NEW MEDIT

CIHEAM BARI

MEDITERRANEAN JOURNAL OF ECONOMICS, AGRICULTURE AND ENVIRONMENT

SPECIAL ISSUE / SEPTEMBER 2021

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New Medit 2021 / Issue n. 3

Bononia University Press

ISSN: 1594-5685
www.newmedit.iamb.it


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http://www.newmedit.iamb.it

Publisher
Bononia University Press
Via U. Foscolo, 7
40123 Bologna (Italy)
tel.: +39 051 232882
fax: +39 051 221019
email: comunicazione@buponline.com

Subscription rate
Print: Italy: € 40; Foreign: € 90.

Subscription office
ordini@buponline.com

Abstract and Index citation
NEW MEDIT is indexed in: SCOPUS, EBSCO, ISI Web Science, CAB Abstracts, EconLit, AGRIS/FAO database

Web page
http://www.newmedit.iamb.it

ISBN: 978-88-6923-859-8

ISSN: 1594-5685

ISSN online: 2611-1128

Graphic Layout
DoppioClickArt – San Lazzaro (BO)

Cover design
Debora Degl'Innocenti

Registrazione
Tribunale Ordinario di Bari, n. 1546 del 4/1/2002

Direttore Responsabile
Giulio Malorgio

NEW MEDIT è associato alla

Factors affecting the adoption of technology in dairy farms in the Konya region of Turkey

Aysun Yener Ögür*

DOI: 10.30682/nm2103j
JEL codes: O3, Q01, Q1, Q55

Abstract

This study aimed to determine the factors affecting the technology adaptation of dairy farms. For this purpose, according to the stratified random sampling method, 125 dairy farms were determined as the sample size. In the analysis of the factors affecting the technology adaptation of dairy farms, a "technology usage index" was created according to the current technology usage situations of the producers. Factors affecting the technology adaptation of dairy farms were determined by multiple linear regression analysis. According to the multiple linear regression analysis results, education, experience/age ratio, workforce, credit usage status, participation in extension activities and income were found to be statistically significant at the 5% level. The yield was found to be significant at the 10% significance level. Enterprises using low and high technology follow technologies from other farmers in the village, television and dealers in the district. Lead farmers should be used in agricultural extension activities and mass media should be used.

Keywords: *Dairy farming, Technology, Regression, Turkey.*

1. Introduction

In 2018, the total Gross Domestic Product of the world was 86 trillion dollars, 3.4 trillion dollars of which belonged to the agricultural sector. The agricultural sector constitutes 3.95% of the world's total Gross Domestic Product, yet one-ninth of the world's population cannot be fed enough (821 million people). In Turkey, the total Gross Domestic Product is 1,507 billion dollars, 96.83 billion dollars of which belongs to the agricultural sector (FAO, 2020; TSI, 2020). The agricultural sector is very important in terms of feeding the country's population, contributing to the national income, providing employment, and providing raw materials to the industrial sector. In the developing and evolving world, one of the most significant and unchangeable problems of humans is adequate and balanced nutrition. When this phenomenon is in question, animal products are indispensable and cannot be substituted with other nutrients owing to their biological properties (TİGEM, 2019). In Turkey, just as in the whole world, livestock holds an important place in adequate and balanced nutrition for the growing population and in terms of use as industrial raw materials in many areas (Yener and Oğuz, 2017). Besides, it is the best source of digestible protein and micronutrients required for human nutrition (Ahmed *et al.*, 2020). Animal husbandry also initiates social functions such as reducing unemployment in rural areas and preventing migration from rural to urban areas. Moreover, in

