Prospects for Farmers' Support: Advisory Services in European AKIS
WP 4 – AKIS ON THE GROUND FOCUSING KNOWLEDGE FLOWS SYSTEM | Topic 2

The capability of extension and advisory services to bridge research and knowledge needs of farmers

Demonstration Farms for Transfer of Knowledge Case Study from Poland (Draft Version)

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Poland
March, 2015

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement nº 311994

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List of Acronyms

AAC - Agricultural Advisory Centre in Brwinów

AMA - Agricultural Market Agency

APA – Agricultural Property Agency

CAP – Common Agricultural Policy

COP - Cooperative of Organic Producers

CTF – Controlled Traffic Farming

FAS – Farm Advisory System

ITLS – Institute of Technology and Life Sciences in Falenty

MARD - Ministry of Agriculture and Rural Development

NRI – National Research Institute

PAAC - Provincial Agricultural Advisory Centres

1 Executive Summary

This report presents the case of demonstration farms that operate within a cooperation network. The purpose of the study was to present the advisory opportunities in the process of linking education and the needs of farmers, with regard to innovative knowledge. In this process the advisory role was shown through the transfer of knowledge involving environmentally friendly practices from research and experiments conducted on demonstration farms. These farms implement many activities to limit the run-off of nitrogen and phosphorous compounds to groundwater, such as the preparation of fertilizer plans using innovative methods of balancing the fertilizer components, the application of intercropping and pro-environmentally friendly usage of organic fertilizers.

The first part of the paper discusses the origin and idea of establishing cooperation network. The scope is described and participants identified. The delimitation criteria are then discussed and presented concerning: the case study, selection and characterisation of the demonstration farms and the spatial range of carrying out the research. The applied research process, the research methods and tools are also briefly described. Next, research results are presented, including the following: participant characteristics within the cooperation networks, identification of knowledge and information sources, reconstruction of the knowledge transfer processes and methods as well as the types of created knowledge and their reference to social problems. Moreover, the agricultural advisory functions are characterised. Finally, the role of agricultural advisory services is defined regarding the process of scientific knowledge transfer. The paper also contains graphic presentation of knowledge flows within the described case study, alongside information regarding the system interactions, and various points of view from their participants.

The descriptive case presents an example of good practice in agricultural advising and advisory services, operating within a created network of cooperation. The network approach is characterised by various formal and informal connections between network participants and the interactions among them. The linkages and interactions between the network participants concern conducting research, designing and implementing solutions and tools, providing advice, and the dissemination of knowledge and information.

The effect of the cooperation of researchers, agricultural advisors and farmers is the formation of new knowledge: its generation, dissemination and adaptation to practice. The network approach contributes to the strengthening and development of collaboration based on partnership for cooperative problem solutions, and the implementation of innovative results.

According to research results, the agricultural advisor plays an extremely important role in the cooperation network. They connect and bind research with agricultural practice. An agricultural advisor has access to various network participants, as well as using a range of knowledge and information sources that are derived from the network participants. Agricultural advisory services permits contact of farmers and researchers, transfers knowledge and information to farmers and provides knowledge about the farmers´ needs and expectations.

2 Introduction

This case study is concerned with knowledge flows and research results within the agricultural knowledge and information system and the role of agricultural advisory services in this process. The study involved the research institute (Institute of Technology and Life Sciences in Falenty), agricultural field advisors from the Provincial Agricultural Advisory Centres (subordinate to provincial self-governments), specialists from the Agricultural Advisory Centre in Brwinów (subordinate to Ministry of Agriculture and Rural Development), farmers (the owners of demonstration farms[1]), and others (e.g. other farmers who are the potential recipients of innovations).

The main purpose of the case study was the identification of connections/linkages between the advisory organizations, science and agricultural practice as well as the identification of the best advisory practices. The network of demonstration farms were chosen as an example. These farms are used to conduct and test new agri-environmental practices. Furthermore, their owners cooperate with agricultural advisory and agricultural research institutes. The research conducted on these farms made it possible to design and disseminate various tools for achieving the assumed goals. These tools include, amongst others: a systematic individual advisory service, annual balance of fertilizer components and fertilization plans, creation of buffer zones, proper crop rotation, use of intercropping and companion crops, cultivation of energy crops, use of simplified agri-technology, application of Controlled Traffic Farming (i.e. setting out special passage routes on the farm), use of precision farming, building appropriate facilities for storing organic fertilizers, cooling liquid manure, the production of compost and set up of biogas plants, phase breeding of livestock, application of phytoremediation fertilizers and phosphorus barriers, as well as building home waste water treatment plants and drainage fields. As Pietrzak indicated [2013], these are examples of actions contributing to good agri-environmental practices.

The prepared tools for minimizing fertilizer losses and applying water conservation are the effect of network cooperation developed by: researchers, subject matter specialists, field advisors and farmers. The basis for the research and the platform for interaction were demonstration farms that assisted in creating and assembling knowledge.

The paper seeks to answer the following research questions:

- Do the agricultural advisory services still play an important role in the transfer of research results into agricultural practice?

[1] Demonstration farms have been established as a result of the implementation of *The Baltic Deal international project 2010-2013*. A total of 117 demonstration farms have been established in the countries of the region of the Baltic Sea, including 47 in Poland. The project was financed from the *Baltic Sea Region Programme 2007-2013 and NEFCO/NIB, Baltic Sea Action Plan*. The main goal of the project was the protection of water by the minimizing of fertilizers losses from agricultural farms without any harm to the productivity and competitiveness of these farms.

- What are the knowledge and information sources used by researchers, agricultural advisors and farmers?

- What is the role of knowledge and information exchange between farmers, research institutes and agricultural advisors (on the example of the cooperation network)?

- Is the cooperation between farmers, agricultural advisors and researchers permanent?

- Who supports farmers´ decision-making process concerning pro-environmental behaviours?

-What is the impact on the effectiveness and competitiveness of agricultural farms exerted by the implementation of good practices and operationalization of knowledge?

Photo 1: Practical training for agricultural advisors and farmers on demonstration farm
Source: www.cdr.gov.pl

3 Selecting and delimiting the case study

The case selection originated from an attempt to show good advisory practices with regard to the transfer of applied research results to agricultural practice and their implementation. The analysis consists of an innovative example of cooperation between science, agricultural advisory and farmers. The case selection was based on the following criteria:

- Advisory practices that are innovative (new solution, new knowledge, new methods, new tools);

- The condition that the case is observed throughout the country (national cooperation network, good practices network, knowledge and information network on the national level);

- The opportunity to observe the results of the case and implementation of new advisory practices (noticeable results, measurable and non-measurable effects).

The selected case shows a continuous cooperation network that associates with the national, as well as international level. These established demonstration farms are the components of the network. Network participants are presented in Figure 1.

