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Adoption of Milk Safety Measures and its Impact on Milk Acceptance by Buyers in Nepal

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Abstract

The production and consumption of safe and hygienic milk is a major concern in a developing country like Nepal. Adoption of food safety measures at farm level can play a critical role in ensuring quality and safety of the milk. This study has examined the factors influencing the acceptance/rejection rates for milk samples using a linear probabilistic and binary probit regression models. The study is based on milk safety survey data gathered from milk producers in six milk-producing districts of Nepal. The study has found that the dairy farmers adopting higher food safety measures have an increased probability of acceptance rate of their milk samples. Dairy farmers associated with a cooperative society, have depicted a higher probability of milk acceptance by 17 per cent. A higher milk sample acceptance rate has been found among the marginal and lower caste households in Nepal.

Key words: Dairy farmers, food safety index, milk acceptance, hygienic milk, Nepal

JEL Classification: Q12, Q13, Q18

Introduction

Mitigating the impact of food-borne diseases by ensuring compliance with food safety standards continues to be a major challenge in the developing countries (Chakrabarti, 2013; Grace *et al.,* 2015). Food is an excellent conduit for pathogen transmission and milk is one of the riskiest food products from health point of view (Thomas *et al.,* 2013; Mangen *et al.,* 2014; Kirk *et al.,* 2014). Further, in developing countries, the majority of milk producers are smallholders and milk marketing is dominated by the informal sector (Grace *et al.,* 2010; Kumar *et al.,* 2011; 2013). There is widespread concern about the food safety risks associated with milk produced by smallholders and sold through informal markets. For a country with one of the worst child nutrition statistics in the world, safe and hygienic milk production is critical. Indeed, these concerns about public health often induce policymakers to advocate for modernization and industrialization of the dairy sector (Grace *et al.,* 2007).

The production of safe and hygienic milk has been one of the main issues in the dairy sector of Nepal (Kumar *et al.,* 2017). In a study conducted by Dahal *et al*. (2010), the mean total bacterial count (TBC) in milk in Nepal was 9-times higher at the farm level and 104-times higher at processing-plant level compared to their corresponding international standards. There have been numerous complaints regarding the quality of milk at the consumer level. In the study conducted by the National Dairy Development Board of Nepal (NDDB, 2014), it was found that about 17 per cent of consumers perceive milk to be adulterated with water, 13 per cent think that milk has a bad odour, and 19 per cent think that milk is not tasty. Effective interventions to mitigate

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food safety risks across the food value chain are the pre-requisites for containing these risks. In this context, the adoption of good agricultural practices (GAP) has emerged as one of the key strategies for reducing the probability of contamination in food products. The Government of Nepal and the National Dairy Development Board of Nepal have developed a code of conduct for adoption of good dairy practices to ensure production of clean milk. Nepal has a poor record of compliance with food safety practices. Milk cooperatives and dairy processors often reject milk brought by the dairy farmers due to its poor quality. This can leave farmers in a predicament, especially if their principal source of income is dairying.

A number of factors can lead to the rejection of milk. The past studies have found that some farmers unethically add water to increase its volume or add thickening agents like starch, flour, skimmed milk powder, or other ingredients to enhance the solid content of the milk (Walker *et al*., 2004; Soomro *et al*., 2014). Failure to adopt and comply with food safety measures at the farm level can be one of the biggest reasons for milk contamination and rejection of milk samples. This study tests an important hypothesis that "The adoption of milk safety measures increases milk sample acceptance rates in Nepal". Against this backdrop, this study attempts to understand the factors associated with the acceptance of milk by the milk buyers (from both private and public agencies) in Nepal.

Most of the earlier studies have focused on food safety issues at the exporter level (Jongwanich, 2009; Handschuch *et al*., 2013; Dou *et al*., 2015), processor level (Jensen *et al*., 1998; Jensen and Unnevehr, 2000; Gould *et al*, 2000; Buckley, 2015), manufacturer level (Antle, 1996) and retailer level (Mortlock *et al*., 2000). Very few studies have examined food safety status at the farm level (Kumar *et al.,* 2011; Kumar *et al.,* 2017). Moreover, as per our knowledge, none of the studies has analyzed the determinants of milk sample acceptance at the farm level. The findings presented in this paper are expected to help improve the milk acceptance rate, increase hygienic milk production and boost the income of dairy producers in Nepal.

