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RESEARCH PAPER

Factors affecting the innovativeness among Buffalo farmers in the Samsun province of Turkey

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Abstract

Innovativeness is the degree of adoption and benefiting from innovations by an individual earlier than others. The early adoption of agricultural innovations contributes to a more effective and efficient production structure for farmers by increasing productivity, quantity, and quality. Although many studies have been conducted in the literature regarding innovation in producing different agricultural products, more research must be undertaken on buffalo production. This study aims to determine innovativeness among farmers raising buffalo in Samsun Province and to reveal the factors affecting it. The data consists of surveys of 184 farmers drawn by stratified random sampling. The research findings showed that large-scale farmers are more innovative than small-scale farmers. The factors affecting innovativeness are socioeconomic characteristics such as the age of the farmer, monthly income, and number of animals they own; and communication behaviors included the frequency of meeting with extension staff, the frequency of reading newspapers, the frequency of using the internet, and seeking the opinions of others on agricultural issues. Measures to be taken in the study area to diffuse innovations in buffalo farming are to provide support to farmers such as breeding animals, milking machines, and cooling tanks; to make farmer organizations more effective in the region, and to take adequate measures for the protection and sustainable use of pasture lands in the area, emphasizing the importance of environmental conservation and the role of farmers in achieving it.

Keywords

Buffalo Farming, Innovativeness, Adoption of Innovations, Diffusion of Innovations

Introduction

Unlimited and unconditional support from public institutions to the agricultural sector is no longer an accepted political idea. Despite certain current levels of public support, farmers must adopt rational production and marketing strategies and adapt to the competitive environment to generate viable incomes. Therefore, future agricultural policy aims to provide farmers with the necessary flexibility to produce the products demanded by the market, taking into account consumer and taxpayer preferences. In this context, farmers must operate more efficiently and effectively to adapt to increasing competition and changing market conditions. The rapid adoption of innovations and their diffusion in rural areas will undoubtedly help achieve this objective for farms (Basarir et al. 2006).

Buffalo farming contributes significantly to local and national economies, particularly in regions with favorable climate, topography, and water resources. It provides a year-round source of income for farmers and allows consumers to access products such as milk, meat, and leather (Yılmaz 2013; Şahin 2015; Hamid et al. 2016; Ozturk et al. 2022). Buffalo farming can be used as an energy source, particularly in developing countries where agricultural mechanization is insufficient; it can be fed with straw and other crop residues; it is relatively more resistant to disease and climate change; and it requires less housing and fewer herders (Nanda and Nakao 2003; Şahin 2015; Hamid et al. 2016). Samsun Province (972,500 hectares, including 375,922 hectares of cultivated agricultural land) is located in the middle of the Black Sea coast, between the deltas where the Yeşilırmak and Kızılırmak rivers flow into the Black Sea. Geographically, it lies between 40°50'N and 41°51'N north latitude and 37°08'E and 34°25'E east longitude. The Black Sea lies to the north of this province, and its neighbors are Ordu to the east, Sinop to the west, Tokat and Amasya to the south, and Çorum to the southwest (SITOM 2024). Thanks to these characteristics, Samsun Province is one of the prime locations for buffalo breeding (SITOM 2024).

Rogers' theory on the diffusion and adoption of innovations has inspired many researchers studying innovation adoption in agriculture (Orr 2003). The perceived benefits of innovation can be demonstrated by concrete measures such as cost reduction, labor savings, or increased profit margins. The ability of extension staff to cooperate with the target audience and demonstrate empathy is among the factors that accelerate change (Ban and Hawkins 1996; Orr 2003; Boz and Akbay 2005; Anderson and Feder 2007; Ali et al. 2012). The technology adoption theory is another model widely applied in many innovation adoption studies, which describes the causal links between system design elements, perceived usefulness, perceived ease of use, attitudes toward its use, and actual usage behavior (Davis 1987, 1993; Venkatesh and Davis 2000). Since its formulation and subsequent developments, technology adoption theory has been used to explain factors influencing technology adoption in various aspects of agriculture (Alambaigi and Ahangari 2016; Kumari et al. 2018; Verma and Sinha 2018; Khoza et al. 2021). A third theory, the technology-organizational environment framework, demonstrates how various factors influence technology adoption and use (Tornatzky 1990; Baker 2012). The techno-organizational framework is used to explain the factors influencing technology adoption in various fields of agricultural research (Shi and Yan 2016; Yoon et al. 2020; Abdullahi et al. 2021; Li et al. 2024).

Although numerous studies have been conducted in various regions of the world on the adoption of innovations in buffalo husbandry, we are unaware of any study addressing this issue in terms of innovation adoption and innovativeness in Turkey, where the importance of buffalo husbandry has been emphasized. Therefore, the overall objective of this study was to determine the factors influencing innovativeness among buffalo husbandry farmers and their socioeconomic characteristics, assess communication behaviors, measure innovativeness, and identify the specific factors influencing it in Samsun Province, Turkey. This study begins by creating an impartial sample and dividing buffalo herders into two groups: the most innovative and the least innovative. It then identifies socioeconomic characteristics and communication behaviors likely to influence innovativeness. The expected results of this study aim to provide useful information to stakeholders involved in the adoption and diffusion of innovations in the region, as well as to scientists.

Materials and methods

Sampling and data collection

The primary materisal of the study was data obtained through a survey of enterprises engaged in buffalo farming in Samsun. In addition, literature on the subject, information provided by public and private institutions, and expert opinions can also be counted among the materials used in the project. The population to which the project results are generalized is all agricultural enterprises engaged in buffalo production in the region. While determining the sample size, the chance of each subject being selected for the sample in the main population used was considered equal and independent of each other.

The target population for this study was all buffalo farmers operating within the borders of Samsun province (Figure 1). In determining the accessible population of the research, the districts and villages where buffalo

Figure 1. Map of the research area. Source: Google Maps.

production is most intensive in Samsun province were first defined. In this context, 13 villages were selected from Bafra, 19 Mayıs, and Alacam districts were identified with the consent of the provincial agriculture and forestry directorate and the buffalo breeders association. The accessible population of the research was determined from the lists regarding the number of animals owned by the farmers in the selected villages. Based on the number of animals, the farmers in the accessible population were divided into three strata, with less than 10 buffalos, between 10–20 buffalos, and more than 20 buffalos. The sample size was calculated using the stratified random sampling method (Yamane and Esin 2010).

$$n = \frac{N\sum N_h S_h^2}{N^2D^2 + \sum N_h S_h^2}, D^2 = \frac{e^2}{t^2} \quad (1)$$

Where

n = Number of farmers included in the sample,

N = Number of farmers in the main population,

N_h = Number of farmers in each stratum,

S_h = Standard deviation in each stratum,

D^2 = Desired variance,

e = Allowed error amount from the main population mean,

t = Value of the allowed confidence limit in the t distribution table.

