

ORIGINAL ARTICLE

Socioeconomic implications of biosecurity practices in small-scale dairy farms

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Background: Biosecurity plays a crucial role in preventing contagious diseases and in increasing farm productivity.

Objective: To determine technical and economic biosecurity scores of farms, and to examine the associations between biosecurity practices (BP) and producers' socioeconomic characteristics.

Methods: The study was conducted on a total of 50 small-scale dairy farms that were randomly selected in Hatay, Turkey. A checklist consisting of 19 biosecurity practices was addressed to the farms. The technical and economic scoring systems were developed by the authors according to presence and cost of the each of the biosecurity practices.

Results: The mean of the technical and economic scores were found to be 9.30 and 17.04, respectively. 'Treatment of sick animals' (98%), 'vaccination against the most common contagious diseases' (90%), and 'barn lime' (86%) were found to be the most commonly used applications. 'Testing for the most common contagious diseases before buying' (10%) was used at the lowest rate. Significant differences were found among the groups regarding education level (<.05), income class (<.05), and herd size (<.01). Biosecurity scores were significantly positively correlated with herd size (<.05) and producers' education level (<.01). There were statistically significant associations between the producers' socioeconomic characteristics and some of the biosecurity practices.

Conclusion: Training programs should be arranged to change the attitudes and perception of small-scale producers concerning poor biosecurity practices. In order to encourage producers to increase biosecurity scores, regulations regarding financial support and penalties could be quite useful at both the regional and national levels.

Keywords: biosecurity; economic; farm; producer; score

1. Introduction

Biosecurity is defined as a set of management procedures that prevent the risk of introducing new diseases to a farm and to minimize or to eliminate the spread of disease within the herd (Gunn et al. 2008; Moore et al. 2008; Fasina et al. 2012). As a part of preventive veterinary medicine, thanks to biosecurity practices (BP), it can also minimize the direct and indirect negative economic effects of infections on stakeholder groups such as producers/farmers, customers, suppliers, and relevant organizations. BP can be divided into two main categories, namely internal and external measures. Isolation of new animals, quarantine procedures, transportation; contacts with other herds and herdsman; and disease testing, visitors' movements and grazing areas can be given as examples for the external measures; on the other hand, disease records, work procedures, staff education, and cleaning and disinfection of barns are included to the internal measures (Pinto & Urcelay 2003; Barrington et al. 2006; Kristensen & Jakobsen 2011).

A correctly applied biosecurity program is not as easy as indicated (Moore et al. 2008), and it can be considered a multidimensional activity (Cox 2005). The perception of its importance among farmers is also a complicated issue (Casal et al. 2007). Although a majority of farmers are aware that biosecurity measures are the most effective way to prevent diseases, they either forget to implement them or implement incorrect measures (Vaillancourt &

Carver 1998). Different factors contribute to successful or unsuccessful biosecurity applications. These factors can be explained as additional workforce, costs and complexities of applications, availability of funds, laws, and regulations affecting the producers' decisions about a new biosecurity plan (Fasina et al. 2012). Furthermore, farmers' perceptions about biosecurity plans are likely influenced by the characteristics of the farms (Casal et al. 2007). According to the opinion of the researchers of this study, compatible with the above views, the application of BPs are largely related to internal factors such as producers' social, economic, and cultural characteristics, and external factors such as relevant legal framework, national or regional health status, and climatic and/or geographic differences. As a part of these internal factors, the understanding of the impact of the socioeconomic factors on biosecurity is important.

Small-scale farms play an important role in the development of the rural economy and reducing poverty among farmers/producers, especially in developing countries. Nevertheless, small-scale producers have faced a number of financial, technical, and legal challenges in recent years (Kirsten & Sartorius 2002; Uddin et al. 2012; Can 2014). A majority of the livestock farms are still small-scale and family-type operations in Turkey (TSI 2011). Mixed farms seem to be less concerned with biosecurity (Casal et al. 2007), and cattle owners generally fail to implement commonly recommended BPs (USDA 2002). At the same

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time, mixed farming is the dominant production system both in Hatay and Turkey (TSI 2011). Based on the above reality, the researchers of the current study decided to work on small-scale dairy farms in order to better reflect the current situation in the region.