Data and Methodology

Data

The primary data for this study were collected using a pre-tested questionnaire. The survey was conducted in 2015 by the International Food Policy Research Institute (IFPRI) and the Institute for Integrated Development Studies (IIDS). The data were collected from six selected districts that are well- known for milk production in Nepal. These were: Illam, Kavre and Surkhet from the Hilly region, and Morang, Rupandehi, and Banke from the Terai region. In terms of development region[1], Illam and Morang districts are from the eastern region, Rupandehi and Kavre are from the central region, and Banke and Surkhet are from the western region of the country. After discussions with the district livestock officers (DLOs), the major village development committees (VDCs) in dairy farming were identified. Households involved in dairy farming from each VDC were then randomly selected. The number of households selected from each district was proportional to the number of households involved in dairy farming. In total, 901 households were surveyed (204 in Kavre, 112 in Illam, 126 in Surkhet, 204 in Morang, 166 in Rupandehi, and 89 in Banke).

The data-set contains information about socio-economic and demographic characteristics of farm households, and provides insights about farming practices and compliance with food safety standards. The analysis of this study is based on the question whether the milk sample was accepted or rejected by milk buyers during the past one month of survey. At the village level, the quality check for milk generally involves a test for water adulteration, and an assessment of colour and odour. It does not include testing for the adulteration of chemicals such as hydrogen peroxide, carbonates, caustic soda, etc. Most farmers did not reveal the reasons for rejection of their milk samples. In the total sample of 901, only 340 farmers reported the acceptance or rejection of their milk samples in the quality test. Thus, our analysis is based on the results from 340 households only.

Methodology

To produce safe and hygienic milk, various food safety measures need to be adopted at the farm level.

[1] Nepal is divided into 5 development regions: (1) Eastern Development Region, (2) Central Development Region, (3) Western Development Region, (4) Mid-Western Development Region, and (5) Far-Western Development Region.

In this survey, various questions related to food safety measures required for clean milk production were asked from the farmers. Kumar *et al.* (2017) have identified 42 practices, which are important for hygienic milk production at the farm level. These practices were categorized into four broad groups: (a) Hygienic Milking (16 practices); (b) Hygienic milk storage (10 practices); (c) Maintenance of hygienic premises and surrounding environment (11 practices); and (d) Animal health (5 practices). We generated the food safety index similar to of Kumar *et al*. (2017) as the weighted sum of the proportion of the food safety measures. The weights of 0.35, 0.20, 0.25, and 0.20 were assigned to hygienic milking, hygienic milk storage, animal health, and hygienic dairy environment/ surrounding, respectively. The food safety index (FI) for the i^{th} farm was computed by Equation (1) :

$$FI_i = \Sigma_{j=1}^{4} w_j p_j \quad \ldots(1)$$

where, w_j is the weight assigned to the j^{th} food safety measures category and p_j is the proportion of the food safety measures practised in each category. These weights add up to one and the FI ranges between 0 and 100 (expressed in terms of percentage). We computed FI to test whether or not the increased adoption of food safety practices translated into higher acceptance rates of milk samples by the buyers. We considered FI as one of the important explanatory variables in our econometric model.

Our dependent variable is the binary variable of acceptance or rejection of milk-sample in the test. Given the binary nature of the dependent variable, we used linear probabilistic and binary probit regression to study the factors associated with the acceptance of milk sample. We were mainly interested in assessing whether the higher adoption of food safety measures was associated with a higher milk-acceptance rate. The adoption of food safety measures by a household can be correlated with different socio-economic and other unobserved factors that can also influence the acceptance rate of milk samples of dairy farmers. Since we did not find a valid instrument, we relied on first estimating the parsimonious model (only including the food safety index variable) and then controlling for other variables in the subsequent models. Our parsimonious model can be expressed by Equation (2):

$$Y = \alpha X + \varepsilon \quad \ldots(2)$$

where, Y is the dependent variable (1/0) indicating whether milk is accepted (1) or rejected (0) by the buyer, X are the intercept and the food safety index variables, α are the coefficients to be estimated and ε is the error-term that is independently and identically distributed in the case of linear probabilistic regression model while following normal distribution in the case of binary probit regression model. The second model adds demographic variables such as age, ethnicity, family size, number of children and elderly members in the family, and education level to the first model. We also accounted for a district-fixed effect to capture the influence of factors that do not vary within the districts. The second model including demographic variables is expressed as Equation (3):

$$Y = \alpha X + \beta S + \gamma D + \varepsilon \quad \ldots(3)$$

where, S is a vector of demographic variables, and D is a dummy variable taking account of the district-fixed effects. The third model includes the variables related to farm characteristics such as farm types, total annual income, annual income from dairy sector, herd size, proportion of animals giving milk in a herd, dairy farming experience, and association with a cooperative. The third model is expressed by Equation (4):

$$Y = \alpha X + \beta S + \delta F + \gamma D + \varepsilon \quad \ldots(4)$$

where, F indicates the vector of farm characteristic variables. We presented the robust standard errors correcting heteroscedasticity in the data. The variables incorporated in Equation (4) are presented in Table 1.