With the help of this formula, the optimum sample size was determined as 184 by accepting a 5% error limit from the mean and 95% confidence interval. The sample size was distributed proportionally to the three strata in the accessible population, and farmers entering the sample from one stratum were determined using the random numbers table. Therefore, the probability of entering the sample for each farmer earning their living from buffalo production in the region was considered equal and independent from each other. Thus, every farmer earning their living from buffalo production meets the criteria to enter the sample.

The data-collecting instrument was prepared considering domestic and international studies on the subject and agricultural policies implemented in Turkey. The content validity of the questionnaire was established by consulting with experts on the subject. A pre-test study was conducted to test the comprehensibility and reliability of the survey by the respondents, and corrections were made to questions that were misunderstood or open to different interpretations. The Likert-scale questions were tested with Cronbach's alpha internal consistency coefficient, and reliability was 82%.

The questionnaire was divided into two parts. The first part included questions regarding the adoption of innovation in buffalo farming. The second part involved investigating the farmers' socio-economic characteristics and communication behaviors.

The questionnaires were primarily completed in village coffee houses and agricultural enterprises. Some surveys were conducted by visiting farmers during animal grazing. If the farmer determined that the sample could not be found or refused to answer the questions included in the survey during the application, the survey was conducted with substitute farmers with the same number of animals. Data collection was completed from August to December 2023.

This study used data from a questionnaire to provide information from 184 buffalo farmers. In addition to closed-ended questions, respondents' comments on farming issues and their solution recommendations were also noted and reported accordingly. These comments gave deeper information about buffalo farming, sustainability, and possible future developments in agriculture and rural livelihoods. Questions to be included in data collection instruments were prepared considering buffalo farming, adoption of innovations in rural communities, agricultural policies, programs being implemented in the region, specific agricultural characteristics, and earlier work completed in this field. The primary research was conducted and utilized to prepare questions for the data collection instruments of this study. A panel of experts established content validity for the instrument. It was pretested to verify the instrument's reliability, and slight amendments were made to prevent misunderstandings. It took approximately half an hour to complete each questionnaire.

Data analysis procedure

Data were analyzed in the order of research objectives. Since the first objective was to determine the socioeconomic characteristics of the respondents, descriptive statistics were utilized to accomplish it. The second objective, defining the communication behavior of the respondents, was also achieved using descriptive statistics. The third objective of this study was to determine and compare the innovativeness of buffalo farmers. For this purpose, the researchers developed an innovativeness adoption index considering the method developed by Demiryürek et al. (2017). This index considers the number of innovations adopted by buffalo farmers and the length of time these innovations have been used on buffalo farms. Farm-level innovations become more sustainable when the innovation adoption score is more significant. Farmers with higher index values are believed to be more innovative than those with lower ones. The method of calculating the innovation adoption index is as follows:

$$Innovativeness = \frac{\sum N_a T_a}{\sum N_i T_i} \times 100 \quad (2)$$

In this equation, Na represents any adopted innovation, and T_a is the period in which the farmer has adopted it. Ni is any practice that has been determined as an innovation for the region, and T_i is the time since that innovation was first introduced to that community. The nominator of the equation shows the number of innovations adopted by each farmer multiplied by their adopted period, and the denominator shows the total of each of the determined innovations multiplied by the period in years they were first introduced to that community. Therefore, the innovativeness score for each farmer gives an idea about how many innovations they adopted and how early or late they adopted these innovations.

Innovations in agricultural production increase productivity and the quality of farming, enabling farmers to obtain a sustainable income from this production area and improve rural communities' living standards and welfare. An innovation is an idea, practice, or project perceived as new by an individual or other unit of adoption." Innovativeness, on the other hand, is the degree to which an individual adopts innovations (Orr 2003). Suppose an individual adopts many innovations in a short period. In that case, they can be assumed to be an innovative person they can be and to be creative. Therefore, the more innovative farmers are in rural society, the earlier they will adopt more innovations and develop their farms faster.

In this context, a total of eleven innovations were determined, namely producing forage crops on the farm, consuming concentrated feeds by adding mineral substances, making corn silage, using a milking machine, having a milk cooling tank, being a member of the buffalo breeders' union, vaccinating animals against diseases, regularly using veterinary services, regularly using agricultural extension services and using social media. These innovations have been proven to have many benefits and contribute to livestock farms in different locations. For example, growing fodder crops (Clark 2004; Bouton 2007), using concentrated feed by adding minerals (Salem and Nefzaoui 2003; Swensson and Lindmark-Mansson 2007), ensilaging (Bacenetti and Fusi 2015), using a milking machine (Mein 2012; Jiang et al. 2017) and a cooling tank (Sant´Anna et al. 2003; Van Schaik et al. 2005), membership in farmers' organizations (Msuta and Urassa 2015; Vu et al. 2020), vaccination (LeBlanc et al. 2006; Cresswell et al. 2013), veterinary services (Sen and Chander 2003; Kwaghe et al. 2015), and extension services (Kareem et al. 2017; Ponnusamy and Pachaiyappan 2018). These innovations were all proven to contribute to animal husbandry significantly and were treated as innovations.

The fourth objective of the study was to determine factors influencing the adoption of innovativeness among buffalo farmers. A binary regression model was used to achieve this research objective. The dependent variable used in the model was coded as more innovative farmers (1) and less innovative farmers (0). In this context, the innovativeness score calculated with the help of formula (2) varied within the range of 3.79 and 62, with an average of 24.20. This was divided into two categories based on the average score. Farmers above average were included in the higher innovation category, and those below average were included in the less innovative category. The binary logistic regression model used in the study is expressed as follows using two categorized dependent variables (Maddala 1983; Greene 2003; Basarir and Gillespie 2006):

$$Prob(y=1) = \frac{e^{x\beta}}{1+e^{x\beta}} = f(x\beta) \tag{3}$$

In the model, $Prob\ (y = 1)$ 1 represents the probability of the first option occurring, e is the natural logarithm base, $f\ (x\beta)$ is the standard logistic distribution function, and x is the independent variable vector used in the study. The independent or explanatory variables used in the model are determined from socioeconomic characteristics and communication behaviors, as shown in Table 2 and Table 3. Some variables were converted into continuous variables, and some into dummy variables that ran into the model. The odds or probability (*Exp B*) rates for the independent or explanatory variables considered in the study were calculated using the following formula:

$$odds(\text{Exp}B) = \frac{P}{1-P} \tag{4}$$

The odds or (*Exp B*) rate for each independent or explanatory variable used in the study explains how many times a unit increase or decrease in this variable increases or decreases the probability of farmers being more innovative, holding all other variables constant.

