Research article

DETERMINING FACTORS AND IMPACT OF HOUSEHOLD INCOME ON DAIRY CATTLE INSURANCE IN NEPAL

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ABSTRACT

Nepalese agriculture insurance market is dominated by livestock sector and cattle are the most popular class of animal in livestock production system. This study was conducted to identify the determining factors and impact of household income on dairy cattle insurance. This study was based on the field survey conducted in Chitwan and Nawalparasi districts of Nepal. A total of 160 households were sampled using a stratified simple random sampling technique. Data were collected using a pre-tested interview schedule and focusgroup discussion (FGD) in 2017. The result of t-test showed annual household income, income from milk sell, and average cattle holding significantly higher in cattle insurer farmers than that of non-insurers. A probit model was used to assess the factors affecting the decision for the adoption of cattle insurance. The probit model revealed that cattle breed, access to loan, income from livestock, and number of cattle had a positive and significant relationship with the adoption of cattle insurance whereas, household size and district dummy had a negative and significant relationship with the adoption of cattle insurance. Income regression function revealed that the adoption of insurance, the number of cattle, and the district of the respondents had a positive and significant relation with income from livestock. The instrumental variable model adopted to combat endogeneity bias showed that adoption of insurance and district of the respondents had a positive and significant relation with income from livestock. Although the results are farmers specific, findings have implications for policymakers regarding promotion of improved breeds and facilitation of farm credit.

Keywords: Insurance, dairy cattle, household income, endogeneity

INTRODUCTION

Livestock is one of the fastest-growing agricultural subsectors in developing countries and its share of agricultural GDP is quickly increasing. Livestock derived food are known to account for about 80 percent of production and consumption volumes globally (Enahoro, Lannerstad, Pfeifer, & Dominguez, 2018). The study conducted by (Maltsoglou & Taniguchi, 2004) stated that livestock and land are the two major components of rural farming and, livestock sector in Nepal has significant importance in terms of household food consumption and cash income where the latter proves to be especially important for smallholders and landless households and the study calls for appropriate integrated policy for strengthening livestock sector which would have an indirect positive impact on the rural poor. In the context of Nepal, livestock is an important component of agriculture, contributes 19.44 percent in the total agricultural GDP and had a wide range of importance by contributing to food and nutritional security, employment and income generation (MoAD, 2020). Despite all these opportunities, there is no separate national livestock policy in Nepal, and instead, livestock-related policies are spread across agriculture and other sectors. The main types of risk in the livestock sector are a sanitary risk, catastrophic climatic risks like flood, theft, injury, illness or death of an animal and other weather risks which can affect pasture and forage availability and therefore on the economic sustainability of the farm (Njavro, Par, & Plesko, 2007). Livestock insurance can be the alternative to the occasional herd loss and could prevent a downward slide of vulnerable populations, crowd-in investment accumulation for poor, and induce financial deepening by crowding in-credit (Philemon, Andrew , & Rupsha, 2015). Although, general insurance was introduced in Nepal in 1937 after the establishment of Nepal Bank Ltd, the country's first commercial bank, and the National Insurance Corporation was established in 1967, livestock insurance began only in 1987 in form of livestock credit or micro-finance guarantee insurance against animal mortality and loss. After the promulgation of crop and livestock insurance directive in 2013 the compulsory involvement insurance companies for livestock and crop insurance have been ensured (MoAD, 2020) and there are 20 insurance companies providing livestock and crop insurances (Subedi, 2021).

Insurance premium rate of 5 percent has been assigned per year and the Ministry of Agricultural Development introduced a subsidy on the premium paid for insurance of crop and livestock in June 2013. The government provides a 80 percent subsidy on insurance premiums paid by individual farmers, farmers' groups, and farmer cooperatives since 2021.

MATERIALS AND METHODS

Study site and sample

Chitwan and Nawalparasi districts of Nepal were selected purposefully for the study to include major cattle rearing districts. The roster of the farmers registered as insurers in the respective districts was prepared with the help of DLSO and insurance companies. The farmers holding the insurance scheme were categorized into clusters according to the Municipality in two districts and the Municipalities were purposively selected. Purposive sampling was employed in the first stage to select the Municipalities and simple random sampling was employed in the second stage to select the insurer and non-insurer cattle farmers. Thus, a stratified simple random sampling technique was adopted to select 40 insurers and 40 non-insurers from each district to comprise a sample of 160 households. Primary data was collected using a semi-structured questionnaire in 160 households, key informant interviews with concerned stakeholders, and focus group discussion (2 in each district). Variables like age, gender, family size, education status, landholding, livestock holding, economically active population, migration status, etc. were analyzed using descriptive statistics like frequency, percentage, mean, standard deviation etc.

