CONTRIBUTIONS OF WEB AND MOBILE APPLICATIONS TO RURAL DEVELOPMENT ON THE BASIS OF PRODUCT MANAGEMENT: A CASE FROM GAP REGION

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ABSTRACT

CONTRIBUTIONS OF WEB AND MOBILE APPLICATIONS TO RURAL DEVELOPMENT ON THE BASIS OF PRODUCT MANAGEMENT: A CASE FROM GAP REGION

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The agricultural sector has maintained its vital importance as it meets the food need of the population in every period of human history. Also, the developments in agricultural production in world history allow to access to the times for focusing on technological developments. Correctly implemented and integrated technological advancement into business processes of agricultural production help agricultural producers to sustain their agricultural activities, especially in rural areas which are disadvantaged areas globally to reach the technological benefits. In light of the product management fundamentals and technological advancement in agriculture, web and mobile applications provide opportunities to farmers by offering to access the information, reaching the market and contacting consumers.

This study aims to provide an evaluation of the potential contributions of web and mobile applications to rural development on the basis of product management fundamentals in the case of the GAP Region in Turkey.

Keywords: Rural Development, Agriculture Sector, Web and Mobile Applications, Product Management Fundamentals

ÖZ

ÜRÜN YÖNETİMİ TEMELLERİNDE GELİŞTİRİLEN WEB VE MOBİL UYGULAMALARIN KIRSAL KALKINMAYA KATKILARI: GAP BÖLGESİNDEN BİR ÖRNEK

Şahin, Gizem
Yüksek Lisans, Kensel Tasarım, Şehir Bölge Planlama
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Tarım sektörü, insanlık tarihinin her döneminde nüfusun gıda ihtiyacını karşıladığı için hayati önemini korumaktadır. Ayrıca dünya tarihinde tarımsal üretimde yaşanan gelişmeler, teknolojik gelişmelere odaklanılması için gereken zamanlara ulaşmayı sağlamaktadır. Teknolojik ilerlemenin doğru bir şekilde uygulanması ve tarımsal üretimin iş süreçlerine entegre edilmesi, tarımsal üreticilerin, özellikle küresel olarak dezavantajlı bölgeler olan kırsal alanlarda tarımsal faaliyetlerini sürdürmelerine, teknolojik faydalara ulaşmalarına yardımcı olmaktadır. Tarımda ürün yönetimi temelleri ve teknolojik gelişmeler ışığında geliştirilen web ve mobil uygulamalar çiftçilere bilgiye ulaşma, pazara ulaşma ve tüketicilerle iletişim kurma imkânı sağlayarak fırsatlar sunmaktadır.

Bu çalışma, ürün yönetimi temellerinde geliştirilen web ve mobil uygulamaların kırsal kalkınmaya potansiyel katkılarının Türkiye'de GAP Bölgesi örneğinde üzerinden bir değerlendirme sağlamayı amaçlamaktadır.

Anahtar Kelimeler: Kırsal Kalkınma, Tarım Sektörü, Web ve Mobil Uygulamalar, Ürün Yönetimi Temelleri

To my beloved family and husband

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ABBREVIATIONS

ARD : Agricultural and Rural Development

CAP : Common Agricultural Policy

DG AGRI : European Commission, Directorate-General for Agriculture and Rural Development

DSS : Decision Support System

EAFRD : European Agricultural Fund for Rural Development

EU : European Union

FA : Focus Area

FAO : Food and Agriculture Organization

FMS : Farm Management Systems

GAP : The Southeastern Anatolia Project

GDP : Gross Domestic Product

GHG : Greenhouse Gas

GIS : Geographic Information System

ICT : Information and Communication Technologies

IFAD : International Fund for Agricultural Development

IoT : Internet of Things

IPARD : Instrument for Pre-accession Assistance for Rural Development

IT : Information Technology

JICA : Japan International Cooperation Agency

KPI : Key Performance Indicators

MVP : Minimum Viable Product

NGO : Non-governmental Organization

NRDS : National Rural Development Strategy

NUTS : Nomenclature of Territorial Units for Statistics

OECD : Organisation for Economic Co-operation and Development

OKR : Objectives and Key Results

OPEC : The Organization of the Petroleum Exporting Countries

R&D : Research & Development

RDP : Rural Development Program

SDGs : Sustainable Development Goals

SQL : Structured Query Language

SSM : Site-Specific Management

UI : User Interface

UN : United Nations

UX : User Experience

WB : World Bank

CHAPTER 1

INTRODUCTION

The agricultural sector has maintained its vital importance as it meets the food need of the population in every period of human history. Diamond (1997) has sought answers by producing science-based theories about how human history developed in his 'Guns, Germs and Steel: A short history of everybody for the last 13,000 years' book. In this essential study, Diamond made the following remarkable determination about the reflection of the development in agricultural production in the history of humanity;

> *"By enabling farmers to generate food surpluses, food production permitted farming societies to support full-time craft specialists who did not grow their food and who developed technologies".*[1]

It is necessary here to clarify exactly what is meant by the aforementioned quote. The quote reflects that the ability to save food surpluses through advances in the agricultural sector has allowed humanity to make progress in other areas such as technology.

National Geographic studies about the Development of Agriculture argue that due to the changes in the history of humanity, which occurred in the agricultural practices about 12,000 years ago, was called the Neolithic Revolution. In the early ages, people were nomadic who were changing their environment continuously as a group of people. The hunter-gatherer lifestyle changed its place to a permanent settlement

[1] Diamond J., *Guns, Germs and Steel*, 30

with the developments in agricultural production by discovering the control of the plants. While the world population was about five million people 10,000 years ago, today consists of more than seven billion people in light of the developments in crop production and animal husbandry [2].

Especially in the last 200 years, agricultural transformations have taken place almost all over the world. That being so, with the developments brought about by the transformation in the agricultural sector, there has been an increase in income levels and improvements in health and economy (Low, 1984). Correspondingly, those who integrate new technologies into stable crop production have experienced economic development (Pingali et al., 2019).

Also, World Bank Group has mentioned the power of agriculture to enhance the income level of the poorest society. A study conducted in 2016 revealed that more than 50% of adult poor workers are those working in the agricultural sector. When the agriculture sector is compared with other sectors, it was revealed by the researchers in the same study that the agricultural sector is two to four times more effective in increasing the income of poor workers [3].

Discussion Paper presented by the European Commission at International Conference on Non-Trade Concerns in Agriculture in 2000 has stressed that in many countries in the world, agricultural activities constitute the economic livelihood in rural areas (European Commission, 2000).

Studies show that there are different approaches and evaluation metrics for rural area definition. However, despite this differentiation in the rural context definition, rural areas are the main pillar of the rural development which has a common goal on a global scale: To design the paths that will enhance the improvement of the rural area by using its potential aspects.

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[2] https://www.nationalgeographic.org/article/development-agriculture/
[3] https://www.worldbank.org/en/topic/agriculture/overview#1

According to the World Bank (1975), rural development is defined as "A strategy aiming at the improvement of economic and social living conditions, focusing on a specific group of poor people in a rural area. It assists the poorest group among the people living in rural areas to benefit from development". From a similar perspective rural development can be seen as a series of actions for a change which includes reconstructing distribution methods (for products, services, added value) that causes adaptations in agriculture, food production, rural subsistence and the rural area (Hebinck et al., 2014). Hence, there are similarities between the rural development definition expressed by Hebinck (2014) and those described by the World Bank regarding economic, social or environmental developments by taking advantage of the sectoral potential of the rural area.

While the aforementioned expressions focus on the economic improvement feature of the rural development, Niki (2002) is concerned with the misleading assumption of agricultural development and rural development as the same. Agricultural development aims at increasing production whereas rural development mainly focuses on the society and institutions (*ibid*). As previously stated, agricultural practices are part of the rural development if rural area is a potential place to conduct agricultural activities in its potential. Furthermore, agricultural development requires investment in infrastructure, technology and labor. (JICA, 2011). Lacroix (1985) states that the primary distinction between agricultural and rural development is that agricultural development concentrates on capital development versus the rural development emphasizes on human capital development.

Principally, agricultural development has had a great impact on technological advancement in human history. It is therefore likely that such unambiguous connections exist between agriculture and technology. As being an important sector in rural development, there is a great concern in the agriculture sector in support of the technology.

However, at this point, the progress in agricultural activities that paved the way for the development of humanity, together with the focus of humanity on other activities and intense, uncontrolled consumption, has left the agriculture sector in a danger.

Various local, national and global policies and regulations are carried out to save the agricultural sector from the bottleneck it is in by being aware of all the dangers. for these policies and efforts to be rewarded in practice, it is necessary to make plans at different scales, and then these plans turn into projects or products as a final service to reach farmers. As studies provide an important insight into how technology shape and improve the agriculture sector from Remote Sensing to the Internet of Things and beyond, ICT is also one of the technological advancements in the agriculture sector by serving web and mobile applications to the agricultural producers.

Correctly implemented and integrated technological advancement into business processes of agricultural production help agricultural producers to sustain their agricultural activities especially in rural areas which are disadvantaged areas globally to reach the technological benefits. Although many technological and biological innovations have been developed in agriculture, it is still dependent on climate conditions (Dellal et al., 2014)

It helped in bridging the information gap between agricultural application developers and farmers by revealing some important demographic information about farmers such as their age, gender, educational level, the type of farming carried out and most importantly, the factors that affected the adoption and continuous use of mobile applications by farmers. Still, it is possible to state that rural areas present different problems such as depopulation, economic decline and land-use conflict, and accommodate concerns for climate change and environment (Yetiskul et al., 2021).

1.1 Context and Problem Definition

Several studies exist in the literature regarding to define the challenges of agriculture sector. Doering and Sorensen (2018) state that one of the challenges of agriculture

in the 21 century in High Level Export Forum – How to Feed the World in 2050, agriculture has to enhance food production for increasing population with a smaller labor force. Similarly, The World Population Prospects 2019: Highlights, which is published by the Population Division of the United Nations Department of Economic and Social Affairs, provides a comprehensive overview of global demographic patterns and prospects. The study conclude that the world's population could reach its peak around the end of the current century, at a level of nearly 11 billion.

According to the United Nations report aforementioned, the world's population is expected to increase by 2 billion persons in the next 30 years, from 7.7 billion currently to 9.7 billion in 2050. To meet increased population's food demand, Food and Agriculture Organization (FAO, 2018) estimated that over one-third of the earth's land surface is supposed to be used as cropland or pastures. Additionally, studies constitute that agricultural production has to be increased by about 60-70% from the current levels to supply increased population's food demand in 2050.

The aforementioned data draw attention to the need for a solution to the increasing food demand. Increasing the arable land amount could be assumed as a solution to increase food production by the some of the views. Silva (2018) points out there are about 1,500 million hectares of arable land worldwide currently (*Figure 1.1.*). Furtherly, studies regarding the arable land issues that one-third of these land in the last forty years reveals that agricultural production areas are in danger of environmental degradation such as erosion, water scarcity, soil health etc.

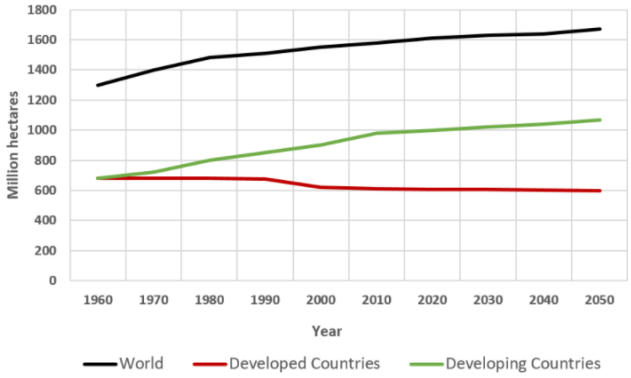

Figure 1.1. The availability of arable land (Food and Agriculture Organization & World Bank)

In 2050, the arable land will increase by about 200 million hectares, mainly from Sub-Saharan Africa and Latin America. This expansion may come at a heavy price as deforestation, in the Amazon for example, would cause severe ecological upheavals and release of more carbon stored in the soils into the atmosphere. These virgin lands are not readily available for agriculture as they lack chemical, physical, biological and infrastructure requirements for single crop species (Silva G., 2018)

The inadequacy of agricultural land products in the face of the rapid increase in the world population, the foresight that climate change, drought and desertification and the ecological deterioration due to these will occur frequently, led the agricultural sector to work on increasing efficiency in the fight against hunger and food safety. The world is facing various problems in meeting the food demand due to unconscious practices. Issues such as food security and access to safe food, as well as economic and social issues such as poverty and increasing inequalities, stand as other problem areas that settlements must face in the near and mid-term (Büyükcivelek, 2020).

An increase in population and food demand, global warming and climate crisis put great pressure on agriculture sector. Also, the population that continues agricultural production is getting older and there are not enough people to carry out these production activities. In addition to the aging of this population, middle-aged people who currently continue to produce are also expected to leave agricultural production and migrate from rural to urban causing various economic, social and spatial problems.

These studies and data constitute a critical piece of evidence base on the necessity of increasing agricultural production. While meeting the food demand of the population, mostly rural areas have been the case for agricultural production so far. Rural areas apart from urban take place more vital activities based on the restricted economic features.

Although technological developments in the last century have paved the way for vertical farming, hydroponic farming, and aquaponic farming practices in urban

areas, these production techniques help to grow certain vegetables and fruit. However, these production techniques are not suitable for all types of crops. The challenging point here is that all crop types can not be produced in this way. Basic agricultural goods such as maize, wheat and corn need to be produced on the land. As increased population cause the urbanization problem, urban areas have less land to continue agricultural activities. Hence, still rural areas are the main source of the agricultural activities. This study focuses on rural agricultural activities rather than urban farming.

Technological advancements are used to find solutions to the problems faced by the agricultural sector such as Internet of Things (Io)T, Big Data, Geographic Information System (GIS) and Information and Communication Technologies (ICT). ICT Unit in World Bank has released 'Mobile Applications for Agriculture and Rural Development' report in 2012 which provides policymakers and development and deployment of mobile applications for Agriculture and Rural Development. According to this report, it said that the dynamic growth of mobile communications technology is creating opportunities for economic growth, social empowerment, and grassroots innovation in developing countries.

When urban and rural areas are compared, Lacobs and Herselman (2006) state that rural areas have problems in accessing the information. Furthermore, their study points out that access to and use of information is the main driver of development. Some scholars have argued that in the less developed world where there is lack of access to Information Technology (IT). Hence, the poverty of information exists. The sector 'agriculture' embodies a multitude of activities which are cultivating soil, growing crops and raising livestock. As the definition of agriculture made by the National Geographic, agriculture is the art and science of previously mentioned

activities.[4] That is, accessing and using the information for scientific activities are crucial while rural areas are disadvantaged places for this access and usage mostly.

One of the areas with the greatest potential impact is the contribution that mobile applications can make to Agricultural and Rural Development (ARD), by providing access to information, markets, and services to millions of rural inhabitants. Therefore, farmers can access the information they need and lack with agricultural applications from their mobile phones.

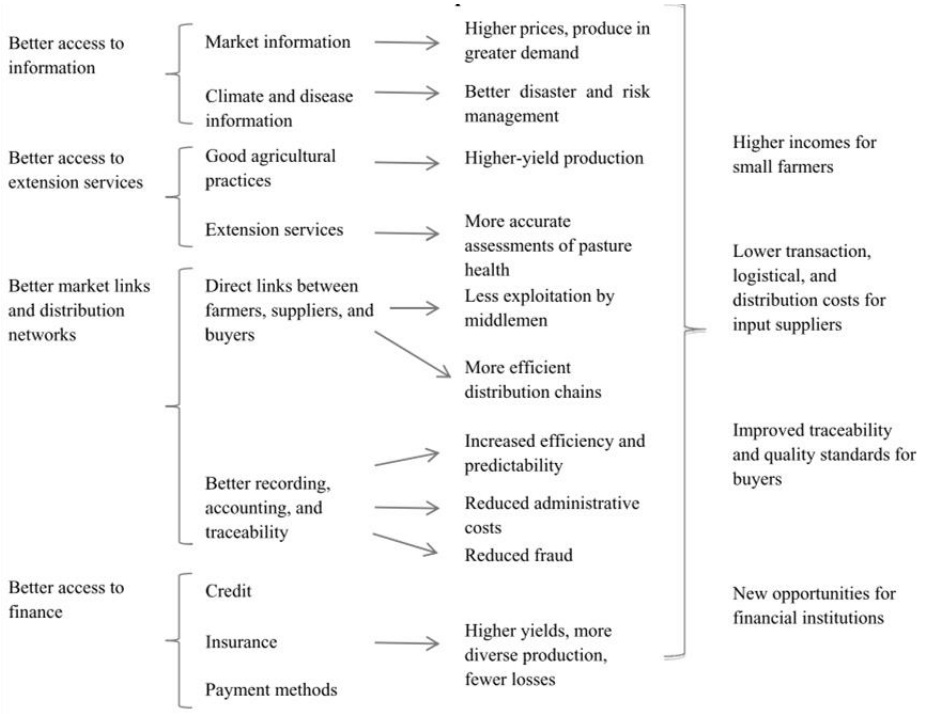

Figure 1.2. Results Generated by Mobile Applications for Agricultural and Rural Development (Qiang et al., 2011)

As is shown above, Qiang (2011) generated a result of quantitative research in Mobile Applications for Agriculture and Rural Development which points out that Agriculture and Rural Development applications offer access to valuable information. The study follows regarding the Kenyan farmers who have experienced

[4] https://www.nationalgeographic.org/encyclopedia/agriculture/

an increase in their income by using DrumNet application. This application tries to come up with the constraints to technology adoption that farmers typically face (Feder et al., 1985; Evenson and Westphal, 1995).

Agriculture and Rural Development application ecosystems in developing countries are fragile (Qiang et al., 2011) and power of the web and mobile applications is not well examined. Also, rural areas are challenging with access to information. Agriculture is the most leading economic activity of the rural places which requires the up-to-date information to conduct activities more effectively. Due to the previously mentioned global problems require a solution that led to an increase in agricultural production. At this point, technological advancement assists farmers to sustain their agricultural practices.

Rural areas are still open to development with their agricultural production potential. For this reason, it is the subject of rural development and the agricultural sector is a still concern of rural development. However, there is an ecosystem where access to information is limited in rural areas, but mobile applications that have already been developed have the potential to reduce this gap. While trying to reduce the gap between access to information and agricultural production activities, mobile applications should be developed on the basis of product management that focuses on the end-user, the needs of the target group, farmers, should be understood, and user-oriented products should be developed by identifying their competencies and deficiencies.

1.2 Aim of the Study and Research Question

This study aims to provide an evaluation of the potential contributions of product management fundamentals in agricultural web and mobile applications to rural development. In light of the product management fundamentals and technological advancement in agriculture, web and mobile applications provide opportunities to farmers by offering to access the information, reaching the market, and contact with

consumers. The developments in agricultural production in the world history, access to the times that allow focusing on technological developments have been provided. At the same time, the technological development in more than one area also affected the agricultural sector. Some of these were practices that helped increase the productivity of farmers, and some practices that allowed farmers to access markets and make their products available to wider consumers. Therefore, there has always been a double-sided influence and this is still an ongoing situation.

Today, urban are service areas that host the majority of the population. The UN World Urbanization Prospects reveal the projected data which shows that 68 percent of the world's population will live in urban areas and this is the increased trend from 58 per cent in the 2016. While the world population was around the 7.6 billion people, 4.2 billion were in urban and 3.4 billion were in rural. In UN's medium fertility case, 6.7 billion people are expected to live in urban, on the complementary 3.1 billion people will live in the rural areas out of 9.8 billion people which projected for the 2050.

Due to the fact that more than the half of the projected population will live in the urban, rural will still stay a place and shelter for the rest of the population. At this stage, this study investigates web and mobile applications as tangible products which are offered by the Information and Communication Technology (ICT) shape the agriculture. The reason why web and mobile applications were preferred in this study is that farmers can use these web and mobile applications without any extra investment costs if they have an internet connection. Here, the mobile application of the same product is also discussed, assuming that access to web applications may be low through computers in rural areas.

This study also covers to provide a critical assessment of the position of agricultural practices in rural development through web and mobile applications. In order to reach the mentioned aim, policy framework, and legal background, main actors, technological advancements in agriculture are going to be evaluated on how they have the power to shape agricultural practices and their output in both short and long

terms. Mobile applications which are operating national, regional or global scale are going to be generally assessed based on the agricultural production requirements in benchmark analysis by product management fundamentals.

In order to achieve the above-mentioned objectives, GAP Precision Farming web and mobile application was evaluated. GAP Precision Farming application is developed by FarmLabs Agriculture Technologies and R&D, which has been operating in METU Technopolis in Ankara, Turkey. With the development of these software products by FarmLabs, the author has taken these products as a case study in this thesis. The author of this thesis also works as a product manager in the agricultural web and mobile software products in the same company. The application developed by FarmLabs is offered free of charge to the farmers in the GAP (The Southeastern Anatolia Project) region by the GAP Administration. GAP region contains the Adıyaman, Batman, Diyarbakır, Gaziantep, Kilis, Mardin, Siirt, Şanlıurfa and Şırnak cities from Turkey. This application has been developed for the access of farmers in the GAP region. The farmers who continue their agricultural activities in these provinces are supported in order to take part in the sustainable agriculture cycle and to access technological developments. The reason for choosing these applications is related to both the experience of the author of this thesis directly in the development of products in agriculture field and ability to directly analyze the application usage patterns of the farmers by accessing the application database with the permission of the company.

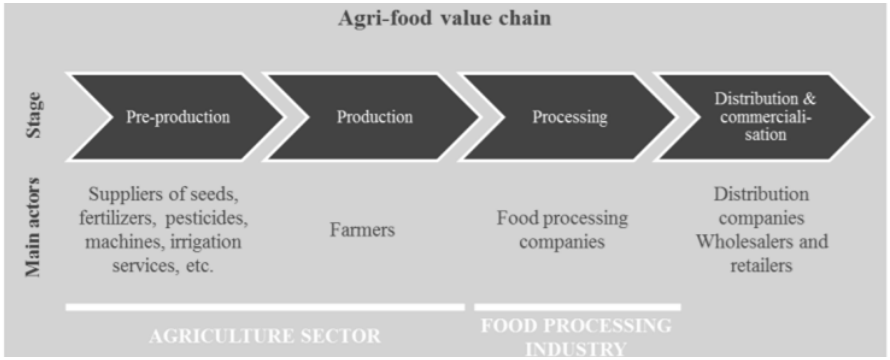

Figure 1.3. Agriculture value chain: stages and main actors (Paunov & Planes-Satorra, 2019)

As it is shown in (*Figure 1.3.*), agriculture value chain contains pre-production, production, processing and distribution & commercialization stages with multiple actors. This study mainly focuses on the preproduction and production stages with suppliers of seeds, fertilizers, pesticides, machines, irrigation services, farmers, etc. as main actors in the agriculture sector. All these stages have several applications and Farm Management Systems (FMS) is one of them. FMS is not only simple farm record-keeping systems, but they also meet the communication and data transfer needs of several stakeholders in value chain. FMS helps with farm operations and functions by collecting, processing, storing, and disseminating data in the form needed (Sørensen et al., 2010).

With its affordable solutions, FMS can be considered as scalable application that offers farmers user-oriented designs, interfaces, automatic data flows, and expert opinions (Murakami et al., 2007). Affordable features of these systems are important because Organisation for Economic Co-operation and Development (OECD) studies point out that in developing countries, more than 50% of the population live in rural areas and most of the poverty. Furtherly, FMS has evolved in sophistication through the integration of new technologies, such as web-based applications and applications for smartphones and tablets (Nikkilä et al., 2010).

This study intends to uncover the current status of web and mobile applications that are used in agricultural practices by farmers in light of the product management fundamentals. In order to define the main problem of the study, context is generated in the web and mobile application platforms that give opportunity to sustain agricultural activities for farmers.

Sub research questions of the study are;

1. What are the main characteristics of rural places and rural development planning?
2. How do agricultural practices play a crucial role in the rural development planning?
3. What are the main technological advancements in agriculture sector?