There are different BPs available, which differ from country to country (Nöremark et al. 2010). It is important to understand the socioeconomic structure and management quality and skills of livestock enterprises, legal regulations, and financial resources of a country before preparing a new infection control plan. An infection control strategy should also be applicable in terms of not only a technical perspective, but also economic aspects (Can & Yalçın 2013, 2014). To the best of the knowledge of the researchers, until now there have been no studies investigating both the economic and technical aspects of the BPs in farm animals for both the region of Hatay and throughout Turkey. The present study aimed to determine technical and economic biosecurity scores of farms, and to examine the associations between BPs and cattle producers' socioeconomic characteristics. The results of this study would be useful to understand the real field conditions and to provide solutions to various herd management problems.

2. Materials and methods

2.1. Farms and data collection

This study was conducted on a total of 50 randomly selected small-scale dairy farms in different parts of Hatay, Turkey. Hatay is a medium-sized city, situated in the Mediterranean region of south-central Turkey (36°15'N, 36°08'E) on the border with Syria. It has a multiethnic and multicultural population (Doğruel & Leman 2009). Data collection began in April 2012 and was completed in January 2013. The average herd size is 19 cows per farm and ranged from 4 to 59. The common breeds were indigenous and Holstein Friesian and their crosses. A majority of the producers also practiced agricultural activities.

Before starting the field work, the questionnaire was pre-tested on a number of producers in order to modify the questions and to determine which BP should be included in the study. Afterward, the researchers composed a final questionnaire inquiring about the producer's socioeconomic characteristics; the checklist consisted of nineteen BPs applied by producers and the cost of the each BP. In other words, in the present study, selection process of the biosecurity measurements was based on both preliminary questionnaires and scientific literatures (USDA 2002; Pinto & Urcelay 2003; Barrington et al. 2006; Casal et al. 2007; Moore et al. 2008; Nöremark et al. 2010; Kristensen & Jakobsen 2011). Each farm was visited once during the study period. In order to provide more reliable data, the checklists considered the observations on each farm, instead of sending the checklist via postal service or electronic mail to the producers.

2.2. Data evaluation

BPs were evaluated in consideration of the technical and economic scores. Each question about BP was answered as either 'yes' or 'no'. A technical scoring system was developed for dairy farms and ranged from 0 to 1 point (the maximum possible technical score was 19 points). The assessment of the technical importance (disease preventive effect) of different BPs is very complex issue. Therefore, in order to avoid subjective assessment, the researchers did not graduate the BPs. The economic scoring system was developed by the researchers according to the cost of each of the BPs and ranged from 0 to 3 points (the maximum possible economic score was 37 points). The 25th and 75th percentile (\$3.09 and \$9.99) were used for cut-off points in the categorization of the annual biosecurity cost for a cow. Points were allocated as follows: if the annual cost of a BP was less than \$3.09 per cow, 3 points; between \$3.1 and \$9.98 per cow, 2 points; and more than \$9.99 per cow, 1 point. In other words, the economic score of each of the BP was reduced by increasing its cost. In this study, a higher score always implied a technically or economically better option for producers.

2.3. Statistical analysis

Scatter diagrams were used to investigate the possible relationship between variables. The relationship between producers' socioeconomic characteristics and biosecurity scores were analyzed using correlation coefficients. Chi-squared analyses were performed to test for possible associations between the characteristics of producers and BP (Özcatalbas et al. 2009; Çiçek et al. 2008). The analysis was completed using SPSS-15.0 software.

3. Results

Preferred scoring systems for the 19 BPs and the frequency of each application are summarized in Table 1. Items 18, 10, 15, and 19 were found to be the most commonly used applications by producers. Only 10% of the respondents indicated that they tested animals for the most common contagious diseases before selling, and only 12% of the respondents adopted separate grazing management practices.

A comparison of biosecurity scores according to the subgroups of socioeconomic factors are shown in Table 2. The mean of the technical and economic scores regarding biosecurity were found to be 9.30 and 17.04, respectively. Statistically significant differences were found in respect to the mean score of different education levels, income classes, and herd sizes.

Correlations between producers' socioeconomic status with technical and economic biosecurity scores are presented in Table 3. It can be seen from the table that the scores were significantly positively correlated with herd size and producer's education level. Moreover, there was also a negative significant correlation between the age of producers and economic score. No further significant

Table 1. Preferred biosecurity scoring system and its frequencies in small-scale dairy farms.

