Chapter

Importance of Socio-Economic and Institutional Factors in the Use of Veterinary Services by the Smallholder Dairy Farmers in Punjab

Shiv Raj Singh, Kamal Kumar Datta and Supern Singh Shekhawat

Abstract

The study has shown the importance of identifying factors that determined the likelihood of using veterinary services in Punjab. Secondary data were used for analysis with the sample size of 1137 dairy households. Estimates of factors influencing the use of veterinary services are reasonably consistent with the farmer decision to use it. The proportional relationship between veterinary services available within the village and use of veterinary services revealed that, distance of veterinary service availability positively influenced the farmer decision to use the veterinary services. There was a positive relationship between herd size and use of veterinary services. More educated farmers are in a better position to use the veterinary services. The principal source of income from agricultural activities was positively influenced by the likelihood to use veterinary services in study area. The model from empirical point of view is very important to predict whether household will be using the veterinary services or not after incorporating the value of the explanatory variables.

Keywords: socio-economic, institutions, veterinary services, commercialization, logit

1. Introduction

The livestock sector in Punjab contributes 33.38% to agricultural gross domestic product (GDP), and 7.91% to state GDP [1]. This indicates that livestock sector is one of the important sectors in the state economy. As per Pingali and Rosegrant [2] "*Agricultural commercialization means more than the marketing of agricultural output, it means the product choice and input use decisions are based on the principles of profit maximization*". In the same pattern, commercialization of dairy farming involves orientation towards marketing of milk and use inputs more intensively for dairy farming. In dairy farming, four inputs viz. feed, fodder, labor and veterinary services are very important. The smooth transition from subsistence to commercial dairy farming is possible only if well integrated markets exist for the input and output.

Veterinary services are one of the important inputs for dairy farming. Dairy farmers face different socioeconomic circumstances in their own setting, which are likely to cause differences in the attitudes towards the available alternatives [3]. Other than socio-economic factor in the dairy farming, institutional arrangement play pivotal role for service delivery system. The main reason for carrying out this study was to understand the socio-economic and institutional factors, which influence the decision for use of veterinary service. The objective of the study was, therefore, to assess important factors that determined the use of veterinary services by dairy farmers in Punjab.

2. Materials and methods

2.1 Source of data

The study is based on the secondary data, available from National Sample Survey Organization (NSSO) on "*Situation Assessment Survey of Farmers*", in the year 2003 (visit-1). *Situation assessment survey of farmers* was conducted (rural sector) in two rounds, i.e. visit-1 (January–August, 2003) and another was visit-2 (September–December, 2003). The visit-1 encompasses detailed information on socio-economic, crop husbandry, animal husbandry, access to basic and modern farming resources, and consumption expenditure of Indian farmers.

This particular survey focused on the rural area by keeping rural farm households as the unit of observations. The sampling design used in the NSS data was stratified multi-stage random sampling with districts as strata, villages as first stage units and farm households as the second stage units. Based on stratified multi-stage sampling design, the survey covered 51,771 sample households at all India level, out of which 1137 sample comprised Punjab's households belonging to dairy farming who reared at least one milch dairy animal.

2.2 Modeling

Both descriptive statistics and econometric methods were employed for the data analysis. In this study, a *logit* model was estimated to determine the factors which made the dairy farmers to decide upon the use veterinary services. Veterinary services include artificial insemination, vaccination and treatment of animals. When the dependent variable is a 0–1 binary variable, the *logit* or *probit* model estimation methods can be used. To predict the dependent variable, the farmers were classified into two groups, who used veterinary services and who did not use. The *logit* model is specified below.

$P_i = \frac{1}{1 + e^{-zi}}$, where P_i is the probability that farmer used veterinary services.

