews with agricultural policy experts from selected institutions. The panel of experts included

civil officers from agricultural institutions (Voivodeship Marshals' Offices and the Agency for Restructuring and Modernization of Agriculture). In the last stage of the study, a questionnaire survey was conducted in the Polish voivodeship of Warmia and Mazury to identify small farmers' (with farm area of less than 20 ha) perceptions of the benefits and barriers to cooperation with clusters. The results were used to optimize the distribution of competences for cooperation with farmers and clusters, including agro-clusters. The proposed solution advocates for the establishment of specialist institutions responsible for eliminating barriers and monitoring the farmers' ability to implement the expected benefits of collaboration.

Materials and Methods

Materials

Poland is one of the largest EU countries that lies at the geographic center of the European continent. Its central location and well-developed road, railway, and aviation infrastructure guarantee easy access to both Western and Eastern European markets. The Polish railway network spans a combined length of 20,228 km and is one of the densest railway systems in the world. Poland also operates numerous sea and trade ports (including in Szczecin, Świnoujście, Gdynia and Gdańsk) which have connections with the most important ports all over the world (Cluster 2016). Poland was selected for the study because it belongs to a group of EU countries with the highest number of agricultural holdings and is one of the largest food producers in Europe. The voivodeship of Warmia and Mazury was selected for detailed analysis.

Political, social, and economic data were gathered in the first stage of the study to set the background for detailed analyses. The collected data are presented in Table 2.

Food production in Poland has increased by more than 57% since 2010, and more than 40% of domestic food production is exported (CSO 2018). The supply of agricultural raw materials and foodstuffs exceeds domestic consumption and guarantees national food security (CSO 2018; SYA 2018). Poland was selected as a model country for this study due to the economic and social implications of national food security. According to the Statistical Yearbook of Agriculture (SYA 2018), the majority of Polish agricultural holdings are small farms under 20 ha, and this group of farms was selected for the study.

Methods

In the first stage of the study, the clusters operating in Europe and Poland were identified and quantified, and their regional characteristics were described based

Table 2 General statistical data on Poland and Polish agriculture

General location and area	Europe/31.3 million ha
Poland area (km)	312,696
Administrative division	Voivodships–(16); District level–counties (380); Local level–municipalities (2478)
Total area of agricultural land	14.62 million ha
Population (2018) (in thous.)	38,411
/population density	/123/ km^2 (CSO 2016)
Including in rural areas (in thous.)	15,344
Land (2018) (in thous. ha) including:	31,269.6
Agricultural land	18,776.5
Forests, land under trees and bushes	9534.2
Land under water	652.0
Mineral excavation sites	29.1
Transport networks	938.7
Residential areas	747.5
Fallow land	465.0
Voivodship of Warmia and Mazury (2018)	
Total area	2,417,347
Agricultural land	1,316,212
Arable land	874,588
Orchards	2516
Permanent meadows	160,560
Permanent pastures	222,129
Built-up agricultural land	26,878
Land under ponds	2599
Land under ditches	10,240
Land under trees and bushes	16,702
Forests and land under trees and bushes	791,007
Farms by size (in percent) (2017)	
up to 1 ha	1.5
1.01–1.99	18.7
2.00–4.99	32.0
5.00–9.99	22.5
10.00–14.99	10.1

Table 2 (continued)

15.00–19.99	5.0
20.00–49.99	7.7
50.00 ha and more	2.5
Rural population	
Voivodeship of Warmia and Mazury	587,523
Population density	25 km^2

Source Own elaboration based on the Statistical Yearbook of Agriculture (SYA 2018)

on a review of the literature. In the following stage, interviews were conducted with 10 experts responsible for agricultural policy and regional development in the Marshal's Office, the Agency for the Restructuring and Modernization of Agriculture (ARMA), and the National Support Center for Agriculture (NSCA). The last stage of the research involved a survey of farmers to identify the perceived benefits and barriers to cooperation with clusters. The survey was conducted using the direct interview method. The questionnaire was developed based on Sustainable Development Goals (SDGs), specifically Goal 9: Industry, Innovation, and Infrastructure (UN 2015a, b; UN DESA 2018; Regulation (EU) No 1305/2013; Regulation (EC) No 138/2004; FOOD 2019). The questionnaire contained 25 questions, mostly closed-ended, single-choice questions. The survey involved 180 small farmers in the Polish voivodeship of Warmia and Mazury.