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economic terms, it can be listed as contributing to the balanced development of the country and providing raw materials to sectors such as the meat, milk, leather, cosmetics, and pharmaceutical industries that conduct their activities in order to increase national income. In the livestock sector, it also constitutes an important place for dairy farming research. The development of the dairy farm industry depends highly on the increase in studies regarding diffusion and adoption of innovations, milk production, consumption, marketing, import, export, consumer demand, and agricultural technologies. When considered in terms of the adoption of agricultural technologies, the dairy sector uses technology more intensely than other agricultural sectors. Studies in this area are therefore rather significant (Williams *et al.*, 1987; Johnson and El-Osta, 1998; Mishra and Morehart, 2001; Gloy *et al.*, 2002; Alvarez and Arias, 2003; Jackson-Smith *et al.*, 2004; Tauer and Mishra, 2006; Oğuz and Yener, 2017; Yener and Oğuz, 2019). The number of cattle in Turkey is 20.861.71,25 and milk production is 17,872,331 tons. The stock of Konya province is 927,082 head and milk production is 1,287,366.11 tons. In Turkey, Konya province holds 5.19% of the number of cattle, and 6.17% of the milk production. 81.28% of the milk produced in Konya is obtained from exotic breeds, 17.94% from crossbreeds, and 0.78% from the local breed (TSI, 2020). Dairy farming enterprises in Konya province have started to closely follow the changes and developments in technology together with exotic breeds. Especially since 2009, the spread of the Instrument for Pre-Accession Assistance for Rural Development (IPARD) program and the national agency support programs in the region, the research results of the universities, and the applied studies of the Ministry of Food, Agriculture and Livestock in the field have improved dairy farming investments and increased total milk production in the region (Oğuz and Yener, 2017; Oğuz and Yener, 2019). However, this alone is not sufficient. The only way to survive in the competitive industry today is the adaptation to innovations in the production process (Kılıçtek and Aksoy, 2019). The basic element of innovation in the production process, therefore, is the use of innovative technology (Örs and Oğuz, 2018). For this very reason, it is highly critical for farmers to keep up with these changes by following new technologies and innovations in terms of the sustainability of livestock activities (El-Osta and Morehart, 2000). The diffusion of technological innovations does not only depend on technological developments, but also depends on the area where technology is used, the features of technological innovation, the technology market system, and the groups that will adopt the technology itself (Rogers 1995; Klerkx *et al.*, 2010; Loevinsohn *et al.*, 2012; Micheels and Nolan, 2016). The most pivotal criterion for the adoption of agricultural technologies and innovations is the socio-economic structure of the enterprises (Fernandez-Cornejo *et al.*, 2007; Keelan *et al.*, 2009; Mignouna *et al.*, 2011; Akudugu *et al.*, 2012). That is why adaptation to agricultural technologies depends on many factors such as the educational status of the enterprises, their enterprises structure, income level, living conditions, and access channels to technologies. When one or more of these factors are absent, technological innovations cannot be delivered to enterprises or are adopted late by enterprises (Leeuwis and van den Ban, 2004; Pannell *et al.*, 2006; Prokopy *et al.*, 2008; Noltze *et al.*, 2012; Ryschawy *et al.*, 2012; Dubeuf, 2014; Rivas *et al.*, 2019). Numerous studies have been conducted to investigate the factors affecting the adoption of agricultural technologies (Katungi and Akankwasa, 2010; Akudugu *et al.*, 2012; Loevinsohn *et al.*, 2012). Socio-demographic characteristics, education, age, experience, credit usage, workforce, yield, income, and extension activities are determined as the factors affecting the adoption of technological innovations by enterprises in the studies. The education level of enterprises has a positive effect on the adoption of agricultural technologies. In other words, as the education level of enterprises increases, their adaptation to new technologies rises in the same way (Namara *et al.*, 2003; Lavison, 2013). Young farmers are more likely to adopt new technologies and accept risk in the process than older

farmers (Mauceri *et al.*, 2005). However, some studies have found that enterprises with a high average age gain knowledge and experience over time and evaluate technological information better than young farmers (Kariyasa and Dewi, 2013). Therefore, the ratio of experience to age was discussed and included in the study. Economic factors are the most important factors that define the behavior of enterprises in the face of new technology. Many studies have unearthed a positive relationship between enterprises income and the adoption of agricultural technology (Mignouna *et al.*, 2011; Lavison, 2013). According to Simtowe and Zeller, the use of credit is important in the adoption of technology, and providing access to liquidity with credit and the ability of enterprises to take credit risk is effective in adopting technologies. Learning about new technology is another factor that influences technology adoption. As regards extension activities, both positive and negative effects of social networks on technology adoption have been defined (Conley and Udry, 2010; Katungi and Akankwasa, 2010). It has been determined that enterprises that take more part in organizations are more open to learning and adopt agricultural technologies more easily (Katungi and Akankwasa, 2010). The usefulness of agricultural extension activities is very critical in accepting agricultural innovations (Mwangi and Kariuki, 2015). Some studies have reported a positive relationship between extension activities and technology adoption (Mignouna *et al.*, 2011; Mwangi and Kariuki, 2015). In developing countries, extension centers frequently continue to offer new technology and select leaders in order to be the most effective (Silva and Broekel, 2016). In addition, for enterprises to adopt technological innovations, these must be taken at the right time according to the needs of the enterprises and must be applied by the enterprises (Peña *et al.*, 2014). While transferring innovations to enterprises, simple language should be preferred and innovations should be demonstrated in practice (Liu, 2010; Mu *et al.*, 2014). In the light of this information, it was aimed to determine the factors affecting the technology adaptation of dairy farms.