$1 - P_i = 1 - \frac{1}{1 + e^{-zi}}$, where $1 - P_i$ is the probability that farmer do not use veterinary services.

$$\text{The Odd}^{"}\text{s ratio} = \left(\frac{P_i}{1 - P_i}\right) = e^{zi}. \quad (1)$$

Taking logarithm on both sides,

$$Ln\left(\frac{P_i}{1 - P_i}\right) = Z_i = \alpha + \beta_i \chi_i + e_i \quad (2)$$

Where, α = intercept, β = vector of response coefficient, e = vector of random disturbance and X_i is the set of explanatory variables.

The binary logistic regression has widely been used to address decision involving binary choice in adoption studies [4]. In this study, the following model was used:

$$\text{vet\_service} = \beta_0 + \beta_1 \text{village} + \beta_2 \text{family size} + \beta_3 \text{socially forward} + \beta_4 \text{land holding} + \beta_5 \text{principal income} + \beta_6 \text{training} + \beta_7 \text{literate} + \beta_8 \text{like agri.} + \beta_9 \text{herd size} + \beta_{10} \text{agri.science centre} + \beta_{11} \text{extension workers} + \beta_{12} \text{literate}^{*} \text{herd size} + \varepsilon_i \quad (3)$$

where, vet_service is the veterinary service used by the farmers, while $\beta_1,\ldots, \beta_{12}$ are coefficients associated with each explanatory variable and ε_i is the error term. Several factors were hypothesized to influence the farmers' decision to use the veterinary services. The description of these factors is presented in **Table 1**. The choice of these explanatory variables was mainly based on the general working hypothesis and partly on empirical findings from literature, and, therefore, a positive or negative sign was assigned depending on the potential influence of a particular variable on use of veterinary services.

The marginal probability was calculated by multiplying the coefficient estimate by *logit* function, by the standard probability density function of the *logit* model evaluated at the mean values of the explanatory variables. For dichotomous explanatory variables with a value of zero or one, the marginal probability was calculated as the difference arising from standard probability density function for explanatory variable value zero or one for the discrete variable [3].

Interaction terms are used extensively in nonlinear models, such as *logit* model. Unfortunately, the intuition from linear regression models does not extend to nonlinear models. The marginal effect of a change in both interacted variables (specially, when herd size is continuous variable and literacy is binary variable) is not equal to the marginal effect of changing just the interaction term. More surprisingly, the sign may be different for different observations. The statistical

Variables	Description of the variables	Expected signs
Dependent variable		
Vet_service	Veterinary service used yes = 1, no = 0	
Explanatory variables		
Village	Veterinary services available within the village = 1, otherwise = 0	+
Family size	Family size (1–5) = 1, otherwise = 0	+
Socially forward	Socially forward (general and OBC) =1, otherwise = 0	+
Land holding	Land holding (ha.) (continuous)	+
Principal income	Principal source of income from agriculture = 1, otherwise = 0	±
Training	Head of household attended any formal training in agriculture = 1, otherwise = 0	+
Literate	Literate head of households = 1, otherwise = 0	+
Like agri.	Farmer likes agriculture as a profession = 1, otherwise = 0	+
Herd size	Herd size of milch dairy animals (continuous)	+
Agri. science centre	Whether accessed Agriculture Science Centre = 1, otherwise = 0	+
Extension workers	Whether accessed extension workers = 1, otherwise = 0	+
Literate * herd size	Interaction of literacy of head of household and herd size of milch dairy animals	+

Table 1.
Description of dependent and explanatory variables used in the analysis and the expected signs.

significance cannot be determined from the Z-statistic reported in the regression output. Ai and Norton [5] showed that the coefficients for such interaction terms, their signs and their significance levels may all be incorrect when using nonlinear models. Ai and Norton [5] suggested a method to overcome this problem. When one continuous variable and one dummy variable are interacted, the interaction effect is the discrete difference of the single derivative. They also derived the standard errors for the interaction effect in *logit* models, applying the delta method.

