DIGITAL FARMING AND PRODUCTIVITY EFFECT: "THE SMART VILLAGE" IN TURKEY

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Abstract: *Food loss and unproductive farming are the main problems in agricultural activities in Turkey. During farming, harvesting and postharvest processes substantial losses take place. The existence of human beings depends on the supply of adequate food. Agricultural activities require detailed care and irrigation, hoeing, fertilization, harvesting etc. are vital problems for farmers. They spend all their time and energy for farming but they get very little. Also The reaction time of production is longer, depending on the variety and breadth of Turkey's climatic characteristics of agricultural land. This results in low efficiency and productivity in agriculture. In order to mitigate these negativity, institutions are trying to put forth new methods most of which are technology related. Digitilization and Internet of Things can be the the most rational methods to solve this problem. Agriculture 4.0, digital farming, smart farming are some of the concepts derived from Industry 4.0 logic and some institutions in Turkey try to help family farmers practice these innovations in their agricultural activities for higher efficiency. "Vodafone Smart Village" which was founded by TABIT (Agricultural Information and Communication Technologies) in Aydın province in Turkey is the first and only comprehensive sample for this purpose. The technologies used in the village provided a great advantage in agriculture and animal breeding. With the support of advanced technology and internet of things, innovations and developments are recorded and it aims to be a new generation professional gate of farming in the future. This is a new generation of rural life model, combining traditional farming methods with the possibilities of advanced technology, increasing production efficiency through information and communication technologies, and making the manufacturer's social life standards elevated with qualified knowledge. Economical objectives of the Smart Farm are at least 20% savings in plant production costs, save at least 22% on livestock costs, 30% revenue growth in livestock, 10% increase in total output, and within the scope of this information, annual revenue increase of 40.000 TL per household is 2 years. This study aims to put forth the productivity effects of various tecnologies and methods used in family farming in a small village. For this purpose, a questionnaire was applied to randomly selected male and female farmers living in the Smart Village. Findings are evaluated in terms of demographic status, education level, developping farming skills, access to information, use of technology, improvement of quality and quantity of products, and effect on productivity.*

Keywords: *Agriculture 4.0; smart village; digitilization; productivity.*

JEL Classification: *O33; Q13; Q16.*

1. Introduction

As digitilization in industrial world gets a great splash with new innovative tecnologies and begin to change the way of business radically, institutional and social structure of countries is also affected by these changes. The developments in information technologies bring innovations in agricultural activities as well as industry sector. Industry 4.0 is the leading concept for all these changes and everything is getting smart and digitalized.

Agricultural activities require detailed care and irrigation, hoeing, fertilization, harvesting etc. are vital problems for farmers. They spend all their time and energy for farming but they get very little. Also The reaction time of production is longer, depending on the variety and breadth of Turkey's climatic characteristics of agricultural land. This results in low efficiency and productivity in agriculture.

Agricultural products are insufficient against increasing population as agricultural productivity decreases for various reasons. According to the report published by UN Food and Agriculture Organization, in 2050, world should produce more than enough food for the world's food needs, at least 70% more than in 2006. In order to meet the ever increasing demand, all producers desire to increase the yield quantitatively and qualitatively, and to go digitalization in agriculture and use Industry 4.0 technologies. (FAO, 2012)

Digitilization in farming involves IoT based data collecting, analyzing and transmission tecnologies like sensors, tracking systems, smart irrigation systems and machine to machine communication systems.