Literature Review

Definition of a Cluster

A cluster is defined as "a geographic concentration of industries which gain advantages through co-location" (Bosworth and Broun 1996) or "geographic concentrations of group of firms with similar products or services, agglomerated and interconnected companies and institutions in a particular field" (Porter 1998). Many clusters include governmental and other institutions, such as universities, standard-setting agencies, think tanks, vocational training providers, and trade associations that provide specialized training, education, information, research, and technical support (Porter 1998). The companies participating in clusters generate public benefits and factor inputs, and they contribute to the dissemination of knowledge (Marshall 1920; Kalnins and Chung 2004; Alcácer and Chung 2007; McCann and Folta 2008; Porter 1998). Clusters can be described as geographical agglomerations of mutually related companies, specialized suppliers, service providers, companies operating in similar sectors and related institutions that both cooperate and compete with each other. The potential of clusters and cluster initiatives in a given country is determined by
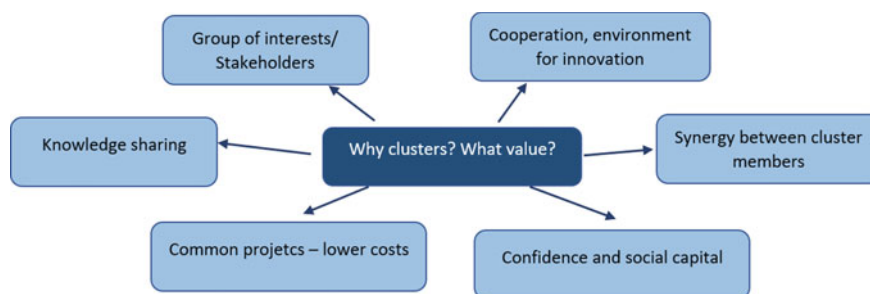
Fig. 1 Definition and value of clusters. *Source* own elaboration

numerous factors, including the business environment and the presence of institutions promoting enterprise growth (Cluster 2016). In the literature, clusters are defined as the geographic concentration of independent entities from different sectors of the economy that cooperate and compete with each other within the value chain. A cluster generates benefits and creates new value for its participants, including enterprises, universities, research organizations, business environment institutions, public administration, and other supporting organizations (Directions 2020). The definition and the value of clusters are presented in Fig. 1.

Clusters strengthen their competitive advantage by combining inter-firm rivalry, collaboration (co-opetition), and innovation (Verdú and Tierno 2019) with rapid transmission and adoption of ideas, generation of important local externalities such as skilled labor, availability of specialized inputs, including physical, technical and legal (such as those relating to certification), and enhanced access to information on technologies and markets (FAO 2010).

Similar assumptions apply to agribusiness sector companies that support small farms. Agribusiness clusters involve producers, agro-industries, traders, and other private and public actors that are interconnected, engaged in the same industry, build formal or informal value networks, address common challenges, and pursue common opportunities in rural areas (FAO 2010). According to FAO (2010), strategies targeting agribusiness and agro-industry development improve the competitiveness of agribusinesses, in particular small- and medium-sized companies (FAO 2010). Agribusiness can undertake new ventures with clusters to maximize their competitive advantage on the local market (Porter 1998). Innovation significantly influences the competitiveness of geographic clusters. The relationships between geographic location and innovation have been studied extensively (Asheim and Isaksen 1997; Baptista and Swann 1998, Baptista 2000, 2001). According to Joly (2011), new ideas, new technical devices, or new forms of organization are developed to meet user needs. The World Bank defines innovation as a process by which individuals or organizations master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country, or the world (World Bank 2006). Innovations are introduced through systems or networks of individuals and organizations to ensure that new practices

and processes are successfully adopted (Akrich et al 2002; Schumpeter 1962). The success of innovation efforts requires the development of a conceptual framework, which entails cooperation between community members and entities responsible for the implementation of innovations (Cohen and Levinthal 1990; Lawson and Samson 2001). In rural areas, innovations are introduced by clusters, and the local community is represented by farmers (Zysk et al 2020). Cooperation between clusters and farmers is key to implementing innovative business solutions for smart specialization and sustainable development in the region and on farms. It contributes to the introduction of modern solutions for more efficient management in agricultural production and the implementation of environmentally friendly technology, and it fosters innovation. These measures are undertaken to promote sustainable development, including regional and economic development with active social participation. The factors that contribute to the effective operations of clusters and cooperation with farmers have to be identified to broaden the existing knowledge and facilitate the achievement of sustainable rural development goals, including Goal 9. Cluster activities should be analyzed to monitor the progress toward sustainable rural development (Fig. 2).