Multicollinearity can undermine the statistical integrity of the model. Multicollinearity in *logit* models is a result of strong correlations between independent variables. The Variance Inflation Factor (VIF) is generally used to detect the multicollinearity in binary models. In the *logit* models often VIF value above the 2.5 considered as cut off point for multicollinearity detection [6]. In our analysis only two variables i.e. self-employed in agriculture (VIF = 3.57) and principal source of income from agriculture (3.21) are collinear on the basis of value of VIF and we drop self-employed in agriculture variable from the analysis. The resultant value of VIF for principal source of income from agriculture was 1.62 in the permissible limit.

3. Results and discussion

3.1 Important dairy farmers characteristics

Descriptive statistics on dairy farmers' characteristics are presented in **Table 2**. Among overall 1.65 million dairy farmers, 70.91% dairy farmers used veterinary services in the survey period. Around 43.64% dairy farmers were able to access veterinary services within the village itself. Half of dairy farmer household size (number of persons) was between 1 and 5. Large number (52.73%) of dairy farmers were self-employed in agriculture with the average land holding size of 1.55 ha. However, 56.97% dairy farmers' principal source of income was agriculture alone. Head of the family played an important role in decision making process and hence, it is very important to study important characteristics of dairy households' heads. From **Table 2**, it is reflected that 47.88% heads of dairy households were literate but less than 1% head of households had training in agriculture. In the survey, 61.21% dairy farmers admitted that they liked agriculture as a profession. Average herd size (number of animals) of milch animal per dairy farmer was about 3.51. Access to Agriculture Science Centre (Krishi Vigyan Kendra) and contact with extension workers may be proxies for access to information. From **Table 2**, it is reflected that only fraction (0.95%) of dairy farmers access the Agriculture Science Centre, personally. However, extension worker's contact with the dairy farmers is somehow satisfactory.

3.2 Factor(s) influencing the choice of veterinary services

Empirical estimates derived from the binary *logit* model are presented in **Table 3**. Empirical estimate signs correspond as depicted in **Table 1**. Given that the model included several binary variables, the chosen level of statistical significance was 1 and 5%. Out of 12 influential factors 4 are statistically significant at 1 and 5% level of significance.

The Odds ratio is useful to determine the number of dairy farmers who used veterinary services. The Odds ratio is defined as the ratio of probability that dairy farmers used veterinary services to that of who did not use veterinary services. As number of dairy farmers in the sample is 1137 and 777 farmers are used veterinary

Characteristics	Number	Percentage*
Sample households (million)	1.65	
Veterinary services used (million)	1.17	70.91
Veterinary services available within the village (million)	0.72	43.64
Family size (1–5) (million)	0.86	51.12
Self-employed in agriculture (million)	0.87	52.73
Socially forward (million)	1.17	70.91
Average land holding (ha.)	1.55	
Principal source of income from agriculture (million)	0.94	56.97
Head of household attended any formal training in agriculture (thousand)	16.15	0.98
Literate head of households (million)	0.79	47.88
Farmer likes agriculture as a profession (million)	1.01	61.21
Average herd size of milch dairy animals (no.)	3.51	
Whether accessed Agriculture Science Centre (thousand)	15.65	0.95
Whether accessed extension workers (thousand)	34.47	2.09

**Figures in percentage indicate percentage to sample households.*

Table 2.
Selected institutional and socio-economic characteristics of dairy farmers using veterinary services.

Characteristics[b]	Coefficients[a]	S. E.	Z	P > Z
Veterinary services available within the village	0.3896	0.1346	2.89	0.004***
Family size (1–5)	−0.1606	0.1366	−1.18	0.24
Socially forward	−0.1353	0.1619	−0.84	0.403
Land holding	0.03844	0.0424	0.91	0.365
Principal source of income from agriculture	0.578	0.1715	3.37	0.001***
Head of household attended any formal training in agriculture	−0.4072	0.6669	−0.61	0.541
Literate head of households	0.5338	0.232	2.3	0.021**
Farmer likes agriculture as a profession	−0.0837	0.1478	−0.57	0.571
Herd size of milch dairy animals	0.1143	0.0476	2.4	0.016**
Whether accessed Agriculture Science Centre	−0.3964	0.7081	−0.56	0.576
Whether accessed extension workers	0.7937	0.7276	1.09	0.275
Interaction of literacy of head of household and herd size of milch dairy animals	0.0076	0.0625	0.12	0.903
Constant	1.1764	0.7976	1.47	0.14

