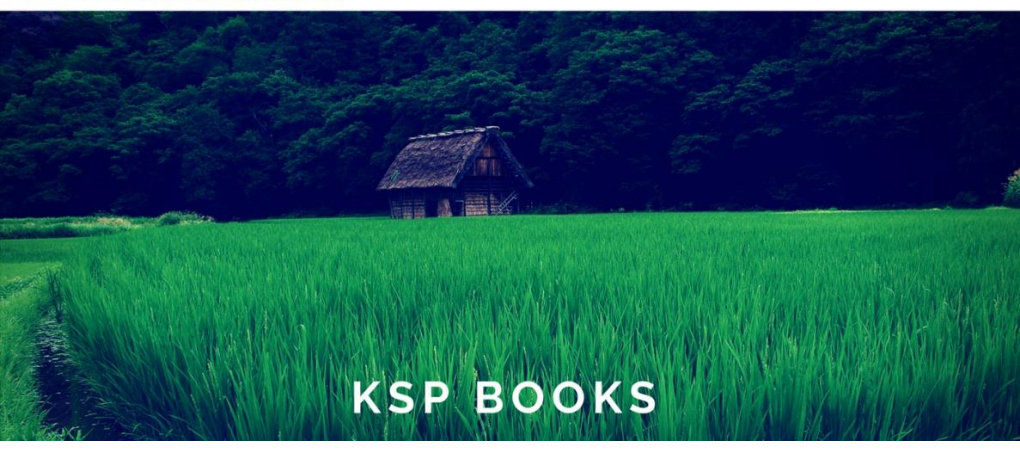
Agricultural Innovations in Turkey

BY SULE AKKOYUNLU



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Preface

The adoption of agricultural innovations is crucial for economic growth as well as economic development. However, in order to help leverage the adoption and diffusion of innovative practices, it is important to understand the process of agricultural innovation and its determinants. Using data derived from interviews, published materials, and observations, this study identifies the key factors that determine agricultural innovations in Turkey. Based on these insights, the paper identifies the characteristics of innovative farmers and suggests policy strategies to encourage agricultural innovations. The analysis shows that agricultural innovations are taking place in Turkey and various public and private stakeholders contribute to the development and adoption of innovation in agriculture. Agricultural enterprises and cooperatives, clusters of innovation, non-governmental organizations, research institutes, government, and international institutions play an important part in the collaborative effort to create and disseminate innovation. In this context, the right institutional incentives, good governance, and an enabling infrastructure are crucial for the facilitation of innovation. The diffusion of innovations through extension services and experts promotes the active participation of farmers and may also have a positive impact on agricultural trade through increasing global competitiveness. Innovative agricultural products not only generate increasing returns for the existing demand for these products, but can increase competitiveness internationally. Since agriculture is mostly associated with a low-margin commodities business with decreasing returns, the potential of innovation in agriculture in making the rural sector more competitive and at the same time more sustainable has been underestimated.

Contents

1. Introduction

Turkey is the world's seventh largest agricultural producer

Innovations in agriculture can reduce poverty, foster development, and stimulate economic growth in many developing countries. In particular, the adoption of innovation can transform the lives of farmers through increased incomes and improved living conditions.[1] Moreover, innovation in technology and management does not just contribute to improved international competitiveness, international trade and economic growth, but also allows farmers to produce more with less.[2] The more efficient use of natural resources through innovation is an essential component of long-term economic sustainability. More importantly, agricultural growth, and hence economic growth is interrelated with innovation, international trade and competition.[3]

Therefore, it is crucial to identify the factors that affect, enhance, and diffuse innovations in agriculture in developing countries. However, agricultural innovations are complex and thus they require an in-depth understanding and a detailed investigation in order to identify the most effective policies and investments to promote innovative behaviour and practices in the agricultural sector.

[1] Berdegué & Escobar (2002) discuss the direct and indirect effects of agricultural innovations on poverty reduction.

[2] Frankel & Romer (1999) demonstrate the positive effect of trade on per capita income growth. They show that a rise of one per cent in the ratio of trade to gross domestic product (GDP) can be linked directly to an increase of 0.5% in income per capita.

[3] Vitalis (2007) shows that growth in the New Zealand agricultural sector is driven by the inter-relationship between innovation, trade and competition. Innovation in the sector has been fostered and advanced by a combination of domestic economic reforms, international export competition, and the emergence of new technologies.

This working paper discusses a number of case studies of agricultural innovations in Turkey and critically assesses the factors that contribute to agricultural innovations in order to complement the previous macro-level analysis (Karapınar *et al.,* 2010) on Turkish agriculture. Karapınar *et al.,* (2010) and Aerni (2007) show that regulations, agricultural reform policies, politics and the general lack of university–industry collaboration increase the costs and uncertainty in the innovation process in Turkey. However, in this study we concentrate on micro-level analysis of agricultural innovations in Turkey and show that the micro-level picture differs from the macro-level. However, these cases at the micro-level at present are insufficient to accelerate the overall agricultural innovations in Turkey. Therefore, the present study also analyses how this process can be accelerated and how available knowledge is harnessed by farmers. The study has important implications and shows that the success stories of agricultural innovations, their determinants and structure, as well as stimulating environments, should be taken seriously. To our knowledge, this is the first study that investigates the agricultural innovations in Turkey extensively at the micro-level and highlights important policy implications and suggestions. The case studies suggest that domestic reforms, politics, regulations and university–industry partnerships have not been in favour of agricultural innovations in Turkey, and innovation and technical progress have not been a priority in agricultural policy-making, as shown in Karapınar & Temmerman (2010).[4] However, the case studies also show that international export competition, the sector's dependency on international markets for its products and responsiveness to this competition, emergence and adaptation of new technologies to local conditions as well as entrepreneurship drive agricultural innovations in Turkey. The country's openness to trade and, therefore external competition, rather than domestic agricultural policies has encouraged firms to adopt new technology and to innovate.[5] Furthermore, the changes in the agricultural sector via innovations have further enhanced trade-related gains

[4] In addition, Karapınar & Temmerman (2010) show that the majority of patents held on agricultural products in Turkey are in foreign hands. However, they also show that the number of agricultural Geographical Indications (GIs) registered in Turkey has been increasing.

[5] Eaton & Kortum (2002) explored the role of trade in spreading new technology for the 19 Organisation for Economic Co-operation and Development (OECD) countries in 1990. They noted that trade does allow a country to benefit from foreign technology advances. See also Sandrey & Vink (2008) for the effect of trade liberalization on the innovations in the agricultural sector in South Africa.

and improved international competitiveness.[6] Thus, innovation and international trade have a two-way relationship: from international trade to innovation and from innovation to international trade. However, the Turkish agricultural sector can still only partially reallocate its resources in response to market signals, since agricultural productivity and agricultural innovations at the macro-level are low.

The EU Customs Union agreement with Turkey excludes agriculture (except processed agricultural products), and therefore, the WTO is the key factor shaping Turkey's agricultural and trade policies, (Häberli, 2010). Thus, Turkey's future market access, and policy space for trade, will depend on the future of the trade agreements. If all World Trade Organization (WTO) Members, apart from the least-developed countries, reduce tariffs and some of their support instruments, this will particularly benefit the developing countries through additional export growth opportunities.

Häberli (2010) argues that Turkey can derive considerable gains from multilateral trade liberalization, even if the Doha Round results in only a partial liberalization of its major export markets, (e.g. agriculture). However, other developing countries will also benefit from the same market access improvements as Turkey due to reduced export tariffs and support instruments. Therefore, Turkey's export competition and competitiveness after trade liberalization will depend on the quality and productivity of agricultural products, which depend, in turn, on the adoption and adaptation of agricultural innovations.[7]

The study is structured as follows:

Section 2 describes the factors that enhance and stimulate innovations in agriculture in general.

Section 3 provides the methodology for the case studies.

Section 4 presents case studies of agricultural innovations in Turkey under different headings as well as their policy implications. The findings of these case studies have important implications for creating a more responsive, competitive, dynamic, sustainable and innovative agricultural sector in Turkey.

The final section provides tentative conclusions and policy recommendations.

[6] Ghazalian & Furtan (2007) find for 21 OECD countries, during the period 1990–2003, that research and development (R&D) in the primary agricultural sector has a strong and positive impact on exports of primary agricultural and processed food products.

[7] See Zilberman, Zhao & Heiman (2012) for the difference between adoption and adaptation in agriculture.

This working paper is potentially very informative for national and regional stakeholders, entrepreneurs, policy-makers, international development partners, and researchers interested in developing evidence-based agricultural innovation policies, practices, and interventions aimed to reduce poverty, increase export competition and international competitiveness and therefore, enhance economic growth.

2. Enhancing Agricultural Innovations

We define agricultural innovations in this study as "the new inputs, machines, and methods used in agricultural production processes in order to increase production, yield or quality".[8] An increase in production or yield, especially productivity in agriculture resulting from innovation, is the main goal. Knowledge is a non-rival, non-scarce good whose consumption always improves economies through welfare effects (Romer, 1994). Knowledge is a non-rival, partially excludable good. Similarly, improved agricultural practices are non-rival goods, but there is a cost of selecting from countless innovations, learning how to apply these new practices to local farming, and experimenting with them until they are tailored to meet local needs. Thus, in addition to agricultural innovations, institutional innovations are required to connect farmers to knowledge and information.[9] Jones & Romer (2010) and Romer (2010) testify to the importance of institutions and institutional change for economic growth. Romer (2010) shows that institutions play the most important role in the adoption of ideas taken from all parts of the world.[10]

[8] Similarly, Diederen *et al.,* (2003a, 2003b) define agricultural innovation as "anything that is new to the farm (e.g., a new type of machine, a new variety of a species, a new product) and that is important for the operations of the farm".

[9] See Ruttan & Hayami (1984) for the the notion of institutional innovations.

[10] See also Nelson (2008) and Acemoğlu (2012).