4. What type of product management fundamentals are available to give opportunity to access web and mobile applications by farmers?
5. What are the potential contributions of agricultural web and mobile applications to rural development?

Based on the results of these questions, it has been undertaken to define a framework pointing out the potential contributions of agricultural web mobile applications to rural development regarding product management fundamentals.

1.3 Methodology of the Research

Scholars state that the research design refers to the overall strategy that is chosen to integrate the different components of the study coherently and logically, thereby, ensuring you will effectively address the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data.

There is multiple ways to reflect research ideas by using several research design methods. This study is going to examine approaches by qualitative, quantitative and mixed-method tools. Data is going to be gathered from case study, reports, statistical calculation and literature review.

Research Statement	*Research Methods*	*Data Gathering*	*Data Analysis*
Evaluation of the Potential Contributions of Product Management Fundamentals in Web and Mobile Applications to Rural Development	• Qualitative • Quantitative • Mixed Method	• Case study (GAP Precision Farming Web and Mobi) • App user review • Reports • User Research • Statistical Data • Literature Review	• Benchmark Analysis • Content Analysis • Operational Evaluation – Database Queries/ SQL

Table 1.1. *Research Methodology*

The data collection instruments for this study were case study examination with product management fundamentals, Google Play & App Store user reviews, sectoral reports, statistical data, user research and literature review.

Also, in order to understand the behavior of users were examined by the database queries which was Structured Query Language (SQL). In GAP Precision Farming web and mobile applications, PostgreSQL was used which is a open source object relational database system.[5] As the product analytics tools used in current product management processes such as Mixpanel[6], Smartlook[7] and Amplitude[8], in this study SQL queries were performed to evaluate product analytics due to the limited number of app users.

In order to understand current situation of agricultural web and mobile applications broadly, benchmark analysis was conducted. App Markets cover several spectrums of agricultural apps such as field applications, weather forecasting applications, agricultural news and tenders' applications, agricultural input (fertilizer, pesticide) price applications, irrigation system management applications, yield monitoring applications and field navigator applications etc. Although the application may operate in one of these areas, it may also include all of them. This completely depends on the decisions made by the company that released the web and mobile application against the problem it wants to solve within the scope of the product.

1.4 Structure of the Research

The structure of this research is as follows (*Figure 1.4.*) and the thesis research topic was covered in six different chapters. The first chapter, current one, provides basic introduction to the research question and methodologies. As this research is

[5] https://www.postgresql.org/
[6] https://mixpanel.com/
[7] https://www.smartlook.com/
[8] https://amplitude.com/

constructed on the software product in web and mobile platforms in agriculture sector, this chapter tries to clarify the research methodologies to define how to link and look for correlation between agricultural software products and rural development in light with the product management fundamentals.

The literature review chapter expressed following the introduction chapter, draws attention to the rural concepts, rural development and rural development planning by pointing out the main players in the rural development both from European Union (EU) perspective and global approaches which focused on the European Union's Common Agricultural Policy (CAP), Green Deal Framework, United Nations (UN), The Organisation for Economic Co-operation and Development (OECD) Policies and World Bank Policies. Besides the international and global policy makers in the rural development and agriculture, Chapter 2 examine the past and current situation of rural development and agricultural practices in Turkey. The reason why this research considers both national, international and global situation in detail is to consider the relevance between these three without missing any aspect of it and to try to reveal the cause and effect relationship between them cleary. Along with Turkey's harmonization process with the European Union, the series of policies extending from the globe scope to the local feeds and develops each other. While the problems experienced in the agricultural sector occur on a global scale, they affect humanity deeply and this effect continues in a more negative way with each passing year. Since this chapter deals with the literature discussions of the thesis on a global and local scale, it is important to draw the general framework.

Along with the Chapter 3, the research goes into the deep with technological advancement in agriculture sector. Since the thesis is built on web and mobile applications that allow farmers to continue their agricultural activities, it arises from the need to address the technological developments affecting the software producta. For the agricultural sector, which is affected by technological developments in many areas, Information and Communication Technologies, Precision Agriculture, Internet of Things, Big Data, Remote Sensing and Geographic Information Systems were discussed within the scope of this study.

Moreover, in the Chapter 4, the focus was on product management fundamentals in web and mobile applications by diving product management processes into the four stages based on the application release in the market which are product strategy formulation, product planning & prioritization, product development & introduction and post-launch performance management. Clear understanding of product management fundamentals is crucial because product management has power to shape web and mobile application and give an opportunity to reach the success of the proposed solution. Hence, it is an important issue to evaluate web and mobile applications in the agricultural sector that can potentially contribute to rural development.

Furtherly, Chapter 5 contains the main discussion point of the research with the previous chapter. Following the completed introduction, literature review, rural place, rural development planning and detailed explanation of the technological advancement in agriculture which are main pillars of the research question, 'GAP Precision Farming' web and mobile agricultural applications were taken into account as a case study of the research. The benefits of these web and mobile application to the farmers who continue their agricultural production and how these benefits can manifest themselves in the field of rural development were emphasized. In order to achieve this, the link between the product targets set in the product development process and the rural development targets was utilized.

And lasty, conclusion chapter synthesizes the discussions of each chapter in light with the research question. Also, review of 'GAP Precision Farming' web and mobile agriculture application as case study of the thesis was revealed to the reach potential contribution of it to the rural development. Mentioned potential contribution was evaluated from economic, environmental and social perspective. Also, in Chapter 6, research contribution to the literature was discussed and limitation of research and recommendation for the future studies were included in this research.

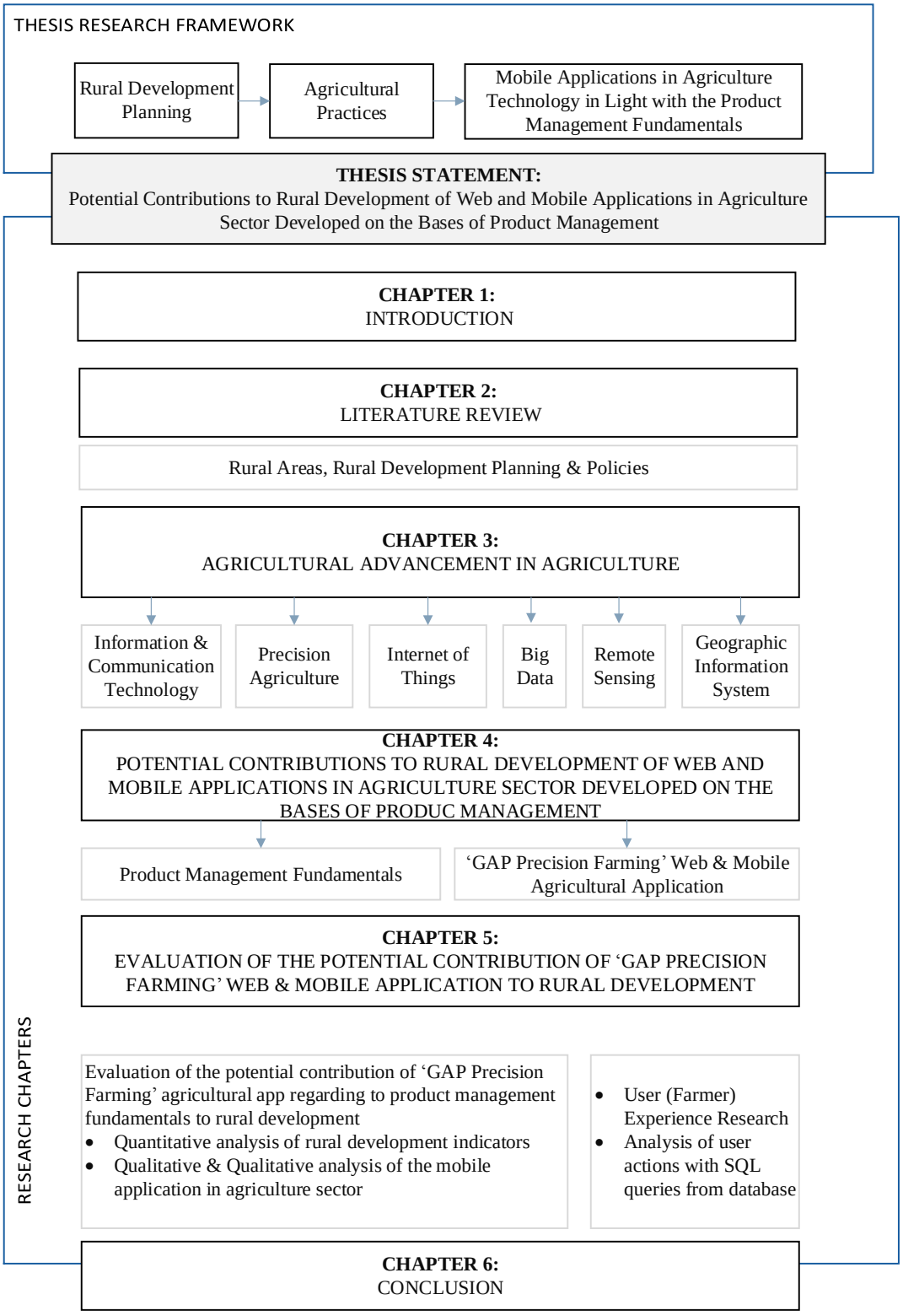

Figure 1.4. Research Framework (prepared by the author)

CHAPTER 2

RURAL, RURAL DEVELOPMENT PLANNING & POLICIES

Oakley & Garforth (1985) states that development is a dynamic concept that proposes to enter into change, starting from the current position or the previous position. Much of the current literature on development pays particular attention to three main aspects of it which are carried out simultaneously by countries: economic, social and human. Economic development focuses on the productive activities to increase income level while the main concern of social development is non-productive activities to have access the social services such as health, education. Along with these, human development stresses out the importance on the points where individuals and communities can reveal their potential by using their talents (Tolunay & Akyol, 2006).

With the migration from rural to urban in the 21st century, the majority of the world's population lives in cities and depopulation occurs in rural, but this does not mean that rural areas can be ignored. It is gathered under three main headings by Torre & Wallet (2016) that rural areas are still important and studies should be carried out on them:

i) Rural places are ever-changing. Rural is a still great place for holding 37.7% of all agricultural land and 3.4 billion people (World Bank, 2014).

ii) Rural areas are featured by high diversity. These features lead rural areas to be characterized as symbols of strong competition between nations and regions.

iii) Rural areas have various values that people need, from daily food to energy sources. On account of these features, rural areas are crucial to the public policies and tactics of many interest groups and governments.

Also, there is a less prominent another example which shows the importance of rural areas is the additional requirement for recreational and natural environments by urban dwellers, or the prospective concerns caused by increasing land consumption and artificialization (Torre & Wallet, 2016).

Studies show that there are different approaches and evaluation metrics for rural definition based on the basic characteristics of the area. Since the definition of rural varies among the regions, importance of clarify how the term is great place for humanity is aforementioned. While the definition of rural area changes according to the geography and demographic characteristics of the area, that is, all rural areas cannot be determined with a single definition; it is inevitable that rural development will change according to each rural area. It also differentiates the definition of rural development, along with industrialization, the subjects it focuses on; at the first point, the main purpose is economic growth, which is aimed to come with modernization; later focused on agriculture, but today it considers all possibilities that offer the opportunity for a better life from a more general perspective. In rural development practice, by making use of the power of policies, solutions are sought for the problems of rural areas and their potential is revealed by using the potential power of the rural development to end or decrease hunger and poverty in its aims[9].

In this study, since development, rural development and the characteristics of rural areas, the role of agricultural practices in this development will be evaluated through the web and mobile applications, the second part of the research focuses on these issues. That is, Chapter 2 concentrates on the literature review of the research on the rural context and rural development planning and policies. In order to understand the

[9] https://www.ifad.org/en/investing-in-rural-people

agricultural practices on which this research is based and seeks answers, it is imperative to address the rural context and rural development plans and policies. That is, the evaluation of the compatibility between the policy, plan and project in Turkey is evaluated through agricultural practices by covering the agricultural mobile application aspects in light with the product management fundamentals.

In addition, this section also covers actors that determine policies and roadmaps for rural development which are European Union (EU), Organisation for Economic Co-operation and Development (OECD), United Nations (UN) and World Bank (WB). The reason why the policies and frameworks of the EU, OECD, UN and WB are discussed in this section for the agricultural activities is the direct and indirect impact and interaction of rural development projects in each country to adapt to these policies and frameworks. These organizations have received more funding in recent years, and they have raised the percentage of their budgets dedicated to food, agriculture, and rural development activities (Organizations, 1977). Also, Villars (1999) discusses the roles of international organizations and non-governmental organizations (NGOs) in terms of their influence on policy formulation, which results in the implementation of institutional reforms and capacity-building programs, and in particular the support provided in terms of financial assistance, communications facilities and other information resources.

Aforementioned actors offer various programs and frameworks for rural areas for countries can be involved, as well as financial instruments to achieve these development goals. Turkey is one of the countries that is included in these programs and needs and uses financial instruments. Therefore, it is important to discuss how these actors deal with rural development and what they aim for in rural development, which is part of this thesis. In fact, the main reason for establishing this connection is Turkey's harmonization process with the European Union and the financial resources it provides for the plans and projects developed within the policies and frameworks of global policy makers. When countries with the scale and capacity of Turkey are evaluated, these financial instruments constitute a cornerstone to become a part of global solutions.

2.1 Rural Context

Regional has a wide meaning to describe area or region. The Rural Planning Association considers regional development as a regional plan including rural and urban development (Niki, 2002). However, the purpose of this study is rural areas and development plans targeting these areas rather than urban areas.

The definition ambiguity in many debates in the field of social sciences also manifests itself in the definition of rural area. The most important reason for different definitions is the variability in the dynamics that determine the rural area. Especially after the world wars, with the importance given by the governments to development, rural areas started to take place on the agenda more. At this point, various definitions of rural areas have been made in different geographies and administrative management styles. Rural often refers to wide land and tiny communities, but the definition of rural areas in both policy-oriented and scholarly literature is often taken for granted or left unexplained. (IFAD, 2010). In this process, some definitions are made according to the population size, while some are made according to the administrative structure and some are made according to the level of access to urban services. The European Commission bases the absence of a single statement in the definition of rural area on the following grounds (European Commission, 2013):

> *i)* the various perceptions of what is (and what is not) rural and of the elements characterizing "rurality" (natural, economic, cultural, etc.)
>
> *ii)* the inherent need to have a tailor-made definition according to the "object" analysed or policy concerned
>
> *iii)* the difficulty to collect relevant data at the level of basic geographical units (administrative unit, grid cell, plot, etc.)

The European Commission used the rural area definition methodology based on population density developed by the OECD in 1994. However, due to the fact that this methodology could not be fully applied, especially in densely populated areas, a

revision process was carried out by the OECD in 2005. The OECD's first approach works in two steps as follows: First, local units are determined and the population density in these areas is defined as rural if there are less than 150 inhabitants per square kilometer. Then regions are divided into three separate classes (OECD,1994):

i) Predominantly Rural Region: If more than 50% of the population of the region is living in rural communes (with less than 150 inhabitants/km²)

ii) Intermediate Region: If 15% to 50% of the population of the region is living in rural local units

iii) Predominantly Urban Region: If less than 15% of the population of the region is living in rural local units

In addition to the first step of the OECD rural area definition methodology mentioned above, in the second step, with the changes made in 2005, the definition of rural area is handled with the following distinction (OECD,2005):

i) Intermediate: If there is an urban center > 200.000 inhabitants representing no less than 25% of the regional population in a predominantly rural region

ii) Predominantly urban: If there is an urban center < 500.000 inhabitants representing no less than 25% of the regional population in an intermediate region

Also, Eurostat produce an urban-rural typology by using three classifications by NUTS (Nomenclature des Unités Territoriales Statistiques - Nomenclature of Territorial Units for Statistics) 3 level[10]:

i) predominantly urban regions, NUTS level 3 regions where more than 80% of the population live in urban clusters;

[10] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Urban-rural_typology

ii) intermediate regions, NUTS level 3 regions where more than 50 % and up to 80 % of the population live in urban clusters;

iii) predominantly rural regions, NUTS level 3 regions where at least 50 % of the population live in rural grid cells.

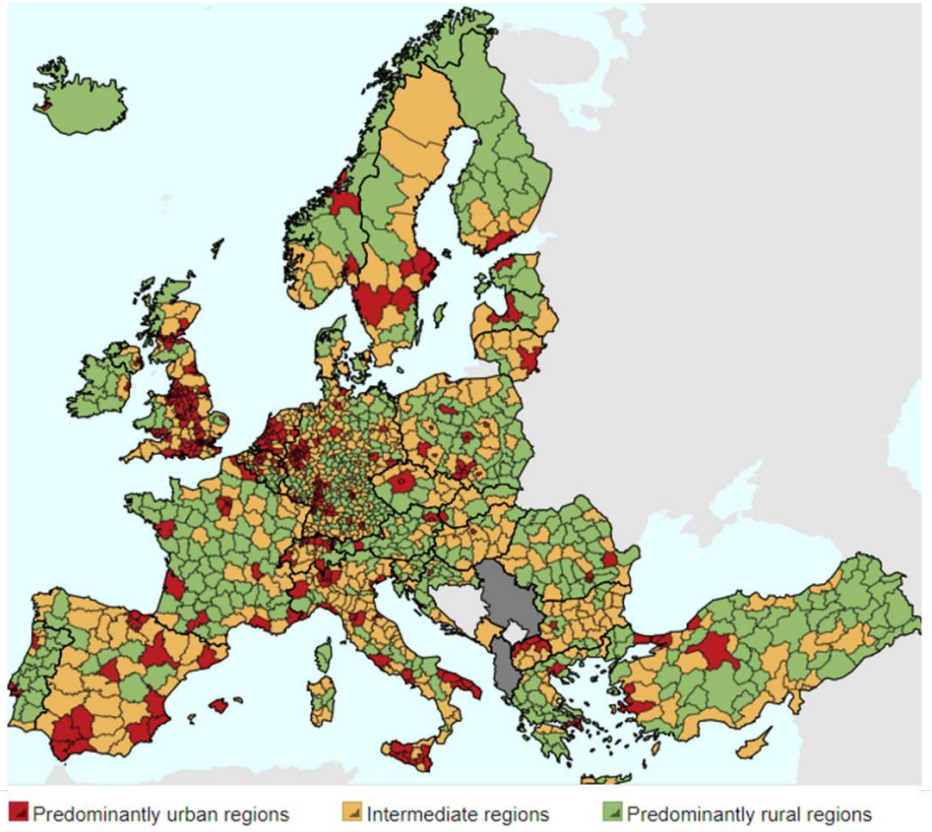

Figure 2.1. Urban-rural Typology, by NUTS 3 Regions (Eurostat, 2013)

In addition, according to 3 different rural area classification methodologies, predominantly urban regions, intermediate regions and predominantly rural regions, the above urban-rural typology map was created with NUTS-3 zoning by Eurostat (2003). Accordingly, predominantly urban regions occupy relatively less areas of the european continent.

Also, by using abovementioned methodology, Eurostat produced a country-based population structure to reveal percentage of predominantly urban regions, intermediate regions and predominantly rural regions (Table 2.1.). accordingly, in

EU-28, 42.48% of the population lives in predominantly urban regions, 35% 10% lives in intermediate regions, 22.42% lives in predominantly rural regions while in Turkey, 33.5% of the population lives in predominantly urban regions, 36%.37 in intermediate regions, 30.49% in predominantly rural regions.

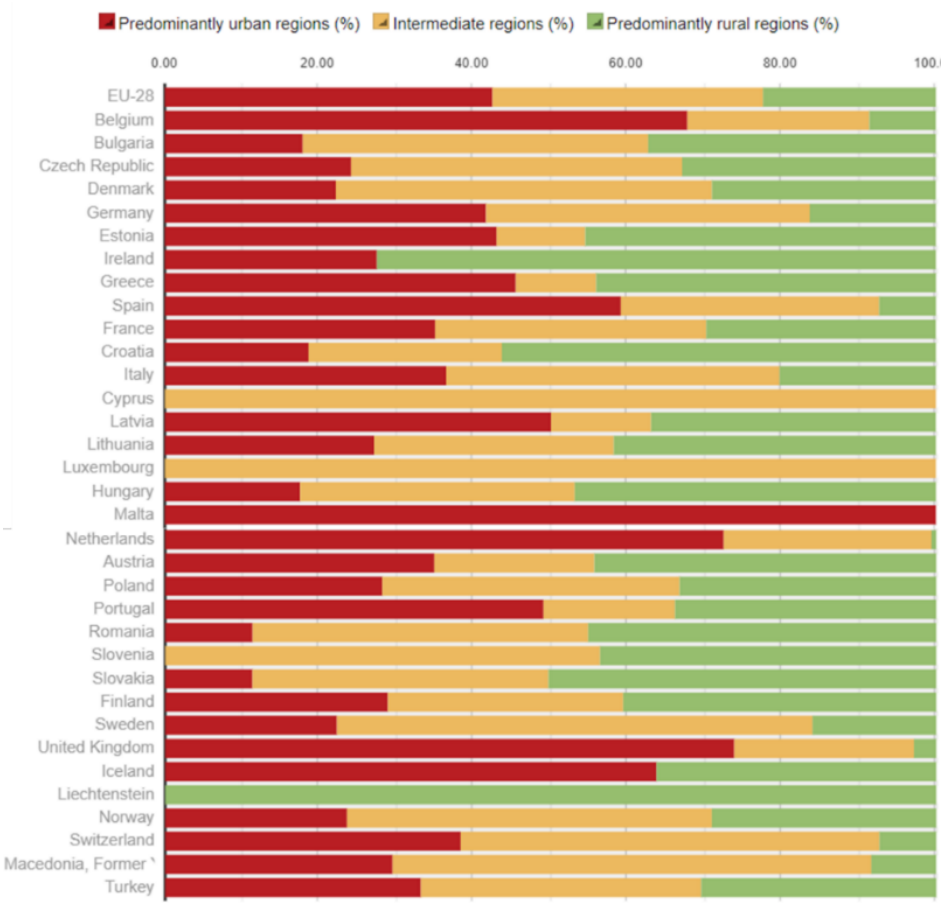

Table 2.1. *Population structure, by Urban-Rural Typology*[11] *(Eurostat, 2013)*

Eurostat defines the rural areas as "an area where more than 50 % of its population lives in rural grid cells" and called "thinly populated area" using technical term[12]. Also, European Commission (2014) states the new degree of urbanization in three category as follows:

[11] https://ec.europa.eu/eurostat/cache/RCI/#?vis=urbanrural.urb_typology&lang=en
[12] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Rural_area

i) Densely populated area: At least 50% living in high-density clusters

ii) Intermediate density area: Less than 50% of the population living in rural grid cells; and less than 50% living in a high-density cluster.

iii) Thinly populated area (alternative name: rural area): More than 50% of the population living in rural grid cells.

Currently there are 3.4 billion people living in rural areas today. Only since 2007 has the urban population surpassed that of rural areas. Around the 92% of the rural population is located in developing countries (FAO,2015). Furthermore, the rural population in developing countries is continuously rising and is expected to do so until 2028. (*Figure 2.2.*).