Figure 1 - Research area.

2. Material and method

This study was conducted in the Konya province of Turkey. Konya is located between 36°41' and 39°16' North latitudes and 31°14' and 34°26' East longitudes. The main material of the study was the primary data obtained from the surveys conducted with the agricultural enterprises engaged in dairy farming in Konya province. In the research area, the province of Konya, 25% of the total population lives in rural areas and their source of income is agricultural activities (Figure 1). The data were collected by the survey method. The fieldwork and survey implementation was completed in August 2015. The surveys were conducted on a voluntary basis. The survey application consists of 3 parts: the socio-economic characteristics, technological applications and communication resources of dairy farming enterprises.

The main frame of the research is animal assets of dairy farming enterprises in Çumra, Karapinar and Ereğli districts, which constitute 15% of the number of animals in Konya. In this main frame, 125 enterprises have formed the sample size according to the stratified sampling method of simple random sampling methods, for a 99% confidence interval and an error margin of 5% (Yamane, 1967). The required data were collected from producers in 125 dairy farms by using the face-to-face survey method.

$$n = \frac{[\sum(N_h S_h)]^2}{N^2 D^2 + \sum[N_h (S_h)^2]} \quad D = \frac{d}{t}$$

n=Sampling size.
S=Standard deviation.
N=Number of total holdings in population.
D=Allowed error rate from the main population average value.
t=Standard normal distribution value.

Nh=h. Number of the population in h (small, medium or large)
S_h^2=is the variance of h.
$D^2=d^2/z^2$.
z is the reliability coefficient (1.96, which represents 95% confidence).

The data in the study cover the production period 2015, and the questionnaires were filled in by the researcher. In this study, an exchange rate of $1 = 2.84 Turkish Liras was calculated (approximate rate in August 2015).

In the analysis of the factors affecting the technology adaptation of enterprises, a "technology usage index" was designed according to the current technology usage situations of the manufacturers. The current technologies used by the enterprises were determined as automatic drinker, automatic feeder, feed mixer, shelter shape, camera system and chip. In the research area, technologies related to dairy farming enterprises were determined in order to calculate the factors affecting the technology adaptation of the producers and each technology was given a score between "0 and 1". This scoring was made into an index.

The technology usage index was calculated as follows (Spielman and Birner, 2008; Knickel *et al.*, 2009; Van Rijn *et al.*, 2012; OECD, 2013; Canan, 2014; Läpple *et al.*, 2015; Läpple *et al.*, 2016; Oğuz and Yener, 2017; Yener, 2017):
Technology Usage Index = (TSNR/MSMR)*100;
TSNR: Total score the manufacturer received;
MSMR: Maximum score the manufacturer can receive.

According to the technology usage index, enterprises are defined as low technology enterprises and advanced technology enterprises. The group consisting of manufacturers with a technology usage index of less than 50% is considered "low technology", and the group that includes manufacturers with a technology usage index of more than 50% is regarded as "high technology".

Factors affecting the technology adaptation of dairy farms were determined by multiple linear regression analysis. Multiple linear regression analysis is a statistical analysis applied to quantify the relationship between the technology use index variable of the enterprises and the education, experience/age ratio, labor force, credit usage status, participation in extension activities, yield, and income variables. Multiple linear regressions for the population are written as:
$Y = \beta + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots\ldots \beta_n X_n + u_i$ n= 1,2,...,n
to show Y (technology adaptation in enterprises); while X_n indicates the independent variable (education, experience/age ratio, workforce, credit usage status, participation in extension activities, yield and income), β1 indicates the variable's unknown parameter, and finally u_i represents error terms. The accordance of the observation values in the regression model with the model is checked with R^2. Calculated R^2 attests that technology adaptation in enterprises is explained by the education, experience/age ratio, workforce, credit usage status, participation in extension activities, yield, and income variables (%). R^2 takes values between 0 and 1, and the values close to 1 indicate that the regression model is proper (Kalaycı, 2005).