Machine to machine communication requires the existence of an information channel, which is called the Internet of Things (IoT). IoT is a network connection and data exchange of objects, equipments, vehicles, buildings or other incorporated electronic devices. IoT provide a system in which the objects not only percept their environment but also allowed to regulate it. Therefore, farmers can use the devices more efficiently and economically. (Gubán & Kovács, 2017)

Sensors collect and transmit data with connections to billions of devices and objects. A machine or an object is smart if it has some kind of electrical power. It is a connected node in the Internet of Things (IoT) or within any number of autonomous systems such as connected cars, wearable technologies, and smart buildings and cities. (Laboisse, 2017)

Agriculture and farming have used wireless sensor networks to improve its production and enhance agriculture yield standard in lowest cost. Farmers can potentially identify the various fertilizers, irrigation and other requirements by monitoring and understanding individual crop and its requirements,. The sensor node, which is small in size and low in power consumption, shows significant potential in this context. Depth of water, soil water tension and system capacity etc. are estimated for irrigation management system to maintain better crop yield. Therefore, there is an increase in the application efficiency of irrigation system by 10%. (Shinghal and Srivastava, 2017)

Water scarcity is one of the greatest problems faced by the world and agriculture need to consume plenty of water. Therefore farmers need a system that uses water reasonably. In order to manage an irrigation system, smart irrigation systems estimate and measure diminution of existing plant moisture, minimizing excess water use. (Ranjani & Sravya, 2018)

2. Digital Farming In "The Smart Village"

Digitilization and Internet of Things can be the the most rational methods to mitigate the food loss and unproductivivity in agricultural activities. Agriculture 4.0, digital farming, smart farming are some of the concepts derived from Industry 4.0 logic and some institutions in Turkey try to help family farmers practice these innovations in their agricultural activities for higher efficiency.
Turkey has approximately 23 million hectares of agricultural land, 66% of which is used for field crops and 20% of it is used for fruit and vegetables. igital agriculture practices in Turkey have yet to be implemented in very limited and there are steps to be taken to accelerate the transformation process. It is important to support the establishment and research infrastructures of enterprises aiming to develop domestic digital agriculture practices. (Ozdogan et al., 2017)

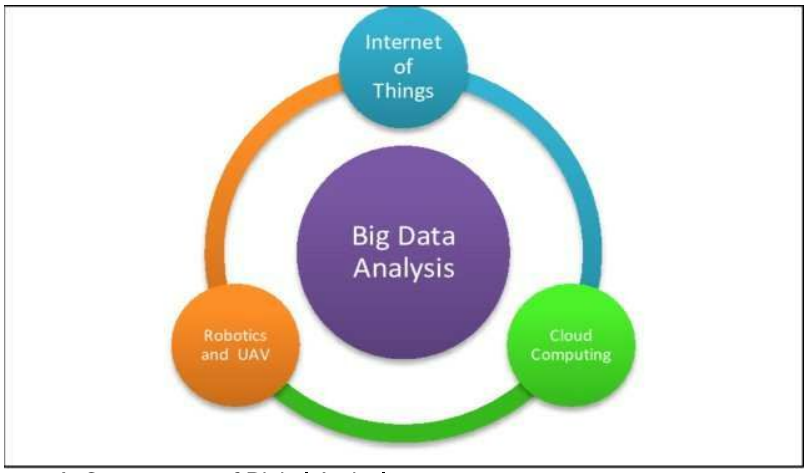

Figure 1: Components of Digital Agriculture
Source: Ozdogan, B., Gacar, A. and Aktas, H. (2017) *Digital Agriculture Practices in The Context of Agriculture 4.0*. Journal of Economics, Finance and Accounting – (JEFA) V.4-ISS.2-2017(13)-p.184-191.

Agricultural business take advantage of developments in digital technology, like increasing the management of arable land and the precision with which animals are monitored and fed, and also controlling agricultural production. It is possible by sensor technology, positioning systems, digital image processing, data visualisation tools, etc. (Brauna et al., 2018)
Mobile phones have advantages on PC's as they are cheaper, easier to carry and learn, and provide an environment for real-time interaction. M-Agriculture refers to the provision of agricultural services and information, using mobile devices such as cell phones, Personal Digital Assistants (PDAs), tablets and other handheld communication or computing devices. They are used to perform weather monitoring by the help of sensor network, in precision irrigation, for automated fertilizing,