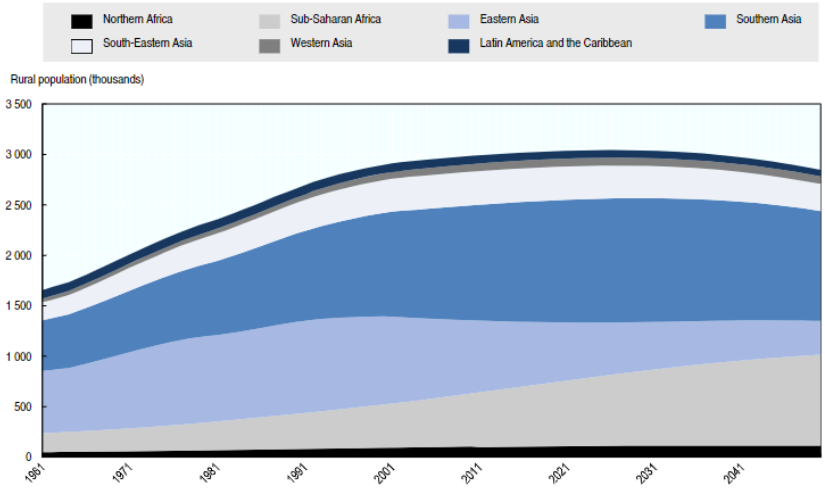

Figure 2.2. The rural population in the developing world continues to grow (FAO,2015)

Rural regions will play a central role in meeting the major global opportunities and challenges of the 21st century. This includes developing new energy sources that meet our climate challenge, innovation in food production for a growing population, and the provision of natural resources that will enable the next production revolution. Some rural areas are performing well and are in a position to grasp these opportunities. Other rural regions have not been as successful and have less capacity to adapt. Structural shifts in manufacturing and natural resource-based industries combined with population loss and ageing mean some rural communities are being

left behind, which fuels discontent. The capacity of governments to effectively address these challenges and opportunities will impact future national cohesion and prosperity[13].(OECD, 2019)

Within the framework of these definitions, facts and projections rural areas exist as places where population density is low, economic life is mostly based on agriculture, natural conditions and traditional values are effective in shaping life, and social opportunities such as education, health and communication are not sufficiently developed. Also, OECD (2019) defines the economies of rural or low-density how differs from urban economies in three pillars. The first one is rural areas are physically distant from major markets. The second one is economic competitiveness issue in rural. The last one is about how the potential of rural areas shapes the local economy there.

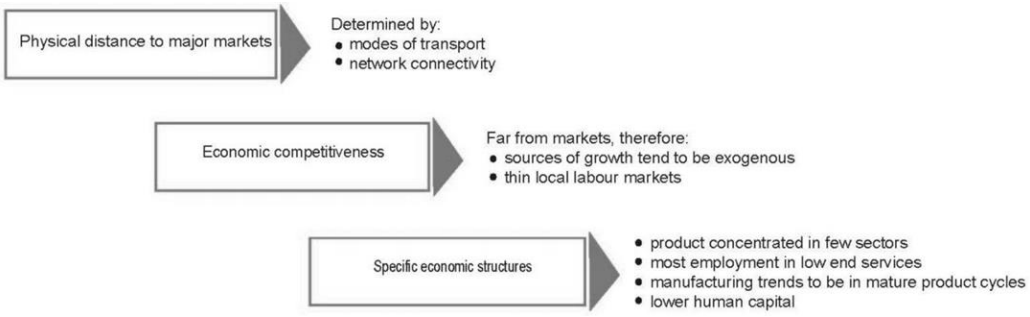

Figure 2.3. Features of low-density economics (OECD,2018)

While many research points out the major problems of the rural such as being distant from services, poverty in rural etc., Cullen (2002) and Rao (2003) has taken an attention to the access issue to Information and Communication Technologies (ICTs) by listing eight different aspects which has a potential to the prevention of rural business corruption and rural people could enjoy the benefits of these technologies and also they stressed out he main obstacle to reach technologies in rural areas;

[13] https://www.oecd.org/cfe/regionaldevelopment/Rural-3.0-Policy-Note.pdf

1. Physical access (lack of a robust telecommunications infrastructure, computers and connectivity) and costs it involves
2. Lack of awareness of the benefits of ICTs
3. Lack of ICT skills and support
4. Attitudinal barriers like cultural and behavioral attitudes towards technology
5. Language barriers in using the Internet especially if English is not the first language
6. Lack of local language information products or content, especially tailored to the assimilation capacities of rural people or interesting and relevant to them
7. Non-availability of governmental information online
8. Lack of motivation to use information over the Internet

These above factors can play a role in a rural community and governments also need to be informed of these in order to ensure they are diminished for better results.

Technology offers transformational solutions for rural areas as it stated in OECD's study. Despite the daunting challenges facing rural areas, there also exist significant, yet-to-be-tapped opportunities arising from advances in technology, science and social organisation. If well managed, technology and science can improve the quality of life of rural households and help in dealing with many of the structural challenges of the developing world, including climate change and environmental crisis, bad governance and corruption, food security, disease, access to services and finance, and low agricultural productivity. For example, ICTs have a multitude of rural applications and can concretely improve the competitive position of the rural sector in the economy. Also, agriculture is still the most important sector in the developing world (World Bank, 2015a) when the agriculture percentage in Gross Domestic Product (GDP) is compared.

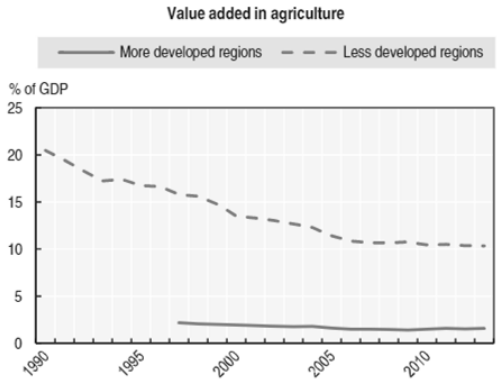

Figure 2.4. Agriculture percentage in GDP (World Bank, 2015a)

Agriculture is regarded as the backbone of a country's economy in developing countries. It plays a significant role to GDP, exports, and the elimination of unemployment. The performance of agricultural extensions is related to the overall performance of the agricultural system (Sritragool et al., 2019). Unfortunately, commonly acknowledged paradigm for evaluating agricultural services' effectiveness is not available in literature (Faure et al., 2016).

Agricultural extension can be regarded as the provision of information inputs to farmers in general. The function of boosting agricultural productivity can be used to assess the role and performance of extension services (Hounkonnou et al., 2018). Information systems can also be defined as a collection of components that use software and hardware to collect, process, and share information and data. These systems are the cornerstones of economic development for businesses of all sizes, large and small (Nikjoo et al., 2011). For most firms, continuous technological growth has resulted in cheaper prices and a wider selection of information systems (Lipaj & Davidavičienė, 2013).

The results of investigation shows that there is no definition of rural area accepted on a global scale. However, all studies have shown that rural areas still host a significant part of the population, have important natural resources, problems in production activities due to difficulties in accessing information and technology, and Since the agricultural sector still has a significant share in a significant part of these areas, it is important to continue the rural studies. In addition, the fact that the

communities living in rural areas have limited access to various services such as education and health compared to those living in urban areas, and in addition to these, have a low income are among other important problems. With all these features, this study includes various definitions of rural areas and common problems and needs in rural areas. In the continuation of this part of current chapter, since the mobile application in which the case study was handled includes the farmers living in rural areas in Turkey, the rural context in Turkey was also discussed.

2.1.1 Rural Context in Turkey

Various definitions of rural areas have been made since the proclamation of the Republic in Turkey. First of all, in the Village Law No. 442, which entered into force in 1924, the following statement was included[14]:

> **Article 1** – *The settlements with a population of less than two thousand (villages), those with a population between two thousand and twenty thousand (town) and those with a population of more than twenty thousand (city) are called. Even if the population is less than two thousand, township, district and province centers with a municipal organization are considered towns. And it is subject to Municipal Law.*

Following the above statement, there is the following statement that takes the population in settlements as a criterion with the Municipality Law No. 5393, which came into force in 2005[15]:

> **Article 4-** *Municipalities can be established in settlements with a population of 5,000 and above. It is obligatory to establish a municipality in provincial and district centers.*

[14] https://www.mevzuat.gov.tr/MevzuatMetin/1.3.442.pdf
[15] https://www.mevzuat.gov.tr/mevzuatmetin/1.5.5393.pdf

According to the decision published in the Official Gazette No. 26070[16] in 2006, the first National Rural Development Strategy (NRDS-I)[17] was adopted during the Ninth Development Plan[18] (2007-2013) period. In this strategy document, the statement in the Eighth Development Plan[19] (2001-2005) was included:

> *Settlements with a population of more than 20,000 are considered cities, and areas other than this are considered villages.*

It is observed that rural area definition varies according to the purpose and scope of activities by different institutions and organizations. Also, according to the statistical evaluation determined by TURKSTAT, there are two different approaches for rural area definition (NRDS-III, 2021) as follows:

> *i)* All settlements outside the provincial and district centers are considered as villages (including towns) according to the administrative status of the settlements.
>
> *ii)* Using the population threshold, the population of the settlements showing the minimum urban functions was accepted as twenty thousand.

In the previous National Rural Development Strategy (NRDS-II), policies and strategies related to rural areas were discussed over the above-mentioned definition of rural areas. However, with the Law No. 6360, which entered into force in 2012, the borders of Metropolitan Municipalities were expanded and rural areas were included in the provincial borders of the municipality. With this new regulation, the total number of existing villages decreased by 47.10% and the total number of villages was recorded as 18,214. In addition to making, it difficult to determine rural

[16] https://www.resmigazete.gov.tr/eskiler/2006/02/20060204-9.htm
[17] https://www.resmigazete.gov.tr/eskiler/2006/02/20060204-9-2.pdf
[18] https://www.sbb.gov.tr/wp-content/uploads/2021/12/Dokuzuncu_Kalkinma_Plani-2007-2013.pdf
[19] https://www.sbb.gov.tr/wp-content/uploads/2021/12/Sekizinci_Bes_Yillik_Kalkinma_Plani-2001-2005.pdf

areas, this change caused an increase in the tax burden by including settlements that are rural and struggling with rural poverty within the municipal boundaries.

According to the final declaration of the Third Agriculture and Council (2019), new regulations were implemented. Regarding rural areas, it was decided to restructure the neighborhoods in metropolitan municipalities as rural and urban, and to preserve the village legal entity structure in rural neighborhoods (No. 17)[20]. On Official Gazette No 31455, The Regulation on Rural Neighborhoods and Rural Settlements was published in 2021. Within the scope of this regulation, it is stated that in rural neighborhoods and settlements with rural area characteristics, gradual exemptions and reductions in taxes and service fees allocated by municipalities will be started[21]. Along with these developments, in the Eleventh Development Plan published in 2019, it was decided to redefine the rural area together with the relevant institutions by TURKSTAT.

When the rural-urban distribution of the population in Turkey is evaluated according to the twenty thousand population threshold determined by TURKSTAT, 28% of the population in 2011, 27.7% in 2012, 13.3% in 2013 and 11.5% in 2019 live in rural settlements. The main reason for this sharp decline between 2012 and 2013 is the enlargement of the borders of the Metropolitan Municipality with the law enacted in 2012 and the inclusion of some rural areas within these borders. In the population projections studies, it is predicted that the migration from rural to urban will continue and the rural population will decrease. When these migration movements are evaluated, it is revealed that they are from low development places to high places.

This part of the Chapter 2 has found that the definition of rural area in Turkey has changed with various legislation and regulations. Although the definition of rural area has changed due to the changes made in the definitions and accordingly a decrease in the rural population has been observed, the existence of rural area

[20] https://www.tarimorman.gov.tr/Haber/4207/3-Tarim-Orman-Surasi-Sonuc-Bildirgesi
[21] https://www.resmigazete.gov.tr/eskiler/2021/04/20210415-2.htm

problems experienced on a global scale is also in question in Turkey. Migration, low income, climate change, lack of access to various services and low technology penetration are among these problems in rural. Moreover, in addition to the regulations made at the government level, Turkey's involvement in the process of harmonization with the European Union and access to financial instruments by being included in the programs of various NGOs can be shown as factors causing change in rural areas. In the continuation of this part of research, which deals with the rural context, the rural development approaches, various applications, definitions and research were given.

2.2 Rural Development & Planning

Governments design and implement a variety of long-term development plans in order to improve the well-being of their citizens. Especially, at the end of the Second World War, many countries suffered heavy damage and developed various approaches to growth and development in order to eliminate the negative consequences of these heavy destructions. For this purpose, the concepts of growth and development in economics are evaluated separately. At this point, while growth mostly points to quantitative changes in the economy target; development rather refers to both quantitative and qualitative changes in economic and social life. Various non-governmental organizations and unions have taken part in the development goal as well as governments and have carried out various studies and produced policies for the sustainability of development and continues to produce. In these studies, especially rural development and its importance were emphasized.

As rural development has been on the agendas of governments and various organizations as an important movement since the 1960s. For this reason, there are various definitions of rural development around similar goals. Administrative Committee on Coordination (1974) from United Nations has stated rural development as "a poverty-oriented rural development activity is one which is aimed at benefiting the relatively less-advantaged segments of the population of rural

areas", while The UNDP (1979) has defined rural development as "a process of socio-economic change involving the transformation of agrarian society in order to reach a common set of development goals based on the capacities and needs of people" (*Evaluation of Rural Development Activities of the United Nations System in Three African Least Developed Countries*, n.d.).

Although agriculture sector is a part of the rural development, general thought about these two issues is the same. Mostly, these are used for each other, while they are aiming different target. Agricultural Development mainly aims at increasing agricultural products such as crops, livestock, fish and etc. Human being, land and capital are simply regarded as production goods and means. On the other hand, Rural Development mainly targets on people and institutions. Rural development includes agricultural development activities; however, it is one of the means of economic revitalization for active farmers and targeted rural villages. (Niki, 2002)

A Dictionary of Human Geography firstly defines development as a process which contains growth or change at individual, community, and social levels. Secondly, it is defined as the planned attempts to transform the standard of living among the populations of a poorer country or region.[22] Similarly, the Cambridge Dictionary considers the subject of development as growth over countable and uncountable quality by expressing the gradual growth of something which makes it more advanced.[23] While dictionary definitions express that development is a process, most of the studies focus on the economic benefits of the development. Therefore, the definition of development is a multilateral concept that focuses on different meanings and goals, influenced by the time and situation in which it is found.

In addition to these expressions, Rabie (2016) considers development issue as a process in which a nation moves forward from the issues that it lacks or lags behind

[22] https://www.oxfordreference.com/view/10.1093/acref/9780199599868.001.0001/acref-9780199599868-e-389
[23] https://dictionary.cambridge.org/tr/s%C3%B6zl%C3%BCk/ingilizce/development

which consists of economic, social and political transformation that enhances the life quality of society. Also, Stiglitz[24] points out that developments is not only about economical welfare, but also involvement of all aspect of society and requires the everyone's efforts from markets to non-for-profit institutions.

Development is a comprehensive process contains several sectoral and societal engagement in it and occurs in any level. The feature of being at any level causes the concept of development to appear in rural areas as well. On account of development, rural development takes a place on each government's agenda and each government has different concerns and aims based on the heterogeneous structure of rural areas.

Because of social, economic, technological and the interaction of various resource elements, large spatial and temporal changes are taking place in rural areas. This change has increased the difficulty of our understanding of rural development characteristics to a certain extent. In addition, there is no doubt that rurality is difficult to accurately define because of the functions, dynamics, and variations (Cloke, 1985)

Ashley and Maxwell present the problematic situation of rural development using three different pieces of proof globally: (i); The existence of rural poverty, (ii); decreasing agricultural aids, (iii); co-creation efforts of international funding agencies and developing country governments for common policy (Ashley & Maxwell, 2002). The reason why this study mentioned rural poverty is based on the following data presented by IFAD: IFAD (2001:15) estimates nearly 1 billion people out of 1.2 billion people in rural has less than one dollar a day to live and work. On this basis access to ICT supports the achievement of goals such as poverty reduction and sustainable development (Torero, 2006) . Also decreasing agricultural aids proof

[24] https://books.google.com.tr/books?hl=tr&lr=&id=j6l2w77aB6gC&oi=fnd&pg=PR9&ots=dkvNpXhB-X&sig=PK8LqTqXKcU_YjiWua3oGp3jGxM&redir_esc=y#v=onepage&q&f=false

laid down in IFAD (2001:41) shows that agricultural aid in the 1990s remained at the level of 35% of the agricultural aid in the 1980s.

As OECD study points out that rural case in developed and developing countries quietly separate from each other based on the population gap and poverty. In developed countries, the rural population makes up on average about 20% of the total population, and the income gap between urban and rural areas is not large. On the contrary, in developing countries, more than 50% of the population live in rural areas and most of the poverty.

Rural development, perhaps because the rural area remains in such poverty was expressed in various ways across time. To illustrate this, there are such expressions in the literature: "poverty allevation (1980), poverty reduction (1990) and poverty eradiction (2000) " phrased are available instead of rural development (Ellis & Biggs, 2001).

The dynamics of agricultural processes have been the subject of recent European studies on sustainable rural development (van Vliet et al., 2015). These studies have common concerns regarding to the depopulation in rural areas due to the migration to urban areas, aging population in agriculture and unwillingness of next generation taking part in agriculture. It is even supported by other studies that these concerns are not unfounded. Human adaption to difficult socio-environmental situation is frequently viewed as migration. Unemployment is among the important causes of migration from rural to urban areas (Lyu et al., 2019).

Even in the Future of Rural Society study published by the European Union in 1988, the important effects of the aging factor in the workforce in the agricultural sector were mentioned. At that time, half of the farmers were 55 years or older and almost half of these farmers did not have the next generation to continue their agricultural activities (CEE, 1988). Unfortunately, the fact that those operating in the agricultural sector are doomed to earn low income causes the next generation not to prefer agriculture, which accelerates migration. In addition, the World Development Report 2008: Agriculture for Development report has suggestion for farmers who cannot

create high value in agricultural production exit from agriculture. However, the same report also states that the exit of this group of workers, who do not have any skills, from agriculture does not guarantee an exit from poverty.

Rural development carries on being a crucial policy field since it expands to a lot of subjects that influence both urban and rural habitants' quality of life (Green& Zinda, 2013). A definition of rural development is made by Lele (1975) as developing life standards of the low-income rural residents and creating a self-sufficient development continuum for them. According to van der Ploeg et. al. (2000), rural development means creating recent products, services and evaluating recent markets while dealing with the development of recent types of cost decline via detailing new technological paths. Moreover, rural development is also related with quality of life of rural people, and as shown in Figure 2.1, the determinants of rural development are natural resources, human resources, capital, technology, institutions and organisations (Singh, 2009)

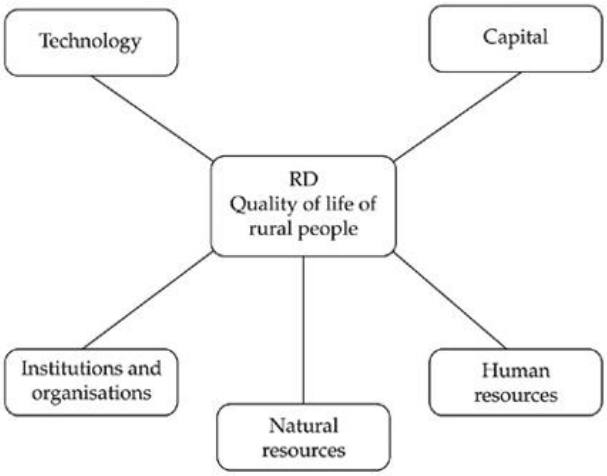

Figure 2.5. Determinants of rural development (Singh, 2009)

Correctly implemented and integrated Information System into business processes is assumed one of the key factors that enhance business performance (Pabedinskaitė 2009; Yahaya et al. 2004; Merkuryev, Tambovcevs 2009). Information systems offer intangible and tangible benefits which makes total benefit estimation of information systems hard (Lipaj & Davidavičienė, 2013).

Rural areas are defined based on the constrained there are faced such as limited productive employment opportunities, poor education and infrastructure, and limited access to markets and services in studies. (OECD, A New Rural Development Paradigm for the 21st Century). Studies continue by pointing out challenges that rural faced contain advances in information and communications, agricultural, energy, and health technologies that can help address some of these challenges.

While previously studies in rural development focused on the agriculture sector basically, latest studies are aware of that rural development has multi-sectoral dimension. Although that awareness is a great step in rural development, agricultural activities still save its importance in rural development. It is not just because of the most of the rural population gain their economic power from agriculture (rate), increasing world population requires more food currently and it will be more in the future based on the projection data.

OECD analysis yields ten lessons that help inform a new rural development paradigm:

1. Rural areas vary enormously, so rural strategies need to tailored to each country's specific conditions
2. Governance is a key factor in the success or failure of rural development
3. Demographic dynamics play a vital role
4. Policies that build on rural-urban linkages can drive development
5. Agricultural development is key for improving welfare in many developing countries today
6. … but there is more to rural areas than agriculture
7. Inclusive infrastructure is critical for rural economic growth
8. Gender equality is fundamental for rural development
9. Inclusive policy approaches are necessary to reduce rural development
10. Rural development and environmental sustainability go hand in hand

In the process of change, the needs of the rural also change. Only issues such as production, self-sufficiency, use of inputs, employment and livelihood are

insufficient to meet the needs of rural areas. This situation puts the holistic service delivery approach in the foreground in rural development. Based on this change, it is necessary for public institutions and organizations, which are responsible for and/or among their priorities, to provide services to the rural areas, as well as the private sector, non-governmental organizations, to make changes in their rural development approaches, and to develop structures that can develop the rural not only in economic terms but also in technological, informatics and cultural areas[25].

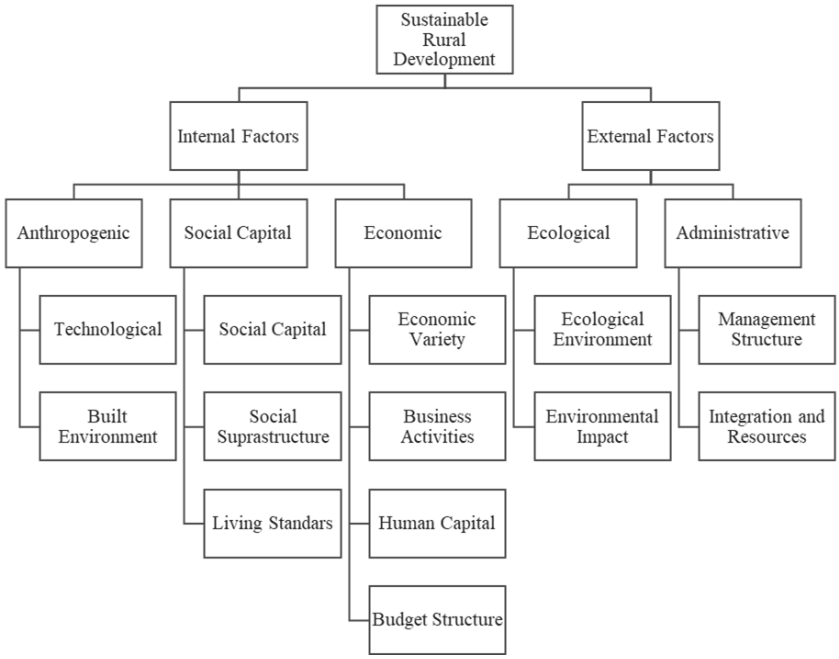

Figure 2.6. The Classification of Rural Development Drivers (Gorbenkova et al., 2018)

Also, there are many drivers in the classification of rural development which are mainly divided into two categories: internal and external factors (*Figure 2.6.*). Moreover, these factors constitute from several class from anthropogenic to administrative.