Biosecurity practices	Technical score		Economic score		All respondents			
					No		Yes	
	No	Yes	No	Yes	N	%	N	%
1. Infection prevention and control training	0	1	0	3	42	84	8	16
2. Record keeping for diseases	0	1	0	3	32	64	18	36
3. Only necessary visits allowed	0	1	0	3	22	44	28	56
4. Provide protective clothing for visitors	0	1	0	3	34	68	16	32
5. All replacements come from the farm (closed herd)	0	1	0	3	40	80	10	20
6. Inspection made by veterinarian on arrival	0	1	0	3	28	56	22	44
7. Cleaning and disinfection of vehicles	0	1	0	2	28	56	22	44
8. Quarantine for new animal on arrival	0	1	0	2	28	56	22	44
9. Testing for the most common contagious diseases before buying ¹	0	1	0	1	45	90	5	10
10. Vaccination against most common contagious diseases ¹	0	1	0	1	5	10	45	90
11. Separate grazing management practices	0	1	0	1	44	88	6	12
12. At least 2 km away from the nearest neighboring farm/barn	0	1	0	1	41	82	9	18
13. Having an insect or rodent control plan	0	1	0	1	27	54	23	46
14. Cleaning and disinfection of barns	0	1	0	2	20	40	30	60
15. Barn lime	0	1	0	2	7	14	43	86
16. Using supportive/supplement (vitamins, minerals, etc.)	0	1	0	2	18	36	32	64
17. Isolating sick animals	0	1	0	2	16	32	34	68
18. Treatment of sick animals ²	0	1	0	1	1	2	49	98
19. Removing diseased animals that did not respond to treatment	0	1	0	1	7	14	43	86

¹Foot-and-mouth diseases, bovine brucellosis, infectious bovine rhinotracheitis and bovine tuberculosis which are the most commonly observed infections in Turkey were taken into account for the item.

²Treatment continued until the clinical signs disappeared in an affected animal.

correlations were found between biosecurity scores and other farm characteristics.

Significant associations between socioeconomic factors and BPs are given in Tables 4–11. A statistically

significant association was found between education level and ‘testing for the most common contagious diseases’ (Table 4). A significant association between herd size and ‘testing for the most common contagious diseases’, herd

Table 2. Comparison of total biosecurity scores according to different subgroups.

Producers' characteristics	N	Technical score	p-value	Economic score	p-value
Age					
Young	7	10.42 ± 2.22	>.05	18.85 ± 4.48	>.05
Middle-aged	33	9.48 ± 3.45		17.63 ± 7.81	
Elderly	10	7.90 ± 1.96		13.80 ± 3.96	
Working experience					
Less than 9 year	20	9.60 ± 2.90	>.05	17.90 ± 6.22	>.05
Between 10 and 19 years	17	8.64 ± 3.46		15.47 ± 7.86	
Upper than 20 years	13	9.69 ± 3.06		17.76 ± 8.88	
Education level					
Primary school	27	8.44 ± 4.97 ¹	<.05	15.22 ± 7.04 ¹	<.05
High School	15	9.46 ± 4.60		17.53 ± 6.67	
Graduate	8	11.87 ± 3.37 ¹		22.25 ± 4.39 ¹	
Income class (per month)					
Less than \$749	27	9.33 ± 3.06	<.05	17.18 ± 6.74	<.05
Between \$750 and 1499	11	7.63 ± 2.80 ¹		13.27 ± 6.14 ¹	
More than \$1500	12	10.75 ± 2.98 ¹		20.16 ± 6.89 ¹	
Herd size					
Less than 24 cows	29	8.48 ± 2.99 ¹	<.01	15.34 ± 6.47 ¹	<.01
Between 25 and 49 cows	10	8.80 ± 3.32		16.10 ± 7.54	
More than 50 cows	11	11.90 ± 1.70 ¹		22.36 ± 5.16 ¹	
All respondents	50	9.30 ± 3.11		17.04 ± 6.93	

¹Scheffe *post hoc* tests revealed that the scores of the groups differed significantly from each other.

Table 3. The correlations between socioeconomic characteristics and biosecurity scores.

Socioeconomic characteristics	Technical score	Economic score
Education level	0.379**	0.369**
Herd size	0.343*	0.348*
Income class	0.099	0.116
Age	-0.262	-0.270*
Job experience	-0.019	-0.034

* $p < .05$; ** $p < .01$.