Results

Adoption of innovations by buffalo farmers

The adoption of innovations among buffalo farms is presented in Table 1. Eleven innovations were determined as described in the materials and methods of this study, and farmers were divided into two groups, namely, large-scale farms and small-scale farms, based on the number of buffalos they owned. Considering the frequency distribution of the number of buffalos owned by farmers, two categories were created: large-scale farmers with 20 or more buffalos and small-scale farmers with less than 20. The chi-square test of independence was used to find if the adoption of each innovation is independent of farm size or if there is any significant association between the variable farm size and each of the selected innovations. Seven of the eleven chi-square tests conducted were statistically significant at 0.05 alpha level or better. The statistically significant innovations were growing forage crops, ensilaging, using a milking machine, using a cooling tank, artificial insemination, and regularly using veterinary services. As shown in Table 1, 81% of large-scale farms grew fodder crops at their farms, while this ratio for small-scale farms was only 41.7%. Ensilaging was adopted by 92% of large-scale and 27.4% of small-scale farmers. A milking machine was adopted by 61% of large-scale farmers and only 11.8% of small-scale farmers, while a cooling tank was adopted by 51% of large-scale farmers and only 8.1% of small-scale farmers. The adoption of artificial insemination was 70% in large-scale farmers and 27.4% in small-scale farmers, while the adoption rate regarding vaccination was 83% in large-scale farmers and 41.7% in small-scale farmers. Finally, large-scale and small-scale farmers' regular use of veterinary services was 65% and 23.8%, respectively. On the other hand, there was no significant association between farm size and each of the selected variables of adding minerals to fodder, membership in farmers' unions, practicing animal insurance, and regular use of extension services.

Table 1. Adoption of innovations by farm size (Large-Scale Farms 20 ≤; Small-Scale Farms < 20).

Variable	Large-Scale Farms		Small-Scale Farms		Total	
	Number	%	Number	%	Number	%
1. Growing forage crops						
Adopted	81	81.0	49	41.7	130	70.7
Not adopted	19	19.0	35	57.3	54	29.3
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 11.312$, $\mathbf{p \leq 0.01}$						
2. Adding minerals to fodders						
Adopted	32	32.0	24	28.6	56	30.4
Non adopted	68	68.0	60	71.4	128	69.6
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 0.253$, $p = 0.633$						
3. Ensilaging						
Adopted	92	92.0	23	27.4	115	62.5
Not adopted	8	8.0	61	72.6	69	37.5
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 81.33$, $\mathbf{p \leq 0.01}$						
4. Using a milking machine						
Yes	61	61.0	10	11.8	71	38.6
No	39	39.0	74	88.2	113	61.4
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 46.43$, $\mathbf{p \leq 0.01}$						
5. Using a cooling tank						
Adopted	51	51.0	7	8.3	58	31.5
Not adopted	49	49.0	77	91.7	126	68.5
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 38.5$, $p \leq \mathbf{0.01}$						
6.Artificial insemination						
Adopted	70	70.0	23	27.4	93	50.5
Not adopted	30	30.0	61	72.6	91	49.5
TOTAL	100	100.0	84	100.0	184	100.0
X2 = 33.133, $\mathbf{p \leq 0.01}$						
7. Farmers Union Membership						
Adopted	69	60.0	50	59.5	119	64.7
Not adopted	31	31.0	34	40.5	65	33.3
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 1.794$, $p = 0.190$						
8. Vaccination						
Adopted	83	83.0	35	41.7	118	64.1
Not adopted	17	17.0	49	58.3	66	35.9
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 33.910$, $\mathbf{p \leq} 0.\mathbf{01}$						
9. Use of veterinary services						
Adopted	65	65.0	20	23.8	85	46.2
Not adopted	35	35.0	64	76.2	99	53.8
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 31.162$, $\mathbf{p \leq 0.01}$						
10. Animal insurance						
Adopted	14	14.0	9	10.7	23	12.5
Not adopted	86	86.0	75	86.3	161	87.5
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 0.451$, $p = 0.631$						
11. Use of extension services						
Adopted	44	44.0	29	34.5	73	39.7
Not adopted	56	56.0	55	65.6	111	60.3
TOTAL	100	100.0	84	100.0	184	100.0
$X^2 = 0.465$, $p = 0.454$						

Measuring innovativeness among buffalo farms

The measurement method of innovativeness among buffalo farms is explained in the materials and methods of this study. Table 2 shows a comparison of large-scale farms and small-scale farms in terms of their innovativeness. The years in which the 11 innovations included in the study were first introduced to the rural community were determined through interviews with farmers and extension personnel working in the district agricultural directorates. The time elapsed since the year each innovation first came to the region was added up, and the maximum innovation score was determined to be 100. If a farmer reached the maximum score, it was assumed to be the farmer who adopted all innovations as soon as they came to the region. Unfortunately, no such farmer was encountered in the study. As seen in Table 2, the highest and the lowest innovative scores for all farmers were 46.97 and 2.87, respectively. These scores varied between 46.97 and 5.74 for large-scale farmers and 26.97 and 2.87 for small-scale farmers. The average innovativeness rates were 18.33 for all farmers, 23.56 for large-scale farmers, and 12.12 for small-scale farmers. An independent sample t-test was conducted to compare the two groups, and it was determined that the difference was statistically significant (t = 10.08, p ≤ 0.01). This study's findings revealed that large-scale farmers were more innovative than small-scale farmers.

Table 2. Comparison of innovativeness by farm size.

Farm size	N	Min	Max	Mean	Std. Dev.	t	p
Big farm (20 ≤)	100	5.74	46.97	23.56	8.35	10.08	≤0.01
Small farms (< 20)	84	2.87	26.97	12.12	6.85		
TOTAL	184	2.87	46.97	18.33	9.33		

Factors affecting the innovativeness among buffalo farmers

In order to determine the factors influencing the innovativeness among buffalo farmers, earlier studies on related subjects (Boz and Akbay 2005; Eryılmaz et al. 2020; Shahbaz et al. 2020) and the research area's agricultural, socioeconomic, and sociocultural characteristics were taken into consideration. The factors likely to influence innovation adoption and innovativeness were determined and examined under two categories: socioeconomic characteristics and communication behavior variables. The variables were coded to run on the binary logistic model, and their descriptive statistics are given in Tables 3, 4.

From the examination of Table 3, it is seen that nine socioeconomic characteristics were included in the study. The first of these was gender, and it is seen that 72% of the participants were male and 28% were female. The age variable was measured as a continuous variable, and the average age of the participants was 44.14 (SD = 10.78). Approximately 39% of the participants stated that they received secondary school education as their highest level of education. The remaining 61% were generally primary school graduates and only literate farmers. The region's average family size was 4.68 people (SD = 1.46). The monthly income of the farmers was calculated as approximately 18241 Turkish Liras. Since most farmers do not have a regular monthly income, their annual income was first asked, and the average monthly income was calculated from their yearly income. The region's average farm size was 39.87 decares (SD = 30.80). The average area of fodder crop cultivation was found to be 20.98 decares (SD = 12.25). The average number of buffalos owned was 27.52 (SD = 33.46). From the answers to whether there was sufficient pasture area in the village, it was understood that 17% of the farmers had enough pasture in their villages. In comparison, 83% did not have enough pasture.