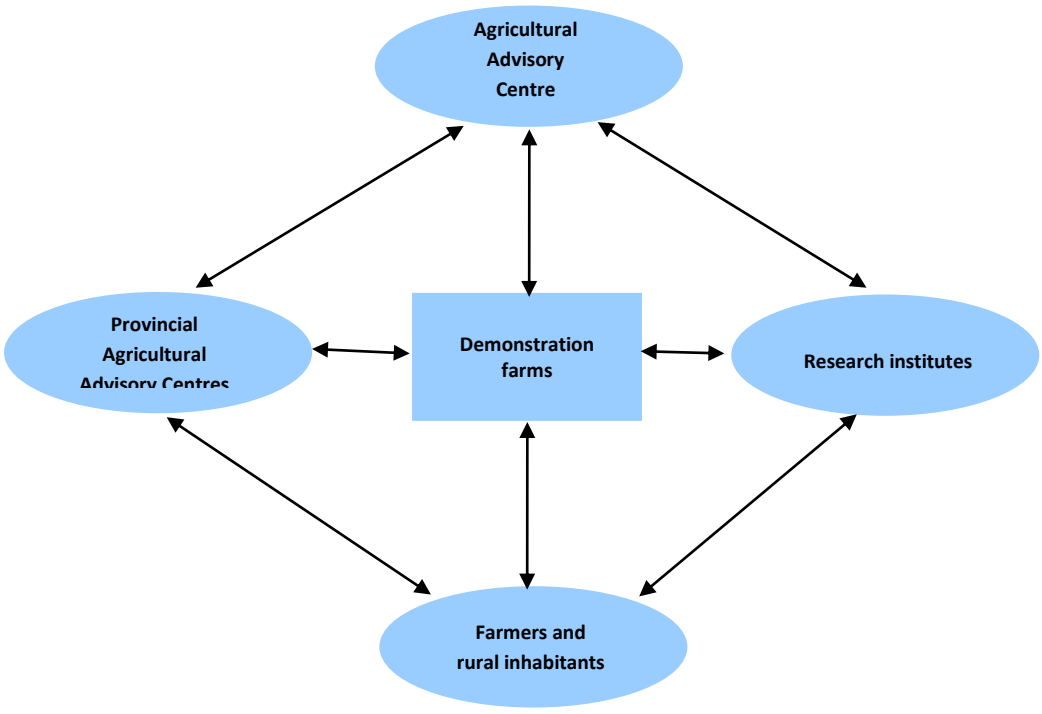


Figure 1: Cooperation network participants
Source: prepared by the authors

Network links are formed by:

- Research institute employees;

- Subject matter specialists from the Agricultural Advisory Centre (AAC)[2];

- Field advisors form the Provincial Agricultural Advisory Centres (PAAC)[3];

- Farmers (owners of demonstration farms);

- Farmers interested in pro-environmental practices that were implemented on the demonstration farms.

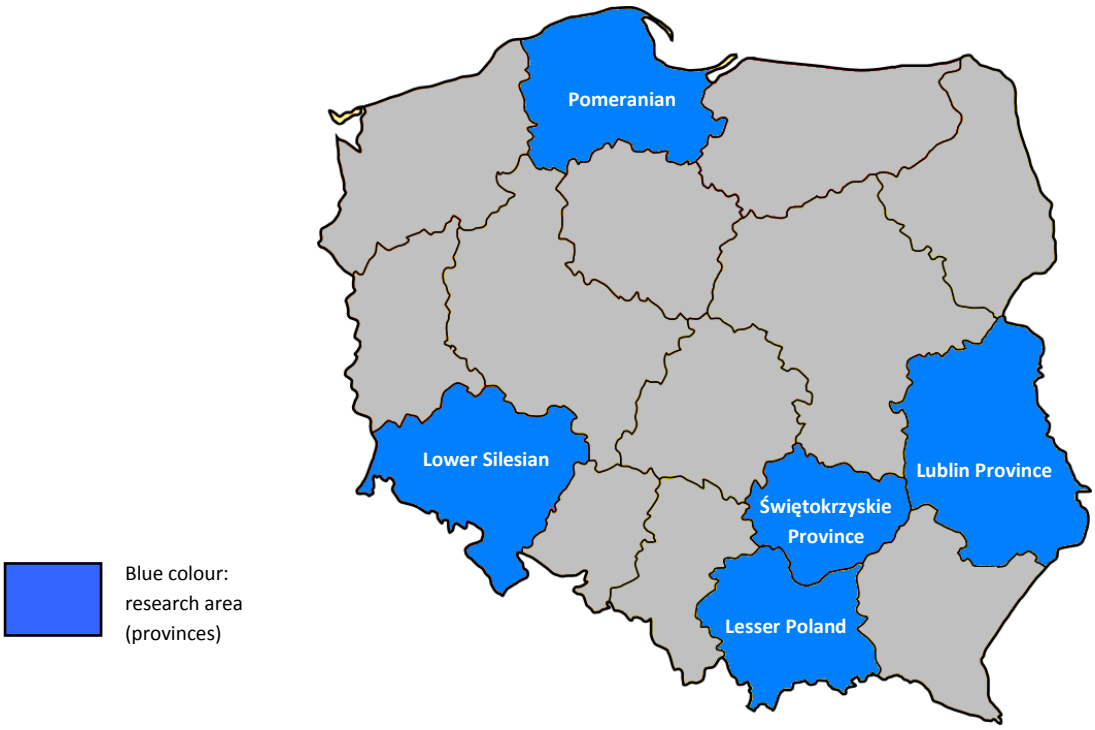
The most important role played by the demonstration farms is that of the cooperation "core", due to the fact that these farms are where the research is being conducted, where discussions and educational meetings are organized, along with training courses and workshops. The demonstration farms are the "meeting place" for all network participants, both farmers and advisors, as well as researchers.

[2] Agricultural Advisory Centre (AAC) in Radom is one of three branches (Radom, Kraków, Poznań) of AAC in Brwinów (near Warsaw) under responsibility of Minister of Agriculture

[3] The Provincial Agricultural Advisory Centres (16 in Poland) are under self-government boards.

4 General description of the case study

The case study sites were selected from five Polish provinces: Lesser Poland, Świętokrzyskie Province, Lower Silesian, Lublin and Pomeranian (see the Map 1). The objective was to select agricultural farms of different areas, different production types and operating in various natural and economic conditions.



Map 1: The scope of research with the regard to the administrative division of Poland
Source: prepared by the authors

The 'cooperation network', in the scope of transfer of knowledge, information and innovation, refers to the national and international level. The direct cooperation initiator and network coordinator is the Agricultural Advisory Centre, branch in Radom (AAC). AAC is one element of the farm advisory system (FAS) in Poland. The main task of this unit is, primarily, organization of professional training for agricultural advisors and dissemination of research results among farmers. Moreover, the AAC sets and runs knowledge and information central systems for the purposes of agricultural advising [[Kiełbasa 2014].

Since the cooperation network includes many stakeholders, a range of representative interests involved in the cooperation were selected. The research included 19 people in total (Table 1).

Table 1: Stakeholders of the network selected to the case study

STAKEHOLDER	SURVEYED PEOPLE
Institute of Technology and Life Sciences in Falenty	Academic researcher (Stefan Pietrzak, Associate Professor)
Agricultural Advisory Centre in Brwinów, branch in Radom	Subject matter specialist (Marek Krysztoforski)
Provincial Agricultural Advisory Centres	Field advisors (five people)
Demonstration farms	Demonstration farm owners (five farmers)
Farmers	Other farmers selected randomly (seven people)

Source: own research

The selection of the demonstration farms for study was purposeful and undertaken in conjunction with agricultural advisors. In total, 47 farms in Poland are involved in this research network of testing environmental practises. The overall area of all the farms involved is almost seven thousand hectares. Average demonstration farm size is 144.8 hectares. The smallest is 7.5 hectares and the largest is more than 1.7 thousand hectares. Average stock was 0.52 DJP/ha, while in livestock farms it was 1.09 DJP/ha. Farms incorporated in the cooperation network differ from one another in utilised agricultural area, production type and its scale. One quarter of all farms maintained cattle, 23% conducted field-scale crops, 23% mixed crops, 21% pig production, and only 9% of demonstration farms carried out horticultural crops [www.baltic.cdr.gov.pl]. Table 2 specifies the selected demonstration farms, followed by a brief description.