Neoclassical economists regard technological change as exogenous, (Solow, 1957). Innovations are evident through a shift in production function, while product innovations are mainly ignored. However, in reality, technological changes that arise from intentional investment decisions made by profit-maximizing agents are endogenous, as stated by new growth theory (Romer, 1990). According to the new growth theory, the stock of human capital determines the rate of growth, and therefore if we consider agriculture to be *a knowledge-based entrepreneurial activity*[11] which is determined by human capital as well as entrepreneurship then the agricultural sector as well as overall economic growth can be sustainable. Agricultural innovation systems[12] can help strengthen the linkages between the various stakeholders (such as farmers, governments, researchers, businesses) in order to promote innovations. In addition, although scientific and technical knowledge that can promote agricultural innovations is widely available worldwide, institutions determine the pace of the diffusion of this knowledge and thus the adoption of innovations. In this process, the role of entrepreneurs and agricultural enterprises in promoting agricultural innovations should not be ignored. Indeed, Nelson (2008) argues that the economic, social and legal systems, and hence institutions, should encourage entrepreneurship for the innovation-induced economic growth.

Agricultural innovations and technologies are either developed by ambitious self-motivated individuals, entrepreneurs, farmers, and research institutes, or imported from other countries. However, even when these innovations and technologies are imported, they should still be adapted to local conditions (Evenson & Westphal, 1995). The adaptation of innovations to local conditions also requires adjustments to the technology and investment in research and learning (Perkins, 1997). Agricultural innovation is thus a process of the accumulation, creation, and use of knowledge, each of which requires infrastructure (e.g. facilities, structures, equipment, services and institutional arrangements), human capital and capacity, entrepreneurship, public–private research partnerships, investment in research and international collaborations, as highlighted with many case studies by Juma (2011). Juma (2011) discusses, for example, how government

[11] The knowledge-based entrepreneurial activity not only incorporates knowledge, human capital and skills into agricultural activity, but also does not see farming as a last-ditch effort for when all other opportunities fall through. It views agriculture as a profitable business opportunity for entrepreneurs. See Vesala & Vesala (2010) and Juma (2011).

[12] See Spielman (2005, 2006) and Spielman & Birner (2008).

spending on agricultural research and extension services have increased agricultural production, and roads linking rural areas to markets have also improved agricultural productivity in Uganda. He also points out that the Uganda Rural Development and Training Program has created strong female leaders for careers in agriculture in Uganda; land-grants colleges promoted research, and education and extension services were the reasons for sustainable agriculture in Costa Rica (e.g., EARTH University); township and village enterprises stimulated agriculture in China; the public–private partnership between the Indian Council of Agricultural Research, agricultural universities and private seed companies in India has contributed generic materials and scientific expertise to improve crop varieties; and the technology alliance between India, Brazil and South Africa was aimed to find solutions to agricultural problems in different regions.

Once the agricultural sector is recognized as *a knowledge-based entrepreneurial activity*, it could easily deal with agricultural challenges such as food security, climate change, and increasing food prices. Thus, tackling these challenges and benefiting from increasingly competitive international markets require knowledge, skills and human capital, as well as entrepreneurship in agriculture. Policy-makers, therefore, need to redesign their agricultural policies and create new agricultural and research institutions and partnerships or adjust, restructure, and upgrade existing ones in order to be competitive in the international markets. Upgrading the knowledge base requires investment in science and technology as well as in the adaptation of technologies to local conditions. The government should also give priority to the empowerment of local communities in terms of their adaptive capacities (that is their capacity to adopt, adapt and apply new innovations), see Juma (2008). In addition, the diffusion of knowledge is most effective when the government, researchers, and the private sector, as well as civil society, interact, as described by agricultural innovation systems. [13] However, the role of regional and international institutional coordination should also be recognized, especially regional and international technology-oriented agreements that can enhance adoption of technology. Information and communication technologies also contribute to agricultural productivity and innovation by facilitating knowledge exchanges (Juma, 2011). Public–private research partnerships are also integral to the knowledge base of a community, suggesting interdisciplinary

[13] See Rajalahti, Janssen & Pehu (2008) for a detailed analysis of the agricultural innovation systems.

linkages. The decentralization of agricultural knowledge can occur through local universities, local research institutes, and regional and international collaborations that enhance innovation adoption (Juma & Lee, 2005; Hong, 2008). Overall, agricultural innovations can occur by increasing the adaptive capacities of local communities through extension programmes, enabling infrastructure, national and international collaborations, regional integration, public–private partnerships, and the promotion of entrepreneurship. More importantly, agricultural growth can be made sustainable only by integrating science, technology, innovations and entrepreneurship into agriculture. Only then can agriculture become a knowledge-intensive productive sector.

3. Methodology for the Case Studies

The case studies were conducted using face-to-face, telephone and email (written) interviews. We can describe the steps in the conduct of case studies as follows:

1. We started detailed general interviews on "Agricultural Innovations in Turkey" with Professor İsmet Boz from Kahramanmaraş Sütçü İmam University; Haluk Balıç from the Turkish Ministry of Food, Agriculture and Livestock; two rural development experts (Murat Bayramoğlu and Nurcan Atlıbaysal) from the Özyeğin Foundation; and Dr Halil Sürek from Thrace Agricultural Research Institute (TARI). We interviewed these individuals based on their academic and scientific publications, their active involvement in agricultural innovations and their reputations in this field. They informed us about agricultural innovations in general as well as about innovations in different regions in Turkey, and made suggestions for case studies.
2. After these detailed interviews we made the list of case studies.
3. Then we started to collect information for each case study, first from a search of the Internet.
4. After this we made phone calls to make an appointment for a face-to-face interview for each case study.
5. However, the respondents preferred to see the questions and to receive information about the project beforehand in an email. Therefore, we prepared a set of questions for each case study and sent them with an email.

Although each case study had different questions, the following were the general questions that we asked: questions about their institutions, firms, products, processes and innovations; the factors that affect adoption and adaptation of the innovations; the factors that help diffuse innovations; the difficulties that they encountered concerning innovations; and the contribution of the innovation to productivity, quality, competition, international competitiveness and trade.

6. A few days later we telephoned the respondents for their answers. They either answered our questions in an email or on the telephone, or requested a face-to-face interview. Most of the respondents preferred to give answers on the telephone, since they were already well prepared and had provided written documents in emails. Also, they often did not have time for a face-to-face interview.

In the appendix we give information on each of the case studies. In addition to the interview type and the names of the interviewees, we provide information about the additional sources of information and the main findings from each case study.

4. Agricultural Innovations in Turkey

Agricultural innovations in Turkey are taking place at the farm level as well as through the work of agricultural entrepreneurs and national and international research institutes. In this section, we describe agricultural innovations and their determinants.

4.1. Public–Private Partnership – Thrace Agricultural Research Institute (TARI)

Regional agricultural research institutes play a large role in agricultural research in Turkey. These institutes have partnerships with the private sector, e.g. seed companies, and their R&D expenses are paid by these partnerships. For example, the TARI is one of 17 regional agricultural government research institutes[14] in Turkey and one of the two institutes[15] that concentrates on rice research.[16] From 1970 to 1982, research on rice centred on regional

[14] Indeed, Burak (2013) shows that it is mainly these agricultural research institutes that contribute to breeding and seed production in Turkey. Although the private sector also has role in breeding and seed production, the private businesses mainly import high-yielding variety seeds and adjust them to local conditions. On the other hand, universities have a very small role in breeding and seed production in Turkey.

[15] The second one is in Samsun.

[16] See Alston & Pardey (1995) for the research-induced productivity growth in agriculture. See also Huffman & Evenson (2006) for the benefits from public and private investment in agricultural research.

problems. In 1982, the TARI initiated the national rice research project under the guidance of a highly motivated Turkish scientist called Halil Sürek, who is also known as 'the Father of Rice' in Turkey.[17] Dr Sürek was sent to Italy by the Turkish government to select rice varieties for import. However, he had the idea of breeding these varieties in Turkey and, on his return, became very active in rice breeding at the TARI. The rice research at the institute under the supervision of Dr Sürek comprises varietal selection and breeding, agronomy, plant protection, rice technology, seed production, and extension. The institute has three breeding projects: the mutation breeding project, the aromatic rice breeding project, and a rice breeding project for herbicide resistance. The researchers conduct three rice breeding activities: hybridization, introduction, and mutation breeding. Although at the beginning of the project working materials such as varieties or lines were imported from abroad, today all working materials are locally produced germplasm and some are even exported to other international institutes, such as the International Rice Research Institute (IRRI). Until 1995, all the rice varieties cultivated in Turkey were brought in from abroad; however, today all these varieties are bred at the TARI. Seven rice varieties have been developed through introduction breeding, 27 introduced through hybridization and selection breeding, and one developed through mutation breeding under the guidance of Dr Sürek. All are registered with the TARI.

Osmancık-97, a high-yielding variety, is the most popular rice variety developed at the institute. It was registered in 1997 and is now grown in 85% of Turkey's rice cultivating areas. Osmancık-97 is commercially registered and cultivated in large areas in Bulgaria and Russia. The rice seed programme, as well as extension services at the TARI, have increased rice productivity in Turkey – rice yield per unit area has increased from 4.5 ton/ha in 1980 to 7.5 ton/ha today. In 2007, the TARI developed and registered another high yielding rice variety called Kızıltan, which is wind-resistant. Thus, much of the research activity at the TARI is devoted to adaptive innovations that are appropriate for specific environments, geographies, and climatic conditions.

The genetic materials created at the TARI are kept at the Turkish National Gene Bank and at the International Rice Gene Bank at the IRRI. The IRRI uses these materials actively in different nursery experiments and for different goals. In addition, the TARI has a partnership with 30 private seed companies in

[17] See Rice Today, Vol.9, No.1.

Turkey. The institute provides seeds to these companies and the companies share 3–4% of their sales income with the institute. This income is then used to pay for R&D at the institute.[18] This collaboration is an important public–private partnership, since there are very few university–private sector partnerships in Turkey. Universities in Turkey are regulated by the Council of Higher Education and the laws and regulations governing university–private sector partnerships have been very strict. The university rectors or chancellors have to ignore the laws and regulations if they are to collaborate with the private sector. There is one exemption to this: the Middle Eastern Technical University Technopark. However, the numbers of collaborations between firms and the research sector and of high-tech start-ups within the Technopark are low and still evolving. This can be explained by the generosity of tax incentives given by the Technology Development Zones Law, which attract companies for operational reasons rather than for collaborations with research institutes and the university.