When communication behaviors were examined, it was determined that 33% of the farmers read newspapers at least once a week, 35% listened to the radio at least once a week, 95% watched television every day, 79% used the internet every day, 26% traveled to the city center at least once a week, 87% sought advice from others on agricultural issues, 57% attended activities such as symposiums, conferences, and meetings on agricultural issues, and 20% met with extension staff at least once a week (Table 4).

Table 3. Socioeconomic characteristics.

Name of the variable	N	Min	Max	Mean	Std. Dev.
Gender 1 = Woman, 0 = Man	184	0	1	.28	.45
Age (Continuous variable)	184	20	80	44.14	10.78
Education 1 = At least secondary school, 0 = Less than secondary school	184	0	1	.39	.48
Family size (Continuous variable)	184	1	8	4.68	1.46
Monthly income (TL/ Month) (Continuous variable)	184	4000.00	60000.00	18241.30	9479.52
Farm size (Decres)	184	5.00	200.00	39.87	30.80
Fodder crops area (Decares)	184	.00	80.00	20.98	12.25
Number of buffalos	184	4	313	27.52	33.46
Public forage areas 0 = Available but not enough 1 = Available, enough	184	0	1	0.17	.380

Factors influencing the innovativeness among buffalo farmers in Samsun province were analyzed using logistic regression analysis. The dependent variable used for this model was coded as "1" for more innovative farmers and "0" for less innovative farmers, and their method of determination was explained in the materials and methods used in this study. The explanatory variables were socioeconomic characteristics and communication behavior variables described in Tables 4, 5.

Table 4. Communication behavior.

Name of the variable	N	Min	Max	Mean	Std. Dev.
Reading newspapers 1 = At least once a week 0 = More seldom	184	0	1	.33	.472
Listening to radio 1 = At least once a week 0 = More seldom	184	0	1	.35	.478
Watching television 1 = Every day 0 = More seldom	184	0	1	.95	.216
Using the internet and social media 1 = Every day 0 = More seldom	184	0	1	.79	.406
Travels to the city center 1 = At least once a week 0 = More seldom	184	0	1	.26	.437
Seeking advice in farming matters 2 = Always 1 = Sometimes 0 = Newer	184	0	2	.87	.586
Attending farming events 2 = Always 1 = Sometimes 0 = Newer	184	0	2	.57	.682
Meeting with extension personnel 1 = One a week 0 = More seldom	184	0	1	.20	.402

Table 5. Factors affecting the innovativeness of buffalo farming.

Name of the variable	B	SE	Wald	DF	Sig	Exp(B)
Gender	.483	.507	.909	1	.340	1.621
Age of the farmer	-.074	.026	8.055	1	**.005**	.929
Education level	-.149	.502	.088	1	.767	.862
Family size	-.029	.171	.029	1	.865	.971
Monthly income TL/ Month	.011	.022	4.353	1	**.037**	1.000
Area farming (Decare)	-.002	.018	.014	1	.906	.998
Fodder crops grown area (Decare)	.018	.033	.296	1	.586	1.018
Number of buffalos	.129	.028	21.639	1	**<.01**	1.137
Public grazing land availability	.239	.282	.716	1	.397	1.270
Frequency of traveling to big cities	-.600	.796	.568	1	.451	.549
Frequency of meeting with extension staff	1.284	.550	5.449	1	**.020**	3.609
Frequency of participating in farming events	.024	.491	.002	1	.962	1.024
Frequency of reading newspapers	1.612	.605	7.109	1	**.008**	5.012
Frequency of listening to radio	.063	.863	.005	1	.942	1.065
Frequency of watching TV	-1.330	1.233	1.164	1	.281	.264
Frequency of using the Internet	1.481	.509	8.477	1	**.004**	4.399
Seeking advice about farming matters	-.887	.417	4.519	1	**.034**	.412
Constant	-1.024	2.116	.234	1	.628	.359

The model was found statistically significant ($X^2(17, N = 184) = 109.324$, $p \leq 0.01$). The -2*Log* Likelihood value of the model was 145.732. It also had a Cox and Snell R^2 value of 0.448 and a Nagelkerke R^2 value of 0.597. According to the classification table, the model correctly classified 82.4% of the less innovative farmers, 79.6% of the more innovative farmers, and 81.0% of all farmers. These measurements indicate that this model can correctly estimate the factors influencing the innovativeness among buffalo farmers in the Samsun province of Turkey.

Results of the logistic regression model are given in Table 3. All significant variables had the expected signs and were evaluated at an alpha level of 0.05 or better. Seven of the seventeen explanatory variables were found to be statistically significant. Three of these variables are among the socioeconomic characteristics: the farmer's age, monthly income, and number of buffalos owned by farmers. The remaining four variables are among the communication behavior variables: frequency of meeting with extension staff, frequency of reading newspapers, frequency of using the Internet, and seeking advice about farming matters. According to these results, innovativeness among buffalo farmers was influenced by the above variables but not influenced by socioeconomic variables of gender, education level, family size, farm size, fodder crops area, and having public grazing land in the village; and communication behavior variables of listening to radio, watching television, frequency of traveling to larger cities, and frequency of participation in farming events.

The *Exp(B)* values for the significant variables are interpreted, holding all other explanatory variables constant. With these conditions, farmers in the younger age category had a 0.93 times higher likelihood of belonging to the more innovative category than farmers in the old age category. Those with higher income had 1 a higher likelihood of belonging to a more innovative category than those with lower income. Farmers with more buffalos had a 1.14 times higher likelihood of belonging to the more innovative category than farmers with fewer buffalos. Those who met with extension personnel more frequently had a 3.6 times higher likelihood of belonging to the more innovative category than those who met with extension staff less frequently. Farmers who read newspapers more often had a five times higher likelihood of being in the more innovative group than farmers who read newspapers more seldom. Those who used the Internet more frequently had a 4.4 times higher likelihood of belonging to the more innovative group than those who used the Internet less frequently. Finally, those who sought advice about farming matters had a 0.4 times higher likelihood of belonging to a more innovative category than those who did not seek advice about farming matters.

Discussion

The adoption of agricultural innovations and their rapid diffusion in rural areas, particularly in developing countries, contributes to more effective and efficient production by farmers and facilitates sustainable rural development. Therefore, the sustainability of crop and livestock production means, from a technical perspective, the continuation of production over long periods; from an economic perspective, sufficient income for farmers; and finally, from a social perspective, the enjoyment of a rural life open to social change and development (Tatlıdil et al. 2009; Shahbaz et al. 2020). One of the most important factors in this regard is the rapid adoption and use of innovations in the agricultural sector.