Empirical analysis and econometrics model

In this study, a probit model was used to determine the factors determining the adoption of cattle insurance. This model was used to identify the determinants (regressors) on the probability of adoption of cattle insurance (regressand). The probit model used is of the form $Pr\ (Y=1) = (X_i)$ where $Pr\ (Y=1)$ represents the probability of adopting a cattle insurance scheme with the change in X variable. A positive estimated coefficient implies an increase in the likelihood of adoption of cattle insurance.

In the probit model, it was supposed that Y_i is the binary response of the farmers, $Y_i = 1$ if the farmer adopts cattle insurance and $Y_i = 0$ if the farmer does not adopt the cattle insurance.

If $Y_i = 1$; Pr $(Y_i = 1) = P_i$
If $Y_i = 0$; Pr $(Y_i = 0) = 1\text{-}P_i$
Where, $P_i = E(Y=1/X)$ represents the conditional mean of Y given certain values of X.
Model specification

$$\Pr(Y=1) = f(b_o + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 + b_9 X_9 + b_{10} X_{10} + b_{11} X_{11} + b_{12} X_{12} + b_{13} X_{13} + b_{14} X_{14} + b_{15} X_{15})$$

Where,
Pr (Y=1) = Probability of adopting cattle insurance scheme
X_1 = Age of the household head (Years)
X_2 = Gender of the household head (Male =1 otherwise 0)
X_3 = Education of the household head (Years of schooling)
X_4 = Household size of the respondent (Number of members)
X_5 = Migration status of the household to abroad (Migrated =1 otherwise 0)
X_6 = Land holding of the household (in ha)
X_7 = Experience in cattle rearing (Years)
X_8 = House type of the respondent (Pakki = 1 otherwise 0)
X_9 = Income from livestock (natural log transformation)
X_{10} = Breed of cattle reared (Improved =1 otherwise 0)
X_{11} = Shed of the cattle (Traditional =1 otherwise 0)
X_{12} = Membership in social organization (Yes =1 otherwise 0)
X_{13} = Technical assistance (Yes =1 otherwise 0)
X_{14} = Access to loan (Yes =1 otherwise 0)
X_{15} = District of the respondent (Chitwan =1 otherwise 0)
b_0 = Regression coefficient

b1, b2…… b14 = Probit coefficient

To determine the impact of various factors on the livestock income, income function regression model was adopted. The annual income from livestock (natural logarithm) was kept as a dependent variable and the regression function was in log-linear form as:

$$Ln(Y) = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8$$

Where,
Y = Annual livestock income (NRs.)
X_1 = Insurance type (Insured =1 otherwise 0)
X_2 = Age of the household head (Years)
X_3 = Gender of the household head (Male =1 otherwise 0)
X_4 = Education of the household head (Years)
X_5 = Land holding (ha)
X_6 = Number of cattle
X_7 = District of respondent (Chitwan =1 otherwise 0)
X_8 = Shed type (traditional =1 otherwise 0)
a = intercept

Regression diagnostics (Instrumental variable model)

Participation in cattle insurance program and its contribution to the annual livestock income were correlated to each other so to combat such endogeneity problem, instrumental variable model was used. In this model, loan access was used as instrument (insurance type = loan access). The model was in the form:

$$Ln\ (Y) = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 + b_9 X_9 + b_{10} X_{10}$$

Where,
Y = Annual livestock income (NRs.)
X_1 = Insurance type (Insured =1 otherwise 0)
X_2 = Number of cattle
X_3 = District of respondent (Chitwan =1 otherwise 0)
X_4 = Shed type (traditional =1 otherwise 0)
X_5 = Education of the household head (Years)
X_6 = Age of the household head (Years)
X_7 = Gender of the household head (Male =1 otherwise 0)
X_8 = Migration status of household members (Yes=1 otherwise 0)
X_9 = Membership in social organizations (Yes=1 otherwise 0)
X_{10} = Technical assistance (Yes=1 otherwise 0)
a = intercept

RESULTS AND DISCUSSION

Annual household income from different sectors

The annual household income from different sectors concerning cattle insurance is presented in Table 1. Among various source of annual household income, milk sell and remittance were found significantly different among cattle insurers and non-insurers. The total household income (NRs. 861369) was significantly higher in cattle insurers (NRs. 1050243) than non-insurers (NRs. 672496) at a 5 percent level. The annual income from milk sell was higher among cattle insurers (NRs. 681395) than non-insurers (NRs. 201403) at 1 percent level whereas cattle insurers had lower (NRs. 134500) annual household income from remittance than non-insurers (NRs. 251550) which was significant at 5 percent level. Positive correlation of on farm income with the adoption of insurance schemes was also found by (Aidoo, Mensah, Wei, & Dadson, 2014).