[a]n = 1137, Log likelihood = −661.21, LR chi^2(12) =97.24, Prob > chi^2 = 0.0000, Pseudo R^2 = 0.0685.
[b]Significant at 1% (***) and 5 (**).

Table 3.
Binary logit model coefficient estimates for determinants of farmers' use of veterinary services.

services, the probability (P) that a farmer is used veterinary services can be computed as $P = \frac{777}{1137} = 0.68$. The probability ($1 - P$) that a farmer is not used veterinary services is $1 - P = 0.32$. Given P, the Odds ratio (O) can be derived as $O = \frac{P}{1-P} = \frac{0.68}{0.32} = 2.13$; it means if one farmers choose not to use veterinary services, then more than two farmers used veterinary services.

The observed proportional relationship between veterinary services available within the village and use of veterinary services implied that distance of availability positively influenced the farmer's decision. The positive relationship was observed between literacy levels of family head and use of veterinary services. It implied that improving the literacy level of dairy households would increase the likelihood of veterinary service usage. Farmers who kept large number of dairy animals were more particular on use of veterinary services. In reality, farmers with large herds are relatively cautious regarding the use of veterinary services since this has economic implications on their enterprises. This also indicates that as commercial dairy farming increases it opens up new opportunities for veterinary doctors. The interaction term of educated head of households and herd size is positively related with the use of veterinary services but non-significant (Z-statistic is 0.12). The *non-significance* of interaction term implies that persons who are educated and have large herd size are not likely to use veterinary services. In case of few observations, the interaction effect is statistically significant, which are smaller in number whereas, it is non-significant for large number (**Figure 1**). However, after estimating the interaction effect, we learned that mean interaction effect is negative (−0.0028) and varies widely. The principal source of income from agriculture positively influenced the likelihood to use veterinary services in study area. It is indicated that as the income from agriculture increased demand for veterinary services also increased.

Table 4 presents marginal effect for the variables, which were presented in **Table 3** with significant coefficients for the use of veterinary services. These probabilities show how changes in specific variables affected the probabilities of a dairy farmers reacting positively towards use of veterinary services. Marginal effect computed for continuous variables were not comparable with those computed for binary variables. The prediction probability of model was very high (0.71) for the use of veterinary services. The dairy farmer's response towards the use of veterinary services was highly influenced (12.05%) by the unit increase in income from agricultural activities. The result of marginal effect also indicated that, the unit increase in the literacy level of the family head increased the probability of veterinary services use by 11.05%. The next most influential variable was increase in veterinary services availability in the villages which enhanced the probability by 8.07% for the use of veterinary services.

This study has shown the importance of identifying factors that determine the likelihood of using veterinary services by dairy farmers in Punjab. Descriptive analysis revealed that, for the majority of dairy farmers the principal source of income was agriculture and they possessed small landholding. Dairy farming offers an opportunity to these marginalized famers to diversify farming business and to secure livelihood. Based on the *logit* model, dairy farmers using veterinary services were classified as following: dairy farmers having more likelihood of using veterinary services had large herd size. The proportional relationship between veterinary services available within the village and use of veterinary services implied that distance of veterinary service availability positively influenced the farmer decision to use the veterinary services. Therefore, the number of veterinary institutions delivering veterinary services should be increased at village level. The positive relationship was observed between literacy levels of family head and use of veterinary services. It implied that improving the literacy level of dairy households increased the likelihood to use veterinary services. The principal source of income from agriculture positively influenced the likelihood of veterinary service use by dairy farmers. It is indicated that as the income from agriculture activity increased the dairy farmers more likely used veterinary

services. Those dairy farmers who were self-employed in agricultural activities were more potent to the use of veterinary services in the Punjab. The model from empirical point of view is very important to predict whether household will be using the veterinary services or not after incorporating the value of the explanatory variables. With the given set of NSSO data, the predicted model showed that 71% of the farmers used the veterinary services as one of the important input in order to commercialize dairy farming.