Table 2: Number of demonstration farms in Poland and selected for the case study

PROVINCE	NUMBER OF OPERATING DEMONSTRATION FARMS WITH REGARD TO GOOD ENVIRONMENTAL PRACTICES	DEMONSTRATION FARMS SELECTED FOR THE CASE STUDY
Lower Silesian	3	Farm of Marian Rak
Kujawsko-Pomorskie	4	---
Lubelskie	3	Farm of Urszula and Piotr Osik
Lubuskie	2	---
Łódzkie	2	---
Lesser Poland	2	Farm of Mariola and Wojciech Kłębek
Mazowieckie	5	---
Opolskie	2	---
Podkarpackie	2	---
Podlaskie	3	---
Pomeranian	3	Farm of Jacek Plotta
Silesian	2	---
Świętokrzyskie	2	Farm of Dariusz Górski
Warmińsko-Mazurskie	4	---
Wielkopolskie	5	---
Zachodniopomorskie	3	---
Total	**47**	**5**

Source: AAC in Brwinów, branch in Radom

1. **Marian Rak** has been running his farm since 1975. The farm area is 102 ha. The main crops are: wheat, corn and mixture of clover with grass. Average yields are at the level of: winter wheat 6 t/ha, corn 10 t/ha, potatoes 35 t/ha, spring barley 4,5 t/ha. The farmer cooperates with his daughter's farm. She raises Limousine beef cattle (14 suckler cows, 1 bull, 4 heifers, 9 calves). On Marian's farm, a wide range of good agricultural practices are used, aiming at, above all, the preservation of biodiversity and limitation of nutrient losses. The farmer tries to link agricultural production with environmental protection, therefore, the farm is conventional and progressive. The areas of lower land were planted with trees and bushes. The farmer applies stubble crops, maintains buffer zones and small ponds as well as establishes ditches and hedges. On the farm, ecological corridors for livestock, walls for bees and natural refuges for bats and owls have been provided. On the farm there are many valuable species of animals which the farmer tries to protect. These include, amongst others, the great crested newt, fire-bellied toad, sand lizards and grass snakes. In 2005, the farmer applied for support from the agri-environmental program, however, good ecological practices have been used on this farm for many years.

Photo 2 and 3: Limousine cattle in Marian Rak's farm
Photo B. Kiełbasa

2. **Urszula and Piotr Osik** run an agricultural farm established in 1930 by the owner's grandparents. In 1984 Piotr Osik inherited the farm and since 1999 he has run an organic production. The owners undertake vegetables growing for industry, organise educational activities, and – to a lesser extent - agritourist activities. Overall farm size is 63 ha, of which 9 ha are meadows and pastures. On an area of approximately 33 ha are cultivated with garlic, cucurbitaceae (mainly pumpkin), bean, brassicaceae (e.g. cabbage), as well as rhubarb and leek. The remaining land is sown with crops and crop mixes. The farm complies with strict principles of organic farming because vegetables are sold to companies which produce food for children and infants. Additionally, the farmer implemented a range of actions aiming at the limitation of nitrogen and phosphorus compounds, including the use of rational natural and organic fertilizers, winter catch crops and rotation of bean plants. The farmer applied good practices with regard to pro-ecological agri-technology. For this purpose the farmer purchased, amongst others: a rows conditioner, weed fire burner, sowing sprinkler and subsoiler to aerate soil. In addition, the owners have their own sewage treatment and solar collectors. On the farm are located small apiaries, nesting boxes and bird feeders. The Osik's farm is one of the leading organic farms in Poland. In 2008, it won the 1st place in national competition for the best organic

farm, and in 2004 gained the prestigious *Giovanni Marcone* award with regard to the implementation of good ecological practices. Furthermore, the owner of this farm is the president of the Cooperative of Organic Producers (COP) and a member of the Council of Organic Agriculture at the MARD.

Photos 4-6: Osik's organic farm
Photo Osik and B. Kiełbasa

3. **Mariola and Wojciech Kłębek** have been running the agricultural farm since 2008. Currently, together with their son, they manage a territory of approximately 420 ha. The main line of production is maize grown for grain as well as (to a lesser extent) wheat for grain. An additional form of activity is agritourism and agricultural support services (like planting vegetables, distributing fertilizers and harvesting). With regard to good practices on the farm, appropriate agri-techniques are used, specialized equipment with which the farm is provided are used (these are, among others, harvester, tractors, trailers and sprayers), as well as compliance with relevant seed storage principles (modern dryer propane heated and grain silos).

Photo 7 and 8: Grain silos in Mariola and Wojciech Kłębek's farm
Photo B. Kiełbasa

4. **Jacek Plotta** has been running an agricultural farm since 1984 and since 2005 he has been using only organic methods. Overall farm size is almost 140 ha, mostly agricultural lands. Meadows and pastures are 12 ha and forests are 15 ha. OIn farm fattening of Danhybryd pigs, intended for export to Denmark and Germany, is conducted in a closed cycle. Annual average stock is 0.2 DJP/ha. On the farm a seed crop of wheat and clover is also produced. Average fodder crop yields are 2.2 t/ha, red clover 0.3 t/ha and spring wheat 1.8 t/ha. Meadows are used extensively. The production of pigs for fattening takes place in closed cycle (30 sows) and annually approximately 200 pigs for fattening are sold. In farm pasture system is applied: sows and piglets are kept in small Danish bars. Additional to the needs of family, the farmer owns two milk cows and a Wielkopolska breed. Applied good practices are primarily: pig farming with use of only ecological methods in grazing system and agri-environmental program assumptions, use of microbiological preparations, and care of small ponds and trees. The total area of five water reservoirs is approximately 1 ha. The farmer also conducts environmental education on the farm in cooperation with the Pomeranian Agricultural Advisory Centre.

Photo 9 and 10: Danhybryd pigs in Jacek Plotta`s farm
Photo J. Plotta

5. **Dariusz Górski** has been running an agricultural farm since 2001. The total farm area is approximately 44 ha (more than 33 ha are arable and 7 ha are permanent grasslands). The owner is involved in the production of pigs for fattening in a closed cycle and the production of cows milk. On the farm, maize and corn are grown for grain. Average yields are 5 t/ha of winter wheat. 4.5 t/ha of triticale, 4 t/ha of rye and 4.5 t/ha of barley. The farmer each year applies stubble catch crops. Dariusz Górski is involved in milk production (58 000 litres on average per year, total cows number: 10), the production of pigs for fattening (on average 500 pigs for fattening). Good agricultural practices relate to, above all, the proper use of livestock buildings and compliance with animal welfare principles. The farmer undertook the modernization of buildings, as well as adding some space, so that different livestock were housed separately.

5 Methods and data collection

The case study method enables the accurate analysis of phenomena, it allows comparisons to be made and differences identified, building relations and links which lead to better understanding. The case study may thus better describe and explain phenomena than extensive statistical survey. This method can be either an analysis of one or in conjunction with other various cases, where data for analysis can be obtained, in particular, by observation, interview and document analysis [Czakon, 2011].

In order to collect data a method of secondary data analysis was used (statistical data from the Main Statistical Office, data from Agricultural Advisory Centre, branch in Radom and from the Institute of Technology and Life Sciences in Falenty) along with primary data. In order to collect primary data in-depth individual interviews were undertaken and a survey method was used. In order to achieve the research objective the following tools were used: survey questionnaire and in-depth interview questionnaires.

In-depth interview questionnaire was used in individual interviews with:

- Researchers;

- Subject matter specialist from AAC;

- Field advisors;and

- Farmers who run demonstration farms.

In-depth individual interview is a method used in qualitative research, based on conducting interviews with a relatively small number of respondents, selected in relation to the research subject or a given problem [Sławińska, Witczak, 2008]. Prepared interview questionnaires were partially structured, that is focused on a given problem and takes into account individual respondent situation and opinion.

In-depth interview questionnaire with the researcher consisted of general questions concerning the researcher profile, tasks being implemented as part of the research institute and detailed questions with regard to the researcher role in the research results transfer into agricultural practice, and effects of cooperation between researcher and agricultural practice. Questions were supposed to determine the direction of knowledge flows between participants in agricultural knowledge and information system.

The in-depth interview questionnaire with the AAC subject matter specialist was aimed at, above all, obtaining information about the role of the AAC in the transfer of research results into agricultural practice, as well as dissemination of good agricultural practices. Questions were related to the respondent's individual functions in the research projects and implementation of advisory tasks within the case.