Results and Discussion

Descriptive Results

The descriptive statistics of variables used in the analysis are presented in Table 1. Out of 340 farmers, milk samples from 50 farmers (about 15%) were rejected while milk samples from 290 farmers (85%) passed the test. The average age of household-head in the sample was 48 years. About 78 per cent of them have studied at least up to primary education level. The average size of the family was 7 members. In terms of landholdings, the farmers have been categorized into 4 groups – (1) Marginal (< 0.33 (ha), (2) Small (0.33-1 ha), (3) Medium (1- 2 ha), and (4) Large (> 2 ha). The majority of farmers were marginal (65%), followed by small (28%) households. The average number of bovine animals per farm was 4 and on an average, about

Table 1. Descriptive statistics of variables used in analysis

Variable	Milk-sample group						
	Total samples		Test passed		Test failed		Test statistic
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Food safety index [a]	75.708	9.543	77.370	8.553	66.259	9.453	0.000***
Demographic characteristics							
Age of household-head (Year)[a]	48.082	11.220	47.331	11.573	52.353	7.746	0.003***
Farmer has at least primary education[b]	0.783	0.413	0.800	0.401	0.686	0.469	0.057*
Farmer belongs to Bahun/Chhetri group[b]	0.809	0.394	0.838	0.369	0.640	0.485	0.001***
Farmer belongs to lower caste[b]	0.038	0.192	0.041	0.200	0.020	0.141	0.467
Family size (No.)[a]	7.452	1.978	7.248	1.976	8.608	1.563	0.000***
Number of children and elderly members in the family[a]	3.842	1.326	3.821	1.314	3.961	1.399	0.487
Annual income (lakh NPRs)[a]	3.143	3.652	2.600	3.009	6.229	5.193	0.000***
Annual income from dairy (lakh NPRs)[a]	1.061	1.067	0.978	1.047	1.532	1.070	0.001***
Farm characteristics							
Farmer has marginal landholding[b]	0.657	0.475	0.683	0.466	0.510	0.505	0.025**
Farmer has small landholding[b]	0.284	0.452	0.252	0.435	0.471	0.504	0.002***
Herd size (No.)[a]	4.158	2.407	3.990	2.510	5.118	1.366	0.002***
Proportion of in-milk animals[a]	0.357	0.245	0.381	0.253	0.222	0.124	0.000***
Association with cooperatives[b]	0.587	0.493	0.676	0.469	0.078	0.272	0.000***
Number of years involved in dairying[a]	18.628	7.739	18.559	8.284	19.020	3.234	0.695

Notes: [a]indicates continuous variables while [b] indicates dummy variables. Mann-Whitney test was used for the binary variables and t-test was used for the continuous variables to test the difference in mean of the variables between the milk sample passed and failed groups.

35 per cent of them were giving milk. The average adoption rate of food safety practices of a dairy farm was found to be 75 per cent.

The milk safety compliance rate was higher for those dairy farmers whose milk sample passed the test. The average adoption rate among the milk sample passed group was 77 per cent, while the milk sample failed group had 66 per cent adoption of food safety practices[2]. The proportion of Bahun/Chhetri[3] was 64 per cent in milk sample failed group and 83 per cent in milk sample passed group. Similarly, the proportion of lower social castes in milk sample failed and passed groups was 2 per cent and 4 per cent, respectively. There was a slight difference in the average size and composition of the families between milk sample passed and failed groups. A slight difference in annual income from dairy was found between the passed and failed groups. The average annual income of farmers whose milk sample failed the test was higher (NPRs 6.2 lakh (NPRs = Nepali Rupees), i.e. higher than those whose milk sample passed the test (only NPRs 2.2 lakh). Similarly, the average annual income from the dairy sector was higher for the milk sample failed group (NPRs 1.5 lakh), than for the milk sample passed group (NPRs 0.97 lakh).

The comparison of dairy households in terms of farm sizes revealed that the proportion of marginal households was less in the milk sample failed group than that of the milk sample passed households. On an average, farmers whose milk samples were accepted, possessed a fewer number of animals than that of the milk sample failed group. In contrast, the proportion of in-milk animals was higher (38%) in the milk sample passed group than in the milk sample failed group (22%).