Fig. 2 Sustainable rural development. *Source* Own elaboration

To achieve the main research objective, clusters in the EU and Poland were analyzed in the first stage of the study. The analysis was based on a review of the literature and the relevant documents (Cluster 2016, 2018; Directions 2020; EPCICh 2020).

Field Research

Clusters in Europe

European clusters were mapped and evaluated in the 2020 edition of the European Panorama of Clusters and Industrial Change report (EPCICH 2020) developed by the European Observatory for Clusters and Industrial Change. The results are presented in Fig. 3.

The report presents the geographic location of clusters across 51 exporting industry sectors in Europe. It analyzes cluster strength and divides clusters into basic-performing, medium-performing, and high-performing regional clusters (Table 3).

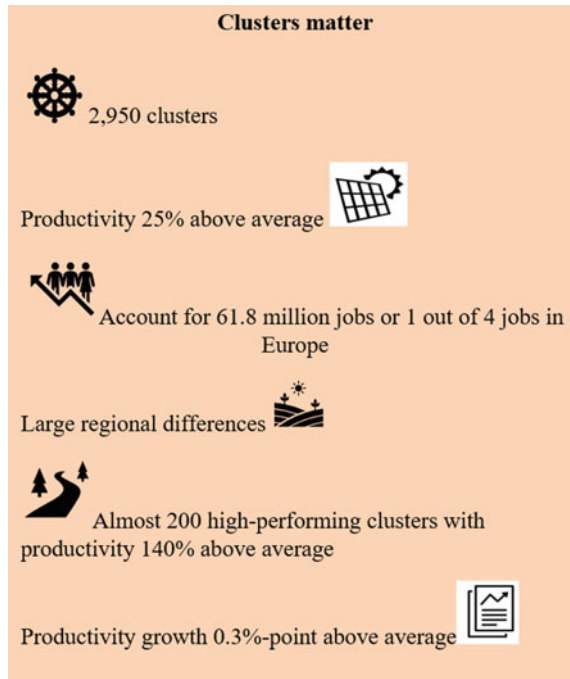**Fig. 3** Characterization of European clusters. *Source* own elaboration based on EPCICh (2020)

Clusters matter

2,950 clusters

Productivity 25% above average

Account for 61.8 million jobs or 1 out of 4 jobs in Europe

Large regional differences

Almost 200 high-performing clusters with productivity 140% above average

Productivity growth 0.3%-point above average

Table 3 Top-25 regions with most clusters

	NUTS code	Region	Basic-performing clusters	Medium-performing clusters	High-performing clusters	Total number of strong clusters
1	FR10	Ile-DE-France	10	30	3	43
	ITC4	Lombardia	20	21	2	43
3	ES51	Cataluña	31	9	1	41
4	ITH3	Veneto	22	15	0	37
5	ES30	Madrid	24	10	2	36
	ITC1	Piemonte	14	15	7	36
7	ITI1	Toscana	21	12	1	34
8	ES52	Comunidad Valenciana	26	7	0	33
	FR71	Rhone-Alpes	22	9	2	33
10	ITH5	Emilia-Romagna	20	11	1	32
		Stockholm	16	14	2	32
12	ES61	Andalucia	23	8	0	31
13	DEA1	Duesseldorf	11	14	4	29
	ITF3	Campania	13	14	2	29
	ITI4	Lazio	15	13	1	29
16	DE11	Stuttgart	15	6	7	28
	ES21	PaísVasco	9	16	3	28
	PL12	Mazowieckie	11	17	0	28
19	DEA2	Köln	10	12	5	27
20	DE21	Oberbayern	22	4	0	26
	IE02	Southern and Eastern	14	8	4	26
22	UK13	Inner London-West	20	5	0	25
23	BE23	East-Flanders	15	9	0	24
	HU	Central Hungary	17	4	3	24
	PL41	Wielkopolskie	17	5	2	24

Source own elaboration based on EPCICh (2020)