The in-depth interview questionnaire with the farmer who runs the demonstration farm contained primarily, questions concerning farmers' opinion on advisory services, knowledge and information sources, innovations in agriculture and conducted research. Questions also concerned knowledge flows issues.

The in-depth interview questionnaire with agricultural field advisors that cooperate with demonstration farms included general questions concerning the Provincial Agricultural Advisory Centres and advisor professional profile. Detailed questions were related to issues concerning cooperation between advisor and demonstration farm and other agricultural knowledge and information system participants. The interview was focused on discussion regarding how new knowledge is generated and how it flows between farmers, advisors and researchers.

In order to obtain further information also survey method was used. This method was used in order to obtain information from farmers who participated in the training, meetings or seminars organized in demonstration farms, or who are located in the neighbourhood. Questionnaires were transferred by field advisors personally to farmers or electronically with request for return. *The questionnaire survey to the farmer* contained questions regarding the agricultural farm description, type of advisory services which farmers used, knowledge and agricultural information system description and assertions about the research transfer into agricultural practice.

The result of the research implementation therefore included:

- conducting 12 individual in-depth interviews,

- obtaining 7 survey questionnaires from among 18 sent to farmers.

6 Results

6.1 Actors and sources of knowledge: Where does the knowledge comes from?

On the basis of collected information and previous knowledge of the Authors, it can be stated that the knowledge and agricultural information transfer process involves the participation of various actors (entities), including:

- Provincial Agricultural Advisory Centres subordinate to provincial self-governments;

- Agricultural Advisory Centre under the Minister of Agriculture and Rural Development;

- Demonstration and educational farms;

- Companies supplying agricultural inputs, e.g. selling: feeds, fertilizers, seeds, pesticides, grains, machines, devices, etc.;

- Companies and cooperatives purchasing raw materials and agricultural products;

- Research institutes;

- Agricultural universities;

- Agricultural high schools and higher vocational schools offering agricultural studies;

- Experimental stations;

- Agricultural associations and trade unions;

- Agricultural agencies: Agency for Restructuring and Modernization of Agriculture (ARMA), the Agricultural Market Agency (AMA), Agricultural Property Agency (APA);

- Veterinary inspection services; and

- Farmers.

The knowledge comes from various sources. The type of knowledge which is needed on farm is mostly determined by the production line, farmer experience in management (the smaller their experience, the more often various sources of information are sought,) and financial capabilities. On the basis of the interviews conducted, various sources of knowledge and information were identified. They are specified below, including the hierarchy of importance (prioritization):

1. The Internet (email, agricultural portals, YouTube, social networks, etc.);

2. Agricultural training courses, e-learning and blended-learning courses;

3. Literature: agricultural journals (e.g. Top Agrar, journals issued periodically by PAAC or by AAC), training materials and instruction materials, leaflets, brochures or agricultural manuals;

4. The research projects conducted in Poland and abroad, working in international teams, joining initiatives;

5. Domestic and international conferences and seminars;

6. Study trips in Poland and abroad (e.g. to other demonstration or educational farms);

7. Experiments conducted on farms by companies supplying production means (e.g. creation of experimental plots, field tests);

8. Workshops, shows, fairs, agricultural exhibitions or festivals.

Agricultural advising directly cooperates, above all, with research institutes, the so-called National Research Institutes (NRI). These are, amongst others: the Institute of Technology and Life Sciences in Falenty, the Institute of Soil Science and Plant Cultivation NRI in Puławy, National Research Institute of Animal Production in Balice, Institute of Rural and Agricultural Development NRI, Institute of Agricultural and Food Economics NRI. All interviewed advisors highlighted the crucial role of the research institutes with regard to previous research and experiments. By working together in research projects, experiments and the dissemination of innovations, it is possible to transfer research results and fulfil the farmers' knowledge needs. Essential links in this process are agricultural advisors who cooperate with research institutes and the researchers employed there. Agricultural advising is therefore a kind of platform between science and agricultural practice. Cooperation between advisors and research institutes has a significant influence on the level and the scope of advisory services provided.

However, agricultural advisors and farmers pointed out that the cooperation with agricultural universities is not sufficient. The reason is, to a large extent, the lack of benefits for the cooperation with practice, i.e. in this case for the cooperation with agricultural advisory and farmers. The respondents pointed to only a few (or zero) contacts with agricultural universities, a lack of research coordination with farmer's needs, and weak research transfer into agricultural practice. Respondents assumed that for the close collaboration between science and agricultural practice, it is necessary for advisory institutions to become a "broker" between the science and a practice. They have direct contact and close relations with farmers, mainly with those who are leaders in rural communities and those who most rapidly acquire innovations. Farmers also highlighted the lack of access to technological knowledge from e.g. specialized agricultural advisors from the Provincial Advisory Centres as well as from research institutes (in the form of, for example, instructional booklets prepared by researchers, described in the advisors opinion as: "published in the past and very useful").

Demonstration farm owners are knowledge creators and co-founders within knowledge network. On demonstration farms, the exchange of experiences occurs (e.g. during training, discussion meetings and seminars), and new knowledge is created (for instance, as a result of research implementation and the conducting of experiments).

Taking into account other farmers, e.g. those who participated in training organized on demonstration farms, it should be stated that they use free public advisory services most often and willingly participate in training organized by advisory centres. With regard to advisory needs all farmers indicated technological knowledge and information about the Common Agricultural Policy (CAP). Moreover, the training sessions that they attended were assessed as interesting, eventful and encouraging good environmental practices. They underlined the innovation of knowledge applied on demonstration farms but, at the same time, they indicated that not all solutions and tools can be applied on their farms. The reasons for this are, for example: the lack of proper financial means, fear of changes or the lack of support (financial, advisory) in the process of the implementation of new solutions.

6.2 Processes and methods to exchange knowledge

The process of knowledge exchange is complex and multidimensional. Knowledge is created, generated, supplemented and processed on many levels. Several methods of knowledge exchange can be specified on the basis of:

- The implementation of common research by agricultural advisory centres and research institutes (advisor- researcher);
- The organization of training sessions for farmers and country inhabitants by the Provincial Advisory Centres (advisor-farmer), including the demonstration farms (farmer-farmer);
- The implementation of the field tests and experiments by researchers from research institutes and universities on demonstration farms (sampling of water and soil, experimental fields, etc.) (researcher-farmer);
- Training and experiments carried out by the companies supplying the means of production (seller-farmer).

In the opinion of the respondents the role of research in agriculture should be essential, but it is insufficient. There is a barrier in the transfer of knowledge directly to the farmer. Research institutes and agricultural universities should equip the AAC with knowledge and information which would be transferred to the local advisors who, in turn, could pass this knowledge to the farmers. The general evaluation by the farmers indicates the lack of measurable effects and the low usability of research in agriculture. Most often it results from the application of the technology transfer model instead of the social interaction or problem solving model. The two latter approaches focus on the close cooperation with farmers and the search for solutions to problems that they face every day. Advisors underlined the significance of the research in growing competitiveness and innovation of Polish agriculture. In their opinion there is no consistent system of knowledge and information exchange between science and practice. This system would be based on a close and regular cooperation of science and advisory services, e.g. in the form of a permanent cooperation calendar (meetings, seminars at the research institutes or universities). As a result of a such cooperation, it would be possible for the researchers to become familiar with the problems reported by farmers, and familiarize advisors with scientific issues.

The partnership of knowledge and information exchange in the case study discussed takes place on many levels and includes many actors. The relations occurring between the most important actors of the knowledge network are presented below. Their character and commonly used methods are described.

I. Farmers ⟷ field advisors

The cooperation of farmers with field advisors has an informal character in many cases. Field advisors often come from rural areas where they work and provide advisory services. Considering the cases discussed it can be noted that all farmers strictly cooperate with local advisors from the Provincial Agricultural Advisory Centres. They regard their availability, knowledge and reliability very highly. Usually farmers use the services related to completing application forms and the law of the European Union. They emphasize that it is a continuous and systematic cooperation (meetings at least once a month). In the farmers' opinion, the public agricultural advisory services most often deliver the wide range of information on research in agriculture. The advisory services initiate cooperation and connect the farmer with the researchers.