Besides, in this model, the degree of correlation between the selected independent variables, linear relationship and multiple correlation problems were examined. In the study, the presence or absence of autocorrelation was checked by the Durbin-Watson test. The SPSS 24.0 statistical software package was used to solve the model.

3. Research findings

The adoption of technologies by agricultural enterprises depends on both the socio-economic characteristics of the enterprise and the properties of the technology (Fernandez-Cornejo *et al.*, 2007; Prokopy *et al.*, 2008; Keelan *et al.*, 2009; Mignouna *et al.*, 2011; Akudugu *et al.*, 2012; Howley *et al.*, 2012). For this reason, both the socio-economic structures of the enterprises and the technologies they use have been examined in the study (Table 1). Of the enterprises using low technology, 63.08% were primary school graduates, 70.77% were in the 15-49 age group, 41.54% had 21-30 years of experience, 32.31% had a workforce of 3-3.99, and 66.15% of them did not use credit. The average number of livestock of enterprises using low technology was 19.74 head, yield was 21.92 kg and income was $ 16,617.78.

Table 1 - Descriptive statistics of independent variables.

		Low Technology		*High Technology*		*Total*		*Low Technology*		*High Technology*	
		No.	*%*	*No.*	*%*	*No.*	*%*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*
Education	Primary	41	63.08	28	46.67	69	55.20	1.66	0.96	2.07	1.18
	Secondary	8	12.31	11	18.33	19	15.20				
	High School	13	20.00	10	16.67	23	18.40				
	College or University	3	4.62	11	18.33	14	11.20				
	Total	65	100.00	60	100.00	125	100.00				
Age	15-49	46	70.77	43	71.67	89	71.20	43.74	10.90	43.07	9.59
	50-+	19	29.23	17	28.33	36	28.80				
	Total	65	100.00	60	100.00	125	100.00				
Experience	0-10	5	7.69	8	13.33	13	10.40	22.49	8.85	23.28	8.90
	11-20	24	36.92	10	16.67	34	27.20				
	21-30	27	41.54	30	50.00	57	45.60				
	30-+	9	13.85	12	20.00	21	16.80				
	Total	65	100.00	60	100.00	125	100.00				
MLP	0-1.99	8	12.31	4	6.67	12	9.60	3.28	1.10	3.97	1.30
	2-2.99	14	21.54	8	13.33	22	17.60				
	3-3.99	21	32.31	18	30.00	39	31.20				
	4-4.99	16	24.62	14	23.33	30	24.00				
	5-5.99	5	7.69	9	15.00	14	11.20				
	6-+	1	1.54	7	11.67	8	6.40				
	Total	65	100.00	60	100.00	125	100.00				
Credit	Yes	22	33.85	17	28.33	39	31.20	0.34	0.48	0.73	0.45
	No	43	66.15	43	71.67	86	68.80				
	Total	65	100.00	60	100.00	125	100.00				
Number of Animals	1-50	61	93.85	10	16.67	71	56.8	19.74	16.20	101.32	73.81
	51-100	4	6.15	30	50	34	27.2				
	101-+	0	0	20	33.33	20	16				
	Total	65	100	60	100	125	100				
Yield (kg/head)	15-20	25	38.46	13	21.67	38	30.4	21.92	3.02	23.70	2.95
	21-25	31	47.69	37	61.67	68	54.4				
	26-+	9	13.85	17	28.33	26	20.8				
	Total	65	100	67	111.67	132	105.6				
Income ($)	0-15,000	30	46.15	10	16.67	40	32.00	16,617.78	24,195.13	37,314.02	88,812.31
	15,001-25,000	30	46.15	26	43.33	56	44.80				
	25,001-+	5	7.70	24	40.00	29	23.20				
	Total	65	100	60	100	125	100				