4.2. Agricultural Innovation System (AIS)–FAO-MFAL[19] Partnership Programme[20]

Although all approaches to agricultural development have focused on 'the capacity to innovate', they have used different methods to achieve this objective. In the 1980s, the first approach, known as the National Agricultural Research System (NARS),[21] was developed by neoclassical economists and it emerged from the failures in the market for agricultural research. This system assumes that knowledge flows *linearly* from known sources (formal research) to end users (farmers). It further assumes that agricultural research is a public good, that the government is important for fostering innovation, and that technological change is exogenous and unchanging. Thus, although agricultural research has high social returns, private benefits are limited by poor market infrastructure in rural areas, which requires public investment to

[18] Thus, the public and private sectors complement each other in agricultural research in Turkey. Research at the TARI leads to innovations that the private sector is willing to pay for in order to obtain rights to innovations. More importantly, this public–private partnership results in a sustainable supply of seed varieties that are wind-and pest-tolerant and disease-resistant.

[19] Turkish Ministry of Food, Agriculture and Livestock.

[20] FAO/Turkey Partnership Programme for 'Capacity Development for Analysis and Strengthening of Agricultural Innovation Systems (AIS) in Central Asia and Turkey'.

[21] See Lundvall (1985, 1988), ISNAR (1992), Nelson (1988, 1993) and Nelson & Winter (1982).

develop technologies to foster agricultural transformation and development.

In the 1990s, the Agricultural Knowledge and Information System (AKIS)[22] concept gained importance by adopting a more sophisticated and less linear approach. This system recognizes the role of research, education, and extension, as well as the flows of knowledge and information between several agents, in generating and fostering technological change and innovation. It introduces the 'knowledge triangle' in which research, education, and extension each represent a point of the triangle, with farmers placed at its centre. However, the AKIS still considers the public sector to be the most important agent for fostering innovation and it ignores the heterogeneity of agents.

More recently, the Agricultural Innovation System (AIS)[23] approach has emerged from the concept of the national innovation system. The AIS emphasizes a wide range of stakeholder participation[24] and linkages as well as the role of institutions in analysing innovation processes. This approach is multidisciplinary and comprehensive; farmers are also included in this complex network of heterogeneous actors who engage in innovation processes. More importantly, according to the AIS, technological and institutional opportunities are determined endogenously. In this approach, innovation is analysed as a process in which the knowledge generated, accumulated, and used by different agents, and agents' interactions are shaped by social and economic institutions. Therefore, the AIS sees the institutional and policy environment as being vital for agricultural innovations. The AIS consists of three elements: the first is the knowledge and education domain that is made up of agricultural research and education systems, the second is the business and enterprise domain that consists of a set of actors and activities that uses outputs from the knowledge and education domain and innovate independently, and the third are bridging institutions – extension services, political channels, and stakeholder platforms – that link the two domains. Agents' interactions deliver new products, processes, services, and forms of organizations that benefit society as a whole. The most

[22] See Röling (1990), FAO and World Bank (2000) and Thai *et al.,* (2011).

[23] See Spielman (2005, 2006) and Spielman & Birner (2008). The concept of the AIS has been successfully applied in developing countries. Hall *et al.,* (2002) studied public–private partnership in agricultural research in India, South Asia and Sub-Saharan Africa, while Ekboir & Parallada (2002) analysed technology opportunities in Argentina.

[24] These agents are research institutes, training and education institutions, credit institutions, policy and regulatory bodies, private consultants/NGOs, farmers, farmers' associations and public services delivery organizations.

important contribution of the AIS is to identify the most severe constraints to agricultural innovation and to target interventions to remove such constraints.

Several agents in Turkey are part of collaborations and linkages that bring about innovations and knowledge in agriculture. The FAO/MFAL project has investigated these linkages and provided two case studies[25] that show the AIS approach to be a success.

4.2.1. Tire (a town in İzmir Province) Dairy Cooperative

Sector. Modern milk production in Tire took off in the 1980s with the importation of Holstein cows from abroad under the Livestock Development Project financed by the World Bank. However, only over the past decade has the transition from family farming to commercial farming in the dairy sector occurred.

Tire Dairy Cooperative: This was established by a few milk producers in 1967, but did not become really active and efficient until 2001 when the board of directors changed. The new board made structural changes and created new plans, programmes, and budgets. Their main objective was to formulate a long-term development plan that took a participatory approach. Now, the cooperative plays a crucial role in the livestock sector in Turkey. It has 2,200 members and collects and processes more than 160 tons of milk per day.

Main Actors and their Roles

- The MFAL: takes the main policy measures regarding food, agriculture, and livestock.
- Agricultural Research Institute: develops technology for animal husbandry, gives training/extensions to farmers and technicians, and prepares training materials.
- Department of Training, Extension, and Publications: prepares training materials in the forms of books, booklets, posters, films, and broadcasts television programmes for farmers, technicians, and all stakeholders.
- İzmir Provincial Directorate of MFAL: keeps statistical data, provides operating permission to agricultural enterprises, sells agricultural inputs, and is in charge of food safety, hygiene, pesticide/herbicide controls, and quality standards such as EURUGAP and ISO.

[25] These two case studies are drawn from the FAO/Turkey Partnership Programme for 'Capacity Development for Analysis and Strengthening of Agricultural Innovation Systems (AIS) in Central Asia and Turkey'.

- The Tire District Directorate of MFAL: provides agricultural training and extension activities.
- Tire Municipality: controls the bazaar and local markets in order to establish discipline and harmony.
- İzmir Municipality: buys a large amount of milk from the cooperative for schools.
- Tire District Governorship: coordinates and monitors bureaucratic activities and provides administrative support to stakeholders and platforms to share and develop ideas to solve particular problems in the district. It also supports cooperatives' activities such as fairs, festivals, and meetings.
- Private companies in the dairy production chain: produce, process, store, transport, and sell dairy products.
- Agricultural input providers: provide inputs such as animal feed, medicine, machinery, tools, equipment, and veterinary services.
- Agricultural Bank and other banks: give loans to farmers and agricultural investors.
- Animal Breeders Association: provides information and services to its members including training and hiring consultants to improve its members' knowledge. It also announces any disease outbreaks.
- Customers: spread knowledge and information and drive the market.
- Development agencies: provide financial support to enterprises on a project by project basis.

Enabling Environment: In recent years, the Turkish government and the private sector have increased their interest in agriculture. The government has started to support agricultural services to farmers through market-oriented production, improved milk subsidies, artificial insemination, fodder crop production, equipment, vaccinations, and modern barn construction. It has also increased agricultural credit facilities to farmers, and services to farmers and farmers' organizations, while private banks have started to offer different kinds of financial products to farmers.

Interaction Mechanism and Innovation Practices: Although the Agricultural Research Institute has limited relations with stakeholders other than governmental organizations/supervisors and other research institutes, agricultural governmental organizations have strong relationships with most stakeholders in this sector. The cooperative, as our focal point, has strong relations with all actors. Although customers and farmers do not have strong

relations among themselves both do have strong relations with the cooperative. Therefore, the cooperative plays a 'hub role' in spreading information, knowledge, innovation, and technology among all stakeholders in the dairy sector. More importantly, it makes great efforts to encourage the development of modern animal husbandry in Tire and shows the latest and most advanced techniques to its members.

Factors for Success: The success of Tire in dairy production can be attributed to a plentiful natural infrastructure including natural resources, climate, and topography; favourable economic and regulatory conditions provided by the government; private sector and private bank involvement; the introduction and spread of modern technologies and scientific approaches; funding possibilities and improved financial systems; availability of trained workers; the support of Tire and İzmir municipalities by buying a large amount of milk under the 'school milk project'; and the good management of the cooperative. Thus, institutional arrangements have helped in using technologies to increase agricultural productivity in the dairy sector.

Ways Forward: Full processing units in the cooperative could be developed. Cost-effective methods of animal husbandry that would increase capacity must also be introduced. These must be competitive in the global market.

4.2.2. Cherry Production in Kemalpaşa (a town in İzmir Province)

Sector: At the end of the 1980s, a new variety of cherry, called Ziraat 900 or the Turkish variety, was developed by the Yalova Agricultural Research Institute of the Ministry of Agriculture. This new variety triggered cherry production in Turkey, especially in the Kemalpaşa district. At the beginning of the 1990s, the district government of Kemalpaşa distributed large amounts of cherry saplings to farmers under the social development programme with technical help from the Kemalpaşa District Directorate of the MFAL. A private company, Yavuzlar, bought these new high-quality cherries in the 1990s. Later, other companies came to the district with their packaging, storage, and logistics facilities. Now, Kemalpaşa is not only an important cherry producer in Turkey, but also an important cluster for cherry production and trade.

Main Actors and their Roles

- The MFAL: takes the main policy measures regarding food, agriculture, and livestock.
- Atatürk Central Horticultural Research Institute in Yalova: developed the new variety of cherry called Ziraat 900, provides

training to farmers and technicians, and develops training materials such as books and films.

- Department of Training, Extension and Publications: prepares training materials such as books, posters, and films.
- İzmir Provincial Directorate of MFAL: keeps statistical data, provides operating permissions to agricultural enterprises, sells agricultural inputs, and is in charge of food safety, hygiene, pesticide/herbicide controls, and quality standards such as EURUGAP and ISO.
- Kemalpaşa District Directorate of MFAL: provides agricultural training and extension activities.
- Kemalpaşa Municipality: controls the closed bazaar and organizes a cherry festival every year.
- Kemalpaşa District Governorship: coordinates and monitors bureaucratic activities, provides administrative support to stakeholders and uses platforms to share and develop ideas to solve particular problems in the district.
- Private companies in the cherry production chain: sell cherries abroad, process, store and transfer cherries, and inform producers about demand in the foreign markets.
- Agricultural input providers: provide all kinds of inputs such as fertilizers, chemicals, machinery, tools, and equipment.
- Agricultural Bank and other banks: provide loans to farmers and agricultural investors.
- Kemalpaşa Cherry Producers Association (NGO): provides information, training, and services to its members.
- Kemalpaşa-Bağyurdu Fresh Fruit-Vegetable Cooperative: markets cherries.
- Kemalpaşa Irrigation Union: prepares and implements annual irrigation schemes in the district and gives information on irrigation to its members.

Enabling Environment: In recent years, the Turkish government and the private sector have increased their interest in agriculture. The government has started to support agricultural services to farmers through market-oriented production and has increased fuel subsidies, soil testing, supplies of fertilizer, equipment, virus-free saplings, and irrigation systems. It has also increased agricultural credit facilities for farmers and increased services to farmers and farmers' organizations, while private banks have started to offer different kinds of financial products to farmers. A bazaar or market for the cherry trade at the district level has also been established. Thus, institutional development, through interactions between

actors, technological adaptation, and trade has helped the cherry industry to flourish.