greenhouse monitoring system, getting information with SMS, in disaster management and rescue missions etc.(Gichamba & Lukandu, 2012)
In Turkey, although there is a quite widespread mobile phone use, due to the high average age of farmers and not enough education level it is hard for them to use mobile agricultural applications.
While the use of smart phones is so common, mobile use is less in agricultural applications. This is because the program base is not sufficiently introduced to farmers; the average age of the agricultural population is high and the level of education is low. (Lee et al., 2014)
The production of agricultural goods is increasingly associated with the generation of data. But only a small part is currently used. The efficient utilisation of data requires the ability to process large amounts of it. The connection of agricultural elements and components along the supply chain via the cloud using Internet of Things and Services (IoTS) platforms becomes of increasing importance. The Internet of Things and Services closes the media gap between the physical and the virtual world and enables the provision of value-added services based on a current and comprehensive understanding of reality. (Brauna et al., 2018)
Agriculture 4.0 or Intelligent Agricultural practices refers to the use of advanced technology and modern information methods in agriculture. Mobile applications are portable and can be used by users to provide instant active use. In addition, uncertainty in the climate and wrong irrigation and the loss of property damage increased the use of mobile devices in agricultural activities. (Wolfert et al., 2017; Chaudhary, et al., 2011)
Objectives of smart agriculture can be as follows:

a. To minimize the use of chemicals in production and to produce products at a lower cost.
b. Thanks to smart agriculture, global warming, which is a problem for the world, is reduced by decreasing environmental pollution.
c. This system, which offers suggestions to prevent unnecessary waste of wasted use of natural resources, contributes to lower costs.

2.1. Vodafone Smart Village

TABIT (Agricultural IT and Communication Technologies Limited Company) was established as a Socisl Initiative company in 2004. The company's aims are to address the information needs of people living in rural areas and dealing with agricultural production, to increase their productivity and profitability and accordingly to improve their quality of life by extending the use of technology and using the possibilities of technology. In business models, TABIT works with a structure including Technology based Agricultural Education, Social Responsibility Projects, M2M, IoT, IOS, Android Applications, SMS, MMS, Web supported Education and Agricultural Technologies. (http://www.tabit.com.tr/)
Vodafone Smart Village is one of the projects of TABIT. The village was built on a land of 88.320 square meters in the village of Kasaplar in Aydın Province in Turkey. Smart Village is a new generation rural life model combining traditional farming methods with the possibilities of advanced technology, aiming to increase the productivity of agricultural production with information and communication technology and to raise the social life standards of the farmers with qualified knowledge. (http://www.tabit.com.tr/)

In addition to various fruit and vegetable applications in the field, there are also some facilities like technology center, activity areas, market, kitchen, dormitory etc. The company serves together 1 million 400 thousand farmers in Turkey with the international partner firms. Significant changes in the field of agriculture and livestock have been recorded with the help of the new generation technology and Industry 4.0.

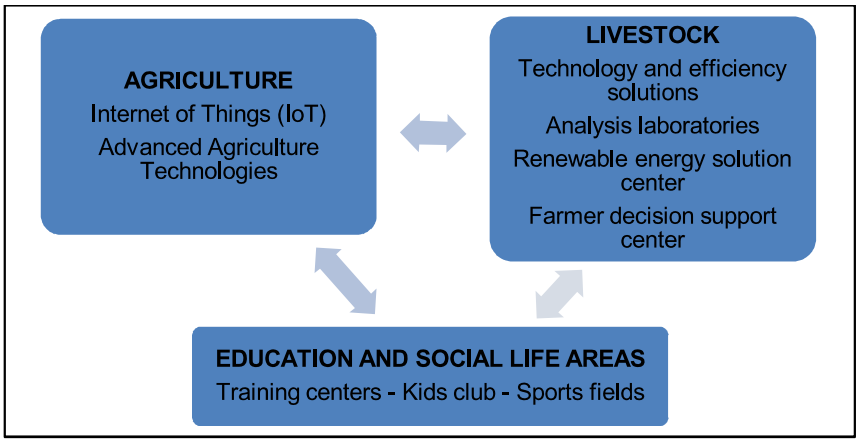

Figure 2: The Scope of the Smart Village
Source: http://www.tabit.com.tr/

Economical objectives of the Smart Village are as follows:
a) At least 20% savings in plant production costs
b) Save at least 22% on livestock costs
c) 30% revenue growth in livestock
d) 10% increase in total output
e) Within the scope of this information, annual revenue increase of 40.000 TL per household is 2 years.