Of the enterprises using high technology, 46.67% were primary school graduates, 71.67% were in the 15-49 age group, 45.60% had 21-30 years of experience, 30% had a workforce of 3-3.99, and 71.67% did not use credit. The average number of livestock of enterprises using high technology was 101.32 head, yield was 23.7 kg and income was $ 37,314.02. Descriptive statistics of the independent variables (education, experience/age ratio, workforce, credit usage status, participation in extension activities, yield, and income) used in the model of the enterprises are given in Table 1. In similar studies, it has been determined that the age of the farmers, farm size and income are important in the adoption of new technologies (Feder *et al*., 1985; Lin, 1991; Abadi Ghadim and Pannell, 1999; Stefanides and Tauer, 1999; Diederen *et al.*, 2003; Dimara and Skuras, 2003; Sauer and Zilberman, 2012; Läpple *et al.*, 2015).

The activities in Table 2 are taken as agricultural extension activities in the enterprises. Low-technology enterprises follow new technologies from dealers in the district center, other farmers in the village and on television. High-tech technology enterprises follow new technologies from dealers in the district center, the internet, television, veterinarians, other farmers in the village and provincial agriculture and forestry directorates (Table 2). Studies have determined that extension activities are important in the adoption of agricultural technologies (Butcher, 1998; Garforth *et al.*, 2003; Millar, 2011; Akudugu *et al.*, 2012; Howley *et al.*, 2012; Dhraief *et al.*, 2019).

In this study, eight technologies have been selected: automatic waterer, automatic feeder, shelter shape, milking machine, milking unit, solar milk cooling system, camera and chip. Descriptive statistics of the technologies used as dependent variables in the model are given below. Of the enterprises using low technology, 89.23% had an open or semi-open shelter, 86.15% had a milking machine, 32.31% had a cooling tank, 15.38% had a milking unit, 6.15% had an automatic feeder, 1.54% had an automatic drinker, and 1.54% used a camera, and 1.54 used a chip. Of the enterprises using high technology, 100.00% had an open or semi-open shelter, 100.00% had both a milking unit and cooling tank, 73.33% had an automatic drinker, 68.33% used a camera, 45.00% had an automatic feeder, and 11.67% used a chip (Table 3).

Factors affecting the technology adaptation of dairy farms were determined by multiple linear regression analysis (Table 4). To measure the correlations between independent variables affecting technology adaptation in enterprises, "part and partial correlation" measurements were made, and it was determined that the par-

Table 2 - The means of agricultural enterprises to follow agricultural technologies.

Agricultural Extension Activities	*Low Technologies*	*High Technologies*
Newspaper reading frequency	2.43	2.38
Radio listening frequency	1.98	1.72
Television watching frequency	3.68	3.77
Internet usage frequency	2.22	3.85
Frequency of meeting with other farmers in the village	3.77	3.33
Frequency of going to district center	3.92	4.52
Frequency of going to the city center	2.72	2.85
Provincial agriculture and forestry directorates	2.60	3.05
Frequency of meetings with veterinarians	3.03	3.55
Frequency of attending conferences	1.86	2.17
Frequency of attending trainings	1.86	2.10
Frequency of meetings with the faculty of agriculture	1.29	1.67

5: Every day; 4: A few times a week; 3: A few times a month; 2: A few times a year; 1: Never.

Table 3 - Descriptive statistics of the dependent variables.

	Low Technology					*High Technology*					*Total*			
	1		*0*		*Std. Deviation*	*1*		*0*		*Std. Deviation*	*1*		*0*	
	N.	*Ratio*	*N.*	*Ratio*		*N.*	*Ratio*	*N.*	*Ratio*		*N.*	*Ratio*	*N.*	*Ratio*
Automatic Waterer	1	1.54	64	98.46	0.12403	44	73.33	16	26.67	0.44595	45	36	80	64
Automatic Feeder	4	6.15	61	93.85	0.24219	27	45	33	55	0.50169	31	24.8	94	75.2
Shelter Shape	58	89.23	7	10.77	0.3124	60	100	0	0	0	118	94.4	7	5.6
Milking Machine	56	86.15	10	15.38	0.36361	0	0	59	98.33	0.1291	56	44.8	69	55.2
Milking Unit	10	15.38	54	83.08	0.37787	60	100	1	1.67	0.1291	70	56	55	44
Cooling Tank	21	32.31	44	67.69	0.47129	60	100	0	0	0	81	64.8	44	35.2
Camera	1	1.54	64	98.46	0.12403	41	68.33	19	31.67	0.4691	42	33.6	83	66.4
Chip	1	1.54	64	98.46	0.12403	7	11.67	53	88.33	0.32373	8	6.4	117	93.6

**More technology is used in dairy farming enterprises.*
**1: Open or semi-open shelter 0: Closed shelter*

Table 4 - Analysis of factors affecting technology adaptation of dairy cattle farms.