[2] Milk sample was accepted for the passed group while it was rejected for the failed group.
[3] Upper castes

Table 2. Acceptance rate of milk samples by different buyer groups in Nepal

Buyer group	Accepted		Rejected		Total
	Number	%	Number	%	
Cooperative	196	98.00	4	2.00	200
Formal processor	91	67.41	44	32.59	135
Informal processor	33	89.19	4	10.81	37
Self-help group	20	100.00	0	0.00	20

Table 2 shows the acceptance and rejection rates of milk by different buyer groups. The rejection rate of formal milk processors was highest (33%), followed by informal milk processors (11%) and cooperatives (2%). However, the milk-buyer self-help group did not reject the milk samples. The dairy farmers associated with cooperatives and self-help groups often undergo various trainings related to food safety, nutrition, hygiene, etc. They are also conscious about the reputation of the cooperatives. Therefore, these dairy farmers are more sensitive towards producing hygienic and safe milk and avoid adulteration. These are some of the probable reasons why the farmers associated with the cooperatives experienced a lower milk rejection rate. However, the rejection rate is higher in the case of formal and informal milk processors. This is not surprising because they are the private milk buyers and do rigorous testing before buying milk. Thus, these acceptance and rejection patterns of milk samples provide insights into the quality of milk being delivered by the milk producers in Nepal.

The bivariate relationship between food safety scores and the average herd size for the milk-sample passed and milk-sample failed groups is depicted in Figure 1. We generally expect a positive correlation between food safety scores and herd size in the milk-sample passed group, and a negative correlation in the milk-sample failed group. But, what Figure 1 reveals is just the contrast. The dairy farmers were more likely to be associated with a cooperative in the milk-sample passed group (67%) than in the milk-sample failed group (7%). The difference was found to be statistically significant. Although no statistical difference in the dairy farming experience was found between milk