25 https://www.researchgate.net/publication/343474169_DUNYA_KIRSALI_VE_KIRSAL_KALKINMAYI_YENIDEN_KESFEDERKEN_TURKIYE'NIN_KONUMU

Ellis and Biggs (2001) draw attention to the themes of general development and moments of motivation the identification of major rural development initiatives from the 1950s to the 2020s by preparing a timeline (*Figure 2.7.*)

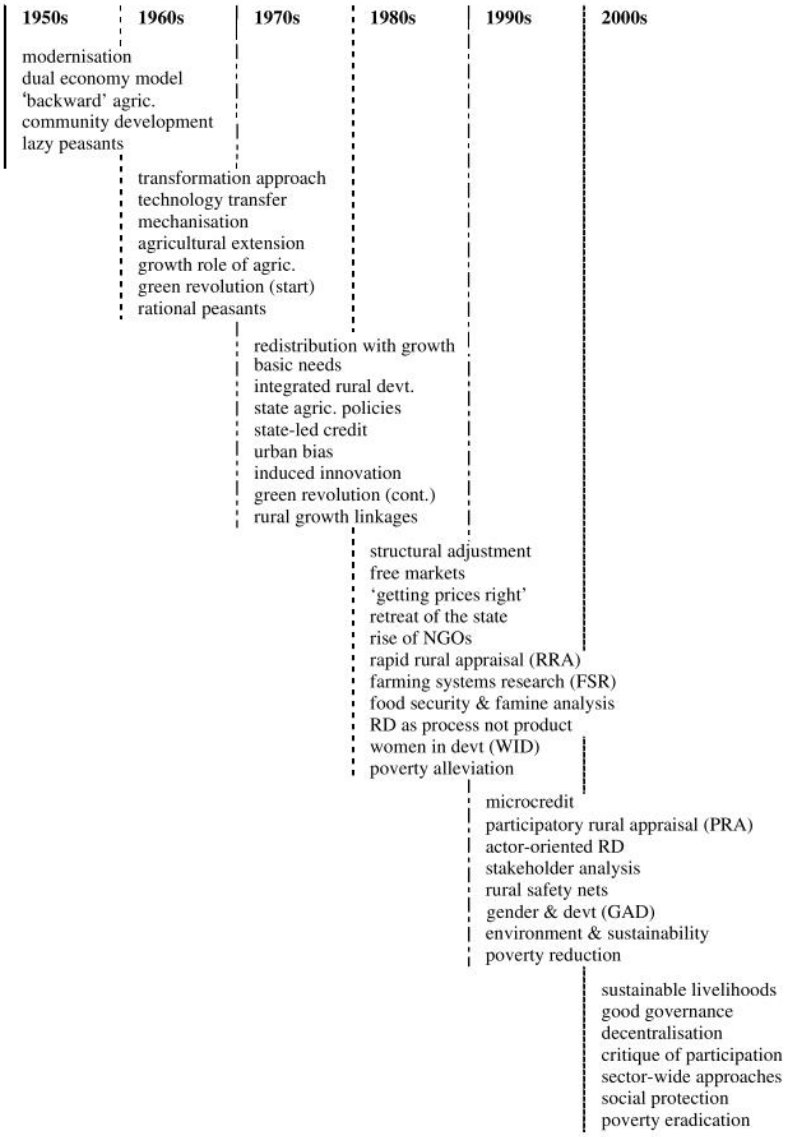

Figure 2.7. Rural Developments Ideas Timeline, 1950s - 2000s (Ellis & Biggs, 2001)

Also, Ellis and Binggs (2001) criticize the expectation that the targets planned in the intellectual field will be directly equivalent in practice at the same time. Therefore, they present with another timeline that this expectation cannot be realized (*Figure 2.8.).*

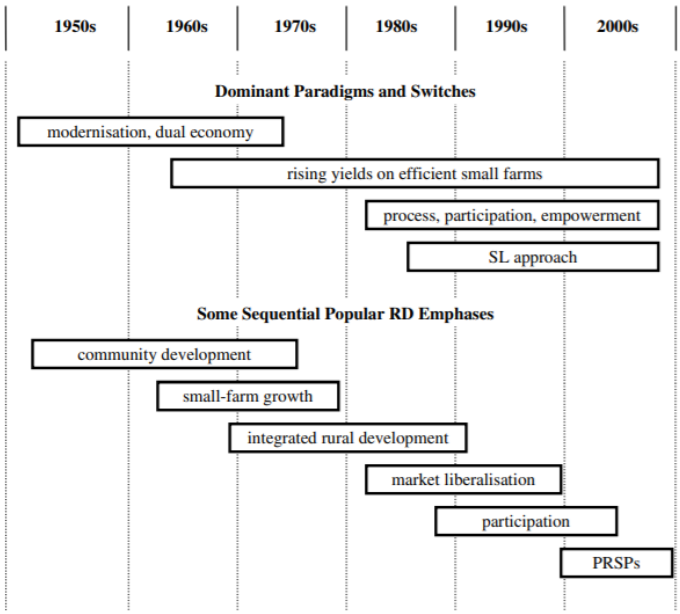

Figure 2.8. Dominant and Sequential Themes in Rural Development, 1950s - 2000s (Ellis & Biggs, 2001)

So far, rural development approaches and their main focuses have been included. Different organizations and researches offer various suggestions for the realization of rural development. However, at the common point of these differing proposals, it is emphasized how important it is to strengthen the rural area in economic, social and environmental fields and to develop tools that can use the potential of the rural area in the most correct way. In addition to all components, it is emphasized that access to information is one of the most important keys to rural development. In the continuation of this research, as in the rural context, rural development approaches and practices in Turkey were included. The reason for this is the assumption that understanding the rural development approach and its current situation in Turkey may make an important contribution to the process in order to address the potential contributions of the mobile application, which constitutes the case study of the research, to Turkey's rural development.

2.2.1 Rural Development in Turkey

In the Rural Development Policies (2004) report published by the Second Agriculture Council of Republic of Turkey Ministry of Agriculture and Rural Affairs (Republic of Turkey Ministry of Agriculture and Forestry), rural development defined as “a process of creating a sense of need for individuals and communities living in rural areas and making their living from the agricultural sector or similar rural occupations, in order to provide them with humane living conditions, and then providing them with all material and moral assistance in order to make efforts in this direction to ensure the development of these communities in a democratic way.” Also, in the same policy report, it is mentioned that rural development has two main components, namely agricultural development and rural industry. Together with these components, the scope of rural development is summarized as follows: "Improvement of infrastructure and superstructure such as agriculture (crop and animal production activities), forestry, aquaculture, small entrepreneurship, rural industry, ecology, environment, tourism, water, housing, education, health, social security services, technology and improving the situation of women, children and poor, employment of the landless and contain many other programs and projects.”

In the National Development Strategy study, the main purpose of rural development is expressed as "the development and sustainability of the working and living conditions of rural society in harmony with urban areas, based on the evaluation of local potential and resources, and the protection of natural and cultural assets" (State Planning Organisation, 2006).

To date, several researches are available on rural development in Turkey. In these researches, the issue of rural development in Turkey is discussed by dividing it into three different periods. The first period is the first years of the Republic, which focuses on the pre-1960s and is expressed as the pre-planned period. The second period is expressed as the planned period that takes place after the 1960s. The third period is the time period considered as the process of harmonization with the European Union. In these three periods, the issue of rural development was handled

with different tools and diversified in line with various objectives. Turkey is still in the category of developing countries that need more work on rural development. These studies are supported by various policies, strategy documents, programs and financial instruments. In this part of the research, important points that are considered as milestones in rural development issues in Turkey are discussed and it is planned to present information about Turkey's general approach and situation in rural development. For this purpose, important issues that shaped these three separate periods are briefly mentioned.

The years between 1920 and 1959, which is expressed as the pre-planned period, caused more attention to be given to the problems of rural society, since the majority of the population in Turkey lived in rural. This period, which is also expressed as the first years of the Republic, focused on activities that would provide economic improvement due to the post-war economic depression of the people living in rural areas. These activities aimed at both infrastructure development and economic and social improvements. This period is also referred to as the reorganization period (Bakırcı, 2007*)*. Enacting the Village Law, Settlement Law, Farmer Landing Law, abolishing the tithe tax collected from agricultural producers, establishing Village Institutes, distributing free seeds to farmers and providing technical support are among the activities in which state support is provided for rural development in Turkey. After this period, mechanization in agriculture has occurred in order to modernize agricultural activities on a global scale, and with the effect of this, the migration movement from rural to urban has accelerated.

After the 1960s, which is called the planned period, the planned development period was started and 5-year development plans were created. In these development plans, regulations regarding rural areas are also included in the sections where the agricultural sector takes place. Up to now, eleven different five-year development plans covering the years 1960 and 2023 have been created. In the last three of these development plans, Ninth Development Plan (2007-2013) - Tenth Development Plan (2014-2018) - Eleventh Development Plan (2019-2023), three separate National

Rural Development Strategies (NRDS) were also prepared (NRDS-I, NDRS-II and NDRS-III).

The first National Rural Development Strategy (NRDS-I) was prepared in the Ninth Development Plan (2007-2013) period. Following this plan and strategy, in the Tenth Development Plan (2014-2018), the second National Rural Development Strategy (NRDS-II) covering the years from 2014 to 2020 was prepared. Finally, in the Eleventh Development Plan (2019-2023), the third National Rural Development Strategy (NRDS-III) covering the period from 2021 to 2023 was prepared.

In the first two of the national rural development strategies (NRDS-I and NRDS-II), its goal is to decrease economic disparities between regions by increasing rural financial power, as well as to expedite rural development by balancing regional development levels. The projects implemented in this process included activities in which various groups, from non-governmental organizations to producers, were involved and local resources were predominantly used. In the third National Development Strategy (NRDS-III) within the framework of the sustainable rural development approach, it is aimed to reduce the migration from rural to urban areas by ensuring the production capacity of the producers and the participation of those living in rural areas in employment and providing the rural population with sufficient economic and social opportunities. While determining these strategies, Turkey's past experience in the field of rural development, international approaches, especially the European Union's policies were given importance and benefited. In addition, attention was drawn to the role of rural development in national development, benefiting from environmentally friendly agricultural practices and information technologies (NRDS-III, 2021).

Various strategic objectives and priorities were determined in the National Rural Development Strategy (NRDS-I) prepared by the State Planning Organization in Turkey in 2006. The priority determined directly in the field of agriculture and food is as follows:

Priority 1.1. Making the agriculture and food sectors competitive

In order for the above-mentioned priority to be put into practice, it was stated that "importance will be given to increasing the level of knowledge and organization of the agriculture and food sector, increasing the contribution of advanced agricultural technologies and information technologies to the development of the sector, and improving innovation and R&D capacity". In addition, priority intervention areas in increasing the competitiveness of the sector are defined as follows:

i) Raising the level of organization and professional-technical knowledge of the producers,

ii) Effective use of water and soil resources,

*iii)*Increasing the competitiveness of agricultural and food industry enterprises,

iv) Strengthening control structures for food quality, consumer protection and food health,

In the third National Rural Development Strategy (NRDS-III), various priorities have been defined from reduction in rural poverty to protection of natural resources. In addition to these, the following priority targeting the use of technology in agriculture is also included:

To expand the use of information technologies in rural areas

In the Eleventh Development Plan (2019) which is approved by the Government of Turkey states the main objectives in rural development from 2019 to 2023 time period:

"The main objective is to increase the production capacity of producers associations and family enterprises and increase the employability of rural labour force, improve the quality of life, fight against poverty and increase the level of welfare of the rural community and keep the population in rural areas with the understanding of sustainable rural development."

Since 1970, rural development projects have been implemented in various provinces of Turkey in order to make better use of natural resources and to eliminate socio-economic differences in rural areas as much as possible (Furat, 2013). The fact that the Instrument for Pre-accession Assistance for Rural Development (IPARD) Financial Contribution Instrument, which entered into force in 2007, was implemented in our country plays an important role in raising the living standards and welfare levels of rural areas and in the development of agricultural and rural infrastructure.

There are different rural development projects in Turkey which are funded by the foreign resources and credits such as World Bank, The International Fund for Agricultural Development (IFAD), The Organization of the Petroleum Exporting Countries (OPEC), Japan International Cooperation Agency (JICA) (T.C.KALKINMA BAKANLIĞI, 2018):

Project	**Period**	**Project Sponsor**
Çorum – Çankırı Rural Development Project	1976 - 1984	World Bank
Erzurum Rural Development Project	1982 - 1990	World Bank - IFAD
Agricultural Extension and Application Project	1984 - 1997	World Bank - IFAD
Bingöl – Muş Rural Development Project	1990 - 1999	IFAD
Yozgat Rural Development Project	1991 – 2001	IFAD
Eastern Anatolia Watersheds Rehabilitation Project	1993 – 2001	World Bank
Ordu Giresun Rural Development Project	1995 - 2006	IFAD - Islamic Development Bank
Agricultural Reform Implementation Project	2001 – 2008	World Bank
Anatolian Watersheds Rehabilitation Project	2005 – 2012	World Bank
Erzincan - Sivas Rural Development Project	2004 - 2010	IFAD - OPEC

Diyarbakır – Batman – Siirt Development Plan	2007 – 2015	IFAD
Ardahan – Kars – Artvin Development Plan	2010 – 2018	IFAD
Çoruh River Basin Rehabilitation Project	2012 – 2019	JICA
Murat River Basin Rehabilitation Project	2012 - 2019	IFAD
Göksu – Taşeli Basin Development Project	2015 – 2023	IFAD
Rural Disadvantaged Areas Development Project	2017 – 2023	IFAD

Table 2.2. *Outsourced Rural Development Projects in Turkey*

As stated in the table above, there are outsourced rural development projects in Turkey (Table 2.2.). The problems encountered during the ongoing and completion of these projects are described by the Second Agriculture Council of Republic of Turkey Ministry of Agriculture and Rural Affairs (Republic of Turkey Ministry of Agriculture and Forestry) as follows (*II. Agriculture Council*, 2004): Rural development decisions are generally taken by central decision-making bodies and the demands of the target audience are not taken into account. However, the contemporary development approach includes studies in line with the wishes of the rural people. Therefore, the target audience, whose expectations and needs cannot be met by development projects, cannot integrate with these projects and the projects fall behind the targets. The choice of location in the projects and the determination of priorities according to political preferences are among other problems. In addition, the frequent change of institutions implementing rural development projects causes organizational problems. This situation, which causes disruptions and delays in the works, extends the project implementation periods and increases the costs. Involvement of heavy bureaucracies at every stage of the projects. Since comprehensive socio-economic analyzes are not carried out before the projects are prepared, the natural resources, agriculture, industry and workforce potentials of the rural development project area are not taken into account adequately. In addition, social factors were not given sufficient importance in the projects. Although an increase in agricultural production was foreseen with these projects, it was not

emphasized where these products would be processed and which markets would be accessed through which channels. Since the monitoring process is not followed in the completed projects, the chances of permanence and continuity of the projects have decreased. Also, capacity building studies were not included in the institutions and organizations involved in rural development practices.

Against the above-mentioned problems, solution proposals that can be considered as alternatives were stated by the Second Agriculture Council. While these emphasize the importance of using modern techniques and technologies for more efficient and quality production in agriculture; it also mentions about taking the principles and approaches of international actors, especially EU regulations and strategies, as a basis.

Development Plan	**Rural Development**
The First Development Plan (1963-1967)	Community Development
The Second Development Plan (1968-1972)	Village and Peasant Problem
The Third Development Plan (1973-1977)	Central Villages
The Forth Development Plan (1979-1983)	Village Cities
The Fifth Development Plan (1985-1989)	Rural Planning Approach
The Sixth Development Plan (1990-1994)	Rural Planning Approach
The Seventh Development Plan (1996-2000)	Central Settlements, Integrated Rural Development Projects
The Eight Development Plan (2001-2005)	Central Village-Central Settlements
The Ninth Development Plan (2006-2013)	Rural Central Settlements, Rural Development Attraction Centers
The Tenth Development Plan (2014-2018)	Rural Development

Table 2.3. *Rural Development Directions in Development Plans in Turkey (Dogan, 2019)*

So far, rural development approaches in Turkey and rural development projects and practices developed in the light of these approaches have been mentioned. In these projects and applications, the problems encountered by the researches are also

included. In addition, there are various regional and global resources that provide funds and loans as financial instruments for the development of these projects. Since these resources are important not only for Turkey but also for all rural areas, various policies and actors in the field of rural development were included in the continuation of this part of the research.

2.3 Rural Development Policies and Actors

The problem of definition of rural area created by the pressure of urbanization appears in a global way. With the understanding that the concept of development cannot be achieved only with economic and technological developments, development approaches focusing on rural areas are being developed.

Although different countries consider the definition of rural development according to the different problems they experience and implement strategies and plans accordingly, umbrella organizations focusing on the problem of more than one country produce generic goals with common policies and strategies. The issue of rural development also continues to produce strategies, policies and plans in a multi-actor

While these structures, in which multiple actors are involved, plan to achieve general and specific goals on a common ground, they continue to strive for a more sustainable and livable world for the future. structure, seeking solutions and making various suggestions.

At this point, among all the actors, the reason why the thesis study focuses on these actors is that they have kept the issue of rural development on their agenda since the 1950s and that they have supported these policies both financially and intellectually by producing consistent policies and supporting these policies with various projects.

These actors not only shape the rural development planning, but also encourage entrepreneurs to develop technology, products and services in the field of agriculture. These incentives consist of financial instruments and strategic advisory. Software

products such as agricultural web and mobile applications also benefit from these incentives. Although web and mobile applications entrepreneurs generate their monetization through the usage of these applications, they also benefit from the EU, WB, UN, OECD, etc. programs.

2.3.1 European Union Policies in Rural Development

Mantino (2010) states that by taking part in the EU umbrella, local entities are encouraged to interchange local knowledge to be combined with global knowledge and act for the reach regional objectives by implementing the regulation that are produced by the EU. EU, which deals with rural development goals as a whole on a regional scale, has important policies and programs. Within the scope of this thesis, especially the current studies of the European Union, Green Deal and Common Agricultural Policy are emphasized.

The EU has accepted rural development as an important element of agricultural development (Celik, 2005). European Commission, Directorate-General for Agriculture and Rural Development (DG AGRI) aims promotion of the use of digital technologies in the implementation of the CAP Strategic Plans (Development, 2020).

EIP-Agri was created to bridge the gap between the innovative solutions created by researchers and the uptake of new technologies by those living and working in rural areas. By creating partnerships between those who will eventually use new technology and those that create them, EIP-Agri aims to accelerate the uptake of change.

During the European agricultural restructuring process, while the production amount of agricultural areas larger than 50 hectares increased; structural changes become almost impossible in surviving small ones (EUR 10, 1985). In the Future of Rural Society (CEE, 1988) which is published by the EU, three essential elements influence the European Commission's approach to rural development:

i) economic and social cohesion, in an enlarged community of very pronounced regional diversity;

ii) the unavoidable adjustment of farming in Europe to actual circumstances on the markets and the implications of this adjustment not only for farmers and farmworkers but also for the rural economy in general;

iii) the protection of the environment and the conservation of the Community's natural assets.

Common Agricultural Policy (CAP) aims to increase agricultural productivity within the principle of sustainability and European Green Deal is a business program which supports the CAP.

European Common Agricultural Policy

The EU's common agricultural policy (CAP), established in 1962, is a cooperation between agriculture and society, as well as between Europe and its farmers. Its goals are as follows[26]:

- support farmers and improve agricultural productivity, ensuring a stable supply of affordable food;

- safeguard European Union farmers to make a reasonable living;

- help tackle climate change and the sustainable management of natural resources;

- maintain rural areas and landscapes across the EU;

- keep the rural economy alive by promoting jobs in farming, agri-food industries and associated sectors.

[26] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en

Through financing and activities that foster rural development, the CAP promotes the vitality and financial viability of rural areas. Rural development is the CAP's "second pillar," supplementing the "first pillar" of income assistance and market reforms by enhancing rural places' social, environmental, and economic sustainability.

The European Parliament, the Council of the EU, and the European Commission secured an agreement, and the new CAP was formally accepted in 2021, with implementation beginning in 2023. The new CAP has set nine specific objectives focusing on how the European Union will ensure the sustainability of agriculture and rural areas in social, environmental and economic dynamics (EU Commission, 2018). These targets to be included in the agenda between 2023 and 2027 are as follows: ensure a fair income to farmers (European Commission, 2018a), increase competitiveness (European Commission, 2020b), rebalance the power in the food chain (European Commission, 2020a), climate change action (European Commission, 2018b), environmental care (European Commission, 2018c), preserve landscapes and biodiversity (European Commission, 2019), support generational renewal (Commission, 2020), vibrant rural areas (European Commission, 2020c), protect food and health quality (European Commission, 2018d).

The European Agricultural Fund for Rural Development (EAFRD) assists for rural development in European Union in light with the CAP's contribution[27]. EAFRD is used by the countries in European Union through Rural Development Programs (RDPs) which need to meet at least four priorities out of six of EAFRD[28]:

[27] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development_en
[28] https://enrd.ec.europa.eu/policy-in-action/rural-development-policy-figures/priority-focus-area-summaries_en

Priority 1: Knowledge Transfer and Innovation	
FA 1A	Fostering innovation, cooperation and the development of the knowledge base in rural areas
FA 1B	Strengthening the links between agriculture, food production and forestry and research and innovation
FA 1C	Fostering lifelong learning and vocational training in the agricultural and forestry sectors
Priority 2: Farm Viability and Competitiveness	
FA 2A	Improving the economic performance of all farms and facilitating farm restructuring and modernisation
FA 2B	Facilitating the entry of adequately skilled farmers into the agricultural sector and generational renewal
Priority 3: Food Chain Organisation and Risk Management	
FA 3A	Improving competitiveness of primary producers by better integrating them into the agri-food chain
FA 3B	Supporting farm risk prevention and management
Priority 4: Restoring, Preserving and Enhancing Ecosystems	
FA 4A	Restoring, preserving and enhancing biodiversity
FA 4B	Improving water management
FA 4C	Preventing soil erosion and improving soil management
Priority 5: Resource-efficient, Climate-resilient Economy	
FA 5A	Increasing efficiency in water use by agriculture
FA 5B	Increasing efficiency in energy use in agriculture and food processing
FA 5C	Facilitating the supply and use of renewable sources of energy
FA 5D	Reducing greenhouse gas and ammonia emissions from agriculture
FA 5E	Fostering carbon conservation and sequestration in agriculture and forestry

Priority 6: Social Inclusion and Economic Development	
FA 6A	Facilitating diversification, creation and development of small enterprises, as well as job creation
FA 6B	Fostering local development in rural areas
FA 6C	Enhancing the accessibility, use and quality of information and communication technologies (ICT) in rural areas

Table 2.4. *Priority & Focus Area (FA) Summaries*

European Agricultural Fund for Rural Development

The EU's rural development policy helps the rural areas of the EU to meet the wide range of challenges and opportunities that face them in terms of economic, environmental and social development. Known as the "second pillar" of the Common Agricultural Policy (CAP), it has been improved for the period 2014-2020 through the process of wider CAP reform[29]. In this context, Competitiveness of SMEs, Environment Protection & Resource Efficiency, Climate Change Adaption & Risk Prevention, Social Inclusion, Low-Carbon Economy, Technical Assistance, Research & Innovation, Sustainable & Quality Management, Information & Communication Technologies, Educational & Vocational Training, Discontinued Measures themes are also included in the budget allocated by the European Union for rural development. Also, EU listed the planned and implemented theme between 2014 – 2020, some of them are selected based on the relativeness to the current research are shown in table below (Table 2.6.):

Theme	Planned (P)	Implemented (I)
Organic Farming	11.006.553 ha	45.614.147 ha
ICT Broadband	14.3%	4.4%
Cooperation	12.063 operations	6.807 operations

[29] https://cohesiondata.ec.europa.eu/funds/eafrd#top

Local Markets	17.274 farm holdings	13.148 farm holdings
Producer Groups	32.150 farm holders	83.775 farm holders
Diversification of Rural Economy	29.889 beneficiaries	16.963 beneficiaries
Investment in Agriculture 1	17.548.078.382 €	9.493.540.433 €
Investment in Agriculture 2	333.521 farm holdings	234.920 farm holdings
Investment in Rural Economy	4.055.359.792 €	2.033.567.624 €
Young Farmers	178.404 young farmers	156.020 young farmers
Farm Advisory Services	992.718 farm holders	643.741 farm holders

Table 2.5. *European Agricultural Fund for Rural Development*

In this part of the research, the approach of the European Union to rural development is mentioned. In this context, especially the EU's Green Deal and CAP were emphasized. In addition, priority areas determined by EAFRD for rural development were emphasized and projects developed over the years in the light of priorities were included. Following the EU's rural development approach, UN's rural development approach, which is another important actor, was included to the research.