Interaction Mechanism and Innovation Practices: The Agricultural Research Institute has very limited relations with stakeholders other than governmental organizations/supervisors and other research institutes, but agricultural governmental organizations have strong relationships with most stakeholders in this sector. Farmers' organizations have strong relations with all actors. Customers and farmers do not have strong relationships with one another, but both groups have strong relationships with the farmer organizations. The following process helped the cherry sector to take off: first, a new cherry variety was developed; second, saplings were distributed to farmers; third, Yavuzlar bought these high-quality cherries; and fourth, other companies came to the district with their packaging, storage, and logistics facilities, and thus a cherry cluster emerged in the district.

Factors for Success: The success of cherry production in Kemalpaşa can be attributed to a suitable natural infrastructure, including natural resources, climate, and topography; favourable economic and regulatory conditions provided by the government; private sector and private bank involvement; the introduction and spread of modern technologies and scientific approaches; funding possibilities and improved financial systems; and the availability of trained workers.

Ways Forward: Cost-effective methods should be implemented and strong farmers' organizations established. These must be competitive in the global market.

These two case studies demonstrate that agriculture can be a knowledge-intensive sector in Turkey if institutions are adjusted to take into account the interactions between farmers, the government, businesses, organizations, cooperatives, and academia, and if a 'bottom-up' strategy is adopted. More importantly, agricultural innovations, by increasing country's international competitiveness, can contribute to economic development and growth.

4.3. Agribusiness – Clusters – Gedelek Village in Orhangazi, Bursa

The food industry is an important component of the manufacturing industry as well as an important contributor to economic growth and development in Turkey. There are some success stories of firms that have taken advantage of the benefits of innovation. For example, the fate of Gedelek changed when a rural entrepreneur called Rıfat Minera came to the village in the 1920s

and distributed Russian cucumber seeds to villagers. He believed that the climate and land in Gedelek were suitable for the production of the Russian cucumber and that the free spring water was invaluable for the production of high-quality pickles. He offered incentives such as credits, bonuses and rewards to villagers who grew cucumbers for him. Villagers had grown cucumbers and produced pickles for 20 years under the guidance of Minera. Minera had sold the pickles to hotels and restaurants and made large profits. However, after 20 years new enterprises emerged, as the knowledge as well as the secrets of making pickles spread from Minera to the villagers. The spread of knowledge from a trained worker was crucial for the pickle industry to develop. Thus, the diffusion occurred through the turnover of workers who gained the requisite experience on the job. It became common knowledge that Gedelek was good at producing pickles, and the pickle industry took off. Today in Gedelek, 50 enterprises (some of which are large) produce more than 200,000 tons of many different kinds of pickles each year. They even make pickles out of walnuts, chestnuts, and eggs. The reputation of the Gedelek pickle industry has spread across national borders and the export side of the industry has been growing fast. Ten per cent of the production is exported to more than 20 countries all over the world. The fruits and vegetables used to produce pickles come not only from the surrounding regions, but also from Çanakkale, Biga, Ödemiş, Afyon, Karacabey, Bandırma, İzmir, Konya and Gaziantep and thus pickle production contributes to these regions' economies too. Gedelek is a village of immigrants now. Its population is increasing and unemployment is non-existent. The living standards as well as per capita income in the village are high relative to other villages in the region. The contribution of pickles to Gedelek's economy is TL50 million. Now, 2,000 people are employed in pickle enterprises (10,000 when transporters, packagers and farmers are included). More importantly, investment in the region has boomed: for example, two packaging companies have been established in the region, while large enterprises such as Zeytursan have opened branches in the region to produce and export pickles. Zeytursan has sales of US$14 million per year from pickles. Thus, the pickle industry cluster emerged in Gedelek through the initiative of a rural entrepreneur, while cooperation between the companies along the value chain helped the sector develop. In addition, agricultural innovation increased international competitiveness, while trade further helped the industry to grow.

The following factors helped Gedelek become a leading pickle cluster: climate and topographic conditions suitable for growing

cucumbers; free spring water; increased international competitiveness; domestic and international demand; and high profits. This success did not come from governmental policies, programmes, or assistance, but rather from a self-motivated profit-seeking rural entrepreneur who started the process and brought skills, knowledge, and interests together. Only then did the pickle/agricultural industry flourish. In addition, agricultural enterprises established later stimulated rural development. Business enterprises that are transferring knowledge to the food industry need to be supported with credits, taxation policies, export processing zones, production networks, access to the main agricultural inputs, and agribusiness education. Thus, the Turkish economic miracle can be the result of rural entrepreneurship.

4.4. Agricultural Cooperatives – Bademli Arboriculture Cooperative (BAC), İzmir

Agricultural cooperatives provide different types of assistance to farmers including input supply, purchasing, processing, and selling of farmers' crops. They also provide their members with agricultural information, especially related to agricultural technology and the latest developments in fertilizers and pesticides. Therefore, they contribute to production, productivity, and quality. There are several types of agricultural cooperatives in Turkey, such as Agricultural Development Cooperatives, Credit Cooperatives, Irrigation Cooperatives, Fisheries Cooperatives, and Sugar Beet Cooperatives.

İzmir as a region has a good reputation for adopting agricultural innovations, and this is generally related to the strong agricultural cooperatives in the region. One of them is BAC, an agricultural development cooperative. BAC was established in 1968 in Bademli, Ödemiş-İzmir by fruit sapling producers and now has 300 active members. BAC produces the best quality saplings in Turkey and exports some of them to the Middle East, Central Asia, Greece and Bulgaria. Their exports had reached USD300,000 in 2012. The demand from abroad is directly related to the quality of saplings. Members produce saplings with technical help from the Aegean University Department of Agriculture under the Macro Project of Bademli Arboriculture Technologies Research and Practice and through collaboration with Süleyman Demirel University. BAC established a formal collaboration with both universities and receives formal help and advice about sapling improvements, fruit production, members' problems with sapling production, and the adaptation of innovations and technologies from faculty members. In addition, research is undertaken by the university to improve

saplings grown on the land owned by the cooperative. R&D activities are conducted jointly by the cooperative and the universities. There is a free flow of information and knowledge from farmers to scientists and from scientists to farmers. Therefore, the quality of saplings and yields of BAC are very high. Thus, the direct interaction between the farming community and academia, a clearly bottom-up approach, has proven to be beneficial.

4.5. Agricultural Biotechnology – Simbiyotek Biological Products

Turkey has been researching and investing in biotechnology, especially agricultural biotechnology, for more than four decades. Turkey's ability to be self-sufficient in food, as well as being an exporter of agricultural products, can be explained by the advancements in biotechnology, as many improvements in agriculture are taking place through biotechnology.[26] By lowering the unit cost of production, reducing the time required for production, and substituting for conventional factors and inputs, biotechnology can improve overall efficiency and quality and thus contribute to the welfare of the whole country. Biotechnology not only increases crop productivity through effective weed and pest control, but also creates more nutritious crops. Research in agricultural biotechnology in Turkey focuses on tissue cultures for plants, agricultural technologies, phytopathology, and pest control. This research aims to improve yields, conserve genetic resources, and control diseases and pests. Today, many public and private research institutes and companies in Turkey are devoted to improving and multiplying plants, controlling phytopathogens, conducting research on artificial insemination (semen preservation), and specializing in pest control.[27]

Simbiyotek Biological Products is a Turkish biotechnology company that was founded in 2004 by researchers with academic and industrial backgrounds in biotechnology, food, drugs, and the environment. It concentrates on organic farming, animal husbandry, and the food sector. More importantly, microbial additives replace chemicals in Simbiyotek products. For example, organic and microbial materials replace chemicals (such as fertilizers), microbial biocontrol agents replace chemical agents (to combat plant diseases), probiotics replace antibiotics (as growth factors), and starter cultures replace acids (in the silage process for animal husbandry). Simbiyotek has a new project that aims to

[26] See Evenson & Gollin (2003) for a more detailed analysis.

[27] The first plant tissue culture laboratory was established at the Aegean Agricultural Research Institute, İzmir in 1977. Other research institutes, centres and companies followed immediately.

benefit from indigenous microorganisms in order to develop and produce microbiological solutions in Turkey. It collaborates with universities and research centres in Turkey and abroad and evaluates and implements academic patents for trade use. It also develops products for these institutions and carries out field trials for them. Simbiyotek is also internationally successful and makes large profits by exporting its products such as Sim®Derma (e.g. to Greece). Sim®Derma is a microbial fertilizer and bioprotectant that is effective on roots and successfully applied to wheat seed coating. Sim®Derma is being tested and awaiting a certificate in other European and Asian countries. Simbiyotek is in fact the leading innovator in the world in terms of utilizing microbiological technology in agriculture. Its products not only increase productivity by up to 27% and are disease resistant, but also increase quality and do not pose a hazard to the environment. Furthermore, Simbiyotek receives offers for international collaboration and the recent collaboration with 19 partners has a budget of 9 million euros.

Turkey has some of the richest natural resources in the world due to its geographical and climatic conditions. Further, two important gene centres (the Near East and Mediterranean) are in Turkey, and the country is a haven for many wild and cultivated plants that can serve as valuable genetic resources. Although Turkey has a great potential for biotechnology considering its existing human resources and knowledge base, there is considerable public opposition to agricultural biotechnology because of campaigns run by NGOs in the print and visual media. Public knowledge and awareness of the possible risks of agricultural biotechnology is very limited. In addition, the government has imposed strict regulations on the agricultural biotechnology sector. Since the Biosafety Law of 2011 was passed, only three soybean and 16 corn transgenic events for feed use are allowed to be imported. The production of genetically modified animals and plants as well as importation of transgenic seeds are also forbidden in Turkey according to the Biosafety Law (Law No: 5977) of 26 March 2010. In addition, researchers also need to gain permission from the Biosafety Board to carry out research. This affects biotechnology research, and thus no Turkish companies and universities have so far developed transgenic seeds. Therefore, the export of the microbiological products produced by Simbiyotek can be considered to be a real success and real agricultural innovation in such an environment.