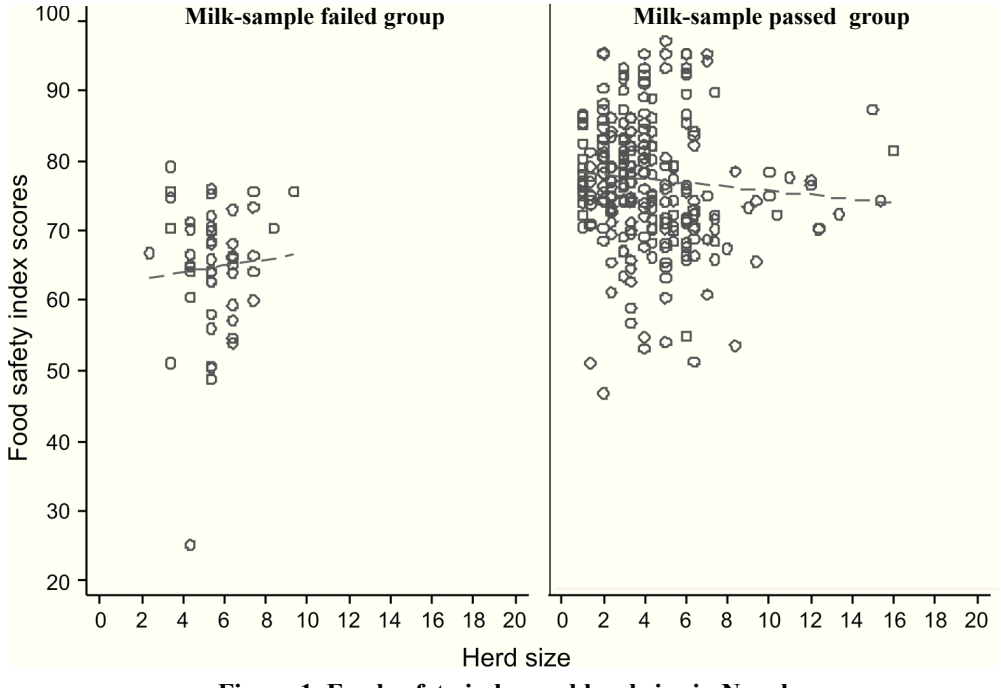

Figure 1. Food safety index and herd size in Nepal

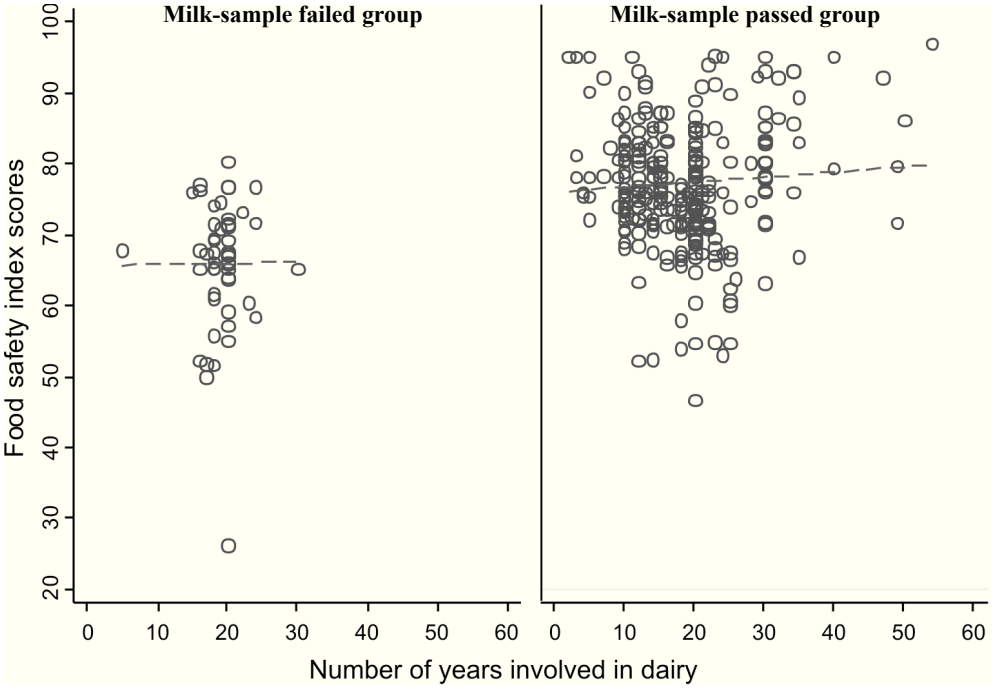

Figure 2. Food safety index and number of years involved with dairying

sample passed and failed groups, a slight positive relationship was observed between food safety scores and dairy farming experience in the milk sample passed group (Figure 2).

Empirical Results

The empirical results from the linear probability regression model are presented in Table 3. The impact of food safety index—the variable of our interest — is found positive and statistically significant in all the models. This presents a robust evidence of the positive effect of adoption of food safety measures on the milk sample acceptance rate. The magnitude of coefficient reduces after controlling for the demographic and farm characteristics, suggesting the importance of these variables in influencing the milk-samples acceptance rate. The coefficient of determination 0.34 indicates that our full model (independent variables) explains about 34 per cent of the variations in the dependent variable (milk-samples acceptance rate). Since the Akaike Information Criterion (AIC) test shows the third model to be a better-fit model (has the minimum AIC value), we have interpreted results only from the full model.

The variables food safety index, lower social caste, marginal landholding, and association with a cooperative have been found to be statistically significant at standard test levels (Table 3). The increase in food safety index by additional one unit is associated with increase in milk-sample acceptance rate by about 1 per cent. This increase in acceptance rate is critical for the marginal and small milk-producing households as they depend on cash from milk-sales to meet their daily needs. Moreover, many of these farmers are likely to consume the buyer-rejected milk instead of safely discarding it, which may have negative effects on the health of the whole family.

The households from lower social castes have roughly 15 per cent higher rate of milk-samples acceptance. Most of these lower caste households are economically poor and are mainly targeted as potential beneficiaries of development projects (Domelen, 2007). They might have received training on milk safety measures or might have been more risk averse.

The milk-samples acceptance is likely to be more from marginal farms than other farms by about 12 per cent. And this is not surprising because marginal farms have limited livelihood opportunities and therefore, are highly sensitive towards the rejection of milk-samples. The larger farms generally have multiple income sources and thus can bear the risk of milk-samples rejection.

Table 3. Factors influencing milk-sample acceptance based on linear probability regression model

Variables	Model 1	Model 2	Model 3
Food safety index	0.0157***	0.013***	0.0074***
	(0.0020)	(0.0020)	(0.0024)
Age of household-head (years)		0.0026	0.0028
		(0.0017)	(0.0018)
Farmer belongs to Bahun/Chhetri caste		0.0995	0.0517
		(0.0639)	(0.0693)
Farmer belongs to lower social caste		0.1782**	0.1538*
		(0.0892)	(0.0896)
Family size		-0.0436***	-0.0100
		(0.0138)	(0.0162)
Number of children and elderly in the family		0.0241	-0.0078
		(0.0194)	(0.0199)
Household-head has at least primary education		0.0183	-0.0027
		(0.0530)	(0.0515)
Farmer has marginal landholding			0.1195*
			(0.0641)
Farmer has small landholding			0.1001
			(0.0733)
Annual income of the household (NPRs in lakh)			-0.0177
			(0.0154)
Annual income from the dairy sector (NPRs in lakh)			0.0020
			(0.0196)
Herd size (No.)			0.0097
			(0.0130)
Proportion of in-milk animal			-0.0001
			(0.0008)
Number of years involved in dairy farming			0.0008
			(0.0018)
Associated with a cooperative society			0.1679**
			(0.0695)
Constant	-0.3359**	-0.0832	0.0817
	(0.1664)	(0.2002)	(0.2109)
District-fixed effects	No	Yes	Yes
AIC	196.004	163.65	158.48
Number of observations	340	340	340
R^2	0.1789	0.3003	0.3425