	B	*Std. Error*	*Beta*	*t*	*Sig*	*Tolerance*	*VIF*
(Constant)	-.352	.125		-2.814	.006		
Education	.043	.013	.243	3.233	.002	.667	1.500
Experience / Age	.260	.125	.155	2.078	.040	.677	1.477
MLP	.032	.011	.205	3.003	.003	.806	1.240
Yield	.007	.004	.114	1.738	.085	.873	1.146
Income	9.863E-7	.000	.358	4.825	.000	.687	1.456
Credit	.111	.025	.289	4.487	.000	.912	1.096
Extension activities	.066	.020	.205	3.222	.002	.929	1.077
R^2=55.6 F=21.150 Durbin-Watson= 1.316							

tial correlation scores between the variables were less than 0.80. Hence, there was no problem with multiple correlations between independent variables. To test whether there was a multi-collinearity problem based on the assumption that there was no linear relationship between independent variables affecting technology adaptation in enterprises, a "collinearity diagnostic" measurement was made. As a result of this measurement, the tolerance values approaching 1 and the VIF value between 1-2.5 indicate that there was no multi-collinearity problem among the independent variables. In addition, it was determined by the Durbin-Watson test that there was no autocorrelation in the study ($0 \leq DW \leq 4$) (Kalaycı, 2005; Topçu, 2008). According to the multiple linear regression results, education, experience-to-age ratio, workforce, credit usage status, participation in extension activities and income were found to be significant at the 5% level. The yield was found to be significant at the 10% significance level. As a matter of fact, it has been determined in different studies that the socio-economic characteristics of enterprises are effective in the adaptation of innovations and technologies

(Offor *et al.*, 2018; Dhraief *et al.*, 2019; Adetarami *et al.*, 2020).

A positive relationship has been determined between the education level of enterprises and their adaptation to technologies. Many studies have found that a higher education level of enterprises increases technology adaptation (Namara *et al.*, 2003; Mohamed-Brahmi *et al.*, 2012; Lavison 2013). Technology adaptation of enterprises is inversely proportional to the age of farmers (Feder *et al.*, 1985; El-Osta and Morehart, 2000). However, in similar studies, it has been determined that the experience of enterprises is important in technology adaptation regardless of education level (Lahoti *et al.*, 2012; Fouzai *et al.*, 2018). Therefore, the ratio of experience to age was used in the study. In other words, technology adaptation of both experienced and young farmers in enterprises is higher than that of other farmers. This shows that the continued agricultural production of the young population in enterprises will increase the technology adaptation of enterprises and ensure the sustainability of enterprises. The labor force, which is one of the means of production, is very important in animal production enterprises, because animal production includes all family members. As a matter of fact, the workforce was significant in the study. As the use of labor increases, the technology adaptation of enterprises increases (Bekele and Drake, 2003; Fouzai *et al.*, 2018). Income is the guiding element for any technological innovation. For this reason, there are studies arguing that the income level of farmers is sufficient in terms of applying modern agricultural techniques in rural areas (Rogers, 1983; Kalanlar, 2005; Prokopy *et al.*, 2008; Triveni *et al.*, 2020). As can be seen in the model, technology adaptation increases as yield and income increase. According to Awotide *et al.* (2016), it has been determined that the yield and income of enterprises that adopt technology are higher than those of other enterprises. Agricultural credit, on the other hand, increases the efficiency of enterprises. It also encourages efficient resource use and profitability (Bashir *et al.*, 2010). Timely access to credit is critical in terms of providing the inputs and technologies required for enterprises to continue their operations (Saboor *et al.*, 2009). Enterprises use the income of the products they obtain for 1 year. As the next harvest period approaches, there is a shortage of cash in enterprises and cash is needed to meet the inputs. Most of their inputs are purchased as cash or credit. This situation leads to an increase in the dependence of enterprises on credit markets. The credit market helps agricultural enterprises develop by providing them with the opportunity to meet their needs and use appropriate inputs (Feder *et al.*, 1990). It provides enterprises with easy and timely access to credit, making new investments or adopting new technologies. As a result, it expands and diversifies farming activities with enterprises' access to credit (Saqib *et al.*, 2018). In the model, it has been determined that enterprises using credit have higher technology adaptation than enterprises that do not use credit.