II. Farmers ⟷ researchers

The partnership of researchers and farmers takes place most often within the implementation of the research projects. They are, however, quite occasional and the role of researchers consists mostly in preparing tools and research methods, then circulating the received results. In the farmers' opinion, this cooperation is insufficient. In addition, farmers often do not receive the results of the research in which they participated. According to the researchers the contact with practice has a tremendous importance. They evaluate highly the engagement with farmers and opportunity to exchange opinions with them. However, in their opinion such contacts are very limited and the reasons for this are the lack of funds for implementing the projects allowing to solve the specific problems of farmers and also inadequate rewarding of researchers for the cooperation with practice at their universities. Another weak point in the cooperation of a farmer with a researcher (in the farmers' opinion) is the fact that the passed knowledge is often too detailed and delivered in an academic way (e.g. lectures). The relations between farmers and researchers can be thus characterised as sporadic and formal.

III. Farmers from demonstration farms ⟷ other farmers

The method most often used in these relations includes training and shows on demonstration farms, to which other farmers and local community are invited. However, there were divergent opinions regarding the cooperation of demonstration farm owners with other farmers. On the one hand, farmers claim that the closest local community is quite reserve to the initiatives undertaken on these farms. On the other hand, they said that they noticed a large interest in the activities performed on demonstration farms (especially those that are organic). Furthermore the respondents noted cases of copying their ideas. Demonstration famers often give advice to other farmers or help to convert some farms to organic production.

IV. Subject matter specialists from the AAC ⟷ researchers

Researchers cooperate with the specialists from the AAC frequently within various research projects. This cooperation is formal and based on bilateral agreements. Researchers prepare research methods and tools, process obtained results and edit scientific publications within the projects. Subject matter

specialists coordinate research projects implementation, and organize meetings, conferences and scientific seminars, during which the research results are presented.

V. Subject matter specialists from the AAC ⟷ field advisors

The cooperation between the AAC and the PAAC is ongoing. The responsibilities of the AAC are, among others, the preparation and introduction of uniform methods of operation of the provincial advisory centres, preparation of the information and training materials, organization of professional training for advisors and teachers from agricultural schools and universities. The most commonly applied methods are group advising, mostly in the form of training, seminars, shows, courses (including e-learning or blended-learning), study trips in Poland and abroad, and also scientific conferences. The cooperation of the AAC and the PAAC is formal and regulated by *The Act on agricultural advisory bodies from 22 October 2004*.

VI. Researchers ⟷ field advisors

On the basis of the data obtained it can be stated that the cooperation of agricultural advisors with researchers is quite sporadic. It is most often the effect of the implementation of research projects in which researchers, farmers and advisors can participate. Researchers very often use the knowledge of field advisors concerning the specific nature of the agricultural farms in the given area. Field advisors, due to the fact that they are close to farmers and their farms, have good contacts with these farmers and a great knowledge about their situation and possibilities. Therefore, researchers often come to local advisors with a request for assistance in the implementation of field tests on agricultural farms. However, the transfer of scientific knowledge to field advisors takes place most often during the conferences and scientific seminars in which field advisors and researchers participate.

VII. Farmers ⟷ companies supplying the means of production

Farmers who deliver products to the market very often use the advice from private companies, most often those who deliver the means of production (e.g. seeds, fodder, fertilizers, plant pesticides, machines and equipment). Farmers assess the professionalism of the private companies very highly due to their narrow specialization strictly corresponding to their specific needs. Such companies constitute a very important source of information, for example, providing test results for farmer. Private companies deliver technological knowledge, most often by means of individual advice on a farm, conducting experiments, testing, delivering free samples, organizing training and discussion meetings for farmers, as well as domestic and foreign trips. Most often such a partnership is formal and long-term (e.g. with one or two companies), entirely financed by farmers. The respondents paying for advisory services are aware that they may fully define their own needs and they can enforce the quality and effectiveness of the services.

6.3 The knowledge content addressed by demonstration farms

Demonstration farms were established in order to achieve specific goals and conduct scientific research. Their functioning is permanent and it does not refer solely to the research implementation period. Demonstration farms serve as a research-training base which serves both researchers and agricultural advisors as well as other farmers. Since these are different farms, i.e. of different sizes, different types of production, located in different parts of Poland, and they meet different needs. Taking the obtained results into account, many types of knowledge developed on demonstration farms can be identified. They are, amongst others:

- Knowledge of the plant production technology (initially concerning proper fertilizing and the protection against pests);

- Knowledge concerning the animal production technology (mainly the nutrition of livestock);

- Knowledge about agricultural technology;

- Knowledge of the environmental protection and ecology;

- Knowledge of agro-environmental programs;

- Economic and farm management knowledge.

The issues raised in the cooperation network and the problems dealt with on demonstration farms have a close connection with public goods. The rationale for actions undertaken is to raise awareness of these problems and make the methods for solving them commonly available. Public goods are those that serve common needs and are used by the whole society, e.g. national defence, administration, education (as the goods delivered to the society by the state) [Maciejczak, 2009, Fijoł, 2011]. Agriculture and rural areas also deliver many public goods, such as: food safety, landscape, multifunctionality in agriculture, organic production, regional products, agritourism, biodiversity, natural environment, innovations in agriculture, etc. The type of knowledge and its content that are processed and developed in the discussed network strictly relate to the problems concerning public goods delivered by agriculture. The topics defined in the cooperation network relate to public goods such as: natural environment, biodiversity, surface, groundwater and natural landscape protection.

The target population for the activities provided on demonstration farms are all farmers in Poland. Due to a big diversity in demonstration farms, they have different problems and implement different ways to solve these problems. These actions correspond to the needs of farmers with regard to the methods and tools to limit fertilizing losses on agricultural farms. They are used for the protection of the natural environment, especially water protection. Farmers use this knowledge commonly because they are all obliged to meet the requirements of cross-compliance principles from 2013, and they will be required to apply the principle of integrated plant protection from the year 2015.

It is commonly known that agriculture belongs to those forms of human activity that have the greatest impact on the natural environment and groundwater. In order to minimize the adverse effect of the agriculture on the environment and biodiversity, the forum of the EU introduced many legal acts and agreements, among others, the Nitrates Directive, Water Framework Directive and the Helsinki Convention. The biggest threat to water quality are the ingredients of fertilizers from agriculture (especially nitrogen and phosphorus). They penetrate groundwater, primarily, as a result of water and wind erosion, washing out nitrates from agrarian lands or ammonia emission from natural fertilizers. It results in water eutrophication, amongst other impacts. Pietrzak states [2013], on the base of his research, that the large losses of fertilizing components are observed particularly on the farms that lead animal production.

Establishing the knowledge and information network in which researchers, advisors and farmers can participate, resulted in the focus on the problem of environmental contamination by nitrogen and phosphorus compounds coming from agriculture. Balanced fertilizer management and the protection of water are supposed to help to protect the public goods provided by agriculture. Demonstration farms implement activities which relate to the region and country, but which also have results in the macroeconomic scale. These tasks correspond to the purposes of the:

- *Nitrates Directive*: "the purpose of the Directive is to reduce water pollution caused by nitrates coming from agricultural sources and the prevention of their further spread" *(Official Journal of the European Union L 31 of December 1991)*,

- *Water Framework Directive*: "the purpose of the Directive is to achieve a good chemical and ecological condition of water throughout the whole European Union until the year 2015" *(Official Journal of the European Union L 22 of December 2000)*,

- *Helsinki Convention*: "the main goal is the Baltic Sea maritime environment protection against the contamination from all sources: from the land, ships and atmosphere" *(Journal of Laws 2000 no. 28 item 346)*.