A total of 2950 regional industrial clusters have been identified across Europe, including 198 high-performing clusters, 898 medium-performing clusters, and 1854 basic-performing clusters (EPCICh 2020). Fifty-five clusters have been identified in the sector of Agricultural Inputs and Services, including one high-performing, 11 medium-performing, and 43 basic-performing clusters. The high-performing cluster is located in the UK (Lincolnshire). Medium-performing clusters are located in Germany (Schleswig–Holstein), Spain (Aragon, Castilla-La Mancha, Comunidad

Valenciana, Andalucía, Murcia), France (Champagne-Ardenne, Bourgogne, Pays-de-la-Loire, Bretagne), and Norway (Hedemark og Oppland). Basic-performing clusters are located in Belgium (1 region), Czechia (4 regions), Denmark (1 region), Germany (4 regions), Greece (4 regions), Spain (3 regions), France (5 regions), Italy (4 regions), Hungary (2 regions), Poland (2 regions), Portugal (2 regions), Romania (4 regions), Slovakia (1 region), Sweden (1 region), the UK (2 regions), Switzerland (1 region), and Norway (2 regions).

Clusters in Poland

Poland is referred to as the economic heart of Europe. Poland is a rapidly developing country and clusters undoubtedly contribute to the growth of the Polish economy. The number of Polish clusters has increased in recent years. The distribution of clusters in Polish voivodeships is presented in Fig. 4.

The location of clusters reflects the economic potential of Polish regions because 48% of clusters are located in the four most developed regions: Mazovia, Lower Silesia, Wielkopolska, and Silesia. Key National Clusters (KNCs) are defined as clusters that are of crucial importance for the national economy and are highly competitive in the international arena. Polish KNCs and their potential are presented in Fig. 5 (Fig. 6).

The group of 134 analyzed clusters represent a wide variety of industries, from traditional to high-tech, and a total of 28 specializations were identified. Many clusters belong to ICT, energy, construction, tourism, production technology, and agricultural sectors. Furniture, clothing, machinery, wood, nanotechnology, geodesy, pharmacy and cosmetics, and maritime economy sectors are represented by one cluster each.
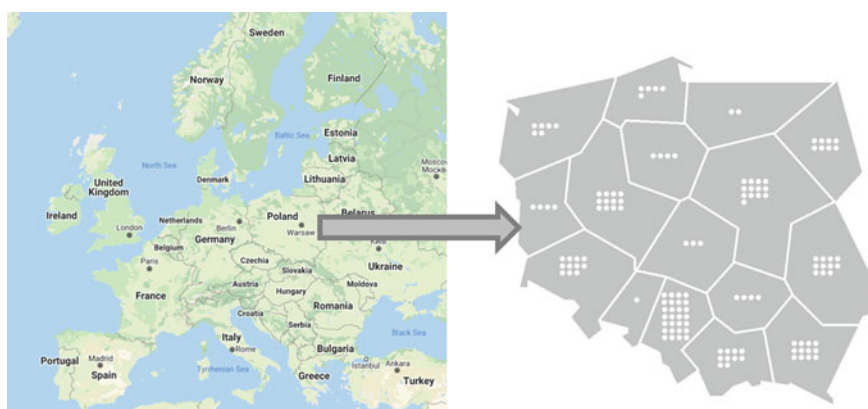

Fig. 4   Location of clusters in Poland. *Source* own elaboration (Cluster 2016)

Key National Clusters in Poland
potential

Cluster

Fig. 5 Polish Key National Clusters and their potential. *Source* own elaboration based on Cluster Policy in Poland (Cluster 2018). The KNCs belong to many industrial sectors, and they are not uniformly distributed across Polish regions (Fig. 6)
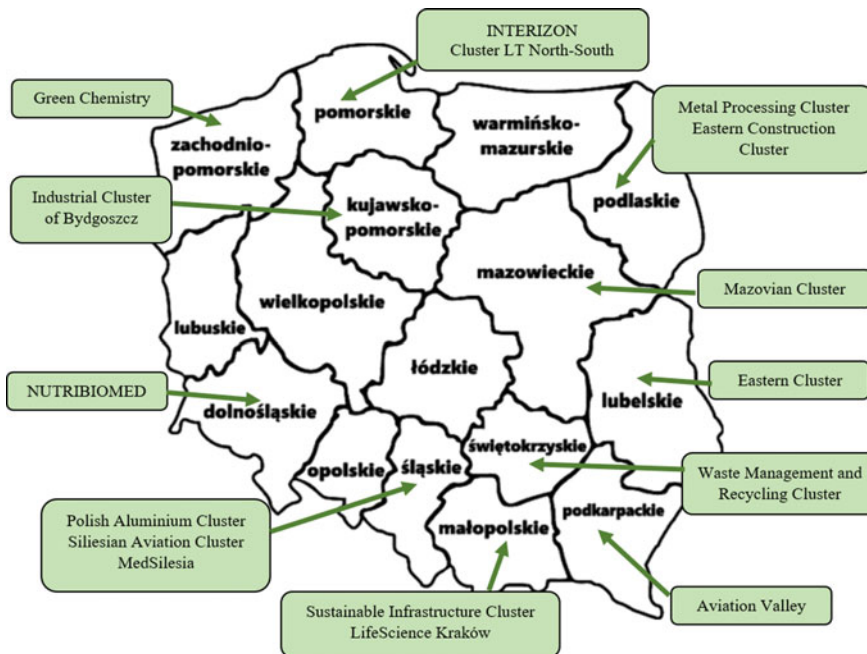