The variables taken as extension activities in the study differ according to enterprises using low and high technology. While low-technology enterprises generally follow new technologies from the dealers in the district center, other farmers in the village and on television, the enterprises using high technology generally follow the dealers in the district center, internet, television, and veterinarians, other farmers in the village and provincial agriculture and forest directorates. Both low- and high-technology enterprises are affected by other farmers in the village and follow innovations from the dealers in the district center. For this reason, opinion leaders should be used to shorten the technology adoption process in the field. In a society, an innovation is primarily adopted by opinion leaders and others follow them. According to Rogers (2003), when opinion leaders are compared with those who follow them, the leaders follow the world by using external communication channels, have higher social status and economic power, and are innovative. It has also been highlighted in different studies that opinion leaders are generally younger, more educated, and socially active and have higher income levels (Odabaşı and Barış, 2003).

Opinion leadership is gained and maintained in cases of individual, technical competence, social accessibility, and compliance with system norms. Opinion leaders become a model in the process of adopting innovation in society. They set an example and guide individuals within the system structure (Fill, 1995). It is acknowledged that the cost of transferring information to enterprises in extension activities is low and facilitates adoption, and that the mass media significantly increase the effectiveness of other diffusion methods (Türkyılmaz *et al.*, 2003). Enterprises that use both low and high technology in their field of activity follow agricultural technologies on television. Sezgin *et al.* (2010) asserted that 41.4% of farmers regularly follow the broadcasts related to agriculture on television/radio. Besides, it is emphasized in several studies that there exists a strong relationship between the adoption of innovations and following the mass media (Ceylan, 1988; Çiçek *et al.*, 2008). High-technology enterprises use the internet effectively. New technologies should be promoted via the internet and stakeholders should be brought together via social platforms.

4. Conclusion and recommendations

In recent years, technology usage has expanded in all stages of agricultural production. This study aimed at ascertaining the factors affecting technology adaptation in dairy farms, and the factors influencing the technology adaptation of the enterprises were determined by multiple linear regression analyses. According to the multiple linear regression results, socio-economic factors modify the technology adaptation of enterprises. Among these features, education, experience-to-age ratio, workforce, credit usage status, participation in publishing activities, and income were found to be significant at 5%, and yield at 10% significance level. The educational status of the enterprises manager should be taken into consideration while introducing new technologies to enterprises. In addition, young people who start farming at an early age will have higher technology adaptation compared to other enterprise owners. This result coincides with the finding that technology adaptation can be increased by providing vocational training to enterprise owners who start the enterprises at a young age. Young farmers in enterprises should be encouraged to remain in agricultural activity. The family workforce was found to be important in the study. Family members should be specialized in enterprises and a division of labor should be made. The division of labor and specialization will increase yield and income by providing quality products in enterprises. Increasing yield in enterprises will increase income, which is another factor affecting the technology adaptation of enterprises. Low enterprise income is a major barrier to enterprises' access to technology. Extension activities are another factor that affects the technology adaptation of enterprises. Enterprises hear about and adopt innovations or technology through their extension activities. In a study, the adoption period of innovations in enterprises was calculated as an average of 15 years. To speed up the adoption process for innovations, the time when manufacturers first hear about innovation, i.e., when they first become aware of it, should be as short as possible. In order to shorten this period, it should be activated with demonstration, television, and radio programs in addition to training presented with current broadcast programs (Yener, 2017). Visual media and demonstration activities should be increased to shorten the time for becoming aware of new technologies in the research area. It is vital to strengthen the link between research and extension activities through a participatory approach involving all stakeholders (universities, non-governmental organizations, the public sector, private institutions, and farmers).

Acknowledgements

This study was supported by Selcuk University Scientific Research Fund (BAP) in 2017 (Project No: 15401020). We would like to thank Selcuk University Scientific Research and Projects Coordination Unit for their financial support for this project.

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