2.2. Technologies and Methods in the Smart Village

Vodafone Smart Village creates a model for environmentally friendly farming in all villages in Turkey, with special spraying unit, early warning systems, irrigation management and farmer information training, providing sustainability of agricultural resources as an obstacle to soil and water pollution through its intelligent systems. With the effect of Industry 4.0, all agricultural machinery from tractors to crop tools are equipped with sensors. In addition, the IoT is entered into the agricultural sector and communication is established between the machines throughout the production. The technologies used in the smart village are irrigation automation, beekeeping tracking system, sera sensor monitoring, meteorological station, intelligent gate and pasture automation, water tank automation, dupont damage detection.
The irrigation operations are activated with intelligent irrigation automation from the computer, phone and its own panel with a single touch. Intelligent irrigation method increases efficiency mitigating unnecessary use of water and reduces the costs by saving more than the normal irrigation method.

Thanks to NFC in the beekeeping tracking system, the amount and mobility of honey in the hive can be monitored remotely. Besides, thanks to the temperature, pressure and humidity sensors in the hive, hive tracking is facilitated and the bees have an increasing effect on the honey yield because the hives are not opened frequently. When there is sufficient amount of honey, the system sends the information message.
By the help of Greenhouse automation designed to minimize damage in greenhouse, IoT sensors are placed in the greenhouse for greenhouse sensor monitoring. QR codes on sensors are matched to the application in the device. The soil temperature and humidity of the greenhouse can be monitored through the system and it is possible to realize less cost, less time and less damage.
Meteorological stations are one of the best solutions for getting weather information on the terrain. By monitoring weather conditions such as temperature, wind speed, rainfall and frost, seed disposal, soil application, spraying and similar agricultural events are taken into consideration.
Thanks to the smart door, cattle are under constant monitoring in the smart village. By pedometer connected to the feet can be followed closely with disease and resentment periods. thus, the intelligent door, which is integrated with the herd management system, divides the cattle into different compartments that are predetermined.
Thanks to Dupont damage detection, high nutritional value of potato, tomato, corn, cotton and similar products are not unnecessarily sprayed. Spraying is done only when a condition is found that will damage the plant

3. Materials and Method

This study aims to examine the implementation of smart farming practices in Turkey and to explore the impact on agricultural productivity. The research is important because of being the first study prepared in the light of the data obtained from the implementation village of TABIT, an innovation company that is the pioneer of this application. Also, this study will be a guide in terms of providing data to further studies.
The effects of various technologies used on productivity were measured by a questionnaire applied to randomly selected thirty male and female farmers living in the Smart Village in Kasaplar village in the province of Aydın.
Conducting the survey on only 30 farmers who apply the smart agricultural practices and the insufficiency of the number of female farmers may affect the results of the study.
The survey is adapted from the survey prepared to investigate the impact of information technologies on productivity in Niğde University. The first part of the questionnaire aims to collect personal information such as gender, age, educational status, working time of farmers. The second part consists of twenty questions to determine the effect of applied technology on productivity.
Chi-square test was used in the analysis of categorical variables obtained from the survey. In independent groups t-test was used to compare total scores according to groups. Descriptive statistics were shown as mean + - standard deviation. The security analysis of the questions was analyzed with Cronbach's Alpha.

Findings are evaluated in terms of demographic status, education level, developping farming skills, access to information, use of technology, improvement of quality and quantity of products, and effect on productivity.