Table 4. Associations between education level and 'testing for most common contagious diseases'.

Education level	Testing for most common contagious diseases					
	No		Yes		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Primary school	27	100	0	0	27	100
High school	14	93.3	1	6.7	15	100
Graduate	4	50.0	4	50.0	8	100

Note: $\chi^2 = 17.407$; $p < .01$.

Table 5. Associations between herd size and 'testing for most common contagious diseases'.

Herd size	Testing for most common contagious diseases					
	No		Yes		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Less than 24 cows	29	100	0	0	29	100
Between 25 and 49 cows	9	90.0	1	10.1	10	100
More than 50 cows	7	63.6	4	36.4	11	100

Note: $\chi^2 = 11.717$; $p < .01$.

Table 6. Associations between herd size and 'removing diseased animals that did not respond to treatment'.

Herd size	Removing diseased animals that did not respond to treatment					
	No		Yes		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Less than 24 cows	1	3.4	28	96.6	29	100
Between 25 and 49 cows	3	30.0	7	70.0	10	100
More than 50 cows	3	27.3	8	72.7	11	100

Note: $\chi^2 = 6417$; $p < .05$.

size and 'removing diseased animals that did not respond to treatment', herd size and 'cleaning and disinfection of barns', and herd size and 'having an insect or rodent control plan' is summarized in Tables 5–8. There was also a significant association between income class and 'barn

Table 7. Associations between herd size and 'cleaning and disinfection of barns'.

Herd size	Cleaning and disinfection of barns					
	No		Yes		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Less than 24 cows	20	69.0	9	31.0	29	100
Between 25 and 49 cows	5	50.0	5	50.0	10	100
More than 50 cows	3	27.3	8	72.7	11	100

Note: $\chi^2 = 5809$; $p < .05$.

Table 8. Associations between herd size and 'having an insect or rodent control plan'.

Herd size	Having an insect or rodent control plan					
	No		Yes		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Less than 24 cows	19	65.5	10	34.5	29	100
Between 25 and 49 cows	6	60.0	4	40.0	10	100
More than 50 cows	2	18.2	9	81.8	11	100

Note: $\chi^2 = 7375$; $p < .05$.

Table 9. Associations between income class and 'barn lime'.

Income class (per month)	Barn lime					
	No		Yes		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Less than \$749	3	11.1	24	88.9	27	100
Between \$750 and 1499	4	36.4	7	63.6	11	100
More than \$1500	0	0	12	100	12	100

Note: $\chi^2 = 6710$; $p < .05$.

Table 10. Associations between income class and 'using supportive/supplement'.

Income class (per month)	Supportive/supplement					
	No		Yes		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Less than \$749	7	25.9	20	74.1	27	100
Between \$750 and 1499	8	72.7	3	27.3	11	100
More than \$1500	3	25.0	9	75.0	12	100

Note: $\chi^2 = 8260$; $p < .05$.

lime', income class and 'using supportive/supplement', and age of producer and 'testing for the most common contagious diseases' (Tables 9–11). It was an important finding that 'testing for the most common contagious diseases' was affected by education level, herd size, and age of producer ($p < .01$). The researchers found that the utilization rate of 'testing for the most common contagious diseases' increased as producers' education level

Table 11. Associations between age of producer and ‘testing for most common contagious diseases before selling’.

Age of producer	Testing for most common contagious diseases					
	No		Yes		Total	
	N	%	N	%	N	%
Young	4	57.1	3	42.9	27	100
Middle-aged	32	97.0	1	3.0	15	100
Elderly	9	90.0	1	10.0	8	100

Note: $\chi^2 = 10,178$; $p < .01$.

increased (Table 4). It was also significantly higher in the young group (Table 11). It is evident from Tables 5–7 that the utilization rate of ‘testing for the most common contagious diseases’, ‘cleaning and disinfection of barns’, and ‘having an insect or rodent control plan’ increased as producers’ herd size increased. Conversely, as can be seen from Table 5, there was a significant negative association between herd size and ‘removing diseased animals that did not respond to treatment’.