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 indicate level of significance at 1 per cent, 5 per cent and 10 per cent, respectively.

The farms associated with the cooperative groups have been found to have a higher probability of milk acceptance, illustrating the value of membership in a cooperative. If a farm is associated with a cooperative group, the probability of its milk being accepted increases by about 17 per cent. The association with cooperatives has been found to have a positive impact on the adoption of food safety practices in milk production in some previous studies as well (e.g. Kumar *et al.,* 2013; Kumar *et al.,* 2017). The cooperative societies provide training to their members on livestock rearing, hygienic milk production, milk handling, and distribution. Any unethical activity by a member can tarnish the reputation of the whole

cooperative society. Therefore, a farm affiliated with a cooperative group is likely to adopt the best dairy practices governing milk safety and its hygiene.

Table 4 presents the results of robustness test using a binary probit regression model and provides the marginal effects. While the results from marginal effects can be interpreted directly in terms of the probability of acceptance versus rejection, the coefficients obtained from the binary probit regression model do not have any meaningful interpretation. Only the sign of coefficients can be interpreted in terms of increasing/decreasing effects on the probability of milk-samples being accepted or rejected. While comparing the results in Table 3 (full model) and Table 4, the sign and statistical significance of the coefficients remain preserved for the majority of the variables, indicating the robust results, especially on the effect of increased milk safety measures on the milk-samples acceptance

Table 4. Robustness check using binary probit model and marginal effect

Variables	Probit	Marginal effect
Food safety index	0.0316*	0.0040*
	(0.0189)	(0.0023)
Age of household-head (years)	-0.0039	-0.0005
	(0.0131)	(0.0016)
Farmer belongs to Bahun/chhetri caste	0.0132	0.0017
	(0.3235)	(0.0406)
Farmer belongs to a lower social caste	0.7429	0.0933
	(0.5682)	(0.0727)
Family size	-0.1237	-0.0155
	(0.1087)	(0.0137)
Number of children and elderly members in family	0.0097	0.0012
	(0.1335)	(0.0168)
Household-head has at least primary education	-0.1770	-0.0222
	(0.2567)	(0.0324)
Farmer has marginal landholding	1.0549	0.1325
	(0.7090)	(0.0887)
Farmer has small landholding	1.3852*	0.1740*
	(0.7726)	(0.0974)
Annual income of household (NPRs in lakh)	-0.1090*	-0.0137*
	(0.0626)	(0.0078)
Annual income from dairy sector (NPRs in lakh)	0.0325	0.0041
	(0.0928)	(0.0116)
Herd size (No.)	0.0591	0.0074
	(0.0769)	(0.0097)
Proportion of in-milk animals	0.0066	0.0008
	(0.0116)	(0.0015)
Number of years involved in dairy farming	0.0239	0.0030
	(0.0315)	(0.0039)
Associated with a cooperative society	1.3048***	0.1639***
	(0.5031)	(0.0622)
Constant	-1.1498	
	(1.4565)	
District fixed effect	Yes	Yes
Number of observations	340	340

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 indicate level of significance at 1per cent, 5 per cent and 10 per cent, respectively.

rate. The marginal effect in the probit model indicates that an increase in food safety index by 1 per cent is correlated with an increase in milk-samples acceptance rate by 0.4 per cent. The farmers with small land-holding will have 17 per cent greater chance of milk-sample acceptance while association with cooperatives increases the milk acceptance rate by 16 per cent. The annual income variable, which was not significant in the linear probability model, turned out to be significant in the probit model. The increase in annual income of dairy farmers by an additional NPRs 1 lakh reduces the probability of milk acceptance by 1 per cent.