2.3.2 United Nations Policies in Rural Development

A conference, also known as Agenda 21, was organized by the United Nations in 1992 under the title of Environment & Development. Agenda 21, which consists of four separate sections, includes a variety of overarching titles from Social and Economic Dimensions (Section I) to Means of Implementation (Section IV). The main reason why Agenda 21 is mentioned in this study is that in the second part of this conference, the field of Conservation and Management of Resources (Section II) for Development, Promoting Sustainable Agriculture and Rural Development (Chapter 14) is included (Agenda 21, 1992). In Chapter 14, the United Nations,

which makes a projection for the year 2025, strikingly expresses its hesitations about meeting the needs of the current food and technology level in the face of the increasing population. Also, UN emphasizes the need for major changes and regulations in the field of sustainable agricultural production and rural development in order to increase food production and ensure food security. It draws attention that these sustainable agricultural production and rural development studies will include the development of new technologies, and will include important initiatives from employment and income generation to natural resource management.

United Nations have defined Sustainable Development Goals (SDGs) which are also take part in rural development.

Table 2.6. *The 17 proposed Sustainable Development Goals (UN, 2015b)*

Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalise the global partnership for sustainable development

2.3.3 OECD Policies in Rural Development

According to the Copenhagen Institute for Future Studies megatrends defines as “the great forces in societal development that will very likely affect the future in all areas over the next 10-15 years”. Also, Larsen (2006) states that if a trend occurs on a worldwide or massive scale, it is referred to as a megatrend. The European Commission Megatrend Hub defines megatrends as long-term primary drivers

visible now and will almost undoubtedly have a substantial impact in the future. OECD (2018), on the other hand, mentions that these global changes have a counterpart in rural areas and expresses megatrends as follows (*Figure 2.7.*):

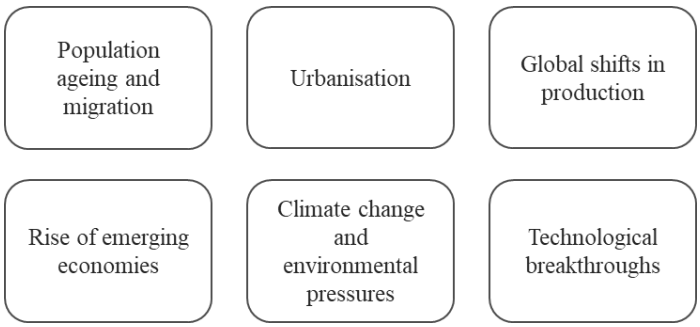

Figure 2.9. Megatrends (OECD,2018)

OECD's Development Centre Studies called A New Rural Development Paradigm for the 21st Century which is a toolkit for developing countries point out that more than three billion people live in rural areas in developing countries. Conditions for them are worse than for their urban counterparts when measured by almost any development indicator, from extreme poverty, to child mortality and access to electricity and sanitation.

	Old paradigm	New paradigm
Objectives	Equalisation or entitlement approach, focused on farm income, farm competitiveness	Competitiveness of rural areas, valorisation of local assets, exploitation of unused resources
Key target sector	Sector based	Various sectors of rural economies (e.g. rural tourism, manufacturing, information and communications technology (ICT) industry, etc.)
Main tools	Subsidies to agriculture	Investments and transfers to low income rural population rather than the agricultural sector
Key actors	National governments, farmers	All levels of government (supranational, national, regional and local), various local stakeholders (public, private, NGOs)

Table 2.7. *The new rural paradigm in OECD countries (OECD, 2006)*

Aforementioned study calls for a new paradigm for rural development that is equipped to meet the challenges and harness the opportunities of the 21st century – including climate change, demographic shifts, international competition and fast-moving technological change.

In rural areas of developed countries, agriculture is much more productive and is not necessarily the predominant provider of income.

2.3.4 World Bank Policies in Rural Development

The World Bank (1975) defines rural development is a strategy aimed at improving the economic and social well-being of a specific group of people: the impoverished in rural areas. Also in the Rural Development Sector Policy Paper, it is pointed out that rural development aims to reduce poverty by increasing productivity in rural.

In 1961, of the world's 3.0 billion people, an estimated 770.8 million (25.1 percent) were directly engaged in farming, and agriculture represented 13.4 percent of overall income (measured in terms of GDP). In the half century since, the world's total population has increased by a factor of 2.4, to a total of 7.4 billion, and agriculture's share of the global economy has shrunk. In 2014, of the world's 7.4 billion people, an estimated 1.3 billion (18 percent) were directly engaged in farming, but agriculture represented just 3.9 percent of overall income (World Bank, 2017).

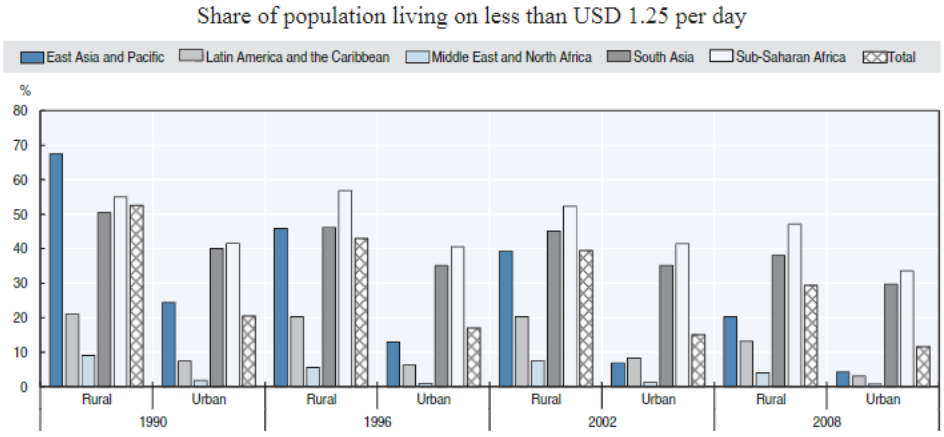

Figure 2.10. The majority of the extreme poor live in rural areas in developing countries (World Bank, 2013)

The issue of reducing rural poverty, which is among the rural development goals of the World Bank, also remains the issue of poverty in rural areas, as shown in the above (Figure 2.10).

The World Bank published a new rural development strategy in 2003 as a result of negative tables such as population growth, poverty in rural areas and urbanization, according to its studies and projections (Giray & Gün, 2015). In the organization of the New Rural Development Strategy by the World Bank, five important strategic objectives are set out (World Bank, 2003):

i) establishing a conducive atmosphere for rural development on a broad scale;

ii) increasing the production and competitiveness of agriculture;

iii) promoting non-farm rural economic development

iv) enhancing social well-being, risk management, and lowering rural poverty;

v) improving natural resource management in a sustainable manner.

The impact of agricultural practices on rural development is measured by the World Bank over the productivity target in agricultural production by using economic indicators (Okidegbe, n.d.).

According to the World Bank the benefits of these apps in the development of the agricultural sector could be achieved through the following ways (Qiang et al., 2011):

i) reach to agricultural information: market information and price, weather condition, pest management, fertilizer management, risk management

ii) reach to agricultural services: assists to increase in productivity, crop yield

iii) reach to marketing and distribution channels: enhanced network between producer, supplier and consumer in value chain

iv) reach to economical instruments: decreased economic loss

Furthermore, the World Bank is the institution that provides loans and funds to governments and the private sector for different sectors. In this context, it provides

various financial instruments in the agricultural sector. The World Bank provided funds and loans to projects in the field of rural development in Turkey.

In this part of the research, Chapter 2, the studies of EU, UN, OECD and WB, which have an impact on rural development, are concluded. Up to this point, the rural issue has been addressed both globally and in Turkey. In addition, the issue of rural development, which targets the developments in the rural area, has also been discussed both globally and in Turkey. To make a general conclusion, the rural area has a complex structure and it is an issue that includes more than one dynamic from rural development and therefore needs to be addressed in a holistic way. In this context, it may not be right to say that the most important issue related to rural and rural development is economy, environment or social components, it is necessary to consider all of these aspects as a whole, and at this point, one of the most important inputs is information. Taking advantage of technological developments to access this information offers an opportunity area.

CHAPTER 3

TECHNOLOGICAL ADVANCEMENT IN AGRICULTURE SECTOR

There is a large volume of published studies describing the role of the technology in changing the way of doing business. Researchers attempted to evaluate the impact of technology on jobs and skills by generalising in two trends. The first one stresses out the changing the perspective from job losses to predicting increase in new jobs. The second one is about the jobs will not be automated because some of the new job fields require more cognitive abilities (Ra et al, 2019). Although, agriculture is still less digitized than many other sectors throughout the world, new technologies have potential to improve decision making processes (Goedde et al., 2020). Nevertheless, Parke (2013) states that the technological advancement and scientific approaches seems to have had a massive influence on the agriculture in recent decades.

Common understanding exists how technology has a vital importance to increase productivity and competitiveness in agriculture, technology has power to modernize agriculture with the multiple advancement in it. Therefore, Chapter 3 concentrates on the Information and Communication Technologies (ICTs), Precision Agriculture, Internet of Things, Big Data, Remote Sensing and Geographic Information Systems as technological advancement in agriculture due to the relation of these technologies with the GEP Precision Farming web and mobile agricultural applications. The mobile application which constitutes case study of this research, directly uses these technologies or reaches users by using the benefits of these technologies cumulatively.

In addition, available studies examine the direct relationship of these technologies with rural development. However, this study does not examine the possible effects of practices on rural development directly through these technological

developments; explores the potential impacts of these on shaping the web and mobile applications on the basis of product management fundamentals.

3.1 Information and Communication Technologies

Information and Communication Technology (ICT) is a type of technology that facilitates information-based activities. Data collection, processing, storage, and presentation are examples of such tasks. Collaboration and communication are becoming increasingly important in these operations. As a result, Information Technology (IT) has evolved into ICT (Horton, 2001). Also, ICT is becoming increasingly significant in agriculture and proposes a new field that aims to promote agriculture and rural development by enhancing information and communication operations (Mahant et al., 2012).

Farmers have chance to benefit greatly from ICT as a decision-support system. Farmers may get up-to-date information on agriculture, weather, new crop types, and novel strategies to boost productivity and quality control via ICT (A. Kumar & Singh, 2012). Dlodlo and Kalezhi (2015) states that affordable, accessible and adaptable features of the ICT enable the use of it even in the rural areas for agricultural practices. The drivers of ICT in agriculture are defined by the World Bank Group (2017) as below:

i) Low-cost and pervasive connectivity,

ii) Adaptable and more affordable tools,

iii) Advances in data storage and exchange,

iv) Innovative business models and partnerships,

v) Demand for agricultural information services.

For all rural areas, the barriers that need to be addressed by broadband ICTs are: 1) distance barriers, i.e., access to administrative and government services and structures, 2) economic barriers, i.e., access to wider business and labour markets, 3)

social barriers of rural inhabitants' access to information traceability of production, products and services throughout the value chain including logistics [30].

In the 21st century, a new knowledge-based farming system is emerging that, based on farm-specific ICTs applications (e-Agriculture2) can support the: profitability at the farm level; production of competitive, market-oriented, qualitative food products; decrease of environmental and climate change impacts; and energy efficiency (FAO, 2005; Downey, 2006). Knowledge and information are key requirements that enable farmers to deal with contemporary challenges, particularly as the new agricultural technologies become more "knowledge-intensive" (Abdon and Raab, 2004).

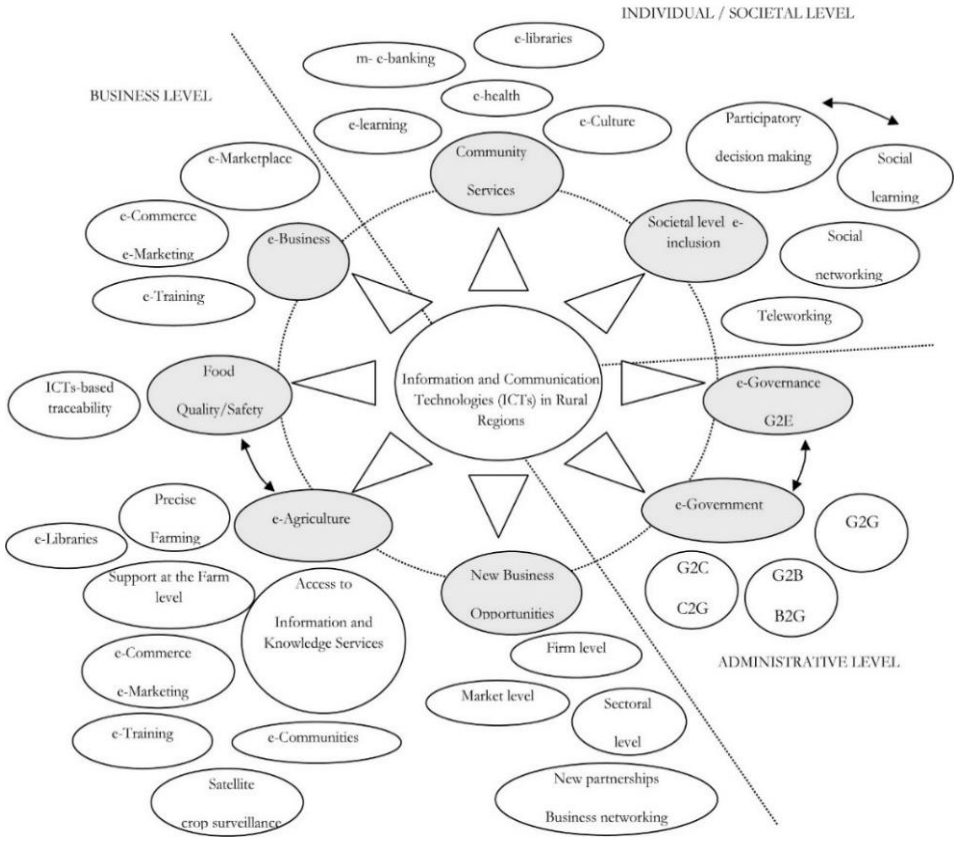

Figure 3.1. Information and Communication Technologies in Rural Regions (NETCOM, 211)

[30] https://journals.openedition.org/netcom/144

Access to information and knowledge systems: supports the acquisition of various kinds of farm-specific information, e.g., weather information for irrigation, seed options, information for field work purposes (Thysen and Detlefsen, 2006), but also information on commodity prices, developments in farm machinery, pesticides and chemicals etc. that aim at supporting decisions at the farm level and improve farm management. As various studies show (FAO, 2005), farmers involved in such processes migrate quickly to web-based transactions.

Although the groupings and definitions in information systems change with the ever-evolving technology, scholars divided information systems into five different categories shown below (Assistant, 2012):

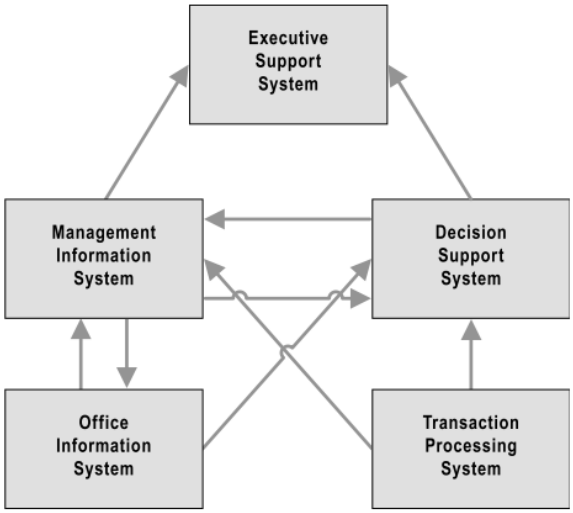

Figure 3.2. Classification of Information Systems (Awais et al. 2012)

Data from management information systems, transaction processing systems, and office information systems is used by Decision Support Systems (DSS) (Lipaj & Davidavičienė, 2013). Also, the use of information technology in the form of DSS to apply agricultural knowledge holds a lot of promise for future success (Yost et al., 2011).

In Transforming Traditional Agriculture, Schultz (1964) has anticipated an essential importance for investments in "nontraditional" inputs such as information and education, as well as increases in the quality of material inputs and people, in helping

to transfer agriculture to a more solid ground and leverage on agriculture as an engine for growth (Alston & Pardey, n.d.). Also, Schultz's (1964) statement points out the information in agriculture:

> *"...The knowledge that makes the transformation possible is a form of capital, which requires investment—investment not only in material inputs in which this knowledge is embedded but importantly also in people.*
>
> *...The man who farms as his forefathers did cannot produce much food no matter how rich the land or how hard he works. The farmer who has access to and knows how to use what science knows about soils, plants, animals, and machines can produce an abundance of food though the land be poor. Nor need he work nearly so hard and long. He can produce so much that his brothers and some of his neighbors will move to town to earn their living. Enough farm products can be produced without them."*

To illustrate, Fixed Sites Rural Survey (FSRS) office from Chinese Ministry of Agriculture's Research Center for Rural Economy conducted a survey about the 20.000 farm households to get a comprehensive importance of ICT in rural. While this study was investigating economic impact of telephones usage by trying to figure out is there any correlation between telephone usage and increased income level. In this case, despite the subsistence farmers mostly interact with their families, studies have revealed that telephone and internet adoption has positive impacts on farming activities from access to sale and supply channels to market expansion (Torero, 2006). For example, farmers accessed their customer to sell products through a telephone order system (Ke and Zhang, 1999)

In short, ICT provides opportunities for rural areas to access information and provides important inputs for rural development. At this point, ICT offers various information systems and among them the decision support system, which is the most important for rural areas.

3.2 Precision Agriculture

Due to the fact that precision agriculture technologies have an important place in the future of the agricultural sector, it is necessary here to clarify exactly what precision agriculture main aims. Precision Agriculture assists to management of input in crop production process within the consideration of environmental concern and it requires site-specific knowledge (Zinov'ev & Sole, 2004). Site-specific knowledge allows to site-specific management (SSM) which is concentrate on the implementing the crop production input with the Right Source, Right Rate, Right Time, Right Place (Roberts, 2009; Thorup and Stewart, 1988) and it is called in the precision agriculture as the 4R Stewardship. The definition of the normative "right" is provided by the principles of sustainable development: optimizing the sustainability performance of agriculture, using indicators selected by its stakeholders (GRI, 2006). This method offers production expense decrease by input optimization for farmers.

Nutrient management is an crucial effect on crop and unmanaged nutrients applications may cause the nutrient losses, contamination in water and air, and increasing the possibility of greenhouse gases (Bruulsema et al., n.d.).

There are two main technologies in Variable Rate Applications (VRA), map-based and sensor-based (Grisso et al., 2011). Map-based VRA is the part of the GAP Precision Farming application which produces Variable Rate Fertilizer map for the farmers to optimize the fertilizer usage in the field. These maps are produced specifically for the field according to the 4R Stewardship principle mentioned above, which is the basic principle of precision agriculture.

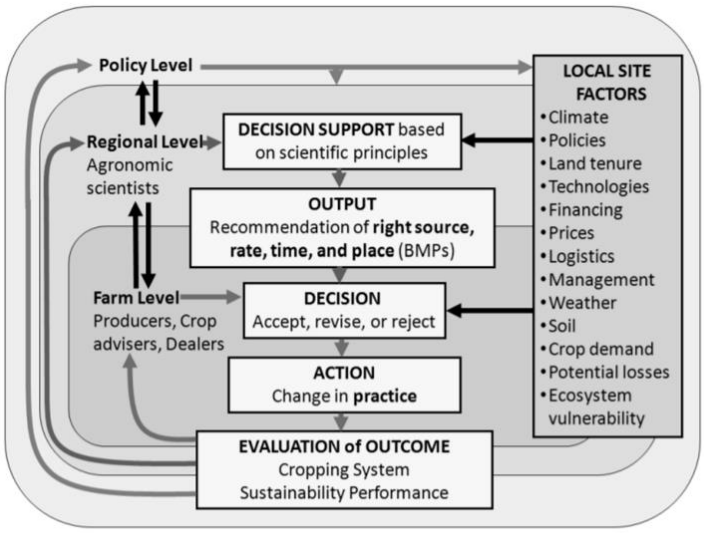

Figure 3.3. Integrated Assessment of Indicators in 4R Stewardship (OECD,2008)

The 4R Nutrient Stewardship concept necessitates evaluation of performance measures in sustainability, whether it is used on the farm by producers and consultants, in the production of recommendations by agronomic experts, or in policy consideration Study in the '4R Nutrient Stewardship Framework' sets out some indicators of sustainability performance to agricultural practices by focusing on the percentage of the crop area that used 4R adoption, kg of applied fertilizer, yield and return on investment. (Bruulsema et al., n.d.)

Briefly, precision agriculture provides agricultural producers with the opportunity to optimize inputs and thus supports farmers in reducing production costs and eliminating negative environmental effects. Variable-rate fertilization maps are offered to farmers in order to ensure precision agriculture applications in the GAP Precision Farming web and mobile application, which constitutes the case study of this research.

3.3 Internet of Things

To date, several studies have investigated that the current way of agricultural production have exceeded the carrying capacity of planet earth and it is necessary to

supply food demand of population without further pollution or resource depletion (Verdouw et al., 2016). From globalization to climate change and growing food demand due to the increase in population, Internet of Things (IoT) is expected to be one of the solutions to these challenges where every 'thing' is uniquely identifiable, equipped with sensors and connected real-time to the internet (*ibid).* IoT combines the concepts "Internet" and "Thing" and can therefore semantically be defined as "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols" (European Technology Platform on Smart Systems Integration, 2008). IoT on the other hand is the connecting of physical things to the internet which makes it possible to access remote sensor data and control the physical world from a distance (Applications, n.d.) . (Kopetz, 2002)

Agricultural informatics is a field which combines the advances in agricultural information, agricultural development and entrepreneurship to provide agricultural-services-enhanced-technology, dissemination and information delivery through information and communications technologies (ICTs) and the internet (Gakuru et al., 2009). It concentrates on consolidating agricultural and rural development through advanced information and communication processes and studies are underway to demonstrate the potential support of IoT technologies in reducing poverty in rural areas and improving the quality of life of people living there (Dlodlo & Kalezhi, 2015).

The GAP Precision Farming application, which is the case study of this research, aims to increase the dominance of the farmers in production by ensuring that the things used in agricultural production communicate with each other.

3.4 Big Data

Agricultural production fields require many information to conduct activities. Moreover, each field produce data with the crop. Cumulatively it points out the big data for agriculture. Big Data is defined as "large, diverse, complex, longitudinal,

and/or distributed data sets generated from click streams, email, internet transactions, satellites, sensors, videos, and/all other digital sources available today and in future" (Coble et al., 2018). Researchers on Big Data promise information storage, processing, and analysis formerly unachievable due to technical constraints (Datafloq, 2015). Also, Bronson and Knezevic (2016) compares a farmer's recording work in a notebook and entering this information into the application using mobile phone, and argues that the recordings made through the application are more effective. De Iulio (2003) states that data does not only exist, it needs to be generated by collecting and organizing data.

Dyer (2016) implies that we are in the midst of an informational revolution in agriculture. Several technologies and data analytics from other sectors are increasingly being applied to agricultural applications (Coble et al., 2018). Big data enables transactions that were not possible before with its processing speed and data volume capacity at the current point. One of these possibilities is weather information used in agricultural applications. In light with the weather services, information such as agricultural frost, wind and precipitation can be provided to the farmers in the early warning system. This information actually provides a decision support infrastructure to the farmers. Because, according to this information, the farmer has to carry out operations such as pre-planting preparation, planting and fertilization under favorable weather conditions. For example, if the fertilizer to be applied to the crop is not suitable for humid weather conditions; the farmer should not perform this operation during humid weather conditions. Current studies show that the most important goals in big data applications are to improve user experience, reduce costs, determine better marketing strategy and create effective processes. Therefore, the agricultural sector benefits from the opportunities provided by big data with one or more of these purposes.

Trends can be consolidated, risks can be identified, and yields can be raised with access to comprehensive agronomic data, this data provides full transparency over

their practices[31]. As the phrase "big data" is applied to agriculture, it implies that it is less about the volume of the data and more about the combination of technology and analytic capabilities that generates way to process information in a more relevant and timely manner (Stubbs, 2016). Furtherly, big data offers relevant patterns to help make better decision in the future.