4.6. Governance

4.6.1. International Initiatives – Leader Farmers Project (LFP)[28]

The LFP first started in 1987 in Tekirdağ through the collaboration of the Turkish and German governments. The LFP was established for the diffusion of agricultural innovations. The project became active in 1988 when two German experts, one advisor, and a number of volunteer farmers started to collaborate. The main objectives of this project are to increase agricultural productivity, increase farmers' adoption of agricultural technologies and innovations, make farmers competitive in international markets and create farmers who can produce ideas and apply these ideas in becoming responsible producers. It aims to achieve these objectives by transferring agricultural knowledge and information[29] from experts to farmers and then by observing, monitoring, and checking whether farmers have been successful in implementing this knowledge. In this process, experts play the most important role. The Turkish Union of Chambers of Agriculture, German Agricultural Society and German Agency for Technical Cooperation all played an active role in the project. At the outset of the project, the Turkish and German governments as well as the farmers contributed financially. For six years, all structural expenses were covered by the German government. In the following years, the model was successfully introduced to Bafra, Malkara, Hayranbolu, Muratlı, Ceylanpınar, Çorlu, Polatlı, Silivri, Şanlıurfa, and Konya. Indeed, 91% of the members of the LFP make savings on agricultural inputs, 73% produce new agricultural products, 81% talk about agricultural issues when they are together, 38% have seen a productivity increase as a result of improved animal husbandry, 16% have seen an agricultural productivity increase, and 91% have changed their machines and equipment. The lesson learned from the LFP is that scientific knowledge is able to flow from experts to farmers and practical knowledge and information (e.g. about farmers' problems) from farmers to experts in the right institutional set-up. Thus, the strong institutional set-up from the start of the project helped harness knowledge and put it to practical use. Further, expert advice was the most effective way of diffusing innovations.

[28] [Retrieved from].

[29] Rogers (1983) mentions two aspects of innovation: 'hardware' and 'software'. 'Hardware' refers to the necessary technology, whereas 'software' is the information on how to use the technology. The availability of information about the innovation is an important precondition for the wider diffusion and adoption of innovations.

4.6.2. International Partnerships – The Honey Road (Balyolu)

A young American entrepreneur realized an idea in 2012. She knew that beekeeping required less land, labour, and resources than animal husbandry in the eastern Anatolian region, and more importantly, would be well suited to the region's environment and ecosystem. Therefore, she built "a unique honey hospitality tourism sector in Northeastern Turkey that provides compelling economic and educational opportunities for women, their families, and small-scale honey producers".[30,31]

Turkey has an important honey economy due to its diverse environments, microclimates, and flower species. Turkey is the world's second largest producer of honey after China, however, Turkey's average per colonyrevenue value is 14,3 kg while China's average revenue per colony revenue values is more than50kg, (Semerci, 2017).[32] In addition, "Turkish honey has the highest average honey prices in the world, with cheap affordable honey sold at approximately 12USD/kilo, decent quality honey sold at 30USD/kilo, and the best marketing and culturally celebrated honey – Anzar honey – sold at approximately 500USD/kilo".[33] Thus, there are great market opportunities and challenges for honey production in Turkey.

In 2012, the Honey Road organized four honey tasting tours that took travellers directly to production sites. This activity did not require dealing with honey export regulations and ensured that honey revenues flowed entirely to beekeepers only. The Honey Road actively involved villagers in the project (eight villages from Kars, Çıldır, Ardahan, Gole, and Şavşat and 16 families took part in the project).[34] Indeed, visitors stayed with these families and the women of the households cooked for and hosted the guests. The Honey Road, in turn, supported the villages' infrastructure, provided education for the girls, and offered small business opportunities for local women. It also provided guests to the hotels and restaurants in Kars, Ardahan, and Şavşat, increased sales of

[30] See de Medici Jaffee (2012).

[31] The EU, Marmara Group, Özyeğin University and Macahel Aricilik also support the idea of training women and beekeeping as a compelling development combination.

[32] [Retrieved from].

[33] See de Medici Jaffee (2012).

[34] The Honey Road brought 14 guests from Germany, Turkey, the US and Malaysia and created a 75 km walking tour over eight days though Northeastern Anatolian villages. It mapped six walking routes and connected with 28 beekeepers (eight were women):10 beekeepers in the Kars region, four in Çıldır, six in Posof, four in Göle, four in Ardahan and four in Şavşat.

local produce and tours, and involved support of and collaboration with local farmers, villagers, and households. Furthermore, it directly connected international consumers with honey producers in eastern Anatolia through its website and National Geographic research.

The success of the Honey Road can be attributed to the varied environment, hospitable people, historical importance of the walking routes, and unique honey. However, the Honey Road lists the following obstacles that beekeepers face: "illegal supplies and honey smuggling from Iran, Azerbaijan, and Georgia; infected supplies and diseases, poor quality equipment; lack of training, education or support; lack of quality control or standardization, branding and marketing; dramatically changing weather and climate impacting flowers, crops, honey, flow, and blooming periods; regional construction, dust, erosion, asphalt roads, and additional environmental factors; rental payments for land; and very unpredictable honey yields".[35] These obstacles can be easily eliminated with the right governmental and regional policies. More importantly, visitors were satisfied with the arrangements and walking tours but complained about not having enough honey to purchase. The experiment of the Honey Road reveals the great potential and demand for agri-tourism in Turkey. Although there are obstacles, these can be easily removed with the right national and regional policies. These policies can take the form of recognizing the region as a home of boutique honey production, supporting, and mentoring local women beekeepers and entrepreneurs so that they receive proper training, supplies and credits, and help with promotion and marketing.[36]

4.6.3. NGOs – Özyeğin Foundation

Regional agricultural differences in Turkey can be explained by the prevailing climatic and topographic conditions as well as by social and economic factors. Almost 90% of fruit and vegetable production takes place in the Marmara, Aegean, and Mediterranean regions, whereas the majority of livestock production takes place in northern and eastern regions. In eastern regions, climatic and natural conditions such as lower rainfall, lower temperature, and higher altitudes as well as socio-economic conditions such as small-scale farming and subsistence production prevent agricultural production and agribusiness. Similarly, the

[35] See de Medici Jaffee (2012).

[36] Ozcatalbas *et al.,* (2010) also discuss the importance of rural tourism (farm tourism and agri-tourism) for Turkey.

Mediterranean, Çukurova, Aegean, Marmara, and Tracia regions are open to innovations, and therefore innovations spread from these regions to the rest of the country. There are several reasons why these regions are open to innovations. First, most of the infrastructural investment has taken place in these regions and the economic conditions are also better. Second, the climatic conditions favour new agricultural innovations. Third, commercial farming is important in these regions. Fourth, farmers from these regions have higher levels of education, incomes and skills. Therefore, in eastern regions, the majority of innovations can be considered to be new, even though they took place many years ago in coastal regions.

An NGO called the Özyeğin Foundation is involved with rural development in Eastern Turkey, especially in the Kurdish villages between Tatvan and Van, which were ghost towns 10 years ago. It helps transform the lives of people who returned to their villages from Mersin and Istanbul after 10 years. Villagers have established several cooperatives with the help of the Özyeğin Foundation in order to sell and market milk, produce corn for animal feed, and rent machines and equipment for agricultural production. In addition, it has initiated cut flower production in greenhouses in Bitlis. This project was seen as impossible at the outset as the climatic conditions are unsuitable for cut flowers in Bitlis. However, the Özyeğin Foundation guaranteed any losses from cut flower production and made arrangements to sell the flowers. More importantly, the foundation supported, educated, and trained local women in cut flower production. The result was a real success. Even though this normal production activity has taken place for several decades in coastal regions in Turkey, especially in Antalya, it is a true innovation for Bitlis. Similarly, in a village in Antep, the olives were rotten by the time they reached the market. The Özyeğin Foundation educated villagers about packaging and provided the first set of packaging free of charge. When packaged olives reached the market in a good condition, villagers were able to make profits and cover the cost of the packaging. The Özyeğin case recognizes the risk in adopting new innovations and suggests that institutional arrangements can help reduce or eliminate this risk.

4.7. Early Adopters, Late Adopters and Laggards – Erzurum and Kahramanmaraş

Sezgin *et al.,* (2011) investigate the factors affecting the adoption of agricultural innovations in the seven districts of the

province of Erzurum. Artificial insemination is considered to be 'the innovation variable' in the study. This is an interesting study, as artificial insemination is thought to be a wrong, sinful and objectionable method in the region. Several extension programmes by the government and NGOs were carried out in order to popularize artificial insemination. Its adoption was explained by several variables: younger farmers with higher education levels had a tendency to adopt innovation, while farmers who make use of incentives to participate in agricultural extension training activities and benefit from media adopt artificial insemination. The results of this study have important policy implications. For example, holding training sessions for farmers, introducing innovations and explaining their benefits, using mass media, and introducing support schemes that operate for a certain period before the acceptance and adoption of the innovation can be effective for the adoption of agricultural innovations.

Boz & Akbay (2005) find that the differences in socioeconomic characteristics and communication behaviour between early adopters, late adopters, and nonadopters of maize exist among farm operators in Kahramanmaraş. The main implication of these results is that extension services are an important contributor to the adoption of agricultural innovations in Turkey.

4.8. Extension Programmes and the Role of the International Seed Companies (Bayer)

When new agricultural innovations and technologies become available, the speed of the dissemination of these recent innovations to farmers by public and private organizations will be determined by the socioeconomic characteristics and the information-seeking behaviour of farmers. One of the sources of farming information in Turkey is the Division of Farmers' Education and Extension of the Ministry of Agriculture and Rural Affairs, which is a governmental organization responsible for training farmers through extension programmes. The second formal source of information is private seed companies such as Bayer, Syngenta, Dow, and Monsanto. These organizations provide training and extension services to customers and farmers. Boz & Ozcatalbas (2010) show that crop producers in Gaziantep province use more information from traditional sources (63%), such as farmers' personal experiences and those of family members and neighbouring farmers, than from modern information sources (37%), such as public extension services, agricultural faculties, farmers' unions and associations, private seed companies, input dealers, the mass media and the Internet. They use this

information for soil operation, seed selection and seeding techniques, fertilizers and fertilizing, pest management, irrigation, input selection and product marketing information. Among modern information sources, contacts with extension services, use of printed materials, and the Internet were influential for the practices covered in the study. Therefore, the study suggests that if farmers have more contact with extension personnel, read printed materials such as newspapers, magazines, and brochures, and use the Internet, they are more likely to be innovative and to benefit from innovative technologies.