Conclusions and Policy Implications

This paper has looked into an issue which has both social and economic relevance for Nepal. Practically, most of the households in Nepal buy milk but milk buyers sometimes do not accept the milk produced by dairy farmers. The rejection of milk has an adverse economic impact on the welfare of marginal and small farmers who obtain a large portion of their household income from milk sale. The main objective of this study was to assess whether the adoption of higher milk safety measures translates into increased milk-samples acceptance rate. For this study, we conducted a household survey among dairy farmers in 6 well-known dairy-producing districts (Illam, Surkhet and Kavre from Hill; Morang, Banke and Rupandehi from Terai) of Nepal. We asked questions regarding socio-economic characteristics, herd size, adoption of milk safety measures, feeding, milk handling and its transportation, etc.

This study is based on information gathered from the dairy farmers regarding their milk samples being accepted or rejected in the quality test. Since this is a sensitive issue, we received response only from 340 dairy farmers. We have found that one unit increase in the food safety index increases the milk acceptance rate by 1 per cent. Also, the acceptance rate was higher for the lower social caste and marginal households. The dairy farms associated with a cooperative group have also depicted 17 per cent higher chance of milk-samples acceptance, highlighting the importance of a cooperative group.

Our findings have important policy implications. We suggest that dairy farmers, however small they may be, should be educated and persuaded to be associated with a cooperative group. Any government policy for promotion of dairy cooperatives will in turn help farmers increase their milk-samples acceptance. The observed positive correlation between food safety index and milk-samples acceptance rates suggests that trainings and sensitization on the hygienic and safe milk production practices is critical for dairy farmers in Nepal. And therefore, efforts should be made to organize such programs regularly in the country.

This study faced some limitations also. First, we did not receive response from all the dairy farmers we attempted to contact. Second, the milk was not accepted sometimes based on physical factors like smell, colour, and thickness. There is a need to conduct future studies focusing on scientific testing of milk samples and reducing non-response bias of dairy farmers in Nepal.

References

Antle, J.M. (1996) Efficient food safety regulation in the food manufacturing sector. *American Journal of Agricultural Economics*, **78**: 1242-1247.

Buckley, A.J. (2015) Food safety regulation and small processing: A case study of interactions between processors and inspectors. *Food Policy*, **51**: 74-82.

Chakrabarti, A. (2013) Attitude and practices towards food safety in domestic consumption: A case study from India. *Journal of International Development*, **25**: 696-713.

Dahal, L.K., Karki, D.B.N. and Shah, R. (2010) Total bacterial counts of raw milk in eastern Terai of Nepal. *The Journal of Agriculture and Environment*, **11**: 46-50.

Domelen, V.J. (2007) Reaching the poor and vulnerable: Targeting strategies for social funds and other community-driven programs. *Social Protection Discussion Paper 0711*. World Bank.

Dou, L., Yanagishima, K., Li, X., Li, P. and Nakagawa, M. (2015) Food safety regulation and its implication on Chinese vegetable exports. *Food Policy*, **57**: 128-134.

Gould, B.W., Smukowski, M. and Bishop, J.R. (2000) HACCP and the dairy industry: An overview of international and US experiences. In: *The Economics of HACCP: Costs and Benefits*. Eagan Press, St. Paul, Minnesota. pp.365-384.

Grace, D., Randolph, T., Omore, A., Schelling, E. and Bonfoh, B. (2007) Place of food safety in evolving pro-poor dairy policy in East and West Africa. *Revue*

D'élevage et de Médecine Vétérinaire des pays Tropicaux, **60**(1-4): 153-162.

Grace, D., Kohei, M.K., Kang'ethe, E.K. and Bonfoh, B. (2010) Safe food, fair food: Participatory risk analysis for improving the safety of informally produced and marketed food in sub Saharan Africa. *Revue Africaine de Santé et de Productions Animales*, **8**(S): 3-11.

Grace, D., Mahuku, G., Hoffmann, V., Atherstone, C., Upadhyaya, H. and Bandyopadhyay, R. (2015) Agricultural research to reduce food risks and increase opportunities for poor farmers: Case studies on aflatoxins. *Food Security*, **7**(3): 569-582.

Handschuch, C., Wollni, M. and Villalobos, P. (2013) Adoption of food safety and quality standards among Chilean raspberry producers–Do smallholders benefit? *Food Policy*, **40**: 64-73.

Jensen, H.H. and Unnevehr, L.J. (2000) HACCP in port processing costs and benefits. In: *The Economics of HACCP: Costs and Benefit*. Eagan Press, St. Paul, Minnesota. pp. 29-44.

Jensen, H.H., Unnevehr, L.J. and Gomez, M.I. (1998) Costs of improving food safety in the meat sector. *Journal of Agricultural and Applied Economics*, **30**: 83-94.

Jongwanich, J. (2009) The impact of food safety standards on processed food exports from developing countries. *Food Policy*, **34**: 447-457.