Fig. 6 Key National Clusters by voivodeship in Poland. *Source* own elaboration

Polish clusters were also analyzed across different sectors and smart specializations in agriculture in each region. The smart specialization concept relies on scientific and technological innovation. Smart specialization can have different definitions, depending on the approach adopted in a given region. Some smart specialization strategies promote the growth of the existing industries and economic sectors,

Table 4 Industrial sectors and smart specializations in Polish voivodeships

Voivodeship	Sector	Smart specialization
Kujawsko-Pomorskie (*Kuyavian-Pomeranian*)	Food industry	Safe food and agriculture
Lubelskie (*Lublin*)	Food industry	–
Łódzkie (*Łódź*)	–	Innovative agriculture and agri-food processing
Mazowieckie (*Masovian*)	Food security	
Opolskie (*Opole*)	–	Agri-food processing technology
Podkarpackie (*Subcarpathian*)	Food industry	–
Podlaskie (*Podlasie*)	–	Agri-food industry and sectors in the value chain
Świętokrzyskie (*Holy Cross*)	–	Modern agriculture and food processing
Warmińsko-Mazurskie (*Warmian-Masurian*)	–	Water management and high-quality food
Wielkopolskie (*Greater Poland*)	Food industry	Bioresources and food for conscious consumers

Source own elaboration

whereas others combine numerous sectors or are related to specific technologies. Industrial sectors and regional smart specializations are not always consistent with the classification of smart specializations in agri-food production and agriculture at the national level (Table 4).

Poland has significant agricultural capital, and it is one of the leading food producers in the European Union. The food industry, food production, and agriculture are the predominant sectors and smart specializations in 10 Polish voivodeships. Smart specializations were directly linked with the relevant industrial sectors in only two voivodeships (Kujawsko-Pomorskie and Wielkopolskie). The clusters in Podkarpackie and Lubelskie voivodeships operated in the food processing sector, and the clusters in Mazowieckie voivodeship operated in the food security sector. In the remaining voivodeships, smart specializations were related to the food industry and agriculture. These findings indicate that agriculture is an important sector of the Polish economy, and that clusters, sectors, and smart specializations will pave the road to the future development of Polish voivodeships. The relevant measures and activities require effective policies targeting agribusiness clusters.

Expert Survey—Policies Targeting Regional Agribusiness Clusters—Opportunities and Barriers

The survey involved direct interviews and telephone interviews with 10 experts responsible for agricultural policy and regional development at the Marshal's Office, the Agency for the Restructuring and Modernization of Agriculture, and Agricultural Advisory Centers in the voivodeship of Warmia and Mazury. The respondents were of the opinion that effective cluster policies, in particular policies targeting agro-clusters, were not available. This observation suggests that a general framework should be established for evaluating regional policies that are responsible for grass-roots initiatives such as agro-clusters. According to the experts, smart specializations in agriculture can be partly identified based on an analysis of regional clusters. A model of cooperation between local governments, businesses and stakeholders could be developed by creating regional platforms for the exchange of experiences and good practices. Financial support is also an important issue. Clusters and their members should have access to financial instruments dedicated to farmers who have an interest in improving their professional qualifications and implementing innovative solutions in their farms. These financial instruments should be available at the regional level.