Demonstration farms have thus become the places where new solutions are tested, as well as new tools and new methods of environment protection. They are then disseminated on a wider scale. These farms conduct training sessions for agricultural advisors and farmers so that they can notice the results of these ecological activities and experiments. Therefore, it can be assumed that the problems raised on the demonstration farms are integrated with public goods in the field of natural environmental protection, especially water.

6.4 The role of advisory services

Considering the case analysed, it should be assumed that agricultural advising and its services perform the following functions [Kania ,2007, Wiatrak, 2006]:

- *Advisory function*: advice and consultations, most often in the form of individual discussion. The objective is to solve a farmer's problems;

- *Educational function*: executed by means of different advisory programs in the form of, for example: training sessions, courses, seminars, lectures, study trips to other demonstration farms. The purpose is to transfer knowledge to farmers or to develop certain skills;

- *Dissemination function*: shows, demonstrations, field tests and experiments (e.g. setting experimental fields). The objective is to encourage farmers to use technological innovations as well as economic and organizational ones;

- *Information function*: collecting, processing and popularizing the information among farmers; this is mainly market information and the one concerning assistance funds under the CAP. The objective is to transfer the up-to-date, reliable, verifiable and functional information to farmers, without assessing it or interpreting;

- *Income function*: implemented, first of all, in the form of individual advisory services on a farm, most often by private advisory companies or by the companies delivering the means of production. The purpose is to strive at maximizing the income from agricultural production by applying solutions to specific problems and expectations of a farmer.

The following entities are included in the implementation of agricultural advising:

- Provincial Agricultural Advisory Centres (field advisors);

- Private companies delivering the means of production;

- Private companies and cooperatives purchasing raw materials or agricultural products;

- Private advisory companies (consulting firms);

-Agricultural chambers;

- Research institutes and agricultural universities.

Public agricultural advising has been very close to farming for many years. Apart from organizing training courses for farmers (*educational function*), it focuses on providing comprehensive assistance to farmers and countryside inhabitants. Recent years it has been shown that the main focus of advise has been helping farmers to apply for financial aid from the EU funds (*the advisory function* and *the information function*). *The Act on agricultural advisory services in Poland of 2004* introduced the possibility of

charging fees for some advisory services. Primarily, those kind of payable services are related to: agricultural accounting, the preparation of business plans, running the accounting books, as well as completing application forms for the EU aid funds.

However, the *income function* of agricultural advising was partially taken over by private consulting companies or by the companies selling the means of production. Most of the surveyed farmers cooperate with private companies which deliver fodder, fertilizers, plant pesticides, as well as machines and devices. In the farmers' opinion, their knowledge is specialized, intended to solve one specific problem, most often in the context of costs reduction and maximizing income from agricultural production. These companies deliver professional technological knowledge and this knowledge is delivered to farmers (*dissemination* function). In the farmers' opinion these companies have access to up-to-date market data and new technologies, and they are mobile, as well as able to rapidly adapt to the market needs. Considering the analysed case it can be stated that the advisory services with regard to technology and innovations have been taken over by private companies delivering the means of production to a large extent.

Demonstration farms perform a very important function with regard to disseminating innovations. They are a base for field experiments and tests carried out by researchers and private companies. As a result, the owners of these farms become pioneers in their regions, with regard to the implementation of new technology.

6.5 The knowledge flows

On the basis of research and analyses the following kinds of knowledge were defined as essential for the case study:

- **Knowledge about limiting fertilizing losses in agricultural production;**

- Knowledge concerning agro-environmental good practices;

- Knowledge concerning modern animal production technologies.

The flow of knowledge has been presented from a farmer's, an agricultural advisor's and a researcher's point of view.

Figure 2 presents the process of creation and circulation of knowledge concerning limiting fertilizing losses in agricultural production from the researcher level. The knowledge is created by researchers and specialists from the Agricultural Advisory Centre on the basis of the experiments conducted on demonstration farms. Due to the operationalization of this knowledge, farmers, country inhabitants and local authorities are able to notice measurable effects of the conducted research. The knowledge is developed on demonstration farms and passed further. The circulation of knowledge is possible as a result of the cooperation of researchers and the AAC. The research results are popularized in the form of scientific publications, monographs or guides prepared jointly by the AAC and researchers. Those publications are transferred to agricultural advisors, farmers and other entities interested in it.

Figure 3 shows the flow of knowledge concerning good agro-environmental practices from the point of view of an agricultural advisor. The knowledge is created by research institutes, universities and the AAC. It is developed by these actors and is characterized by direct flows. Then it is passed to field advisors and farmers. Demonstration farms are very important in the process of creating this knowledge because they are the places where the knowledge is gathered and the creation of practical solutions takes place. Then it is passed further, i.e. to farmers, countryside inhabitants, local authorities and other entities interested in it.

Figure 4 shows how the flow of knowledge concerning animal production technology is organized, with particular focus on the fertilizing economy from the point of view of a farmer. The knowledge is created mainly by the AAC, research institutes and agricultural universities. It is developed in demonstration farms and in the Provincial Agricultural Advisory Centres. Demonstration farms are becoming the source of knowledge for other farmers and country inhabitants. In the process of transfer of knowledge to agricultural practice, participation occurs with private advisory companies that specialize in technological consulting, as well as with companies supplying means of production. The farmer has the opportunity to compare the knowledge about innovations passed by agricultural advisory centres with the knowledge delivered by private advisory companies or those delivering the means of production.