Farmers need to update their skills and knowledge continuously in order to keep up with agricultural innovations and technology. Several extension projects and programmes help farmers update their agricultural knowledge and skills in Turkey. However, farmers in general have little time to attend these extension services. Therefore, distance education methods in agriculture, called 'the Project of Extensive Farmer Education through Television (YAYCEP)', were introduced by the Turkish Ministry of Agricultural and Rural Affairs in cooperation with the State Radio and Television Institution, Anadolu University, and the Ministry of Finance. The first phase of the project (YAYCEP-I) took place between 1991 and 1997, and it consisted of 23 agricultural and rural topics (338 television programmes, each lasting about half an hour) about animal husbandry and breeding, crop production, plant protection, agricultural mechanization, farmers' organizations, among others. These television programmes were supported by supplementary materials such as agricultural manuals and 800,000 books were distributed to participants. Altogether, 113,123 farmers were registered and took an exam at Anadolu University during YAYCEP-I. Of these, 33,205 successfully obtained a certificate and 2,005 were rewarded with various prizes having a total value of USD 3,376. The project cost about USD 5 million (USD 44 per farmer). During the second phase of the project (1999–2006) (YAYCEP-II), 317,570 farmers were registered, 140 television programmes were broadcast and 151,910 manuals were distributed (Demiryürek, 2006). YAYCEP is considered to be the most extensive agricultural distance education project to be applied in a developing country. In fact, it was selected as the most successful project at the World Summit on Sustainable Development in Johannesburg in 2002 in terms of alleviating poverty and diffusing innovations (see MARA, 2006).

It is possible to increase agricultural productivity through relevant, reliable, and useful information and knowledge on land, labour, livestock, capital, management, innovations, and

technologies. Therefore, the transfer of agricultural information and knowledge by extension services, research and education programmes, and agricultural organizations and associations is crucial to enable farmers to take advantage of market opportunities. Demiryürek *et al.,* (2008) analyse whether members and non-members of the Dairy Cattle Breeders' Association use current information systems differently in the Samsun province of Turkey. They find that association sources help member farmers select European breeds, organize themselves under the association, and keep records of the breeds that generate higher milk yield per cow. Members also have more contacts with universities, researchers, association experts, and medicine suppliers, as well as more access to agricultural manuals, computers, and the Internet.

Demiryürek (2010) studies the information systems used by organic and non-organic hazelnut producers in the Terme district of the Samsun province and find that organic farmers make more use of information in order to acquire new knowledge and skills. Organic producers use information sources more frequently and more actively than do non-organic producers. In addition, Demiryürek *et al.,* (2012) show that organic hazelnut producers are less risk averse[37] than conventional producers. They suggest that better extension services and farmers' training activities for organic agriculture and land consolidation can increase the educational and skill levels of farmers and therefore facilitate their access to information. This, in turn, can alleviate risk and accelerate the process of conversion to organic hazelnut production.

Bayer CropScience provides expertise in seeds, breeding, crop protection biologicals, and chemistry and environmental science solutions in Turkey. It has an important share in the Turkish market and it has established good connections with clients. It now knows its clients/farmers very well and has introduced new products such as high-yielding seeds by categorizing clients/farmers. In this process, farm size and land ownership are important factors.[38] The firm categorizes farmers under four headings and introduces new products using the following four methods:

[37] There is always a risk involved in the adoption of innovations in terms of their appropriateness to the farm and their performance.

[38] Feder & O'Mara (1981), Feder *et. al.,* (1985) and Sunding & Zilberman (2001) find that adoption rates are related to farm size. Sunding & Zilberman (2001) show that the extra profit from adoption increases with farm size and that this explains why larger farmers are early adopters. In addition, large fixed costs and credit constraints reduce adoption by smaller farmers. Capital might be available only for large farmers. In addition, large farmers can bear risks because of their large wealth holdings.

1) **Early adopters:** These farmers are open to new innovations and adopt them immediately. They can afford to take risks, as they have enough resources. Bayer has face-to-face contact with these farmers, who are active in finding out about new technologies and innovations in agriculture, such as new high-yielding seeds and in observing other farmers' innovation behaviour. They compete with each other in adopting new technologies and innovations in agriculture and serve as a model to other farmers. Bayer meets these farmers individually.

2) **Followers:** This group adopts innovations later than early adopters. Its members are rather sceptical and want to first see the advantages or better financial returns of new innovations, gained by the early adopters. These farmers experiment with new innovations only after seeing the actual profits derived by early adopters. Bayer organizes training and extension programmes for this group and introduces its products to these groups of farmers. Bayer's aim with this activity is to turn followers into early adopters so that the number of early adoptors will increase.

3) **Calculators:** This group does not adopt new innovations until it sees the results, outcomes and profits from other farmers. Bayer organizes agriculture days for large groups of farmers in this category to introduce their new products. After these agriculture days, some farmers in this category switch to the second category.

4) **Laggards:** Bayer has little hope that the farmers in this category will adopt innovations at all. Therefore, it reaches this group through mass media such as leaflets and brochures. Few farmers switch to other categories from this category because they are not open to innovations – they are traditional farmers. Further, financial constraints, farm size, and land ownership are also barriers to adopting new innovations for these farmers.

4.9. The Role of Private Sector – Agricultural Banking

Although agricultural loans are mainly financed by state-owned banks, e.g. Ziraat Bank, and Agricultural Credit Cooperatives, more private banks have recently become involved in different forms of financing. Now, there is a large credit market for agriculture in the private banking sector in Turkey, and this can be related to the increase in investments in agricultural innovations and technologies. In the past two years, private bank credit to agriculture has increased by 50%. Banking services also include zero-interest credit cards for farmers that can be used for purchasing agricultural inputs such as seeds, fertilizers, pesticides, fodder, and fuel. The banking sector provides a variety of financial products that can help farmers with agricultural production,

processing, packaging, marketing and trade and, more importantly, innovation. Banks visit farmers in the most remote areas and introduce their financial loans and products face-to-face. A private bank called Şekerbank with its EKOKREDİT and its credit to organic farmers is popular. For example, Şekerbank lent 30 million TL to farmers who reconstructed or equipped their farms in order to conserve energy and water. With EKOKREDİT, 2,000 farmers have saved on energy and water consumption.

4.10. Smart Solutions to Agricultural Problems with Turkcell[39]

Turkcell is the leading Turkish mobile phone operator with more than 30 million subscribers. In 2010, Turkcell launched the 'Turkcell Farmer Package'. This service, in addition to advantageous communication, sends to postpaid and prepaid subscriber farmers important information free of charge. These messages cover topics ranging from humidity, precipitation and wind speed data to national and international farming-related news, warnings, products, discounts through co-branded offers, and location-specific information as well as information from the Ministry of Agriculture. They provide mobile training programmes to raise productivity and also support hundreds of thousands of farmers at fairs organised in six different provinces throughout the year. This service has so far reached one million farmers.

In July 2012, Turkcell launched the 'Machine-to-Machine Platform' for farmers (including fish farmers), which includes maintaining and controlling temperature/humidity levels on farms, climate control systems in greenhouses and irrigation systems in fields via mobile phone interfaces. Water savings through automated remote watering have reached 20%, while the efficiency of greenhouses and animal farms has increased and damage and animal deaths from frost prevented. This innovation was developed in Turkey by Turkcell and has been exported to the USA by a technology partner (Kodalfa) of Turkcell.

In October 2012, Turkcell launched AgroMed in collaboration with Doktar Agriculture and Animal Information Systems, which provides agricultural consultancy tailored to farmers' specific needs. The Turkcell AgroMed project aims to increase farmers' revenues by 10%, while reducing costs by 20%. Turkcell AgroMed is the first service of its kind, providing farmers with required information based on crops, specific territories, and soil

[39] [Retrieved from] on 10/12/2018.

characteristics through SMS. The service is supported by a call centre, communication centres, and agricultural engineers, while field trips are required. Thus, it offers help in all aspects of farming from soil analysis, planting planning, and pesticides to stock farming along the agricultural value chain.

4.11. Adjusting Technologies to Local Conditions

Griliches (1957) in his pioneering work on the diffusion of hybrid corn in the US, argued that technological distance in agriculture can only be surmounted through local adaptations of technologies. He showed that farmers in Alabama could only benefit from hybrid varieties that were adopted in the Corn Belt States once the research in Alabama used knowledge acquired in the Corn Belt. Similarly, it was not until rice threshing technology that had been developed in Japan was adjusted to different circumstances that it became useful in the Philippines. Likewise, the IRRI in the Philippines led several breeding programmes to develop new rice varieties that were suited to tropical conditions. The success story of Alara Tarım also proves that it is crucial to adjust technologies to local conditions.

Alara Tarım (Alara Agricultural Products) was established in 1986 and today it is one of the biggest exporters of figs and cherries in the world.[40] It has achieved this status by employing agricultural technologies effectively. The company has skilled and farsighted managers who have adapted American cherry production techniques to a different economic and cultural environment. It has made large investments in in-house design and research and it spends 5% of its sales profits on R&D as well as working with international experts. Alara Tarım earns more than TL 50 million annually from cherry exports, which it has achieved by continuously improving its products, adopting the latest technologies to local conditions, and rapidly reallocating its resources in response to market signals.

The US has traditionally been the world's leading cherry exporter. However, there were 1–2-week delays until the products reached world markets from the California and Washington regions. Turkey filled this gap initially and then later made product improvements and increased product quality, adopted the latest technologies such as modified atmosphere packaging and adjusted the latest technologies from the US to local conditions (e.g. Mobile

[40] Alara Tarım is a fruit and sapling company with 15 nurseries in seven cities (Adana, Afyon, Antalya, Bursa, Çanakkale, Manisa and Mersin), totalling 4500 decare.

Hydro-Cooler System) to increase its market share from 1-2 weeks to 8–10 weeks. Now, it exports more cherries to England than California and Washington do. The firm has even bought a company in Argentina called Rio Alara where it grows cherries on an area of 500 decare. Rio Alara is now the biggest cherry exporter in Argentina. Alara Tarım more recently developed a new cherry variety that can be kept in good condition for 45 days. These cherries will be exported to China.

The success of Alara Tarım lies in the fact that it changes its production structure in response to new technologies. Specifically, it takes advantage of the latest developments in transportation and weather-controlled technologies that improve packing, storage, and shipping; adopts new technologies to local conditions; takes part in international fairs to learn about the latest technologies; adopts the latest technologies first and diffuses these latest innovations to local markets; works with international experts; is consumer and market-oriented; is active in product improvement, packaging and marketing; and educates farmers continuously. These innovations not only make Alara Tarım internationally competitive by reducing its relative price of its products in world markets, but also help the industrialization of Turkish agriculture. In addition, in the winter, Alara Tarım uses the tea-houses to educate farmers, runs training sessions for thousands of farmers in its nurseries, and shows them the latest technologies free of charge so that the farmers can meet the high quality standards.