The offices of voivodship marshals could participate in such initiatives by communicating important information about cluster operations and cluster policies (meetings, workshops, conferences) on dedicated Web sites, and by organizing events, missions, study tours, and information centers. Various incentives and support measures should be initiated to encourage farmers to implement innovative solutions in agricultural production and in their farms. Dedicated Web sites containing information about agricultural cluster policies, projects, members, and membership options could also promote the establishment of regional clusters. According to the surveyed experts, promotional measures contribute to the development of clusters and influence the operations of individual farmers. Clusters should be promoted not only on local and regional markets, but also in the international arena to facilitate cooperation with high-performing clusters. Collaboration between clusters, including the commercialization of research results, networking, and the creation of project consortia, is also an important consideration. To promote the growth of clusters, effective intellectual property policies is needed to protect innovative solutions and novel products. The proposed measures will improve the status of local farms, promote the development of cluster members, and drive innovation in agro-clusters.

Farmer Survey

The survey involved 180 farmers in the voivodeship of Warmia and Mazury. The size of the surveyed population was dictated by the number of farmers who could be directly accessed. The survey was conducted in line with international standards

Table 5 Characterization of the respondents

Parameter	Total
Number of farms: • farms with an area of up to 20 ha	180
Sex: Women Men	154 26
Age: 18–34 35–54 55 +	20% 35% 45%
Average farm area in ha up to 2.9 ha 3–4.9 ha 5–9.9 ha 10–19 ha 20 ha	11% 14% 20% 25% 25%
Percentage of respondents who recognized the benefits of cooperating with clusters	77.1%
Percentage of respondents who identified the barriers to cooperation with clusters	51.2%

Source own elaboration

applicable to Sustainable Development Goals, in particular Goal 9: Industry, Innovation and Infrastructure, as well as a review of the solutions implemented in other countries, including Germany (Pölling et al 2017). In the questionnaire, the respondents were asked to identify the expected benefits and barriers to cooperation with clusters. The respondents are characterized in Table 5.

The majority of the surveyed farmers were 55 and older. Most respondents owned farms with an area of 10 ha to more than 30 ha. More than 77% of the farmers were of the opinion that cooperation with clusters could deliver benefits, whereas the barriers to such cooperation were identified by more than 51% of the respondents. The perceived benefits of cooperation within clusters are presented in Table 6.

The survey revealed that farmers recognized the benefits of cooperation within clusters. Most respondents were of the opinion that cluster membership can deliver financial benefits, increase farming incomes, facilitate the implementation of innovative solutions and new technologies, and expand the farm's productive output. Every fourth farmer expected the implementation of environmentally friendly solutions. It should be stressed that according to the respondents, cooperation with clusters could improve resource use efficiency, decreases costs, promotes specialization, and facilitates the introduction of new types of agricultural production. Other identified benefits included the possibility of selling products when the prices of agricultural commodities are highest, generation of off-farm incomes (agricultural services), and enhanced competitive advantage.

These findings confirm that agro-clusters expert a positive impact on farm operations. By cooperating with clusters, farmers can expect to improve their performance and expand agricultural operations. According to the respondents, cooperation with

Table 6 Perceived benefits of cooperation within clusters

Benefits	Respondents (%)
Financial benefits	40
Innovation and new technologies	32
Increased agricultural production	30
Implementation of environmentally friendly solutions	24
Improved resource use efficiency	22
Specialization	20
New type of agricultural production	15
Selling products when the prices of agricultural commodities are highest	10
Off-farm income (agricultural services)	9
Lower production risk	5
Access to new markets (agricultural commodity exchange, food processing companies)	5

Source own elaboration

agro-clusters not only delivers financial benefits, but it also promotes the implementation of innovative solutions and specialization, thus expanding productive output and improving the efficiency of agricultural production.

The respondents also identified the barriers to cooperation with clusters. The results are presented in Table 7.

The vast majority of the surveyed farmers identified several barriers to cooperation with agro-clusters. The most frequently identified obstacles were the absence of previous experience of cooperating with clusters, lack of incentive, insufficient information about cluster membership, no contact persons for communicating with

Table 7 Barriers to cooperation with clusters

Barrier	Respondents (%)
No previous experience of cooperating with clusters	30
No incentive to cooperate with clusters	25
Insufficient information about cluster membership	20
No offers of membership	19
No contact person for communicating with farmers	18
Excessive formal requirements	15
Membership offer does not match the farm's profile	14
No need to cooperate with a cluster	10
Cluster is located far from the farm	9
High service costs	4

Source own elaboration

farmers, excessive formal requirements, and the lack of perceived need to cooperate with clusters.