4. Discussion and conclusions

In the present study, a relatively small sample size was used. One of the important reasons is that checklists were completed by the researchers on each farm based on observations, instead of sending a questionnaire to the farms. The researchers believe that more reliable data concerning the BPs could be obtained by conducting farm visits, but it requires more time and resources compared to sending the questionnaires by mail. Moreover, it is not always easy to obtain producers’ permission to visit their farms. Although the study provides important information on the socioeconomic aspects of BPs in small-scale dairy farms, larger and more comprehensive studies are needed for Turkey.

In this study, the mean technical score (9.30) was equal to 49% of the maximum possible total score. In the United Kingdom, according to 34% of sampled farmers, BPs among cattle producers were almost non-existent (Anon 2007). The producers scored the biosecurity on their own farms as 6.7 on a scale of 0–10 (the worst score was 3 and the best was 10) (Casal et al. 2007). According to the present study results, some of the important BPs were not preferred by producers, despite the fact that the mean biosecurity score was found to be at a moderate level. Producers may choose not to implement biosecurity recommendations because of a lack of awareness about the potential risks to their farms and/or confusion concerning the specific recommendations (Moore et al. 2008). Furthermore, it is emphasized that the producers perceived the potential risk of the introduction of disease as low (Nöremark et al. 2010). Incorrect decisions about BPs can lead to serious adverse effects on farms (Kobayashi & Melkonyan 2011). Different factors that contribute to unsuccessful BPs are given by authors as follows: it is indicated that information concerning biosecurity is limited for cattle producers due to inconsistent message (I), a

lack of clarity and insufficient evidence of efficacy (II), (Brennan & Christley 2012), Producers’ mutual mistrust (III), their apathy about biosecurity (IV), failure to cooperate (V) (Heffernan et al. 2008), the gap between national biosecurity recommendations and on-farm practices (VI) (Hennessy 2007), and also poor training (VII) and poor record keeping (VIII) (Vaillancourt & Carver 1998) can be responsible for unsuccessful biosecurity plans. Producers need to understand their responsibility and the consequences of their actions (Hennessy 2007). Moreover, in order to ensure sustainability of the biosecurity plans, farmers should be consistently followed and/or supported by local veterinarians who can play an active role in implementing biosecurity measures.

Financial considerations may be the most important factor for farmers for the adoption biosecurity measures. There is a converse relationship between the willingness of producers to adopt a biosecurity measure and its estimated cost (Fraser et al. 2010). On the contrary, in the present study, there was no significant correlation between income class and biosecurity scores. However, all biosecurity scores were significantly positively correlated with herd size and producer’s education level (Table 3). In the opinion of the researchers, herd size can be seen as a type of economic indicator. The field of behavioral economics, at the intersection of economics and psychology, plays an important role in decision-making processes. People’s economic decisions and choices, that are not simple issues, are affected by psychological, social, and emotional factors (Hogarth et al. 2002; Simith 2005).

Although a number of studies have been conducted concerning the cost of disease (Brennan & Christley 2012), only a few studies consider the overall cost benefit of biosecurity programs (Cox 2005). It is claimed that if it is possible to calculate the potential economic impacts of biosecurity, the benefit-cost ratio would increase significantly (Fasina et al. 2012). Although ‘infection prevention and control training’ and ‘record keeping for diseases’ are cheaper and easier to use, according to the study results, only a small number of producers used these practices. Especially, the implementation of the cheaper and/or easier practices must be increased among the small-scale producers.

In the present study, only 32% of the producers provided protective clothing for visitors. Less than 40% of the producers reported that they provide protective clothing for visitors (Nöremark et al. 2010). It is reported that in the United States, a small number of dairy producers use disposable boots or footbaths (USDA 2002). Even if a sanitary ford was used by 70% of the farms, there was no scheduled program for changing the disinfecting solution (Casal et al. 2007). Thirteen percent (USDA 2002) and 55% (Casal et al. 2007) of producers reported that controlling visitor access or restriction of visiting practices have been carried out on their farms; 44% of them used vehicle access (USDA 2002). Most visitors never cleaned their vehicles after visiting farms (Brennan & Christley 2012) and very few farmers used measures such as showering and quarantine periods for people (Ribbens et al. 2008). It is suggested that non-farm vehicles should not be allowed

on a farm unless essential (Brennan & Christley 2012). In the present study, 56% of producers have preferred to allow only necessary visits; also 44% and 60% of respondents have performed cleaning and disinfection of vehicles and barns, respectively (Table 1).