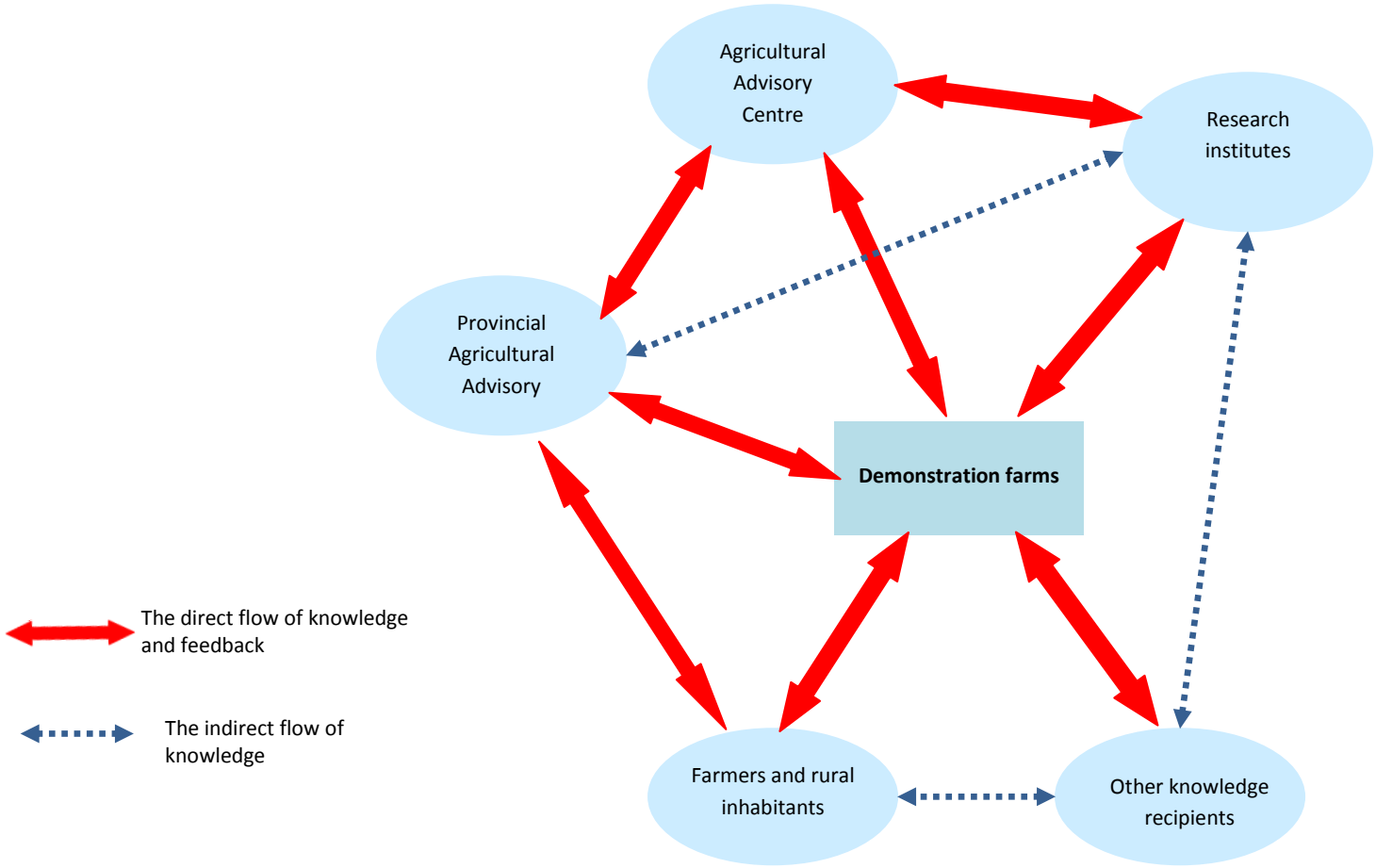


Figure 2: The flow of knowledge concerning limiting fertilizing losses in agricultural production from the perspective of researcher
The source: author's own research

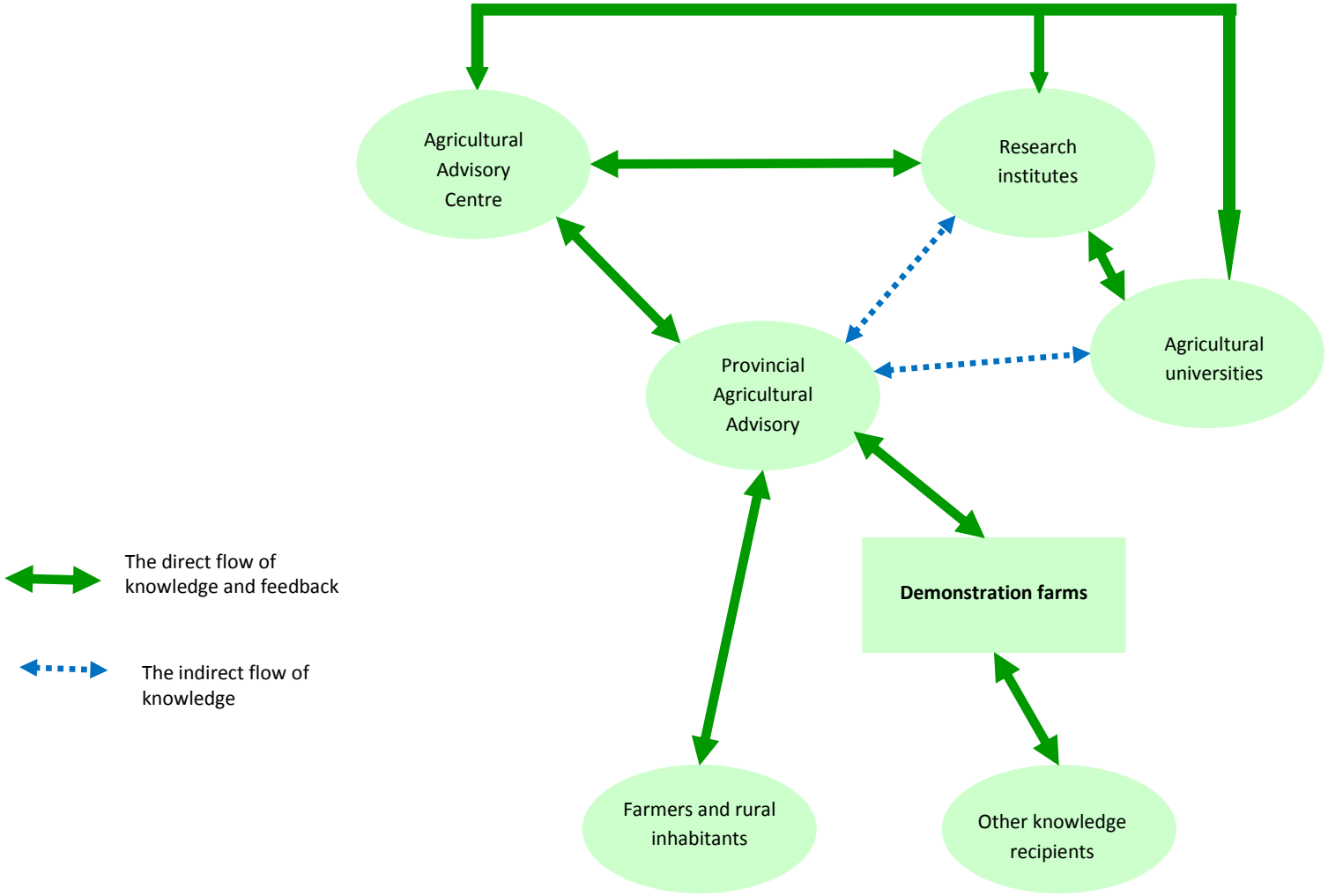


Figure 3: The flow of knowledge concerning agro-environmental practices from the perspective of an advisor
The source: author's own research