4. Findings of the Survey

The relational level and reliability of the survey questions were examined with cronbach's alpha test and it is found highly reliable with 0,812 value.
There are 30 villagers that answer the survey questionnaiere, 26 of them is male (86,7%) and only 4 of them is female (13,3%). Majority of the survey participants are 41 years and over and this shows that the average of those who are engaged in agriculture is quite high.
Education level is very low with 76,7% of the participants are primary school graduates. Those interested in agriculture for 20 years or more are 83,3%. Most of the farmers has engaged in farming for many years
Almost all of the villagers (96,7%) said that technologies used in agriculture contribute to their development of farming profession and they take part in the idea that fast access to information prevents product waste due to seasonal uncertainties. No significant relationship was found between gender and contribution of technology to professional development. On the other hand, when evaluated in terms of education level, Table 1 shows the results on contribution of technology to professional development of farmers.

Table 1: Contribution of technology to professional development in terms of education level

Education Level	Partially agree	Agree	Absolutely agree	Total
Not literate+primary school graduate	1 (4,3%)	18 (78,3%)	4 (17,4%)	23
Junior high school graduate and above	0 (0,0%)	5 (71,4%)	2 (28,6%)	7
Total	**1 (3,3%)**	**23 (76,7)**	**6 (20,0%)**	**30**

Table 2 shows the contribution of technology to professional development in terms of period interested in agriculture. No significant relationship was found between period interested in agriculture and contribution of technology to professional development.

Table 2: Contribution of technology to professional development in terms of period interested in agriculture

Education Level	Partially agree	Agree	Absolutely agree	Total
<20 years	0 (0,0%)	4 (80,0%)	1 (20,0%)	5
>20 years	1 (4,0%)	19 (76,0%)	5 (20,0%)	25
Total	**1 (3,3%)**	**23 (76,7)**	**6 (20%)**	**30**

When asked if agricultural technology used in farming allows more work with less labor or not, all female farmers replied positively. On the other hand, only 42,3% of

the male farmers stated that they realized more work with less labor with agricultural technology.
Answers of the farmers to our question if "Products have improved in both quality and quantity" are shown in Table 3. There is no significant relationship between age ranges and effect of technology on efficiency.

Table 3: Products have improved in both quality and quantity

Education Level	Partially agree	Agree	Absolutely agree	Total
Female farmers	1 (25%)	2 (50%)	1 (25%)	4
Male farmers	3 (11,5%)	6 (23,1%)	17 (65,4%)	26
Total	**4 (13,3%)**	**8 (26,7)**	**18 (60%)**	**30**

When asked in terms of efficiency and performance "Have more products been obtained than before with minimum input in production?", 100% of the participants agree. When evaluated in terms of education level, Table 4 shows the results on efficiency of technology in farming.

Table 4: Efficiency of technology in farming in termes of education level

Education Level	Partially agree	Agree	Absolutely agree	Total
Not literate + primary school graduate	0 (0,0%)	4 (17,4%)	19 (82,6%)	23
Junior high school graduate and above	1 (14,3%)	5 (71,4%)	2 (28,6%)	7
Total	**1 (3,3%)**	**5 (16,7)**	**24 (80,0%)**	**30**

5. Conclusion

As agriculture is vital for human existence, Agricultural losses and inefficient production should be minimized with the help of technology. By providing digitalization in agricultural activities and using innovative methods, and aiming to improve family farming, TABIT founded "Vodafone Smart Village" in a characteristic farmer village in Turkey.
The farmers living in the village were asked about technologies used and performance improvement. The survey results show that the average age of the farmers is high, their education levels are low and they are engaged in farming for many years.
In addition to performance improvement with technological innovations, The Smart Village aims to make agriculture a respected profession transferred to younger generations with social innovation. However, long and laborious efforts are needed to familiarize farmers with new technologies and methods. With months of training, farmers had to see the results of the application as concrete.
When the answers were examined, the results showed that the technological applications positively affect the productivity in agriculture. As a result, it was found that the applied agricultural technologies increased the productivity of the agricultural activities, regardless of participants' age, education and working time.
For the purpose of spreading smart agricultural practices to society, state and government policies must also be engaged in addition to individual initiatives. In

particular, it is appropriate for farmers to receive agricultural training for life and to inform them about the innovations in detail and practically.

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