It is reported that most producers did not isolate animals moved from another farm (Brennan & Christley 2012); 50% of producers introduced new animals directly into the herd without prior isolation (Nöremark et al. 2010); less than 20% quarantined or tested new additions to the farm (USDA 2002); and less than half of the farms kept the replacement livestock in an independent building (Casal et al. 2007). Only a few producers were aware of the newly purchased animals' disease history (Brennan & Christley 2012). In the present study, the lowest level application was 'testing for the most common contagious diseases before selling' affected both by education level and herd size ($p < .01$). The utilization rate of 'testing for the most common contagious diseases' significantly increased with an increase in the producers' education level and herd size (Tables 4 and 5). In the current study, only 36% of producers used record keeping for diseases and 44% of respondents used quarantine for new animals upon arrival (Table 1).

Among the producers, the most common intervention was vaccination, followed by the administration of anthelmintics (Brennan & Christley 2012). Thirty-three percent of producers applied rodent and insect control plans (Casal et al. 2007), and less than half of producers have a vector control program (USDA 2002). Treatment of stock post-movement was carried out by majority of producers. Thirty-six of the producers reported a regular routine veterinary visit (Brennan & Christley 2012). In the present study, almost all of the producers used vaccination against the most common contagious diseases. Nearly half of the producers carried out insect or rodent control (Table 1). The utilization rate of an insect or rodent control plan increased as producers' herd size increased (Table 8). Diseased animals that did not respond to treatment were removed from the herd according to producers' statements (86%). Interestingly, the researchers found a significant negative association between herd size and 'removing diseased animals that did not respond to treatment' (Table 6).

In general, individual producers are not interested in social benefits (Kristensen & Jakobsen 2011); furthermore, the impacts of zoonotic risk, international trade, and welfare concerns are not crucial issues for them (Casal et al. 2007). Nevertheless, there are good examples concerning social benefits, animal welfare, food safety, and public health concerns available from many parts of the world (e.g. Western Europe and North America) and they are important issues for producers who live in these countries. The gap between national biosecurity recommendations and on-farm practices (Hennessy 2007) can adversely affect holistic plans about biosecurity. Collective behavior toward epidemic threats would assume the government's responsibility (Heffernan et al. 2008). Although producers believe that government should make a greater contribution toward biosecurity, veterinarians agree that producers should take more responsibility

(Gunn et al. 2008). It is indicated that a rational biosecurity plan depends on the type of herd and the amount of risk that exists (Amass 2005). An appropriate biosecurity plan needs to be specific, easy, economically applicable, cost-effective, clear, suited to the local conditions, and should be flexible for individual situations (Wells 2000; Cox 2005; Scott et al. 2007; Fraser et al. 2010). Good BPs also have other objectives, such as reducing or eliminating antibiotic use (Amass 2005).

To improve biosecurity at the farm level, farmers must be motivated to change behavior in the right direction (Kristensen & Jakobsen 2011). It has been reported that principles of behavioral economics have a significant effect on decision-making actions of individuals (Hogarth et al. 2002; Simith 2005). This means that rationality in decision-making does not always prevail; often non-rationality (e.g. emotional state; perceptions) plays a greater role. It is indicated that small-scale cattle producers will not let authorities slaughter their infected animals unless they receive reasonable compensation (Nampanya et al. 2010). Financial support and penalties are important factors, which could be necessary to facilitate the adoption of biosecurity measures (Fraser et al. 2010; Fasina et al. 2012). Additionally, the construction of a biosecurity index system could be a better practice for dairy farms (Kristensen & Jakobsen 2011).

It was concluded that there were significant relationships between certain socioeconomic factors and BPs. The current findings could be helpful to solve a number of problems about dairy herd health issues. Further comprehensive studies are needed to determine the effect of socioeconomic and socio-demographic factors on farm BP and biosecurity scores. Training programs should be arranged to change the perception and attitudes of small-scale producers toward BPs. Especially, the implementation of the cheaper and/or easier BPs must be increased among the producers. The potential economic benefits of BPs should be better demonstrated and explained by the authorities, such as the Food, Agriculture, and Livestock Ministry, livestock organizations, and private veterinarians. Eventually, regulations about financial support and penalties can be quite useful at both regional and national levels in order to increase biosecurity scores.

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