The structure of the natural environment and agricultural climatic conditions provide exceptional opportunities for the cultivation of certain plants and animals in this region. Buffalo farming, which has been practiced for years in the research area, is considered one of these opportunities. The Kızılırmak Basin and its birdwatching paradise, rich in pastures, water resources, and wetlands that buffaloes can thrive on, benefit from the historical experience of their ancestors' farmers. Therefore, efficient buffalo farming will not be an obstacle in the future. However, it is necessary to adapt to changing production and market conditions and increase the quantity and quality of production. This continuity will only be possible with the rapid adoption of agricultural innovations and their dissemination in rural areas.

Level of innovativeness of livestock farmers

According to the analysis of the research data, farmers in the region achieved innovativeness scores ranging from 3.79 to 62, with an average of 24.20. Farmers with an innovativeness score above the average of 24.20 were considered more creative, while those with a lower score were considered less innovative. As the innovativeness score increases, farmers tend to adopt more of the innovations presented in Table 1. Since the innovativeness index takes into account the length of the innovation adoption period, it can be concluded that the most innovative farmers also adopted these innovations earlier than others. Thus, innovation should contribute to the profitability of buffalo farming. For example, early adoption of innovations such as fodder crop production, the addition of mineral nutrients to feed, silage, milk tanks, and the use of milking machines will undoubtedly contribute to the farmer's productivity and commercialization.

The adoption and diffusion of innovations in agriculture is an important issue that continues to be researched in different regions of the world. Aksoy et al. (2011) analyzed the factors affecting the adoption of innovations among dairy farmers in Erzurum Province, Turkey. They found that farmers who raised improved breeds rather than indigenous breeds and those who received more livestock support policies tended to adopt innovations earlier than others. Quddus (2012) studied technology adoption on dairy farms in Bangladesh and found that rural farmers were more reluctant to adopt dairy farm innovations. Triveni et al.'s (2018) study, conducted in Andhra Pradesh, found that the level of knowledge among dairy farmers had a positive impact on the adoption of innovations on dairy farms. A study conducted in Tirunelveli district, Tamil Nadu (Senthilkumar 2018), found that adopting innovative dairy technologies in farmers' fields increased milk production. A recent survey conducted in peri-urban areas of Surat city, Gujarat (Sabapara 2024), identified six buffalo husbandry practices, such as housing, feeding, breeding, healthcare, milking, and calf-rearing management, and found varying levels of adoption for each practice. Other studies have focused on the effect of training on buffalo farm owners (Dixit et al. 2019), existing husbandry practices (Viswkarma et al. 2018), common characteristics of buffalo farming (Palacpac et al. 2015), and willingness to pay for buffalo insurance (Khan et al. 2013).

Socioeconomic characteristics

The socioeconomic characteristics were found to be inversely proportional to age but directly proportional to income and the number of buffaloes. Thus, younger farmers have higher incomes, and more animals are more innovative. According to generalizations developed by Rogers (2003) from studies conducted worldwide, farmers who adopted innovations earlier performed better on certain socioeconomic characteristics than those who adopted them later. No differences were found in certain socioeconomic characteristics. For example, regarding farmers' age, some innovations were adopted earlier by older farmers and others by younger ones. Therefore, it was not possible to generalize whether early adopters were younger or older. However, the current study revealed that younger farmers were more innovative. This is explained by the increase in rural exodus in recent years and the fact that a greater number of elderly people have remained in the villages. These farmers continue to farm their land using more traditional methods and are less inclined to innovate. In contrast, young farmers who remain in the villages are more enterprising, more willing to develop their agribusiness, increase their incomes, and improve their families' well-being. This situation, therefore, makes them more innovative. Among Rogers' (2003) socioeconomic generalizations, we find that farmers who adopt innovations earlier have higher incomes and larger farms. These generalizations are corroborated by the results of the current study.

Farm size proved to be an effective parameter, as larger farms adopted more innovations than smaller ones. Previous studies have also shown that innovation adoption is higher among larger farms than among smaller ones. Studies conducted in countries such as China (Hu et al. 2022), Italy (Vollaro et al. 2019; Vecchio et al. 2020), Ethiopia (Worku 2019), Ghana (Donkor et al. 2018), and Kenya (Nyariki 2011) have revealed that larger-scale farmers tend to adopt agricultural innovations and new technologies compared to smaller-scale farmers. Different studies conducted in Turkey have also yielded similar results. Studies by Ozsayin (2020), Shahbaz et al. (2020), and Yener and Oguz (2017) revealed that dairy product farms with a larger number of cows had higher adoption rates. Innovation adoption has also been measured among small ruminant (Acıbuca and Budak 2021) and beef cattle (Boz 2014) farmers in Turkey, and both studies found higher adoption levels on farms with more animals. These research findings indicate that regions with larger farms and a greater number of livestock farms have higher innovation adoption rates and, consequently, greater rural development potential.

The use of socioeconomic characteristics, communication behaviors, and personal variables has been shown to be effective in influencing the adoption of innovations in different regions of the world (Rogers and Pitzer 1960). For example, a socioeconomic generalization indicated that early adopters were more educated, a communication behavior generalization suggested that early adopters read newspapers more, and a personality generalization indicated that early adopters were more empathetic (Orr 2003). In an early study by Ryan and Gross (1943) on the adoption and diffusion of hybrid corn among Iowa farmers, it was found that early adopters of the innovation had larger farms, higher incomes, and higher levels of education than late adopters. In a study conducted in Ohio by Rogers and Pitzer (1960), farmers who adopted irrigation were more educated, had larger farms, and had closer contact with the agricultural extension service than non-adopters. Lin (1991) studied the effect of farmers' education level on hybrid rice adoption in China and found that the education level of the household head had a positive impact on the adoption rate and intensity of innovation adoption. Research by Wairumi et al. (2022) studied innovation adoption on dairy farms in Kenya and found that the adoption of technical knowledge was influenced by hired employees, milk records, the total number of dairy cows, and the education of the household head. In contrast, the adoption of organizational innovations was influenced by income, farm size, milk records, and access to milk information.

Communication behaviors

Farmers with better communication behaviors were more innovative in terms of frequency of meetings with extension staff, frequency of newspaper reading, frequency of internet use, and seeking advice on agricultural issues. According to Rogers' (2003) generalizations on communication behaviors affecting the diffusion and adoption of agricultural innovations, farmers who adopt innovations earlier benefit more from mass communication channels and establish more frequent contacts with agricultural extension organizations than those who adopt them later. This contributes to their greater innovation and increases their economic opportunities. Previous studies have shown that the media play an important role in the adoption and diffusion of agricultural innovations. For example, Eryilmaz et al. (2020) determined that television and the internet are among the most commonly used dissemination methods among dairy farmers. In this regard, farmers should be made more aware of dairy farming innovations through television and the internet. Similarly, studies by Boz and Akbay (2005) and Boz (2016) demonstrated that farmers' communication behaviors play an important role in the diffusion and adoption of agricultural innovations. In this context, programs aimed at encouraging farmers to adopt agricultural innovations in a given region must first identify the most frequently used communication methods and then develop extension and training programs using these methods.