When big data collected, a set of advanced methodologies and technology known as "big data analytics" is needed to capture substantial information, allowing farmers to gain financial benefit from it (Al-Kodmany, 2020). In this way, information to be used in application areas can be obtained. In other words, big data analytics is a technique used to analyze large data sets in order to obtain information that will guide the decision-making process (Gandomi & Haider, 2015).

While some researchers think that big data is characterized by the volume, velocity and variety; some researchers also mention about the veracity characteristic of the big data.

volume	velocity	variety	veracity
the size of the data	measuring the flow of data	frequent lack of structure or design to the data	accuracy and credibility of the data

Table 3.1. *4V of the Big Data (Cable et all, 2016)*

Big data may come from a variety of sources. In agriculture, ground sensors which are placed to the field, airborne sensors, mobile applications which suplly the information related to the crops, yields and weather condition generate big data. At this stage, GAP Precision Farming application has several modules which constitutes big data and using big data analytics to convey valuable input to the farmers. That is, firstly farmers create data by each click in mobile application and secondly mobile application uses big data analytics to turn these data into the meaningful insight for

[31] https://www.cubictelecom.com/blog/big-data-modern-precision-farming-agtech/

farmers. While these services could be included to the mobile application by using third party developer services, some of them also generated by the main producer of the mobile application.

3.5 Remote Sensing

Remote sensing in the agricultural practices refer to the observation of vegetation indices by a remote device to get qualitative and quantitative qualitative or quantitative features of the crop (Matese et al., 2021). It is essential to uncover the meaning of the vegetation to better undertand the importance and the aim of the remote sensing activities. Xue and Su (2017) states that vegetation indices are gained from remote sensed images to evaluate cover situation, vigor and growth pattern. In agriculture case by using the vegetation indices with remote sensing activities, it is possible to comprehend the crop coverage in the field, its growth stage of it and vigor. Particularly, these forms of data used to agriculture provide not only an objective basis for agricultural production management, but also the necessary information for crop yield estimation (Mulla, 2013).

Within the scope of this thesis, the images obtained from the satellite, one of the remote sensing methods are emphasized due the fact that mobile application case study using advantages of satellite images. Using data mining methods to classify multi-spectral and multi-temporal satellite images obtained by remote sensing method from agriculture and agriculture-based production models; Studies are carried out to increase productivity with the determination of the vegetation density of the determined area and the extraction of the agricultural product pattern, fertilization and irrigation activities to be carried out in a conscious and controlled manner according to the nutritional needs of the plant. Plant nutrient planning (water, fertilizer, mineral, etc.) and optimal development suggestions in agricultural production, obtained with the planned production infrastructure to be created in line with these studies, can be delivered to the end user via web and mobile applications. At the same time, critical information affecting the production of the phenological

follow-up of the products and vegetation indexes and agricultural land pattern can be transferred to the user from satellite images in accordance with the phenological calendar. In this context, service models that set an example for information-oriented technology applications in agriculture can be created by combining the results obtained by classification algorithms from satellite images taken from the appropriate spectral band and the data obtained from terrestrial spectral measurement.

The GAP Precision Farming application, which is the case study of this research, analyzes the high-resolution images provided by Sentinel-2 satellite in the variable rate fertilization maps it offers to the farmers. These high-resolution images provided by satellites are the result of developments in remote sensing.

3.6 Geographic Information Systems

A Geographical Information System (GIS) is a database technology that is used to intelligently produce, disseminate, store, update, analyze, and predict location-based information. With GIS technology, farmers can shape their production activities according to following the analyzes of the production areas from their mobile devices by taking advantage of the opportunities offered by the applications without collecting the agricultural spatial data themselves. At this point, farmers can save money by performing more efficient operations with spatial data that provides input to their decision-making processes (Soomro, 2015).

GIS has a wide area of use, also finds use in the agricultural sector, which is important both economically and socially and needs technological developments. It is mainly used actively in farm management, pest tracking, crop tracking, yield tracking and soil analysis processes in agriculture sector.

GIS can be used to create more effective and efficient farming techniques. With soil analysis, production activities can be carried out by determining which areas are suitable for agricultural production. GIS operates widely, integrated into production,

with public institutions managing programs that support farmers and protect the environment (Akça and Esengün, 2003).

Data acquisition is very difficult due to the unique characteristics of agriculture and the problem of keeping records. For this reason, agriculture has to adapt to the innovations brought by the developing technology and technology, and one of these innovations is GIS technology. GIS, which can be used in almost all areas, also has wide application areas in agriculture and provides significant ease. With the use of GIS technology, data can be kept in digital environment, it becomes easier to update, and it is possible to develop a standard by creating models with existing data (Karakayacı and Oğuz, 2007).

In agricultural applications, parcellation status and soil map, land capability classes, suitability for irrigated agriculture, suitability for agricultural use and potential use groups are transferred to the GIS environment as map layers, and ideal land uses can be determined on the basis of parcels. In this way, it is possible to establish the appropriate management system for each parcel, to determine the crops to be produced according to the potential land use or to determine the appropriate crop pattern according to the rotation system, and more than one scenario can be produced for rotation applications. The most common use of GIS for agricultural purposes is on soil classification, yield estimation, soil surveys, and basin planning (Başayiğit and Şenol, 2008).

In the third Chapter of the research, the technological developments, which are the components of the case study, and the place of these developments in the agricultural sector were mentioned. While ICT is important in providing information to the rural area, precision agriculture is important in providing input optimization, keeping the input use of farmers at the optimum level, increasing efficiency and reducing production costs. While IoT technology enables auxiliary objects in agricultural production to communicate with each other, it is mentioned that meaningful information is presented to farmers by analyzing large volumes of agricultural data with Big Data. With the Remote Sensing issue, it was mentioned that the data that

will provide the decision support infrastructure to the farmers is obtained from high resolution images and analyzed with GIS tools and delivered to the farmers and included in the production processes. Although these technologies are part of the solutions developed against the problems in the agricultural sector, one of the most important problems of rural areas, the inability to access information and technologies, constitutes an obstacle to the widespread use of these technologies and their inclusion in production processes.

CHAPTER 4

PRODUCT MANAGEMENT FUNDAMENTALS IN WEB AND MOBILE APPLICATION

There are two main reasons for including product management fundamentals in research and case study in this thesis. The first one is evaluating the possible contributions of web and mobile applications to rural development; to reveal how the product management in the web and mobile application development process shapes these applications. The second is the criticism of the fact that rural development projects are abolished as a point, that they do not deal with rural areas holistically, and that they are influenced by the political agenda of the period. In response to these criticisms, the web and mobile application developed by the private sector takes all farmers who continue their agricultural activities in rural areas as target group and does not have any political influence. Product management fundamentals aims to have a web and mobile application in the market, which was developed with the aim of ensuring the penetration of farmers into ICT by evaluating the needs and usage habits of farmers with a user focus. These are studies carried out without ignoring user needs and capacities. Products are living organisms that continue to meet the needs of users with various updates according to the experience of using the web and mobile applications.

Regarding to the Project Management Body of Knowledge (PMBOK) which is released by the Project Management Institution (2021), each project has three main constraints which are budget, schedule and scope. Organizations that develop products also act within the framework of various constraints, as in project management.

There are numerous approaches and strategies for managing various sorts of projects in project management. Traditional (Waterfall) and modern project methodologies

(Agile) can be classified into two categories (Ungureanu, 2014). Customer satisfaction is a top concern in the Agile Methodology (Singh, 2021). Also, products are developed under the Agile Methodology too. In product management with Agile Methodology, there are Minimum Viable Products (MVP) and quick experimentation to test hypotheses and validate ideas. Frequent releases assist in maintaining a continual feedback loop between the client and the product (McCloskey, 2018).

A product is anything that can be offered to a market for attention, acquisition, use or consumption in order to satisfy a want or need (Kotler, Philip & Amstrong, 2016). Software is an information good that manifests human know-how in bits and bytes (*Kittlaus, Hans-Bernd and Peter Clough (2009). Software Product Management and Pricing, Springer*). Because of its adaptability and flexibility, software is becoming a more essential facilitator and catalyst of innovation (Maedche et al., 2012). The product is in a constant state of change according to customer needs or market conditions (Porter, 1985). The state of constant change is actually a necessity to develop more usable and preferable products (*Leh80.Pdf*, n.d.). Also, product management fundamentals aim to ensure the product features are aligned with market situation, need and interest of users (Maedche et al., 2012). The Product Triangle (Figure 4.1.) is revealed by the Product School (*2017*) to illustrate the main location of the product management where stays intersection point of the product design, product marketing and product development.

Figure 4.1. The Product Triangle

Software product such as web and mobile applications generate value for the users. Various examples of software products are also found in the agricultural sector to meet farmer needs or offer a novel solution. As this study investigates the potential contribution of GAP Precision Farming web and mobile applications to rural development in light with the product management fundamentals. Regarding to the aforementioned statements about the product management which point out that product management build a bridge in-between product and customer. Also, product management activities take part in the middle of the product design (visual & experience), product development (technical & functionality) and product marketing (sales & reaching to the customer) activities. Based on the location of the product management, thesis looks for the attribution of the product management activities to the GAP Precision Farming web and mobile applications. Regarding to the GAP Precision Farming is a software product, software product fundamentals are required to examine within the scope of the research.

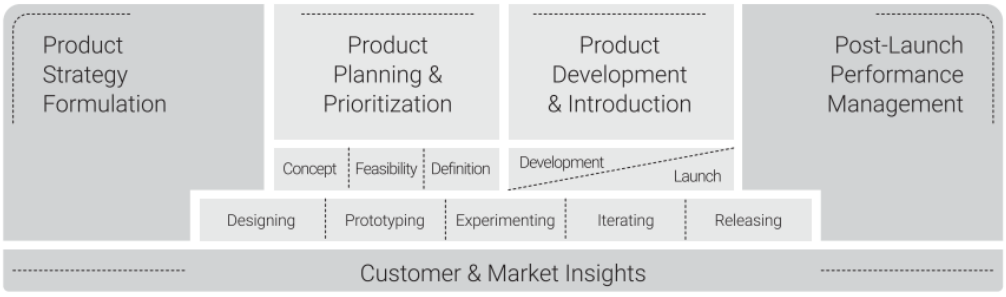

Figure 4.2. Product Management Life Cycle Model

Haines (2021) introduced the Product Management Life Cycle Model which do not have clean edges and some areas within the model blend into others; all are connected.

Many software development organizations have been transitioning from building customer-specific software to market-oriented standard software since the late 1960s (Vlaanderen et al., 2010). Apart from rural development projects which are implemented to the chosen constraint area, GAP Precision Farming is also developed for the market which contains farmers.

4.1 Product Strategy Formulation

Discussions are held about which problem a solution is sought regarding the idea put forward in the product strategy formulation process. GAP Precision Farming web and mobile application, which is the case study of this thesis, addresses the problems of farmers which are listed below:

> *Problem 1*: Limited number of agricultural applications in the market which are both financially and physically accessible.
>
> *Problem 2*: Technology gap between small, medium-sized farms and larger ones.
>
> *Problem 3*: Uncontrolled and not optimized usage of fertilizer (which is one of the most used and expensive input in agricultural production).
>
> *Problem 4*: Environmental impact of fertilizer usage

As each product is developed to find solution for problems or meet the needs, GAP Precision web and mobile application was developed by the FarmLabs Agriculture Technologies and R&D as a solution for farmers problem that are faced in the agricultural production in rural and tries to meet the farmers need in agricultural production. In this regard solution in the application could be defined as:

> *Solution:* Field monitoring system and variable rate fertilizer map producer application for sustainable agricultural production for farmers especially small- and medium-sized farms who hold less than 50 hectares agricultural fields.

In order to convey the solution to the farms, application operates with multiple modules in light with the technological advancement which were previously discussed in Chapter 3.

4.1.1 Market Research and Benchmark Analysis

Market research is one of the essential parts of the product management activities to understand current situation of the consumer demand and available competitors in the market. Regarding to the customer demand, mobile application should meet the expectation of the user. Also, it is essential to comprehend the solutions of competitors available in the market to attract the attention of potential users by highlighting the competitive advantage. In this process, there are multiple mobile applications in market both in national and global scale. Since there are applications with local language support from global players, it is important to include them in market research. Therefore, the market research was not only carried out in Turkey, but also on a global scale.

Based on the input comes from market research, findings were compared and revealed to conduct benchmark analysis. Benchmarking is the comparison of products, services, and processes between competitive organizations in the same industry, and between firms with similar processes in different industries (Sammut-bonnici, 2017).

Apart from the case study of this thesis, a benchmark analysis was made by considering 3 different applications in the country and 2 separate applications from abroad. According to this evaluation, common points in all products were field tracking, variable rate fertilization map production, keeping records of agricultural operations and presenting agricultural weather information to farmers. This information presented in the field of precision agriculture provides the information and market access needed for rural development through web and mobile applications.

Another important point here is the loan opportunities offered to farmers through applications such as İmeceMobil and Deniz'den Toğrağa developed by banks in Turkey. An opportunity to access the market is created for low-income farmers.

Feature \ App	Case	National			International	
	GAP Precision Farming	İmece Mobil	Deniz'den Toprağa	Tarlam Cepte	OneSoil	Agrivi
Field Tracking	✓	✓	✓	✓	✓	✓
Variable Rate Fertilization Map	✓	✓	✓	✓	✓	✓
Agricultural Operation Log	✓	✓	✓	✓	✓	✓
Agricultural Weather	✓	✓	✓	✓	✓	✓
Field Comparison	✓	X	X	X	X	X
Irrigation Service	X	✓	X	✓	✓	✓
Spraying Service	X	✓	X	X	✓	✓
Agricultural Loan	X	✓	✓	X	X	X
Agricultural Hardware – IoT Integration	✓	X	X	✓	X	X
Early Warning	X	✓	✓	✓	✓	✓
Consulting an expert	✓	✓	✓	✓	X	X

Agricultural News & Announcement	X	✓	✓	✓	X	X
Market Information (Fertilizer, Diesel)	X	✓	✓	✓	X	X
Market Place	X	✓	X	X	X	X
Web Platform	✓	X	X	✓	✓	✓
Mobile Platform (IOS/Android)	✓	✓	✓	✓	✓	✓

Table 4.1. *Benchmark Analysis of Agricultural Applications (prepared by the author)*

Also, all of these products serve on the mobile platform, the number of applications serving on the web platform is limited. In addition to the benchmark study, applications such as Orbit, Tarla.io, Agrovisio, Agcurate in Turkey were also evaluated.

However, the most important point that emerged as a result of all this evaluation and the subject that provides a competitive advantage to the GAP Precision Agriculture application is the Variable Rate Fertilization equipment. Because, only with this and similar hardware solutions, variable rate fertilization activities can be carried out in the field. According to the researches, it is not known how much fertilizer savings are achieved by using the variable rate fertilization maps recommended by other applications by the farmers in the field.

In addition to the benchmark analysis, the status of these applications in the Google Play is evaluated and presented in the table below. Accordingly, 3 of these applications operating in the field of precision agriculture appear in the productivity category, while one of them appears in the field of finance and one in the field of business. In addition, these applications have more than 10,000 downloads due to the fact that they have reached the previous customer masses of the software

companies they were developed. However, the number of active users cannot be taken into account as these applications do not have permission to access the databases. For this reason, it may not be correct to make inferences by only considering the number of downloads.

Application	**Application Category**	**Score (5)**	**Download Rate**
İmeceMobil (Turkey, Is Bank)	Productivity	4.6	100.000+
Deniz'den Toprağa (Turkey, DenizBank)	Finance	3.9	100.000+
Tarlam Cepte (Turkey, Turk Tractor)	Productivity	2.8	10.000+
OneSoil (Belarus, OneSoil)	Productivity	4.5	100.000+
Agrivi (Crotai, Agrivi)	Business	-	10.000+

Table 4.2. *Application Status in Google Play, 30.04.2022 (prepared by the author)*

In addition to the above evaluation, the user comments of the applications included in the benchmark study on Google Play and App Store were evaluated. Considering these comments, some revisions were made in the web and mobile application, which was the case studies of this thesis. The various comments that contributed to the case study were compiled and anonymously presented below.

When the user reviews were evaluated, the farmers who use the Deniz'den Toprağa application mostly say that they cannot change or delete the information they have provided. Users also complain that they can't mark their agricultural production areas accurately enough. Moreover, users stated that they had problems in the messaging section of the agricultural expert consultation feature, which is among the application features.

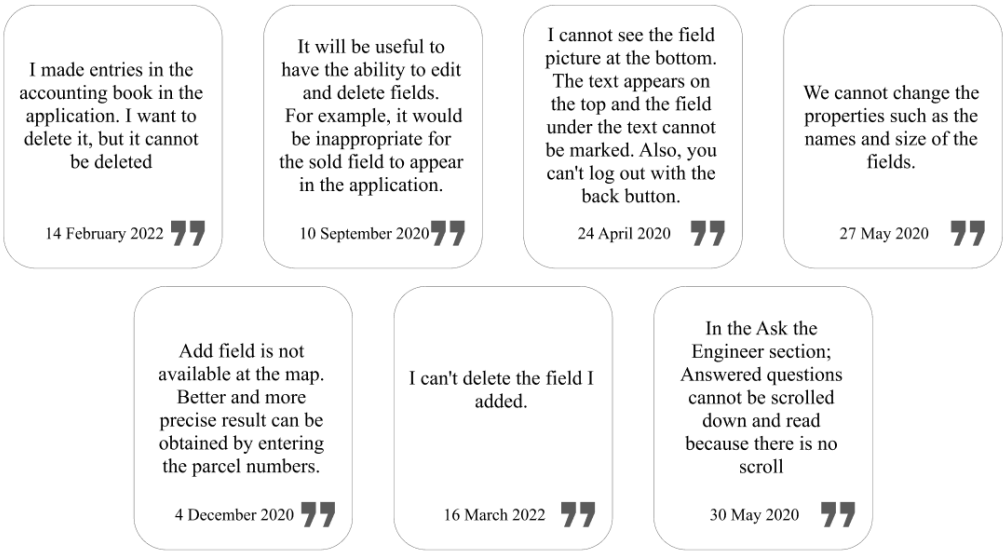

Figure 4.3. User reviews on Deniz'den Toprağa, Google Play

When the reviews of the Tarlam Cepte application developed by Turk Tractor were evaluated, the farmers state that they cannot edit their field and the information provided by the application is not correct. They also mention that the viewing periods of satellite images used in practice should be increased. In addition, users are reluctant to provide personal information such as their citizenship number and state that they are reluctant to pay the application during the trial period.

Figure 4.4. User reviews on Tarlam Cepte, Google Play

When the user reviews of the OneSoil application, which is one of the foreign software products, were evaluated, it was stated that the farmers are missing the crop types and they do not know the legends of the data provided in the application. Users want to be able to view their own .kml files by uploading them to OneSoil application. In addition, farmers in Turkey have request for Turkish language support. The current version has Turkish language support. The reason for including this review is to show that products that give importance to user opinions try to meet user demands by making updates accordingly. In addition, farmers who continue their agricultural activities in rural areas produce in the local language. For this reason, it is important that the markets where the products are released should support farmer's local language.

Figure 4.5. User reviews on OneSoil, Google Play

In general, refinements were carried out in the requirement list of the GAP Precision Farming application with the information obtained when market research, benchmark analysis and application reviews were evaluated. However, with all the information obtained, some features have been added to the product roadmap for future versions, not for MVP, in order not to delay the release of the product to the

market. Prioritization processes were carried out with the RICE scoring framework in order to achieve temporal separation among these features.

However, to make a general inference, users actually want to be able to track their agricultural production areas. Farmers want to carry out this follow-up with accurate information in their local language. In addition, since some maps offered by applications do not have legends, users cannot directly access the information they need. However, the information, which is the most important and valuable input of rural development, should be accessible to farmers and should be easily understood. Only in this way can technology adaptations be increased and agricultural and rural development can be mentioned.

4.1.2 User Research and Persona

User research is important to better know the target group of the developed application and to adopt the needs more accurately. Since the farmer group discussed in this research is mostly a group living in rural areas and has low technology penetration, it is a necessary step to explore how to adapt these users to the mobile application developed. Along with user research, the process called personas and defined by the Nielsen (2014) as "a method to communicate data about users and to aid in the perception of users" is required.

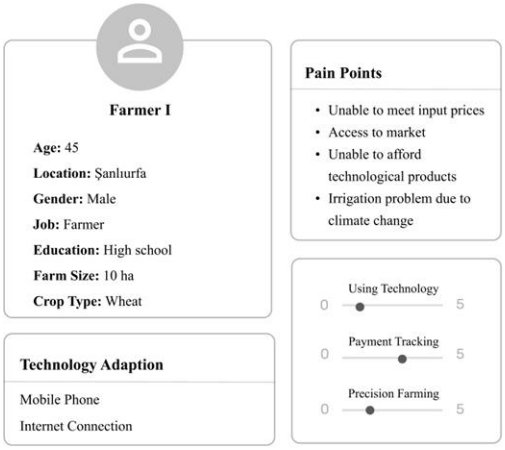

Figure 4.6. Persona - Farmer I (produced by the author)

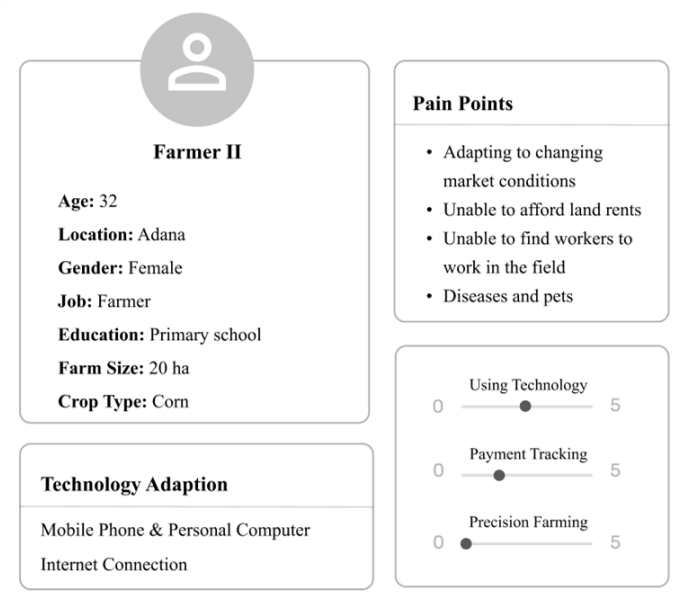

Figure 4.7. Farmer II – Persona (produced by the author)

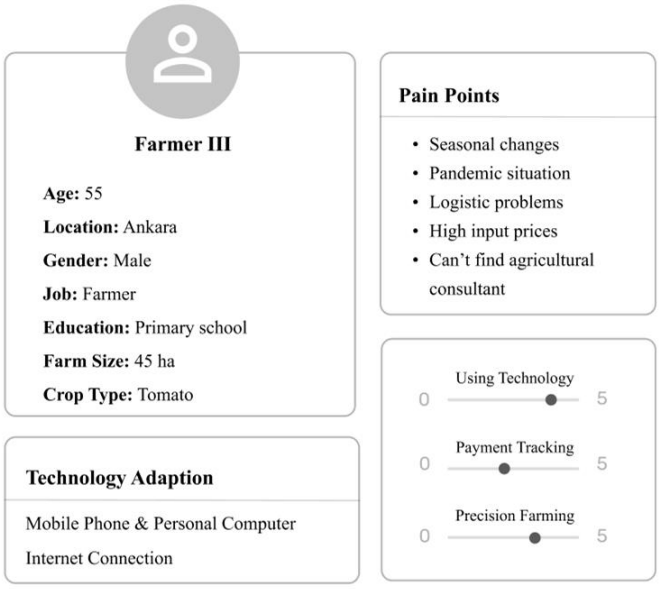

Figure 4.8. Farmer III – Persona (produced by the author)

As shown in the figures above, three separate persona cards were designed together with the user researches carried out in order to better understand the needs of the

users who are making value propositions through software products, to identify their pain points and to develop the application features accordingly. According to these studies, the common problems of the farmers are the inability to adapt to the input prices and changing market conditions. Although the size of the agricultural land on which each farmer carries out agricultural production varies, the land size of the farmers in the target group is below 50 hectares. This farmer group is defined as small and medium-sized firms. Therefore, this group benefits from less technological developments in their agricultural activities. In addition, their financial power to access technological developments is limited. In addition to all these researches, users need to have access to financial tools to penetrate the technologies (Singh, 2009), which are considered as components of rural development, to be accessible to farmers. These financial instruments can be accessed through loans. However, since the income obtained by the farmer from agricultural activities is not at a level to meet the repayment of these loans, it is necessary to keep the expenditures made by the farmer during the production activity at the optimum level and thus create an extra resource. Hence, fertilizer saving in the value proposition, the GAP Precision Farming app offers farmers this opportunity.