The lack of previous experience and the absence of incentives for cooperating with clusters could indirectly indicate that agro-clusters are not highly active on local markets. Clusters that actively encourage farmers to cooperate can significantly contribute to the development of social capital in rural areas and promote entrepreneurial and active attitudes. The fact that the respondents expected to be personally addressed by clusters could indicate that some farmers do not directly recognize the potential benefits of cooperating with agro-clusters. Many farmers lack the knowledge about agro-clusters' competences and field of operation. Therefore, clusters should initiate promotional activities to distribute such information and encourage farmers to cooperate.

The results of the survey indicate that members of agro-clusters can play a very important role in eliminating barriers to effective cooperation with farmers. Possible solutions to improving the collaboration between farmers and agro-clusters are proposed in the next section.

Solutions for Improving Cooperation Between Farmers and Agro-clusters

The results of the present study suggest that agro-clusters are responsible for some of the barriers to cooperation with farmers. Many clusters do not offer incentives that could encourage farmers to cooperate. The lack of personalized incentives motivating individual farmers to join agro-clusters is one of the reasons for farmers' passive stance. Farmers are reluctant to become cluster members because they lack the knowledge about possible benefits. Agro-clusters do not employ dedicated personnel who would assist potential members in filling in the required documentation and encourage farmers to become members. Some farmers do not see the need to work with clusters, do not have sufficient knowledge about cluster operations, and are unable to access the relevant information online due to the absence of dedicated offers. Farmers often lack to time to search for new opportunities because farm work is a full-time job that occupies most their waking hours. In view of the above, the authors proposed a solution that would enable clusters to effectively channel their resources and distribute responsibilities for cooperating with farmers. The developed system would facilitate the flow of information between agro-cluster businesses and potential members. As part of the proposed solution, members of agro-clusters would share responsibility for eliminating the existing barriers and incentivizing farmers to join the cluster. The designed system also features dedicated units that would be responsible for field operations and direct communication with farmers. A diagram illustrating the structure of the proposed system for cooperation with farmers is presented in Fig. 7.
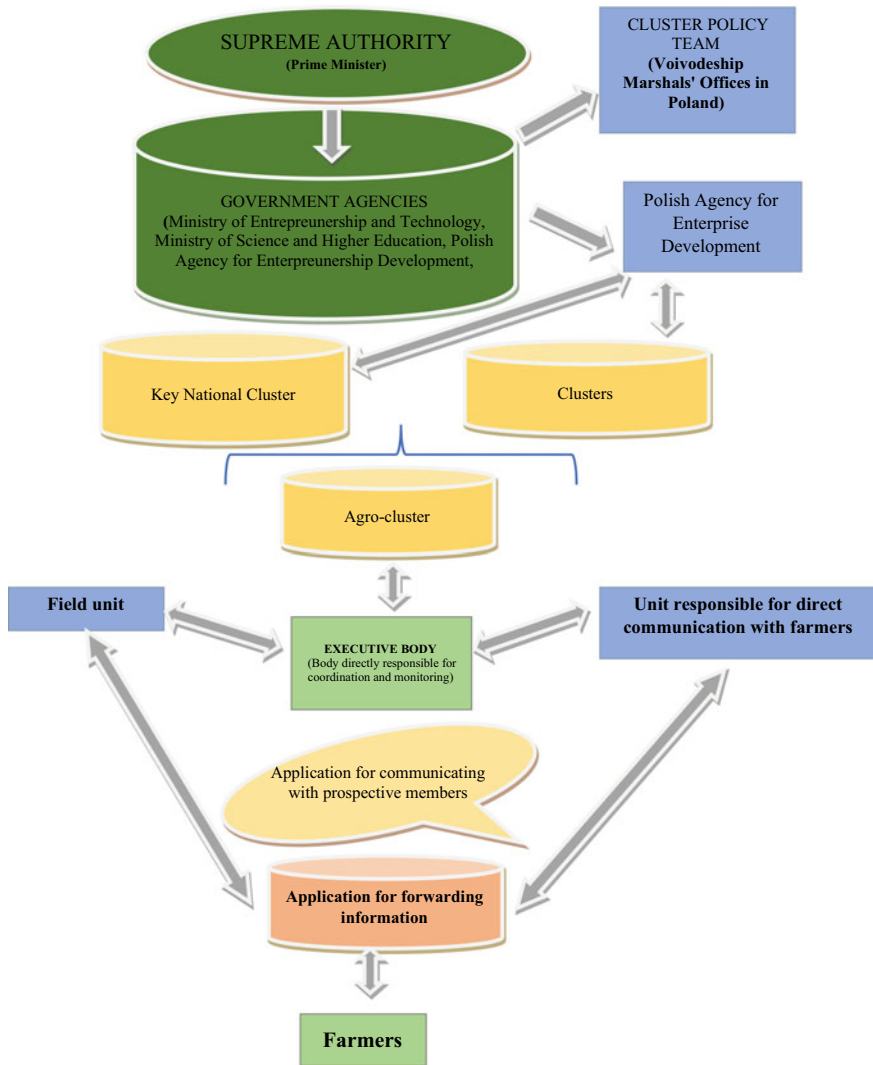
Fig. 7 Distribution of responsibilities to facilitate cooperation between agro-clusters and farmers. *Source* own elaboration