Regarding the diffusion and adoption of innovations, various communication behaviors of individuals play an important role in the diffusion and adoption of innovations. These behaviors include the frequency of listening to the radio, the frequency of watching television, the frequency of reading printed materials, and contact with agricultural extension organizations (Rogers 2003). In their research on the adoption and diffusion of hybrid cocoa in Ghana, Boahene et al. (1999) found that the farmer's interaction with the agricultural extension service significantly affected the acceptance of the proposed innovation. Yani and Fajeri (2022) studied the adoption of innovations among Indonesian swamp buffaloes. They found a significant influence only with the intensity of extension service use but no significant impact. In addition, the authors found a significant influence on the intensity of extension service use but no significant impact on socioeconomic characteristics. Communication with agricultural extension staff had a significant influence on the adoption of maize production in Kahramanmaras province of Turkey (Boz and Akbay 2005), while farmers' communication behavior affected their receipt of information regarding innovations in improved rice production in Bangladesh (Hossain et al. 2011).

In the region, buffalo farming is primarily for dairy production. Some buffalo farmers sell their raw milk to restaurants, cafes, and milk buyers who act as marketing intermediaries. Some farmers make more profit by processing the milk into higher-value yogurt, cheese, or buffalo curd. Animals are raised for dairy production for an average of 10 to 12 years, after which a decline in average milk production is observed. During this period, the animals are replaced with younger ones, and the older ones are mainly sold to slaughterhouses to meet consumer demand for buffalo meat. During the study, most producers noted a growing demand for buffalo products in the region. In this context, buffalo farming is a promising sector for farmers in the region.

Conclusions

This study revealed that buffalo farming in the region is mainly carried out using traditional methods. However, the innovativeness rate of large-scale farmers was found to be statistically significant compared to small-scale farmers. This study finding may lead to the conclusion that large farmers in the region are more oriented towards working for commercial purposes and, therefore, are more innovative. This research finding is also consistent with the income level and the number of significant animal variables in the binary regression model used to measure innovativeness. Small-scale farmers in the region produce using methods inherited from their ancestors and grandfathers, who are more attached to their traditions. In this context, encouraging and supporting farmers to expand their farms may be an important policy proposal.

Research findings showed that young farmers are more innovative and older farmers are more conventional. Therefore, choosing young farmers as the target audience for innovation diffusion studies may be an appropriate approach. Innovative farmers benefit more from extension services, read newspapers more often, use the Internet more, and seek the opinions of others on agricultural issues more often. These are also characteristics that can be considered in studies on the adoption and diffusion of innovations in buffalo farming.

The most critical stakeholders in the region for implementing innovations in buffalo farming and spreading them to rural areas are the provincial and district Agriculture and Forestry Directorates, the Buffalo Breeders Association, consumer organizations, the faculty of agriculture, and the faculty of veterinary medicine. The Buffalo Breeders Association can bring all stakeholders together and provide coordination.

Although the models mentioned were used in forming the theoretical framework of this study, it was mainly inspired by Rogers' diffusion of innovations theory. In this context, the factors likely to affect innovativeness in the region were modeled as individual variables. For future studies, it would be more beneficial to examine the factors likely to affect innovativeness using the constructs included in the Technology Acceptance Model and the Technology-Organization Environment Framework.

Author contributions

IB and OK contributed to data collection and analysis; AB, EF, and BD contributed to research design and model selection; all authors contributed to writing and editing the article.

Conflicts of Interest

The authors declare no conflicts of interest. The funders had no role in the study's design; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

Abdullahi HO, Hassan AA, Mahmud M, Ali AF (2021) Determinants of ICT adoption among small-scale agribusiness enterprises in Somalia. arXiv preprint arXiv: 2103.01769. https://doi.org/10.14445/22315381/IJETT-V69I2P210

Acıbuca V, Budak DB (2021) Factors influencing adaptation of innovations in small ruminant production in the TRC3 Region in Turkey. Emirates Journal of Food & Agriculture (EJFA) 33: 499–406. https://doi.org/10.9755/ejfa.2021.v33.i5.2623

Aksoy A, Külekçi M, Yavuz F (2011) Analysis of the factors affecting the adoption of innovations in dairy farms in Erzurum Province, Turkey. African Journal of Agricultural Research 6: 2966–2970. https://academicjournals.org/AJAR

Alambaigi A, Ahangari I (2016) Technology acceptance model (TAM) as a predictor model for explaining agricultural experts behavior in acceptance of ICT. International Journal of Agricultural Management and Development (IJAMAD) 6: 235–247. https://doi.org/10.22004/ag.econ.262557

Ali A, Altarawneh M, Altahat E (2012) Effectiveness of agricultural extension activities. American Journal of Agricultural and Biological Sciences 7: 194–200. https://doi.org/10.3844/ajabssp.2012.194.200

Anderson JR, Feder G (2007) Agricultural extension. Handbook of agricultural economics 3: 2343–2378. https://doi.org/10.1016/S1574-0072(06)03044-1

Bacenetti J, Fusi A (2015) The environmental burdens of maize silage production: influence of different ensiling techniques. Animal Feed Science and Technology 204: 88–98. https://doi.org/10.1016/j.anifeedsci.2015.03.005

Baker J (2012) The technology–organization–environment framework. Information Systems Theory: Explaining and Predicting Our Digital Society 1: 231–245. https://doi.org/10.1007/978-1-4419-6108-2_12

Basarir A, Gillespie JM (2006) Multidimensional goals of beef and dairy producers: an inter-industry comparison. Agricultural Economics 35: 103–114. https://doi.org/10.1111/j.1574-0862.2006.00143.x

Basarir A, Karli B, Bilgic A (2006) An evaluation of Turkish agricultural production performance. International Journal of Agriculture and Biology 8: 511–515. http://www.fspublishers.org

Boahene K, Snijders TA, Folmer H (1999) An integrated socioeconomic analysis of innovation adoption: the case of hybrid cocoa in Ghana. Journal of Policy Modeling 21: 167–184. https://doi.org/10.1016/S0161-8938(97)00070-7

Bouton J (2007) The economic benefits of forage improvement in the United States. Euphytica 154: 263–270. https://doi.org/10.1007/s10681-006-9220-6

Boz İ (2014) Determination of best management practices and innovations in beef cattle farming and their adoption in the Eastern Mediterranean Region of Turkey. Bulgarian Journal of Agricultural Science 20: 552–562.