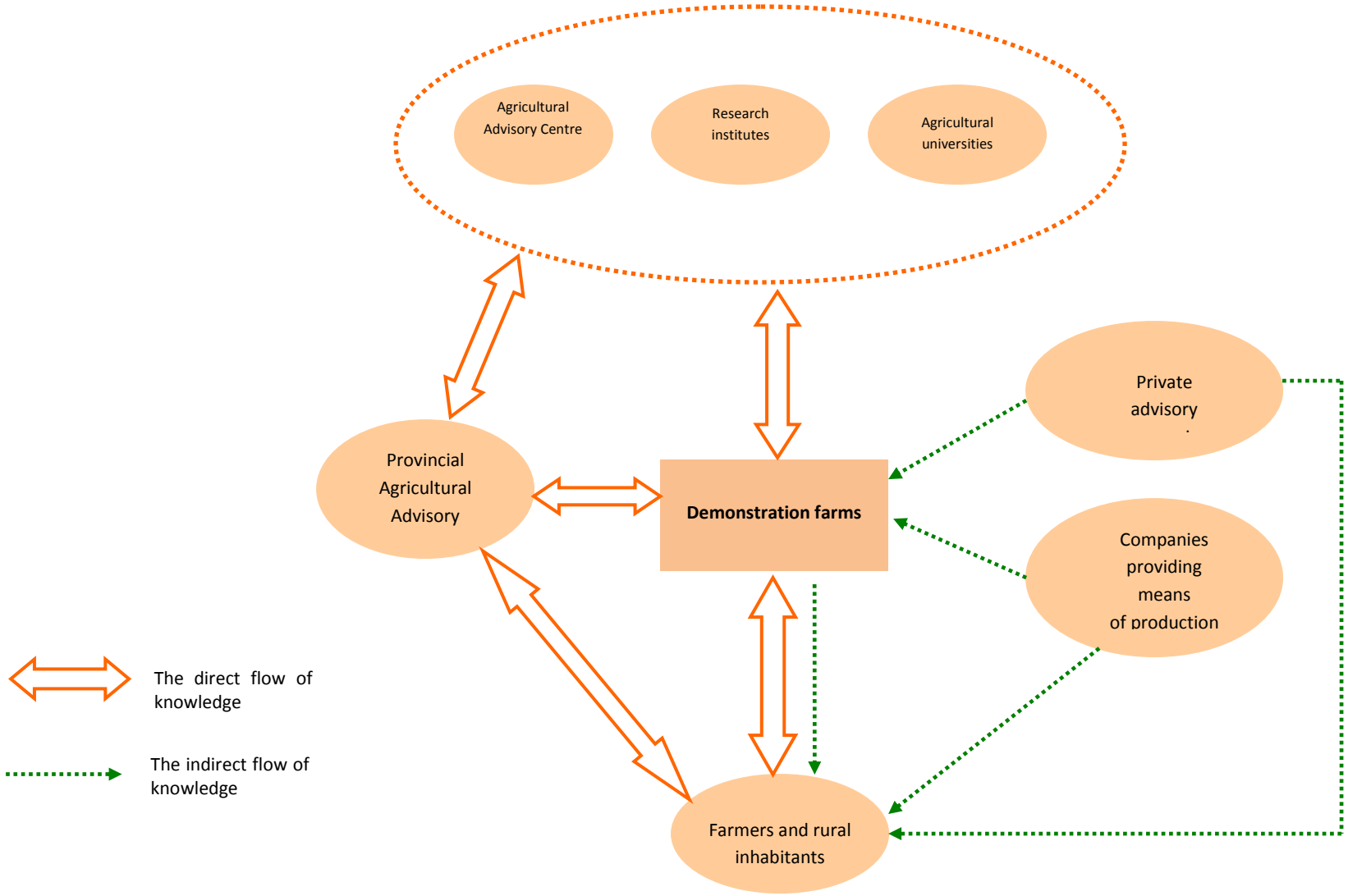


Figure 4: The flow of knowledge concerning animal production technology from the perspective of a farmer
The source: author's own research

7 Discuss and assess the performance of the knowledge flows and identify best-fit practices for advisory services

The discussed case study is an example of the cooperation of researchers, specialists from the AAC, agricultural field advisors and farmers in the process of the creation of new knowledge. In the respondents' opinion, the flow of knowledge takes place in many directions - often at the same time. The knowledge is created on many stages; it is generated and developed on every level. It is of a dynamic character and it often evolves, depending on the needs of its recipient and promoter.

On the basis of the obtained information, it can be stated that the strongest links in this process are formed by:

- The AAC subject matter specialists --- agricultural advisors from the PAAC;

- The AAC subject matter specialists --- researchers;

- Field advisors --- farmers;

- Farmers --- the companies supplying industrial means for agricultural production.

According to the opinion of those surveyed, the strongest link in the knowledge network is the cooperation of farmers and advisors from agricultural advisory centres. According to the respondents this link should be strengthened and maintained. The flows of knowledge and information between researchers and specialists from the AAC are also significant. This cooperation has a special meaning mainly with regard to the fact that the knowledge is there created and then passed to field advisors and farmers. The knowledge created and generated on demonstration farms flows vertically in both directions. It is directed up to the research institutes in the form of research results and hypotheses testing results, but it is also passed to the AAC as a result of the cooperation. It is also directed down to farmers, village inhabitants and local authorities. The knowledge created as a result of the cooperation of researchers, field advisors and farmers is used both in science and in agricultural practice. Hence, new knowledge is created on demonstration farms and then it is processed and disseminated externally. The knowledge created as a result of the field tests and experiments is also stored on demonstration farms.

Considering the analysed system of the flow of knowledge we can distinguish its basic processes as follows:

- *Creating knowledge*: new knowledge is created on demonstration farms with the cooperation of these farms owners, specialists from the AAC and researchers;

- *Processing knowledge*: the knowledge is processed (modified, tested, improved) on demonstration farms with the participation of farmers, field advisors, and (to a lesser extent) researchers;

- *Transferring knowledge*: demonstration farms pass the generated knowledge to other farmers and countryside inhabitants through different channels of knowledge and information; to a broader extent, knowledge is popularized by researchers and specialists from the AAC, most often in the form of the publication of scientific papers;

- *Using knowledge*: new knowledge is used by other farmers and rural residents to, amongst other practices, optimize fertilization and restrict fertilizing losses; by researchers to develop further directions of scientific research in agriculture; and by specialist from the AAC to prepare educational and training programs for provincial agricultural advisors.

The significant aspects which should be considered regarding the flows of knowledge and the identification of the best practices in advisory services have been identified as follows:

- The implementation of research and educational projects (i.e. with the participation of the representatives of science, farmers and advising) allows the strengthening of the cooperation between researchers and farmers. It is particularly important in the process of the transfer of research results to agricultural practice, therefore, it should be strengthened and maintained. The direct cooperation of researchers and farmers enables the establishment of partner contacts, conversion of theoretical knowledge into practical knowledge, and monitoring the changing needs of farmers.

- Due to the huge fragmentation of agriculture in Poland, advisory services should be maintained and supported. Farmers value the work of field advisors and have a high opinion regarding the quality of their services. The role of the public advisory services in the dissemination of scientific research results, conducted in the national research institutes and agricultural universities, is significant. Field advisors are able to transfer this knowledge directly to the farmers and countryside inhabitants.

- Using methods of group advising such as discussions, demonstrations and experiments, provides good results regarding the adaptation, development and transfer of knowledge. According to the respondents surveyed (i.e. farmers, advisors and researchers), these methods bring the best results and are most preferred.

- Farmers are open to practical knowledge, which can be used directly on their farms. The possibility of observing research results on demonstration farms makes them introduce innovations much faster. They contribute to environmental protection by implementing the developed good practices in limiting fertilizing losses and water protection.

8 Conclusions

The agricultural advisory services in Poland have a long history and their effect on the development of agriculture is substantial. These effects result from, above all, the availability and prevalence of the services provided. The system of advisory services in Poland consists not only of public units of agricultural advising and agricultural chambers. Private advisory companies have become of greater importance in recent years. It is observed that there is a growing number of farmers that use specialized companies delivering means of production. This is the result of growing competition on agricultural markets of the European Union, growing specialization of agricultural farms, as well as the increasing scale of agricultural production in Poland. However, taking into account the number of agricultural farms in Poland and their large diversity, the importance of public provincial advisory centres should be maintained and emphasized, and their actions should be strengthened.

On the base of the case study results, the research questions can be answered as follows:

- Agricultural advisory services in Poland play very important role in the system of knowledge and information. They enable the transfer of knowledge into agricultural practice and provide constant access to advisory services for farmers;

- The respondents pointed to many sources from which they derive knowledge and obtain important information. The most common were: internet, training courses, individual discussions with field advisors, popular and scientific journals, and scientific publications;

- The field advisors and the PAAC are the main “connector” of the scientific sphere (national research institutes, universities) and agricultural practice (farmers). Field advisors transfer current information to farmers, indicate what sources can be used, where to seek important information, where to obtain knowledge, and how to use it. Agricultural advisors also constitute a valuable source of feedback for the subject matter specialists from the AAC and researchers, initially with regard to sociological and economic knowledge of a given region, of the rural environment, social groups and farms;

- The cooperation of farmers with field advisors is of a permanent nature, as opposed to the cooperation with researchers (which is sporadic);

- The ecological and pro-environmental actions undertaken by farmers are usually initiated by field advisors, cooperating permanently with farmers. Farmers have many of their own ideas and inspirations, but even so they often count on the opinions and support of field advisors before they implement these ideas;

- In the respondents' opinion scientific research in agriculture, the creation of new knowledge and its operationalization, result in increasing innovation. Modern technological solutions have a significant impact on economic values. It improves farm competitiveness, because it refers to innovation and science. In the case described, social needs and the protection of public goods are also important. The

application of new knowledge has a positive impact on the natural environment, and especially on water, in this case.

The respondents have underlined the significance of cooperation in implementing innovation in agricultural practice. The network approach integrates the participants and contributes to the consolidation of the cooperation between them. Despite many positive features this cooperation also has some weaknesses. The main problem is poor feedback from advising to science. Because agricultural advising has an important role in connecting practice and science, it should not only be limited to providing knowledge and information to farmers, but it should also transfer feedback to science. Such information enables the improvement of conducted research and makes it possible to focus on the needs of farmers.

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