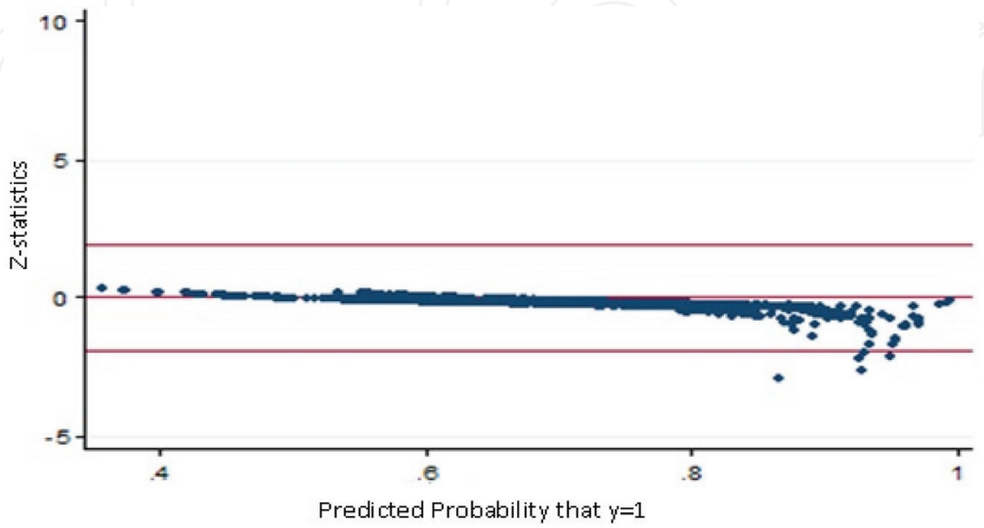

Figure 1.
Z-statistics of interaction effect (literacy of head of household and herd size of milch dairy animals) after logit.

Characteristics[a]	Marginal effect	S. E.	Z	P > Z
Veterinary services available within the village	0.0807	0.02757	2.93	0.003***
Family size (1–5)	−0.0334	0.02838	−1.18	0.239
Socially forward	−0.0279	0.0331	−0.84	0.398
Land holding	0.008	0.0088	0.91	0.364
Principal source of income from agriculture	0.1205	0.0357	3.38	0.001***
Head of household attended any formal training in agriculture	−0.091	0.1578	−0.58	0.564
Literate head of households	0.1105	0.0476	2.32	0.021**
Farmer likes agriculture as a profession	−0.0174	0.0306	−0.57	0.57
Herd size of milch dairy animals	0.0238	0.0099	2.4	0.016**
Whether accessed Agriculture Science Centre	−0.0885	0.167	−0.53	0.596
Whether accessed extension workers	0.1373	0.0996	1.38	0.168
Interaction of literacy of head of household and herd size of milch dairy animals	0.0016	0.013	0.12	0.903

Marginal effects after logit y = Prob. (whether used veterinary services yes = 1) (predict) = 0.71.
[a]Significant at 1% (***) and 5 (**).

Table 4.
Marginal effects of explanatory variables on the probability of veterinary services used.

Author details

Shiv Raj Singh[1*] Kamal Kumar Datta[2] and Supern Singh Shekhawat[3]

1 Department of Agricultural Economics, C.P. College of Agriculture, S.D. Agricultural University, Gujarat, India

2 Agri Business Management, Central Agricultural University, School of Post Graduate Studies, Meghalaya, India

3 Krishi Vigyan Kendra, Kotputli, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

*Address all correspondence to: shivagritech2007@gmail.com

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