Kirk, M., Ford, L., Glass, K. and Hall, G. (2014) Foodborne Illness, Australia, circa 2000 and circa 2010. *Emerging Infectious Diseases*, **20**(11): 1857-1864.

Kumar, A., Shinoj, P. and Shiv Jee (2013) Do dairy co-operatives enhance milk production, productivity and quality? Evidences from the Indo-Gangetic plain of India. *Indian Journal of Agricultural Economics*, **68**(3): 457-468.

Kumar, A., Wright, I.A. and Singh, D.K. (2011) Adoption of food safety practices in milk production: implications for dairy farmers in India. *Journal of International Food & Agribusiness Marketing*, **23**: 330-344.

Kumar, A., Thapa, G., Joshi, P.K. and Roy, D. (2017) Adoption of food safety measures among Nepalese producers: Do smallholders benefit?. *Food Policy*, **70**: 13-26.

Mangen, M.-J., Bouwknegt, M., Friesema, I.H.M., Haagsma, J.A., Kortbeek, L.M., Tariq, L. and Havelaar, A.H. (2014) Cost-of-illness and disease burden of food-related pathogens in the Netherlands, 2011. *International Journal of Food Microbiology*, **196**: 84-93.

Mortlock, M.P., Peters, A.C. and Griffith, C.J. (2000) Applying HACCP to small retailers and caterers: A cost benefit approach. In: *The Economics of HACCP: Cost and Benefits*. Eagan Press, St. Paul, Minnesota. pp.301-314.

NDDB (National Dairy Development Board) (2014) *Final Report on Study on Cost of Milk Production*. Lalitpur, Nepal.

Soomro, A.A., Khaskheli, M., Memon, M. A., Barham, G.S., Haq, I.U., Fazlani, S.N., Khan, I.A., Lochi, G.M. and Soomro, R.N. (2014) Study on adulteration and composition of milk sold at Badin. *International Journal of Research in Applied, Natural and Social Sciences*, **2**(9): 57-70

Thomas, M.K., Murray, R., Flockhart, L., Pintar, K. and Pollari, F. (2013) Estimates of the burden of foodborne illness in Canada for 30 specified pathogens and unspecified agents, circa 2006. *Foodborne Pathogens and Disease*, **10** (7): 639-648.

Walker, G.P., Dunshea, F.R. and Doyle, P.T. (2004) Effect of nutrition and management on the production and composition of milk and protein. *Australian Journal of Agricultural Research*, **55**: 1009-1028.

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Appendix Table 1. Distribution and adherence of milk safety adoption practices in Nepal

Milk hygiene	Percentage of adoption	Milk storage	Percentage of adoption	Dairy environment	Percentage of adoption	Animal health	Percentage of adoption
Cattle milked separately from stall	68.7	Milk from diseased animal kept separately	64.1	Floor of stall feed area kept well-drained daily	1.9	No feces in the animal body	73.4
The floor of milking area kept well-drained daily	21.7	Milk from seriously diseased/ infected animals discarded	28.2	Floor of stall feed area kept clean daily	4.0	Diseased animals isolated	61.1
Floor of milking area cleaned daily	25.7	Milk stored separately from the animal shed	92.5	Dung disposed immediately after excretion	63.6	Animals washed regularly	61.4
Hands washed before milking	97.9	Floor of milk storage area dried regularly	66.4	Urine drained immediately after excretion	49.8	Animal drinks clean water	75.1
Hands dried before milking	54.1	Milk storage area swept regularly	98.0	Chemicals used in dairy area	39.3	Dry cow therapy	4.5
Hands sanitized before milking	93.5	Milk storage area washed regularly	2.5	Chemicals used as per instruction	91.5		
Utensils without joints	90.3	Milk storage area kept free of pests	85.7	Workers wear suitable clean clothes	86.1		
Utensils dried before milking	80.5	Milk containers used for bulking without joints	75.2	Nails trimmed regularly	96.0		
Utensils cleaned before milking	97.7	Milk containers used for bulking washed regularly	77.9	Cuts/wounds covered with appropriate waterproof dressing	65.1		
Utensils sanitized before milking	94.3	Powder/baking soda mixed before selling milk	4.3	Dairy farm inspected regularly to ensure safety of overall farm	43.6		
Utensils washed immediately after milking	92.7			Store empty containers/utensils in refrigerator	36.8		
Milk thrown after use of medicine	33.0						
Udders/teats cleaned before milking	95.2						
Udders/teats dried before milking	48.6						
Udders sanitized before milking	89.3						
Milk pasteurized and labelled	9.0						