4.1.3 Business Model

Business model defines the how the business generates money. Web and mobile application is constructed on the Business-to-Business (B2B) and Business-to-Consumer (B2C) business model. However, the main purpose of including this topic in the research process is user needs that vary according to these business models rather than how the application will generate money. Therefore, defining the same functions to reach an individual user and reach a corporate customer may cause ignoring the needs of one of these two groups. Also, based on the business model, marketing strategies vary. Kumar and Raheja (2012) states the main difference between these two business models by clarifying that B2B applies the solutions exclusively to other businesses where many people are involved in the decision

process while B2C applies the solutions to consumers where individual is involved in the decision process. To illustrate, in current case, B2C business model tries to reach single farmer, B2B tries to reach larger firms which are quite big company and they have their own agricultural producers or contractors to goods in their market.

4.2 Product Planning and Prioritization

Product management life cycle model offers product planning and prioritization as a second phase in the model. In this phase, product and user requirements were gathered and collected in the product backlog. The product backlog consists of a list of features that will be included in the relevant product when the product is published on the market and made available to users. The items planned to be owned by the software product are collected in this pool. The items included here can expand and contract depending on market research, user research and interviews, and the know-how of the team that developed the product. Since the product is a living organism, the product backlog was not created once in this process. Product backlog refinements, which are defined as various improvements within the life cycle of the product, have been made.

Sprint plans were made using prioritization methods to decide which of the items in the product backlog should be done first. Sprint planning is the planned workflow processes that take place in Agile Management and change in approximately from one to four weeks. In this study, two-week sprints were run.

In addition, tests regarding the modules planned to be included in the software products were carried out in the agricultural production area located in the geography where the software products are used. Hence, pilot studies had been conducted to analyses product algorithm and user requirements in detail.

4.2.1 Product Backlog and Sprint Planning

After the product strategy formulation, which is the first process of the product management lifecycle, the features that solve the problems that the product is planned to solve are collected in the product backlog. The parts of the product that will emerge with the development of more than one feature are brought together in this section. As stated before, this process is not completed once. With the additions and subtractions made during the product life cycle, backlog refinement is made. Backlog refinement in web and mobile application, which is the case study of this thesis, has been improved according to technical requirements, user expectations, product key performance indicators and data obtained from the pilot field study.

In this process, in order not to delay the launch time of the product and to understand the needs and behaviors of the users as quickly as possible, the market was launched with the Minimum Viable Product (MVP) that shows the most basic features of the final product. Again, in this process, prioritization methods were applied and the application features that the user basically needed were developed in this process.

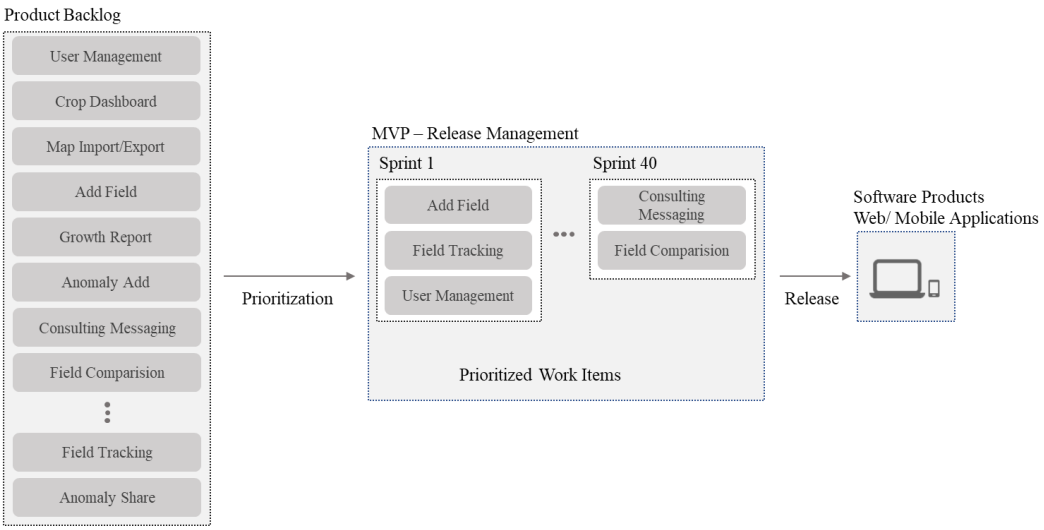

Figure 4.9. Product Planning

As shown in the figure above, there are multiple features in the product backlog. As mentioned before, for the first release of the product which included features such as

add field, field tracking, user management, and progress report were realized. The reason why these features are included in the first release is that this product is an application that allows farmers to follow their agricultural fields and provides an opportunity to get suggestions, on the basis of which agricultural field can be added and the growth of the crops in this area can be monitored.

4.2.1.1 Product Prioritization Frameworks

There are various frameworks used to prioritize items in the product backlog. These frameworks allow prioritization by considering items from different points. Different prioritization frameworks can be used for different products. This may vary depending on the point of view of the organization that develops the product and the points it values more. In this study, mostly RICE framework was used. RICE framework uses four different factors to prioritize the items: reach, impact, confidence and effort. After using this framework, RICE score is calculated and generally highest score has the priority in the task list. That is, RICE score is useful for task ranking, as well other prioritization methods.

Reach	**Impact**	**Confidence**	**Effort**
Number of affected users	Feature's impact on users	Confidence level about the reach and impact	Allocated time (person/month) for completion

Table 4.3. *RICE Scoring Factors*

Based on the calculation of RICE score reach, impact and confidence factors have positive impact on score, while effort has negative.

$$\text{RICE Score} = (\text{Reach}*\text{Impact}*\text{Confidence})/\text{Effort}$$

In the case study of the current thesis, RICE scoring example is listed below. Based on the RICE scoring calculation, Map Export task's score was higher than Report Share. Due to the ranking of the scores, Map Export has priority.

Priority	Task	Reach	Impact	Confidence	Effort	RICE Score
1	Map Export	78	5	60%	2	**117**
2	Report Share	82	4	50%	3	**55**

Table 4.4. *RICE Scoring in Case Study*

Also, more than one prioritization activity was carried out during the product launch, but not all of them were included in this study one by one.

4.2.2 Pilot Studies

In this context, input applications such as fertilization in traditional agriculture were handled with the assumption that the agricultural production environment is uniform. In this management, the geographical, physical and chemical characteristics of the land (soil and plant characteristics, topography, etc.) were neglected. Moreover, these characteristics, which vary according to the land, were not taken into account during the agricultural production phase. This situation causes the formation of a production process that creates negative effects such as the application of an input amount above or below the required amount. In this context, Variable Rate Application (VRA) technologies provide farmers with the opportunity to apply location and/or need-based agricultural inputs. With the variable rate application, it is aimed to ensure the use of optimized agricultural inputs. The data collected by inputs and sensor technologies enables location-based applications to save time, cost and fuel, while optimizing the use of resources for a sustainable agriculture. Variable rate application systems use the data they receive from sensing devices (sensors) that evaluate the variability of agricultural areas depending on spatial coordinates, and thanks to the algorithms they contain, the map to which the variable rate application will be made is created. Thanks to this map created in the system, optimum agricultural input (fertilizer, pesticide, seed, etc.) is used in precise measurements and for the needs.

Technological developments mentioned in Chapter 3 are the technologies used in web and mobile applications, which is the case study of this thesis. In addition, web and mobile applications generate variable rate fertilization maps. But before this production, field test studies were carried out in order to test the algorithm developed in order to suggest a variable rate fertilization map during the planning phase of the product.

The purpose of the web and mobile application is to realize an application process that can be monitored, controlled, measured and can provide decision support infrastructure and application infrastructure for the necessary applications in the light of all these data. Agricultural production cycle takes place in the form of tillage, planting, fertilization, spraying and crop harvesting. In this context, the aim of software products is to realize the applications that will provide the required inputs in the light of the information obtained from the previous stage in each stage and the applications that will ensure the maximum level of product with the optimum level of input of this cycle. Accordingly, in order to determine the requirements of the software products to be developed and to collect user requirements, the fields where agricultural production will be carried out were selected to carry out pilot studies. In this context, the activities carried out were as follows:

1. Soil survey and productivity mapping studies,
2. Creation of yield maps of the wheat plant in this area,
3. Second crop corn cultivation in the said area,
4. Application of variable rate base and top fertilizers in second crop corn cultivation,
5. Creation of yield maps of corn plants,
6. Use of agricultural machinery to detect variability and enable variable rate applications.

Evaluation studies were carried out within the borders of Harran Plain GAPTAEM stations, together with TUBITAK-UZAY, GAP Administration and GAP Agricultural Research Institute Directorate (GAPTAEM) officials and FarmLabs

Agriculture Technologies and R&D, in the pilot areas where the research and agricultural activities were carried out. It was decided to work on a 70 decares field in the center pivot area of GAPTAEM Talat Demirören Station, parcels 7 and 10, as well as GAPTAEM Gündaş Station. The parcels numbered 7 (42 decares) and 10 (40 decares) of the GAPTAEM Talat Demirören Station studied were determined as the parcels where variable rate applications could be applied. In the center pivot area of GAPTAEM Gündaş Station, 70 decares of land have been determined as the parcels on which conventional agricultural applications were made.

The first station, located at the 34th km of Şanlıurfa Akçakale road, is a station where pilot studied and research activities were carried out. It represents the Harran plain with its 485 decares of land and all kinds of infrastructure. In this context, the related station is a station that is subject to intense and different applications in terms of agricultural applications.

As a result of the evaluations, it was decided with the agreement of GAP ADMINISTRATION - GAPTAEM - TÜBİTAK UZAY and FarmLabs to use two separate agricultural parcels with 42 da and 40 decares sizes as application parcels during the pilot studies.

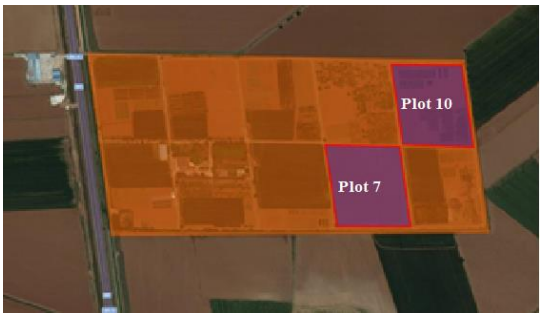

Figure 4.10. Agricultural Plots Allocated to Talat Demirören Station

The parcel status of the parcels in the image above is as follows.

- Plot no. 10: It has been plowed and ready for planting as of January-2019.
- Plot no. 7: As of January-2019, it has been planted with corn.

The second station is located at the 18th km of Akçakale - Suruç road and has an area of 4.824 decares and is used for production and trials. In this context, it has been found appropriate with the agreement of GAP ADMINISTRATION – GAPTAEM – TÜBİTAK UZAY and FarmLabs to carry out the necessary works on a 72 decares plot of land with a radius of 450 meters, located within the center pivot irrigation area within the relevant station where irrigation is provided by the Center Pivot system.

Figure 4.11. Gundas Center Pivot Station

Within the scope of the studies the trial plots at Talat Demiröre Station and Gündaş Station, which were defined as the application areas, and studies were carried out to create soil survey and productivity maps. In this context, the relevant analysis and mapping process was carried out as a flow within the framework of the plans below:

Step I: Performing the soil sampling study before planting the first crop

Step II: Execution of soil survey studies of pilot plots

Step III: Creation of soil value maps in line with soil sample analysis results

Step IV: Creation of "Primary Crop – Wheat" productivity maps via the Yield Mapping System

In this context, within the framework of the above-mentioned process steps, the existing soil maps of the pilot plots used in the activities were created, the variability was determined, the spatial and structural changes could be observed, and the

aforementioned findings were processed and interpreted in such a way as to form a data base for variable rate agricultural practices.

Within the framework of the activities carried out within the scope of the pilot studies, it was aimed to transform agricultural production into a controlled production at every stage by constructing a traceable agricultural production infrastructure. In this framework, it was aimed to optimize input and construct a sustainable production infrastructure by using the following technologies in the pilot lands determined:

i) Variable Rate Base Fertilizer Application
ii) Growth Monitoring with Remote Sensing
iii) Variable Ratio Top Fertilizer Application
iv) Yield Mapping

Field	**Base Fertilization (kg/da)**	**Fertilization (kg/da)**	**Yield (kg/da)**
Plot No. 10	15 kg/da	27,50 kg/da	1070 kg /da
Plot No. 7	19 kg/da	28,50 kg/da	1300 kg/da
Center Pivot Plot	45 kg/da	45-50 kg/da	1090 kg/da

Table 4.5. *Fertilization and Yield Result*

The practices carried out in this context were presented within the framework of the input used per unit area and the yield values obtained due to the different sizes of the agricultural lands, the different effective cultivation lands, and the seasonal conditions that vary throughout the production period, as well as the variable input types.

Within the scope of the aforementioned results, although the yield values per decare of "plot 10" and "center pivot plot", where agricultural production was carried out as

the second product, were close to each other, it was seen that an input saving of 30% was achieved on the basis of the amount of input consumed.

4.3 Product Development and Introduction

There are studies related to the publication and market launch of the web and mobile applications developed according to user and technical requirements. With the completion of the work in the previous phase of the product life cycle model, the software development process of web and mobile applications started.

Figure 4.12. Sprint Planning

Software products were made available to farmers by running two-week sprints with the product team formed by software development, data analysis, product management and product design teams.

4.4 Post Launch Performance Management

It includes the evaluation of the user behavior of the product offered to the market and the updates to be made in the web and mobile application with continuous

feedback. At this point, the Objectives and Key Results (OKRs) determined during the product development process and the effective use of the application was evaluated. OKR is one of the frameworks which could be used to assess and trace the goals of the product. Firstly, product team set the objective to define the one of the aims which will be achieved with product. Once the goal has been set, key results are defined to express how it will be understood that this goal has been achieved. It also determines what needs to be done to achieve key results in the field of initiatives. In case study, the first objective was to increase in active fields. Active field means that fields where field follow-up and progress report are produced within a month. Also, four different key results and initiatives were defined as it is shown below:

Figure 4.13. Objective and Key Results (prepared by the author)

In addition to the goals defined using the OKR framework, the north star metric, which is the most important indicator of the success of the product, was defined, which is created by bringing together the most important metrics of the application. OKRs could be different for each product, as well as generic metrics could be produced. However, the north star metric is more product-specific combined metrics.

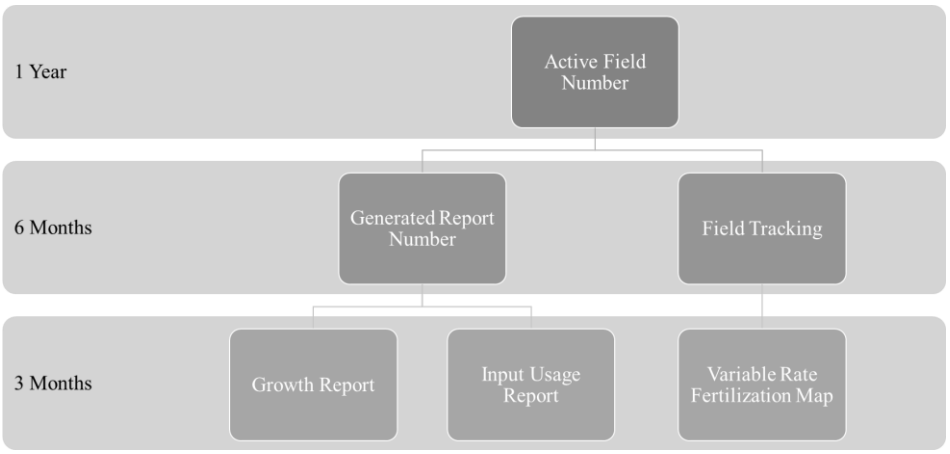

Figure 4.14. North Star Metric (prepared by the author)

It was the number of north-star metric active fields specified in line with the features and objectives of the GAP Precision Farming application. The metric, expressed as active field, was measured through the number of reports produced by farmers in the last six months and the field tracking module. While the number of active users was also followed as a metric; the reason why the active field number was specified as the north-star metric is that the actual value proposition of the mentioned software product is included in the field tracking feature. While every time a user spends in the application is important for the use of the application, the most important point is the evaluation of the reports produced for the farmers and the analysis of the satellite images and the use of the decision support infrastructure offered to the farmers.

CHAPTER 5

EVALUATION OF 'GAP PRECISION FARMING' WEB & MOBILE APPLICATION

Projects have been developed in order to reduce the difference with other regions by making the best use of the potential resources of the nine provinces in the Southeastern Anatolia Project region. The GAP Regional Development Program covering the years 2021 and 2023 has been prepared by the Southeastern Anatolia Project Regional Development Administration. In addition, the GAP Action Plan was created for the years 2014-2018 and 2008-2012. At the common point of these studies, various targets have been determined to support agricultural activities in the GAP Region and to support the digital transformation in the field of agriculture. These targets include enabling farmers to monitor their agricultural production with technological products and spreading precision agriculture technologies that aim to optimize the use of inputs such as fertilizers[32].

Along with the GAP Precision Farming application, which was developed in line with the above-mentioned objectives, the web and mobile application, which is the case study of this thesis, is offered to the farmers free of charge by the GAP Administration.

One of the important problems experienced in rural areas is expressed as the large number of rural settlements and the dispersion of these settlements by the Second Agriculture Council of Republic of Turkey Ministry of Agriculture and Rural Affairs (2004). This problem makes it difficult for the rural population to access infrastructure and superstructure services, makes public investments difficult and

[32] http://www.gap.gov.tr/tarim-sayfa-15.html

prevents producers from organizing. At this point, it becomes difficult to reach the goal of rural development. However, while evaluating the potential contributions of mobile applications to rural development, which is the research subject of this thesis, it is an important approach that the mobile application targets all producers regardless of location.

In particular, the mobile agricultural apps show significant potential for the modernization of the agricultural sector (Costopoulou et al., 2016) Revels et al. (2010) defined mobile applications as any application service accessible from mobile phones via wireless and mobile communication networks. Coursaris and Hassanein (2002) suggested four types of mobile applications based on consumer needs: communication, information, entertainment and commerce. In this regard, GAP Precision Farming is mainly based on the communication and information.

With access to information and education in agriculture and agriculture-related sectors, information gives an opportunity to farmers obtain and use information effectively in decision-making processes at the point of realizing agricultural production activities. In this way, with the adoption of technology, improvement in agricultural practices can be achieved (Belakeri et al., 2017).

Balit (1996) point out that the least expensive input for rural development is knowledge and information, essential for bringing about social and economic change. The success of green revolution in Asia and Near East indicates that giving rural communities access to knowledge, technology and services will contribute to expanding and energizing agriculture (Pandey, 2015).

Coherence between Agriculture and Rural Development study of OECD states that main concerns of rural development are viability of rural areas, increase in welfare of rural people and good management of land where agriculture has an importance (Kilkenny, 2006). In today's rapidly changing ecosystem, the existence of agricultural producers is only possible if they have access to financial instruments that can sustain their development with good management (Husemann & Novkovic, 2014). While access to the food needed by the society was cheap and adequate until

the late 1980s; Today, the expectations from the agricultural sector on the basis of environmental concerns are much higher than in the past (Rohwer, 2010).

It is possible to deal with huge data volumes and benefit from them by following the listed process below (Husemann & Novkovic, 2014):

- Collection of Data;
- Processing of Data;
- Providing Data;
- Using Data.

That is, the company that developed the web and mobile application collects, processes and provides agricultural data to users. Users also use them by incorporating them into agricultural production processes. In the data collection process, it is carried out by using the tools of third-party developers and the developments in the field of agricultural technologies.

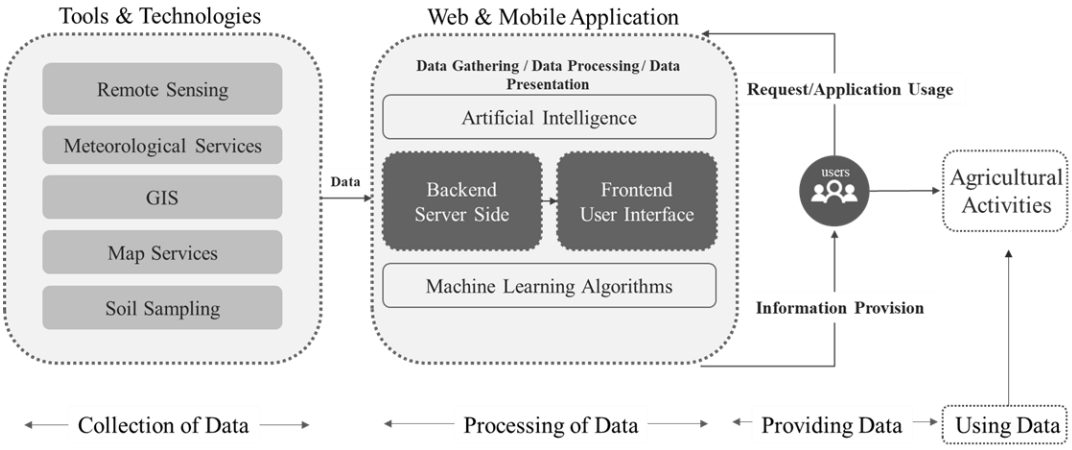

Figure 5.1. Data Flow and Agricultural Activities (prepared by the author)

With the results of this GAP Precision Farming application, which is thought to provide important contributions to the agriculture sector, it has been tried to reveal how the optimum production target for the producers in plant production can be achieved with an effective and environmentally friendly fertilizer use program.

The outputs of this product, which is carried out in the field of precision agriculture and makes use of satellite technology. This application, which is accessible to users consists of map, operation, anomaly, field tracking and field comparison modules.

The main purpose here is to evaluate the activities of the farmers, who are the beneficiaries of the software product, through web and mobile applications, with Structed Query Language (SQL) queries from the relational database. It is going to be possible to evaluate farmer actions with this query language, which offers the opportunity to evaluate quantitatively. The outputs of this section constitute the main inputs of the next section and are important for problem and due diligence.

There were 147 active farms since the application's publication date. The total number of fields in these farms is 220. In these fields, planting, irrigation, fertilization, spraying and harvesting operations were carried out 514 times in total. During this whole process, farmers detected 216 findings in their fields. The total number of farmers performing all these operations is 139. The total cultivated area is 301.675 decares. While accessing this information, some of the inputs provided by the development team as test data in order to test the software product have been ignored, but still some are included in them.

Total Field Area	301.675,20 da	
Number of Farms	147	
Number of Field	220	
Number of Farmer	139	
Number of Agricultural Operation	514	Sowing Operation
		Irrigation Operation
		Fertigation Operation
		Spraying Operation
		Harvesting Operation
Number of Anomaly	216	
Number of Expert	22	

Communication with Experts (Conversation)	198	
Number of Crop Type	8	Cotton, Golden Grass, Sage, Wheat, Barley, Gherkin, Sunflower, Corn (grain, irrigated agriculture, dry agriculture)
Fertilizer Saving Rate		25,25%

Table 5.1. *General Information about the GAP Precision Farming Application*

While 30% fertilizer savings were achieved in the pilot field study, which was carried out to test the algorithms before the application was published and detailed in Chapter 4; in the variable rate fertilization activity carried out after the application was published, 25.25% fertilizer savings were achieved as shown in the table above. Since the agricultural areas are not exactly the same and these agricultural production activities were carried out in different periods, changes in this ratio are considered natural.