4.12. Government Agricultural Policies, Projects and Programmes – AGroFOod Clusters Platform (AGFORISE)

The importance of increasing agricultural productivity and promoting innovation in agriculture has been acknowledged, but is not a priority for the agricultural policies of the Turkish government, and moreover the Turkish government has adopted, in general, a top-down approach to innovation. Until the early 2000s, the government supported prices for commodities, subsidized input prices and invested in infrastructure in order to achieve its objectives. During the 2001–2008 period, the World Bank Agricultural Reform Implementation Project (ARIP) which had a neoliberal approach [41] was carried out and price support was abolished, subsidies eliminated, and direct income support

[41] Caliskan & Adaman (2010) mention that neoliberal agricultural policies were a response to bureaucratic, top-down and corrupt practices. However, during and after the implimentation of the neoliberal agricultural policies the Turkish government carried on with its top-down practices.

introduced. The Turkish Undersecretary of Treasury, the World Bank, and the Turkish Ministry of Agriculture and Rural Affairs were the prominent players, and unfortunately farmers were kept outside the policy network during the formulation of ARIP (Akder, 2010). Cakmak & Dudu (2010) find significant inefficiency in agricultural production, despite the ARIP; however, they also show that the farmers producing export-oriented crops have relatively higher efficiency. The EU's Instrument for Pre-Accession Assistance on Rural Development, which aims at alignment with the EU Common Agricultural Policy (CAP), was also introduced during this period. However, the EU CAP focuses on protection and safety rather than entrepreneurship and innovation (Aerni, 2007). In 2009, new policy measures were taken, such as the abolition of direct income support. However, area-based payments, such as fertilizer and diesel payments have increased. Other major policies include minimum purchase prices, deficiency payments, compensatory payments, agricultural insurance payments, livestock support, interest concessions, and export support. The ARIP reform aimed at increasing agricultural productivity and efficiency through market-oriented policies. R&D in agriculture was the main theme of the Agricultural Law of 2006. However, more funds from the ARIP were devoted to predatory policies than to the productive policies. Yet, productive policies could enhance rural development through the support of local entrepreneurial initiatives and the generation of new markets (Akder, 2010). Likewise, Aerni (2007, 2010) argued that rural, as well as sustainable, development in Turkey depend on investments in human capital and improved access to business-relevant knowledge, capital and technology.

The Turkish government has been directly involved only very recently in agricultural development projects within several national and international programmes that aim to increase agricultural innovations and technologies. One of these projects is '*AGroFOod Clusters Platform with Common Long-Term Research and Innovation Strategy towards Economic Growth and Prosperity'*. This platform is formed with 13 partners from three regions (Mersin (Turkey), Emilia-Romagna (Italy), Murcia (Spain)), each bringing their regional and international expertise in order to transfer knowledge. The Turkish public research takes place through the Alata Horticultural Research Institute. The cluster has 62 members and it has made many agricultural knowledge transfers and created an agricultural knowledge base. The main objectives of the platform are to transfer knowledge, create an R&D&I (Resarch and Development and Innovation)

strategy dialogue and cooperation, to enhance trade and investment opportunities in the agrofood sector, and to stimulate the utilization of national/EU R&D funds in the agrofood sector. Partners contribute to strengthening regions' capacities by investing in and collaborating on and conducting research, and through technological development activities in agriculture. In addition, research and commercial members collaborate to achieve financially rewarding research. This collaboration is particularly beneficial for Turkey, since the country can benefit greatly in terms of research, development, innovation and technology as well as trade and investment. For example, a joint project with a Spanish seed company for breeding new high yielding seeds has started. In addition, in order to encourage the sales for the domestic Turkish firms, a pesticide- and fungicide-free, pure line has been established.

For example, the Institute of Biometeorology is one of the main organs of the Italian Research Council (*Consiglio Nazionale delle Ricerche*), the main public organization in charge of scientific and technological research in Italy. This institute investigates the relationships between agricultural and biological surfaces and between the environment and climate. Employees study natural and human-created systems as agricultural systems that can increase knowledge of physiological, productive, and conservation issues. Their methods include agrometeorology, ecophysiology, remote sensing, modelling, plant pathology, plant physiology, and economics. The protection of the health and biodiversity of agricultural systems and the improvement of the quality of the agrofood industry are primary focuses of the institute. It also has experience in low environmental impact methodologies, agrometeorological and micrometeorological models, laboratory analytics, consumer sciences, and food quality.

Likewise, the National Technological Canned Food and Food Products Research Business Association is a private non-profit organization with 45 years of experience that has been recognized by the Spanish government as an innovation and technological centre. In addition to R&D, its activities focus on technology transfer programmes that aim at fostering innovation in the Spanish agrofood sector, transferring to industry the research results of different institutes and transferring the research results of Spanish universities to the agrofood sector. Therefore, these university–private sector research partnerships in Spain and Italy can also encourage university–private sector research partnerships in Turkey. Turkey can also benefit from the partnerships between

Italian and Spanish universities and the private sector indirectly.[42] For example, the University of Ghent in Belgium had the leading role in preparing strategies for the cluster. In addition, Agforise takes parts in the Food Cluster Initiative[43] within which 31 European regions with ambitions in food research and food production cooperate. The Food Cluster Initiative connects projects in the field of food and regions from Framework Programme 7 and the European Regional Development Fund with Food Innovation Network Europe to create a European Food Cluster and enhance trading partnerships. These partnerships involve continuous institutional adaptations that will help structure Turkish institutions as well as internationalize them so that more effective approaches to agricultural innovations can be adopted. This cluster encouraged the Turkish government to invest in agricultural research and development, helped open agro-techno-parks in Turkey and made Mersin an important fresh fruit cluster. Many joint R&D projects (more than 30) and scientific collaborations with Turkey were started, topics in agricultural research were identified and the funding for R&D increased. In addition, this cluster enables many agribusinesses in Mersin to follow and adopt agricultural innovations from the other two regions – Emilia-Romagna and Murcia. The Alata Horticultural Research Institute has become the leading institute and a model amongst the 63 governmental agricultural and veterinary research institutes in terms of research and development as well as preparing, receiving and managing scientific projects as an outcome of this international collaboration. The university–private sector partnership has developed and increased as an outcome of this cluster. The competition between the scientists within the universities in terms of preparing and submitting scientific national and international research proposals has also increased.

[42] Evenson & Gollin (2003) emphasize the importance of international agricultural research for productivity growth in agriculture as well as increased average caloric intake as a result of lower food prices.

[43] [Retrieved from] on 10/12/2018.

5. Conclusions

This study contributes to an understanding of agricultural innovations in Turkey by analysing and investigating innovation behaviour in agriculture at the individual, institutional, and regional levels. Our findings support previous findings on agricultural innovation by emphasizing the role of farm size, land ownership, education, extension programmes, research partnerships, innovation systems, cooperatives, adaptation to local conditions, national and international collaborations, private sector involvement, NGOs, governance, entrepreneurship, and biotechnology in inducing more innovations. Our study also draws attention to the importance of agricultural innovations for international competitiveness and, therefore, international trade.

Our analysis shows that farmers and the private sector respond positively when there are opportunities to produce new, improved, or higher-yielding products. The case studies show that policies can affect innovation and that the bottom-up approaches deliver more benefits. However, the government's efforts to strengthen education, training, and extension services in agriculture can also encourage innovations. The study suggests that knowledge, research in agriculture, and innovation are the key ingredients for sustainable agricultural development in Turkey. Agricultural innovations take different forms and take place in different regions, and several factors can accelerate the process. Training and extension services have a particularly important role in spreading innovations. The linkages and partnerships between the research sector and the private sector also help accelerate this process.

As this paper demonstrates, there are many avenues for agricultural innovations and many actors and agents are involved in them. For example, on one hand, institutional constraints are important in the adoption of innovations, whereas, on the other hand, new technologies can affect the institutional structure as well as the operation of agricultural industries. Thus, innovations in agriculture and their adoption will involve overall changes in the structure of institutions. This is particularly needed in the Turkish context as the majority of the government policies take the form of top-down approaches.

As shown with the FAO/MFAL projects, close interactions between farmers, the government, businesses, and the research sector can be beneficial. The Kemalpaşa case further suggests that the promotion of research and investment in science and technology and the accumulation of knowledge can help the agricultural sector take off and be sustainable. Thus, agriculture can be sustainable only if it is considered to be a knowledge-intensive sector. This further suggests that interactions between key actors in agriculture should be supported and promoted so that agricultural innovation systems that consider knowledge as a fundamental characteristic can be created. The Kemalpaşa case also demonstrates that there is a strong interrelationship between innovation, trade and international competition.

The TARI case demonstrates that public–private partnerships exist in Turkey and are highly successful. Thus, the positive spillover effects of linkages between education, science, and agricultural practice suggest systematic public support for agricultural education. Therefore, the interactions among universities, farmers, businesses, the government, and civil society should be facilitated and partnerships should be established formally. A new generation of universities that concentrates on agricultural innovations and private sector partnerships should also be created. In addition, the Turkish Academy of Sciences should get involved in agricultural innovations and adoption of technology by offering grants and rewards, and setting up projects in this area. Furthermore, as the Bademli Cooperative case shows, there should be direct linkages between farmers and researchers so that farmers can explain their needs and difficulties to researchers, who should respond accordingly. This is especially important for innovation adoption – for the increased quality of saplings and international competitiveness. The Bademli Cooperative case also shows the importance of adopting a bottom-up strategy.

The institutional set-up that would help the transmission of information from farmers to scientists and the transfer of

knowledge and innovations from scientists to farmers is crucial in this process. In addition, farmers' own experiences as well as their innovations should be considered and a bottom-up approach should be adopted. More importantly, output and input prices are important factors in farmers' adoption of innovations. Changing relative factor prices for labour and capital and improved agricultural product prices certainly affect the adoption behaviour of profit-maximizing farmers. The Bademli case also demonstrates that not only technical innovations but also institutional innovations are taking place in Turkey. Farmers' cooperation has contributed to the emergence of institutional innovations that not only increase yields but also quality. We also found a strong relationship between agricultural innovations and international trade in the Bademli case.