Boz I, Akbay C (2005) Factors influencing the adoption of maize in Kahramanmaras province of Turkey. Agricultural Economics 33: 431–440. https://doi.org/10.1111/j.1574-0864.2005.00305.x

Clark EA (2004) Benefits of re-integrating livestock and forages in crop production systems. Journal of Crop Improvement 12: 405–436. https://doi.org/10.1300/J411v12n01_06

Cresswell L, Richens I, Archer S, Breen J, Huxley J, Randall L, Remnant J, Wapenaar W, Biggs A, Kerby M (2013) Veterinary vaccination advice and perceived farmer compliance on UK dairy farms. Livestock 18: 166–174. https://doi.org/10.12968/live.2013.18.5.166

Davis FD (1987) User acceptance of information systems: the technology acceptance model (TAM). Working Paper #529, Michigan State University. https://quod.lib.umich.edu/b/busadwp/images/b/1/4/b1409190.0001.001.pdf

Davis FD (1993) User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. International Journal of Man-Machine Studies 38: 475–487. https://doi.org/10.1006/imms.1993.1022

Demiryürek K, Abaci Nİ, Abaci SH, Atasever S, Erdem H (2017) Effect of Dairy Cattle Breeders' Association (DCBA) membership on sustainability of innovations in Samsun province of Turkey. Custos e Agronegocio 13: 37–44. http://www.custoseagronegocioonline.com.br/

Dixit V, Tripathi H, Sharma M (2019) Assessing the impact of training on socio-psychological variables of buffalo owners. Indian Journal of Extension Education 55: 86–89.

Donkor E, Owusu V, Owusu-Sekyere E, Ogundeji AA (2018) The adoption of farm innovations among rice producers in Northern Ghana: Implications for sustainable rice supply. Agriculture 8: 121. https://doi.org/10.3390/agriculture8080121

Eryılmaz GA, Kılıç O, Boz İ, Kaynakçı C (2020) Süt sığırcılığı yapan işletmelerin tarımsal yeniliklerin benimsenmesi ve bilgi kaynakları yönünden değerlendirilmesi: Samsun ili Bafra ve Canik ilçeleri örneği. Journal of the Institute of Science and Technology 10: 1361–1369. https://doi.org/10.21597/jist.665198

Greene WH (2003) Econometric Analysis 5th ed. Prentice-Hall International Inc, New York, NY, USA.

Hamid M, Siddiky M, Rahman M, Hossain K (2016) Scopes and opportunities of buffalo farming in Bangladesh: A review. SAARC Journal of Agriculture 14: 63–77. https://doi.org/10.3329/sja.v14i2.31246

Hossain KZ, Islam M, Bhuiyan M, Wazad M, Rahman M (2011) Farmers communication behaviour in receiving information on improved rice production technologies. Journal of Innovation and Development Strategy 5: 28–33.

Hu Y, Li B, Zhang Z, Wang J (2022) Farm size and agricultural technology progress: Evidence from China. Journal of Rural Studies 93: 417–429. https://doi.org/10.1016/j.jrurstud.2019.01.009

Jiang H, Wang W, Li C, Wang W (2017) Innovation, practical benefits and prospects for the future development of automatic milking systems. Frontiers of Agricultural Science and Engineering 4: 37–47. https://doi.org/10.15302/J-FASE-2016117

Kareem M, Phand S, Manohari P, Borade M (2017) Animal husbandry extension service delivery: farmers' perception in four major Indian states. Journal of Agricultural Extension Management 18.

Khan MA, Chander M, Bardhan D (2013) Willingness to pay for cattle and buffalo insurance: an analysis of dairy farmers in central India. Tropical Animal Health and Production 45: 461–468. https://doi.org/10.1007/s11250-012-0240-z

Khoza S, de Beer LT, van Niekerk D, Nemakonde L (2021) A gender-differentiated analysis of climate-smart agriculture adoption by smallholder farmers: Application of the extended technology acceptance model. Gender, Technology and Development 25: 1–21. https://doi.org/10.1080/09718524.2020.1830338

Kumari S, Jeble S, Patil YB (2018) Barriers to technology adoption in agriculture-based industry and its integration into technology acceptance model. International Journal of Agricultural Resources, Governance and Ecology 14: 338–351. https://doi.org/10.1504/IJARGE.2018.098022

Kwaghe AV, Vakuru CT, Ndahi MD, Usman JG, Abubakar A, Iwar VN (2015) Veterinary services as a panacea for agricultural development and increase in Nigeria's gross domestic product (GDP): a review. International Journal of Life Sciences 4: 134–146.

LeBlanc S, Lissemore K, Kelton D, Duffield T, Leslie K (2006) Major advances in disease prevention in dairy cattle. Journal of Dairy Science 89: 1267–1279. https://doi.org/10.3168/jds.S0022-0302(06)72195-6

Li L, Min X, Guo J, Wu F (2024) The influence mechanism analysis on the farmers' intention to adopt Internet of Things based on UTAUT-TOE model. Scientific Reports 14: 15016. https://doi.org/10.1038/s41598-024-65415-4

Lin JY (1991) Education and innovation adoption in agriculture: evidence from hybrid rice in China. American Journal of Agricultural Economics 73: 713–723. https://doi.org/10.2307/1242823

Maddala G (1983) Limited Dependent and Qualitative Variables in Econometrics. Cambridge University Press. Cambridge, MA. https://doi.org/10.1017/CBO9780511810176

Mein GA (2012) The role of the milking machine in mastitis control. Veterinary Clinics: Food Animal Practice 28: 307–320. https://doi.org/10.1016/j.cvfa.2012.03.004

Msuta PB, Urassa JK (2015) The contribution of farmers organizations to smallholder farmers well-being: A Case study of Kasulu district, Tanzania. African journal of agricultural research 10: 2343–2349. https://doi.org/10.5897/AJAR2014.9261

Nanda AS, Nakao T (2003) Role of buffalo in the socioeconomic development of rural Asia: Current status and future prospectus. Animal Science Journal 74: 443–455. https://doi.org/10.1046/j.1344-3941.2003.00138.x

Nyariki DM (2011) Farm size, modern technology adoption, and efficiency of small holdings in developing countries: evidence from Kenya. The Journal of Developing Areas 45: 35–52. https://doi.org/10.1353/jda.2011.0016

Orr G (2003) Diffusion of innovations, by Everett Rogers (1995). [Retrieved January 21, 2005]

Özsayın D (2020) Factors Affecting the adoption of innovations in dairy cattle farms in TR22 South Marmara Region of Turkey. Yuzuncu Yıl University Journal of Agricultural Sciences 30: 576–584. https://doi.org/10.29133/yyutbd.735573

Ozturk N, Kocak O, Peker A, Serva L, Kaygisiz F, Kecici PD, Yalcintan H, Kilic HI, Magrin L (2022) Characteristics of buffalo farming systems in Turkey based on a multivariate aggregation of indicators: A survey study. Animals 12: 3056. https://doi.org/10.3390/ani12213056

Palacpac EP, Honorio MGF, Valiente EM, Jacang RT (2015) Common characteristics of progressive dairy buffalo farmers in Nueva Ecija, Philippines. Philippine Journal of Veterinary and Animal Sciences 41: 109–118.