5.1 Economic Contributions

Fertilizer expenditures constitute more than 40% of agricultural production costs in wheat production based on the data provided by the Chamber of Agricultural Engineers in Adana, Turkey[33]. These data were provided for the year between 2020 and 2021. However, since this time period Turkish Chamber of Agriculture Union states that in fertilizer, which is an important agricultural input, in the last 1 year as of December, ammonium sulfate fertilizer increased by 437 percent, urea fertilizer by 403, ammonium nitrate fertilizer by 371 percent, DAP fertilizer by 294 percent and 20.20.0 compound fertilizer by 261 percent. In order for the use of fertilizer to

[33] https://www.zmo.org.tr/genel/bizden_detay.php?kod=26110&tipi=3&sube=2

be sustainable, fertilizer prices must be kept at reasonable levels[34]. Although the 2022 wheat production cost has not been announced yet, this increase in the price of fertilizer also increases the rate of fertilizer in the production cost. That is, fertilizer expenditure rate in production cost increases with increasing fertilizer prices.

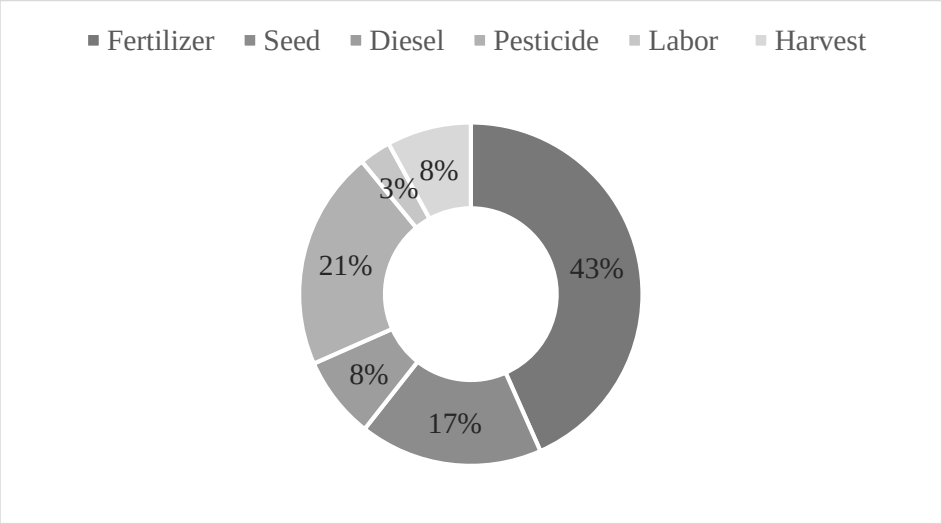

Figure 5.2. Production cost of 1 kg of wheat (Adana, 2020-2021)

Although the fertilizer savings of the application users vary according to the land size and fertilization activities, the necessary information on a sample field is given below to show the average fertilizer savings in an average field.

One of the research compiled by the Lowder (2016) states that 94% of the 460 million farms in the world perform agricultural production under 5 hectares. In the figure shown below, more than 85% of areas with farm size less than 5 hectares produce cereals such as maize, corn, barley which are the main crop types for food supply. Also, as mentioned earlier in Chapter 2, more than 50% of adult poor workers take part in agriculture sector (World Bank, 2016) which are mainly small and medium-sized firms. Moreover, agriculture sector has power to enhance the income level of the poorest society. Because, agriculture sector is two to four times more

[34] https://www.tzob.org.tr/basin-odasi/haberler/tzob-genel-baskani-bayraktar-2021-yilini-degerlendirdi-ve-2022-beklentilerini-acikladi

effective in increasing the income of poor workers than any other sector in rural areas. As Lacroix (1985) states that while agricultural development is about capital development, rural development is about human capital development.

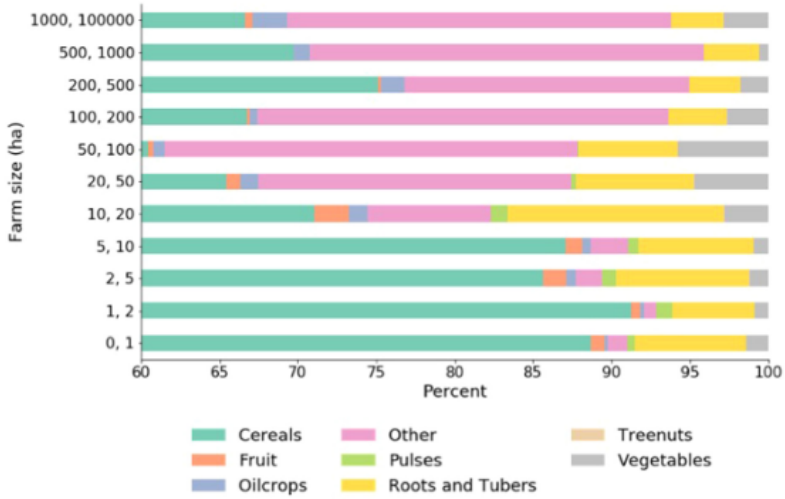

Figure 5.3. Crop type within farm size class (Ricciardi et al., 2018)

In both development models, the increase in income level allows both to ensure the continuity of agricultural production and to meet the other basic needs of low-income farmers living in rural areas with economic gains. In addition, the decrease in production costs not only allows the individual economic gain of the farmers, but also reduces the budget that countries like Turkey, which is dependent on foreign sources for fertilizer consumption, should allocate for fertilizer exports and allows these budgets to be shifted to different areas.

In this study, 25,25% fertilizer saving was achieved with the variable rate fertilization map in a 72 decares field produced in the web and mobile application. With this rate, there could be minimum 10% reduction in the cost of agricultural production.

Farmers have chance to generate variable rate fertilization map by using web and mobile applications. By performing this process, farmers can consume fertilizer at the optimum level.

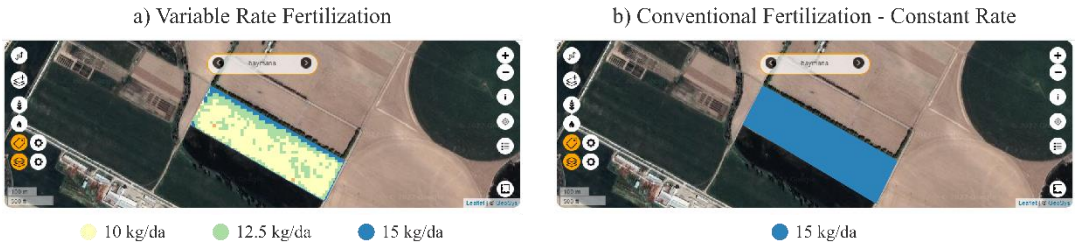

Figure 5.4. Variable Rate Fertilization Comparison

From the maps showing the fertilization doses in the agricultural production areas above, variable rate fertilization was made from the one on the left (a). On the right (b), it is shown what kind of fertilization activity would have taken place if fixed rate fertilization had been made in the conventional method. According to the variable rate fertilization map, the agricultural production area was divided into three separate zones and the nutrients needed by the crop were applied to the right place at the time it needed it. According to this fertilization process, 15 kg/da of fertilizer is applied to only 6.3 decares of an area of 72 decares; If fixed-rate fertilization had been applied to the same area shown on the right, 15 kg/da of fertilizer would have been applied to the entire area. In this way, more fertilizer is used than the plant needs with the fixed rate fertilization activity. The use of more fertilizers both requires more economic expenditure for the farmer and causes this negative effect to increase due to the use of excess fertilizer, since the fertilizer has a negative impact on the environment.

As shown in the table below, in the variable rate fertilization process, the field was divided into three different growth zones and three different doses were applied. In the fixed-rate fertilization process, the amount of fertilizer needed to be used and the economic equivalent of this were expressed when the needs of the crops at different points were ignored and the same amount of fertilizer is applied to each point, that is, a single dose fertilization process was carried out.

	Variable Rate Fertilization			Conventional Fertilization
Fertilization Zone	Zone I	Zone II	Zone III	Uniform
Kg/da	10 kg/da	12,5 kg/da	15 kg/da	15 kg/da
Field Size (da)	43 da	22.7 da	6.3 da	72 da
Fertizer Consumption	430 kg	283 kg	94,3 kg	1080 kg
Total Fertilizer Consumption	807,3 kg			1080 kg
Fertilizer Expenditure	13.120 TL			17.712 TL
Fertilizer Saving Rate				**25,25%**

Table 5.2. *Fertilization Consumption & Expenditure Comparison and Saving Rate*

Accordingly, in the variable rate fertilization process, 25.25% saving was achieved both in fertilizer consumption and in the amount of fertilizer expenditure. In short, fertilizer savings were achieved with the variable rate fertilization map created by these applications. In this way, production costs can be reduced for farmers who are currently in a low-income situation. That is, these technological advancement in agriculture sector has potential for farmers regarding to the economic contribution.

5.2 Social Contributions

The target user group of the web and mobile application, which was the case study of this thesis, was small and medium-sized agricultural firms. The scales of agricultural firms are classified according to the size of the area where they carry out agricultural production. Small and medium-sized agricultural firms have less than 50 hectares of agricultural production area. Due to less agricultural land holdings, their

agricultural production is more limited than large-scale farms, and therefore their income is relatively less.

In addition to the volume of agricultural production, there is a significant technology penetration difference between firms of this scale and larger-scale firms. Studies have shown that one of the most important factors that can reduce the difference between small and medium-sized agricultural firms and large ones is technology adaptation. At this point, cost-effective technological solutions to financially disadvantaged farmer groups who live in rural is essential point for the agricultural development. Also, studies and researches state that agricultural development is one of the powerful tool to end extreme poverty and boost shared prosperity.

In GAP Precision Farming web and mobile application, farmers access to information related to their agricultural field and improve the agricultural production. Farmers have chance to generate a variable rate fertilization map for their field and monitor the growing stages of the crop. It's one of the ways to use of ICT in rural.

Moreover, this software product makes its value proposition to farmers on all small and medium farms, regardless of age or gender. Therefore, farmer groups continuing their agricultural activities in rural areas are not excluded according to their demographic structure.

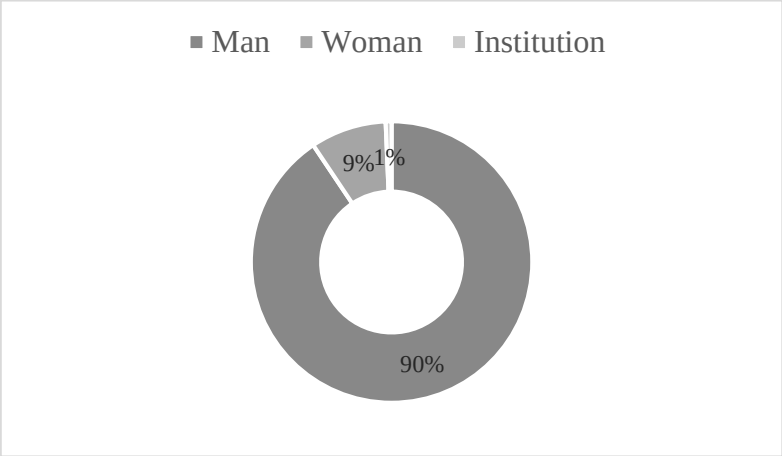

Figure 5.5. User gender & type

As shown in the figure above, 90% of the users are male farmers, while 9% are female farmers. In addition, 1% of the application users are public institutions. However, the distinction between gender and user type is based on the information provided by the user registered to the application. Therefore, in the application where a farmer is registered, more than one farmer may be operating in the field of agricultural production.

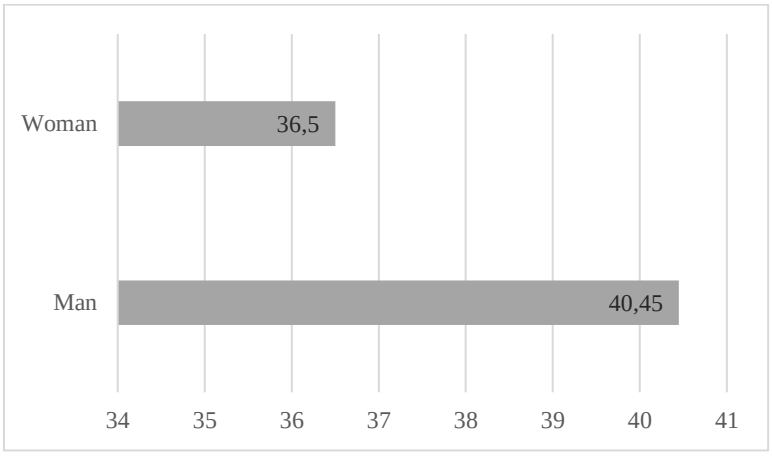

Figure 5.6. Average age by user gender

When the average age of application users was evaluated by gender as it's shown above, the average age of male users was 40.45, while the average age of female users was 36.5. According to this assessment, the average age of female users was younger than male users. In addition, when the average age of registered users was evaluated, it was seen that the application matches the persona study revealed in the product management process. However, on the other hand, when an evaluation was made according to the average age groups in rural studies, it was revealed that GAP Precision Agriculture application users were a younger group.

In addition, it can be mentioned that there is a potential contribution in terms of food security, depending on the agricultural production with less fertilizer consumption by the farmers.

To sum up, the social evaluation is made through the case study of the thesis, it was concluded that female users use the application as much as 1 in 10 of male users. At

this point, it was required to carry out various studies in order to increase the registration of more female farmers and the frequency of using the application in rural areas. As previously mentioned in Chapter 2, OECD states that gender equality is crucial aspect of any intervention in rural for development. Although the practice was developed regardless of gender, as stated by the OECD, different value propositions should be made for rural female farmers in order to achieve gender equality.

5.3 Environmental Contributions

Food supply emits greenhouse gases into the atmosphere at every stage(European Environment Agency, 2015). 9.3 billion tons of carbon dioxide equivalents comes from agriculture and related land use activities globally (FAO, 2020). Agriculture accounts for 10% of the EU's greenhouse-gas emissions (European Environment Agency, 2015). Also, N2O emissions from synthetic fertilizers contributed 13 percent to the total emissions (FAOSTAT, 2020). Reduction of chemical fertilizers is necessary for the sustainable agriculture and reduction of GHG emissions (Kitamura et al., 2021)

In the medium to long term, a decrease in fertilizer contamination led to increase in soil productivity and decrease the GHG emissions. World demand for the fertilizer nutrients (N+ P2O5 +K2O) use was assumed as 201.663 thousand tons in 2020 (FAO, 2017). A reduction of 25% in fertilizer demand together with variable rate fertilization activities corresponds to an annual fertilizer savings of approximately 50.000 tons. Therefore, this rate allows fertilization activities, which correspond to 13% of greenhouse gas emissions caused by agricultural activities, to decrease to 9.75%.

It is important to reduce the problems caused by fertilizer consumption in the long term for problems such as changes in weather conditions during production periods and pollution of water resources due to climate change.

The possible economic, social and environmental contributions of the GAP Precision Farming application, which is the case study of this thesis, are discussed separately. In addition, the possible contributions to the economic, environmental, social and planning fields as a result of all the findings are discussed cumulatively in the table below. In this table, the current features of the GAP Precision Farming application are considered as 'current features' and the direct and indirect contributions of these features in the mentioned areas are presented separately. Accordingly, the 'Field Tracking' feature primarily provides a direct contribution to the farmers in the economic field. At the same time, with this feature, which allows farmers to follow their agricultural production areas, it is expected to contribute in the social, environmental and planning areas in the long run.

According to this assessment, field tracking, variable rate fertilization map, meteorological services, field comparison, agricultural hardware - IoT integration and consulting expert features have a direct impact on farmer's economy. While consulting an expert feature has a direct impact on the social side, meteorological services feature has a direct impact on environmental side. Rest of current features has indirect impact on the before-mentioned sides.

In addition to the existing features of the GAP Precision Farming application, there are various features planned to be published in the short and long term. In this table, features that are planned to be released are referred to as 'future features'. Likewise, the direct and indirect positive impacts of these features on the economic, social, environmental and planning fields were evaluated. Accordingly, the planned variable rate irrigation and spraying, market information features may have a direct positive effect economically. Farmer-to-farmer communication feature can have a direct positive effect in the social field. Other future features may have an indirect positive effect on the specified area.

		Economical	Social	Environmental	Planning
Current Features	Field Tracking	✓	✓	✓	✓
	Variable Rate Fertilization Map	✓	✓	✓	✓
	Agriculture Operational Log	✓	✓	✓	✓
	Meteorological Services	✓	✓	✓	✓
	Field Comparison	✓	✓	✓	✓
	Agricultural Hardware – IoT Integration	✓	✓	✓	✓
	Consulting an Expert	✓	✓	✓	✓
Future Features	Variable Rate Irrigation & Spraying	✚	+	+	+
	Agriculture News & Announcement	+	+	+	+
	Grant & Support	+	+	+	+
	Market Information (Diesel, Seed, Fertilizer)	✚	+	+	+
	Farmer-to-Farmer Communication	+	✚	+	+

✓: Direct positive impact ✚: Direct positive impact (future feature)

✓: Indirect positive impact +: Indirect positive impact (future feature)

Table 5.3 *GAP Precision Farming Application Contributions (prepared by the author)*

Considering the rural area and rural development issue in Chapter 2, the most important conclusion is that people in rural areas are mostly in the agricultural sector and are a low-income group. It is also stated that the most important input for rural development is information and that rural farmers have difficulties in accessing this information. As stated in the case study in this thesis, these solutions offered to farmers free of charge by the regional administrations act as a bridge for the delivery of information to the farmers. With these web and mobile applications, farmers were provided with opportunities such as monitoring their agricultural lands, consulting experts in the field of agriculture when necessary, presenting the weather forecast for agricultural production and accessing variable rate fertilization maps.

Technological developments in the agricultural field mentioned in Chapter 3. These developments are key components used in the GAP Precision Agriculture platform. All these developments can provide agricultural technologies to farmers and a decision support system. While it is not possible for farmers to interpret satellite images on their own in daily life or use geographic information systems; Gathering all these technologies on a single platform and presenting them to farmers in the most usable way is an important value proposition.

In Chapter 4, the case study of the thesis, Gap Precision Agriculture, talks about how web and mobile applications were developed on the basis of product management. As mentioned in the same section, a pilot field study was conducted to test the algorithms of the application, which includes a variable rate fertilization map in the value proposition while developing the product. In addition, the expectations of the farmer were gathered through market research, user research, and business model determination, and the product was planned and managed accordingly, and web and mobile applications were developed with software, data, design and product management teams together. This development process focused on how software products can affect farmers in economic, social and environmental areas and what potential contributions these applications can provide.

In Chapter 5, potential contributions to the economic, social and environmental fields, such as economic gain, food security, and climate change, as well as the potential contributions of farmers using this application were evaluated. In addition, with these solutions being offered to farmers free of charge, the problems created by economic conditions, which are one of the most important obstacles for farmers' access to technological developments, are tried to be eliminated.

CHAPTER 6

CONCLUSION

The agricultural sector, which is trying to meet the food demand of the increasing population, is in a difficult situation for many reasons. Among these reasons, there are problems such as the pressure of global warming on the agricultural sector, the migration movement from rural to urban, increasing agricultural production costs and the inability of farmers who are already low in income to continue their agricultural production. In order to cope with these problems, local, regional and global players develop various policies, strategies, projects and products.

Also, agricultural practices could be supported on the light of ICT products such as web and mobile applications. These applications are provided to act as a Decision Support System to sustain farmers activities provide raise employment in rural area, in total. Moreover, the sustainability of these rural entrepreneurs would maintain a self- sufficient development continuum for the rural inhabitants (Lele, 1975). It is expected that rural development is about creating new products and evaluating new markets with recent technological ways (van der Ploeg et. al. 2000).

Under these conditions, the aim of this thesis is to investigate the possible contributions of web and mobile applications, namely software products in the field of agriculture, developed by the private sector on the basis of product management, on rural development. For this purpose, the development and market launch processes of the GAP Precision Agriculture web and mobile application developed by FarmLabs Agriculture Technologies and R&D. It has also been made available to farmers in the GAP region by the GAP Administration. As a case study, GAP

Precision Farming web and mobile applications were examined and the application usage pattern of the farmers were evaluated.

Until this point of the research, while rural development, rural development policies and actors were discussed in the Chapter 2, agricultural technological advancement in the products that also serve rural development were included in the Chapter 3. In the Chapter 4, what were the product management basics in the backbone of the thesis subject and what kind of product management fundamentals and frameworks were used in the software products that are the case study of the thesis. In the previous chapter, namely the Chapter 5, it was discussed how the topics discussed and researched in the previous chapters were connected to each other in the feature of these software products.

While existing studies in the field of rural development in the literature emphasize the importance of information and communication technologies, they also emphasize that information is the most valuable input. The web and mobile application, which was the case study of this thesis, provide value proposition in the field of precision agriculture, provide information with various modules and produce variable rate fertilization maps that provide an average of 25% fertilizer saving for farmers who have low income and live in rural areas. In addition, information about farmer actions and production patterns can be accessed in this whole process, depending on the application usage, and since the software product is a living organism by nature, new fields and development opportunities can be offered to farmers with this information.

6.1 Contribution to the Literature

The contribution of this study to the literature is addressed in two ways. The first of these is related to rural development. The rural development researches in the literature mostly evaluate the policies in the field of rural development or proceed by considering one of the rural development projects as a case study. There are also studies evaluating the impact of various technologies on rural development.

Secondly, it is about product management, web and mobile applications. There are research studies in different sectors involving these two topics. However, studies dealing with the intersection of these two issues with agriculture and rural development is limited. Therefore, considering the web and mobile applications developed for the agricultural sector on the basis of rural development and product management and their potential contributions to rural development can be considered as a contribution to the literature.

6.2 Limitations of Research

The research involves various limitations due to its characteristics. The problems in the agricultural sector appear as a global issue that concerns all humanity. There are problems at all points in this sector, from the producer to the consumer. The farmer group, which is considered as a producer in this study, cannot perform its agricultural activities financially due to the increase in production costs due to financial constraints and variability. In this process, where the demand for food is increasing and continues to increase, it is obvious that the agricultural supply cannot be met. Due to the economic conditions that farmers in it, farmer group has limited potential to afford technological products. Also, the usage rate of the web and mobile applications, which are the subject of this research, and the information on the websites of the enterprises, marketing materials and application stores were examined. Access to the database of the applications that are the subject of the benchmark analysis study was not possible due to confidentiality, and therefore, the product analytics that deal with the daily, weekly and monthly usage metrics of the farmers who are the application users cannot be accessed. Beside the alternative applications, for case study of the research, GAP Precision Farming web and mobile application was evaluated by accessing to the database of the application with the permission of the FarmLabs Agriculture Technologies and R&D company.

In addition, while it can be determined which modules are accessed by the farmers using the software application; It cannot be determined whether the farmers actually

use the information obtained by using these modules in their agricultural activities in the field. This point constitutes another limitation of this study.

6.3 Recommendation for the Future Studies

Studies to be conducted in a similar field may consider more than one application separately or in a cumulative way. Within the scope of this study, other web and mobile applications are included only in the benchmark area. As it is shown among the limitations of the study that the users in that application do not have direct access to the usage patterns, user behaviors in different applications can also be measured in subsequent studies with the obtaining of company permissions. In addition, the current software product is an application developed with the aim of optimizing the use of fertilizers, and in future studies, various web and mobile applications focusing on different aspects of agricultural production can be included in the research and studies in this field can be enriched.

Information provided by farmers using web and mobile applications is declaration-based. In other words, the information entered by the user is assumed to be correct information. Therefore, the information entered by the user is incomplete or incorrect and cannot be confirmed. At this point, future research studies in a similar field and approach may consider using various control mechanisms to confirm the accuracy of these actions.

Finally, this study was conducted by considering software products that have been in use for more than 2 years. It has a smaller number of users than a regular software product, due to the lack of adequate marketing studies and the fact that it only serves a certain geography in Turkey. At this point, in future studies, using software products that have been in use for many years and aimed to expand the user base and have achieved this can provide information about more farmer behavior and rural areas.

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