The Bayer case demonstrates that farm size is an important determinant of adoption of innovation; therefore, information and the means for knowledge acquisition should be delivered to small farmers at minimum cost. Because early adopters of innovations take risks, they could be compensated with subsidies. However, subsidizing early adopters who happen to be higher-income farmers would worsen uneven income distribution. Therefore, more extension services should be directed to the small farmers.

The Özyeğin case study also demonstrates the importance of risk in adopting technologies as well as the financial support and extension services that can help eliminate this risk. More importantly, women can play an active and professional role in agricultural production with the right training and extension services. In addition, collaboration between civil society and institutions would benefit the overall economy. Recent developments in the banking sector and financial products for the agriculture industry suggest that the removal of credit constraints to small farmers would enable them to adopt innovations as well as to extend their intensity of adoption.

The experience of the AGroFOod Clusters Platform suggests that international and regional cooperation involving research institutes can help the adoption of agricultural innovations by reducing risk and increasing profitability, even though this platform is still in its infancy. Therefore, regional economic integration and trade should be promoted and enhanced, and more national and regional clusters should be established. Platforms like this can help modernize and structure Turkish agricultural institutions and the industry's infrastructure. More importantly, they can help create regional and international markets for agricultural products and trade. In this process, while the

government facilitates the exchange of knowledge, research institutes create knowledge and agribusiness enterprises make up the centre of the learning.

Turkish agriculture might undergo a technological revolution if the biotechnology sector receives public support, which requires greater public awareness about the benefits of biotechnology. The case study on biotechnology shows that innovations in biotechnology are taking place even with local start-ups derived from the collaborations between academic researchers and venture capitalists. Academic researchers who establish biotechnology companies can create new opportunities for product development, e.g. they may motivate multinationals to change and improve their product development strategies. The Simbiyotek case shows that there is a great potential for biotechnology and for international gains from biotechnology in Turkey. Thus, agricultural innovations and international trade are indeed related.

The LFP shows that farmers can become more technologically proficient as they accumulate information from experts. The set-up costs associated with establishing and enabling infrastructure for institutions will facilitate innovation adoption, which should initially be externally financed. The LFP proves that agricultural innovations can be promoted through infrastructure, human capacity building, and good governance. The role of the adoption of the German infrastructure from the start of the programme, and hence the foundational institutional structure for the diffusion of knowledge from experts, should be acknowledged. The LFP suggests that it is easy to create internationally competitive farmers with the right institutions.

The success of Alara Tarım suggests that imported innovations should be adapted to local conditions. This requires large agricultural investments, especially in adaptive R&D. Thus, investments in R&D are important for agricultural productivity and growth. The lessons from Gedelek show that agricultural enterprises can be effective at stimulating rural development. This, in turn, suggests that agricultural enterprises should be supported through credits, grants, tax exemptions, and rewards as well as institutional reforms. Furthermore, Gedelek stimulated growth in non-agricultural sectors, which contributed to overall economic growth. Thus, increasing employment and income in agriculture can increase nonfarm rural incomes by stimulating demand for non-agricultural goods and services. The Alara, Bademli, and Gedelek cases showed that trade played an important role in this process. The Turkish government can also play a role in further accelerating this process by helping firms meet complex

international standards. It can also support clusters with tax exemptions and various regulations.

By enabling information and communication technologies, Turkcell have helped diffuse a wealth of information to farmers easily and effectively. New services from Turkcell have increased the usage of cell phones as well as agricultural productivity, efficiency, and incomes. The banking sector has recently been active in providing the most important input for farming – credit. This can be explained by the increased profits of farmers from the adoption of innovations and biotechnology in recent years. By restructuring its institutions, the government can convert agriculture into a knowledge-based entrepreneurial activity. Thus, it needs to consider science, technology, and innovations as its top priorities and accept that the source of growth is knowledge. Once agriculture in Turkey becomes a knowledge-based entrepreneurial activity, then economic development will accelerate and economic growth will flourish.

Furthermore, the importance of biotechnology should be recognized and accepted at the government and national levels. An independent scientific advisory board should be established to advise the public on biotechnology and its implications for agriculture. Turkey should establish more regional and international collaborations, projects, and programmes such as the AGroFOod Clusters Platform, and these should include the Turkish government as well as research institutes in order to increase agricultural productivity by reinforcing regional and bottom-up approaches to agricultural development. In addition, larger regional and international markets can make investments, as well as research in agriculture, more efficient and help harmonize agricultural standards across borders. The Turkish government can support these initiatives by adopting more proactive trade policies by lowering high tariffs and eliminating export subsidies.

The promotion of innovations through agricultural extension is seen to be an effective approach, and this should be supported at the governmental, private, and international levels. Farmers should be continuously exposed to specialized training and extension programmes, as studies show that these are effective in encouraging the adoption of innovations. Improvements in agricultural human capital will certainly raise agricultural performance. Training, extension programmes, and expert services will assist farmers to adopt new, efficient, and productive farming practices. A bottom-up strategy in which knowledge and the problems of farmers take priority should be adopted.

As a future research topic, this study could be extended by investigating specific innovations with surveys of farmers in certain regions. Such extensions might inform us about the effectiveness of public policies at stimulating local innovations. The clear goal is to increase agricultural productivity and quality by promoting the adoption of new techniques among farmers. Investment in research can benefit existing institutions, since innovations are complex and require strategic and system change on the parts of farmers, the government, researchers, and the private sector. The personal characteristics of farmers as well as the economic, structural, and institutional environment of farming should be taken into account in making decisions on innovation adoption. However, focusing only on farmers will also lead to pro-innovation bias.

Multiple communication links between farming, research, and extensions should be established so that 'bottom-up' innovations are possible. In addition, a broad vision of a knowledge network with the involvement of farmers, the government, advisors and researchers should be strengthened, since innovations do not occur randomly, but rather intentionally on farms by farmers or in laboratories by scientists. It is crucial to provide farmers and rural entrepreneurs with the support – regional, national, international, public, and private – they need to achieve technology adoption. Hybrid networks or multi-actor platforms can be more effective at providing this structure than government policies alone. Building partnerships, networking, and extension services with national and international partners are important features of innovation processes.

Appendix
Information on the Case Studies

Institutions, Places, Projects, Programmes, Firms and Sectors	Interview Type	Interviewee	Additional Sources	Main Findings
Thrace Agricultural Research Institute (TARI)	Face-to-Face	Dr Halil Sürek	Rice Today, Vol: 9, No:1; [Retrieved from]. [Retrieved from]. on 10/12/2018.	Complementary Public–Private Partnership
FAO-MFAL Partnership Programme	Email	Karin Nichterlein	Power Point Presentations	Transition from family farming to commercial farming in the dairy sector through Agricultural Innovation Systems; creation of a cluster for cherry production and trade through Agricultural Innovation Systems.
Village Gedelek	Telephone	Osman Trak	[Retrieved from]. on 10/12/2018.	Creation of agribusiness by a rural entrepreneur; the spread of knowledge to the village through turnover of workers; cooperation between companies along the value-chain; high exports and increased international competitiveness.
Bademli Arboriculture Cooperative	Telephone	Seval Özdemir; Nuray Uçar	[Retrieved from]. on 10/12/2018.	The direct interaction between the members of the cooperative and academia, a clear bottom-up approach helped grow high-quality saplings and become internationally competitive.
Simbiyotek Biological Products	Telephone	Şems Yonsel	[Retrieved from]. [Retrieved from]. on 10/12/2018.	Great potential for biotechnology in agriculture for production and export purposes.
Leader Farmers Project	Telephone	Ali Hakan Doğanuz	[Retrieved from]. [Retrieved from]. [Retrieved from]. [Retrieved from]. on 10/12/2018.	Scientific knowledge is able to flow from experts to farmers and practical knowledge and information (e.g. about farmers' problems) from farmers to experts in a suitable institutional set-up.
Honey Road Inc.	Email	Catherine de Medici	The Annual Company Report	Great potential and demand for agri-tourism.
Özyeğin Foundation	Face-to-Face	Nurcan Atlıbaysal; Murat Bayramoğlu	[Retrieved from]. on 10/12/2018.	Risk in adopting new innovations; institutional arrangements can help reduce or eliminate this risk.
Kahramanmaraş and Erzurum	Sezgin *et al.*, (2011) Boz &	Published scientific articles	See reference list.	Younger farmers with higher education levels, higher level of income, larger farms,

	Akbay (2005)			more contact with extension services, and who are more cosmopolitan, and opinion leaders and benefit from mass media means adopt innovations; the importance of extension services as an important contributor to the adoption of agricultural innovations.
Bayer	Face-to-Face	Kubilay Demirci; Semih Turabi	[Retrieved from]. on 10/12/2018.	Introduces new products such as high-yielding seeds by categorizing clients/farmers according to farm size and land ownership; utilizes four methods in this categorization.
Şekerbank	Telephone	Hande Ulusunar	[Retrieved from]. [Retrieved from]. [Retrieved from]. on 10/12/2018.	Large credit market for agriculture in the private banking sector in Turkey which is related to the increase in investments in agricultural innovations and technologies.
Turkcell	Telephone	Banu Uzgur; Esra Ramazanoğulları; Dündar Özdemir; Doğan Tankut	[Retrieved from]. [Retrieved from]. [Retrieved from]. on 10/12/2018.	The importance of information and communication technologies for agricultural innovations.
Alara Tarım	Telephone	Dr Cihangir Korkmaz; Kerim Taner	[Retrieved from]. [Retrieved from]. [Retrieved from]. [Retrieved from]. on 10/12/2018.	Crucial to adjust technologies to local conditions; a strong connection between agricultural innovations, competitiveness and trade.
Agforise	Telephone	Koralp Özkut; Davud Keleş Ahmet Zahteroğulları; Hürrem Betül Levent	[Retrieved from]. [Retrieved from]. on 10/12/2018. Power Point Presentations	International collaboration provides research, development, innovation and technology as well as trade and investment opportunities; transfers knowledge; re-structures Turkish institutions and internationalizes them.

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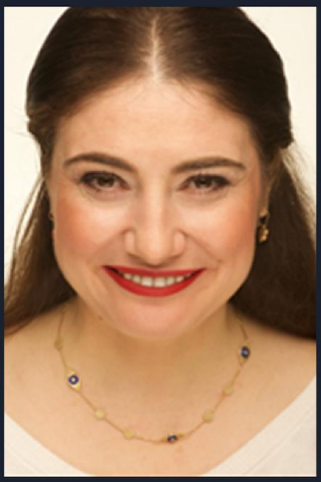

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