Ponnusamy K, Pachaiyappan K (2018) Strengthening extension research in animal husbandry: review of issues and strategies. The Indian Journal of Animal Sciences 88: 137–143. https://doi.org/10.56093/ijans.v88i2.79229

Quddus MA (2012) Adoption of dairy farming technologies by small farm holders: practices and constraints. Bangladesh Journal of Animal Sciences 41: 124–135. https://doi.org/10.3329/bjas.v41i2.14132

Rogers EM, Pitzer R (1960) The adoption of Irrigation by Ohio farmers. Ohio Agricultural Experiment Station Wooster, Ohio.

Ryan B, Gross NC (1943) The diffusion of hybrid seed corn in two Iowa communities. Rural Sociology 8: 15.

Sabapara GP (2024) Adoption of improved buffalo husbandry practices in Peri-Urban Areas of Surat City, Gujarat. Indian Journal of Animal Production and Management 40: 197–203. https://doi.org/10.48165/ijapm.2024.40.3.11

Şahin G (2015) Türkiye zirai hayatında manda (*Bubalus bubalis*) yetiştiriciliği ve manda ürünlerinin değerlendirilmesi. Coğrafya Dergisi, 14–40.

Salem HB, Nefzaoui A (2003) Feed blocks as alternative supplements for sheep and goats. Small Ruminant Research 49: 275–288. https://doi.org/10.1016/S0921-4488(03)00144-5

Sant´Anna DD, Silva CABd, Gomes ST (2003) Risk analysis of investments in-farm milk cooling tanks. Revista de Economia e Sociologia Rural 41: 407–420. https://doi.org/10.1590/S0103-20032003000200005

Sen A, Chander M (2003) Privatization of veterinary services in developing countries: a review. Tropical animal health and production 35: 223–236. https://doi.org/10.1023/A:1023343429498

Senthilkumar S (2018) Adoption of innovative dairy farming technology in the farmer's field. Asian Journal of Dairy and Food Research 37: 26–27. https://doi.org/10.18805/ajdfr.DR-1289

Shahbaz P, Boz I, ul Haq S (2020) Adaptation options for small livestock farmers having large ruminants (cattle and buffalo) against climate change in Central Punjab Pakistan. Environmental Science and Pollution Research 27: 17935–17948. https://doi.org/10.1007/s11356-020-08112-9

Shi P, Yan B (2016) Factors affecting RFID adoption in the agricultural product distribution industry: empirical evidence from China. SpringerPlus 5: 1–11. https://doi.org/10.1186/s40064-016-3708-x

SITOM SITvOM (2024) Samsun Tarımı ve Tarımsal Yatırım Potansiyeli. İlkadım Samsun.

Swensson C, Lindmark-Mansson H (2007) The prospect of obtaining beneficial mineral and vitamin contents in cow's milk through feed. Journal of Animal and Feed Sciences 16: 21–41. https://doi.org/10.22358/jafs/74110/2007

Tatlıdil FF, Boz I, Tatlidil H (2009) Farmers' perception of sustainable agriculture and its determinants: a case study in Kahramanmaras province of Turkey. Environment, Development and Sustainability 11: 1091–1106. https://doi.org/10.1007/s10668-008-9168-x

Tornatzky LG (1990) The Processes of Technological Innovation. Lexington/DC Heath & Company.

Triveni G, Sharma G, Satyanarayana C, Rao KS, Raghunandhan T (2018) Knowledge level of dairy farmers on adoption of dairy innovations in Andhra Pradesh-An Analysis. Indian Research Journal of Extension Education 18: 1–4.

Van den Ban AW, Hawkins HS (1996) Agricultural Extension. 2nd Edition, Blackwell Science, UK, 294 pp.

Van Schaik G, Green L, Guzmán D, Esparza H, Tadich N (2005) Costs and benefits of improved milking practices in smallholder dairy farms in the 10th region of Chile. Mastitis in dairy production. Wageningen Academic, 242–247. https://doi.org/10.3920/9789086865505_033

Vecchio Y, Agnusdei GP, Miglietta PP, Capitanio F (2020) Adoption of precision farming tools: The case of Italian farmers. International Journal of Environmental Research and Public Health 17: 869. https://doi.org/10.3390/ijerph17030869

Venkatesh V, Davis FD (2000) A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science 46: 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Verma P, Sinha N (2018) Integrating perceived economic wellbeing to technology acceptance model: The case of mobile-based agricultural extension service. Technological Forecasting and Social Change 126: 207–216. https://doi.org/10.1016/j.techfore.2017.08.013

Viswkarma R, Singh R, Kushram P, Singh S, Sharma S (2018) Existing status of buffalo husbandry practices in Jabalpur. The Pharma Innovation Journal 7: 08–11. https://doi.org/10.22271/tpi

Vollaro M, Raggi M, Viaggi D (2019) Innovation adoption and farm profitability: what role for research and information sources? Bio-based and Applied Economics 8: 179–210.

Vu HV, Ho H, Le QH (2020) Impact of farmers' associations on household income: evidence from tea farms in Vietnam. Economies 8: 92. https://doi.org/10.3390/economies8040092

Wairimu E, Mburu J, Ndambi A, Gachuiri C (2022) Factors affecting adoption of technical, organizational and institutional dairy innovations in selected milksheds in Kenya. Agrekon 61: 324–338. https://doi.org/10.1080/03031853.2022.2090972

Worku AA (2019) Factors affecting diffusion and adoption of agricultural innovations among farmers in Ethiopia case study of Ormia regional state Westsern Sewa. International Journal of Agricultural Extension 7: 137–147. https://doi.org/10.33687/ijae.007.02.2864

Yamane T, Esin A (2010) Temel örnekleme yöntemleri. Literatür Yayıncılık.

Yani W, Fajeri H (2022) Analysis of the adoption level of swamp buffalo farming and its relationship with social economic factors in Paminggir Subdistrict of Hulu Sungai Utara Regency, Indonesia. Russian Journal of Agricultural and Socio-Economic Sciences 126: 128–134.

Yener A, Oğuz C (2017) The effect of socio-economic factors on adoption of innovations in dairy farms. Turkish Journal of Agriculture-Food Science and Technology 5: 1389–1393. https://doi.org/10.24925/turjaf.v5i11.1389-1393.1421

Yılmaz S (2013) Afyonkarahisar Yöresi Manda Yetiştiriciliği: Küçükçobanlı Köyü örneği. Adnan Menderes Üniversitesi, Fen Bilimleri Enstitüsü Aydin.

Yoon C, Lim D, Park C (2020) Factors affecting adoption of smart farms: The case of Korea. Computers in Human Behavior 108: 106309. https://doi.org/10.1016/j.chb.2020.106309