In the proposed system, the distribution of competences was arranged in a hierarchical order, and entities that play a key role in communication with farmers were identified. The division of management tasks from the macro- to the micro-scale supports effective coordination of activities aiming to expand cluster membership (Duczkowska-Piasecka 2012).

The developed system features supervisory, executory, and advisory bodies. The Prime Minister is the supreme authority who supervises the operations of government agencies (Ministry of Entrepreneurship and Technology, Ministry of Science and Higher Education, Polish Agency for Entrepreneurship Development, National Center for Research and Development), the Cluster Policy Team as an advisory body responsible for cluster policy (for example, Marshal's Offices in Polish voivodeships), an executive body (Polish Agency for Enterprise Development), Key National Clusters and clusters. Agro-clusters constitute a separate category in the existing group of clusters. Each agro-cluster would establish an executive body that would be directly responsible for monitoring and coordinating the relevant measures. Executive bodies would monitor the performance of units that are directly responsible for communicating with farmers as well as field units. This division of responsibilities would speed up communication and improve cooperation with farmers. The system also features a dedicated application that would speed up communication and enable farmers to submit the required information to clusters.

Conclusions

The future of the European Union rests on economic and social cooperation between the Member States. This assumption should also be applied to the operations of clusters, including agro-clusters. Agro-clusters are a link that combines agricultural production with commerce, science, consumers, and government institutions. The present study demonstrated that clusters play an important role in EU policy, including in Poland. These findings are important because the identified benefits and barriers to cooperation between farmers and agro-clusters can be used to implement solutions that promote effective collaboration on the agricultural market. By joining agro-clusters, small farmers can strengthen their position in the food supply chain, establish cooperation with new partners, reach new markets, and increase their competitive advantage by implementing innovative solutions and new technologies.

In the proposed division of competences, agro-clusters would create dedicated units that would be responsible for direct communication with farmers and would eliminate barriers to cooperation between farmers and clusters. Farming is a time-consuming occupation, and the developed system would feature an application that would enable farmers to submit the required information to clusters and minimize formal reporting requirements. Farmers who become members of agro-clusters can benefit from economies of scale by stabilizing their market position, promoting their products together with other members of the cluster, and increasing production profitability. Cooperation with clusters enables farmers to implement innovative technological solutions in agricultural production and decrease production costs by negotiating discounts on bulk purchases of fertilizers, pesticides, and machines.

The proposed measures can strengthen cooperation between farmers and agro-clusters which play an important role in economic policy. The economic policies of the EU Member States should combine regional and industrial policy tools to promote

the implementation of smart specialization strategies. Smart specialization programs support regional development. Clusters play an important role in the implementation of smart specialization strategies in European regions.

Smart specialization in European regions contributes to food security. Food security policies should rely on cooperation between government agencies, agro-clusters, and producers of agricultural commodities (farmers). The proposed system for the distribution of competences and responsibilities will eliminate barriers to collaboration between farmers and clusters and will contribute to the achievement of Sustainable Development Goals in Europe, in particular Goal 9: Industry, Innovation, and Infrastructure. Effective cooperation between state institutions, research centers, agro-clusters and farmers enables the introduction of modern solutions in agriculture, promotes environmentally friendly technologies, and fosters innovation.

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