Table 1. Annual household income from different sectors by cattle insurance

Source of Income (In NRs.)	Overall (N= 160)	Insurers (n=80)	Non-insurers (n=80)	Mean Difference	T-value
Cereals	25036	30808	19265	11543	1.621
Vegetables	16915	22558	11272	11592	1.480
Livestock sell	59798	74880	44717	30162	0.621
Milk sell	441399	681395	201403	479992	3.138***
Service	85231	63925	106537	-42612	-1.480
Own business	27312	29500	25125	4375	0.266
Wage/labor	12650	12675	12625	50	0.006
Remittance	193025	134500	251550	-117050	-2.197**
Total HH Income	861369	1050243	672496	377747	2.136**

Note: *** and ** indicate significant at 1% and 5% levels, respectively.

Annual household income of cattle insurer and non-insurer

A single continuous variable, annual household income (NRs. In natural log) was selected for analysis form the subset of household income from various sectors. The boxplot in Figure 1 reveals that dairy cattle non-insurer farmers have lower level of income than that of dairy cattle insurers. Similarly, the cattle non-insurer farmers have lower median income than that of dairy cattle insurers. The income of non-insurers was found to be more consistent than that of cattle insurers.

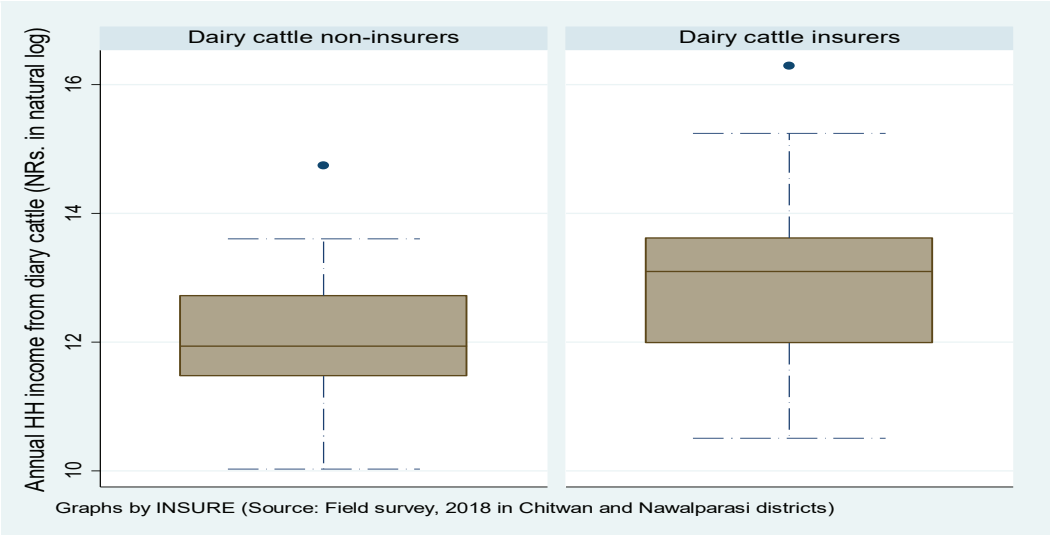

Figure 1. Annual household income of cattle insurer and non-insurer

Cattle rearing behavior and breed types

The average experience of respondents in cattle rearing was found to be 12.08 years with insurers having higher average experience (12.45 years) than non-insurers (11.71 years) (Table 2). The total livestock unit (LSU) of the study area was found to be 5.26 with insurers having higher LSU (6.52) than non-insurers (4) which was significant at a 10 percent level. The average cattle holding of the study area was 6.11 with insurers having higher cattle holding (8.40 cattle) than non-insurers (3.83 cattle) which was significant at a 1 percent level.

Table 2. Cattle rearing behavior of respondents by cattle insurance

Variables	Overall (N=160)	Insurers (n=80)	Non-insurers (n=80)	Mean Difference	T-value	P Value
Experience in cattle rearing (years)	12.08	12.45	11.71	0.73	0.478	0.633
Total livestock unit (LSU)	5..26	6.52	4.00	2.51*	1.775	0.078
Cattle Holding	6.11	8.40	3.83	4.56***	4.115	0.000

Note: *** and * indicate significant at 1% and 10% levels, respectively.

Six types of cattle breeds were found to be reared in the study area. The majority of the respondent (51.90%) reared Jersey cattle breed followed by Local (19.40%), Holstein (13.10%), Local*Jersey (8.10%), Local*Holstein (4.40%) and Holstein*Jersey (3.10%) (Table 3). The chi-square test was used to determine whether there was a significant difference in the cattle breed reared between cattle insurers and non-insurers. Chi-square results revealed a significant difference between insurers and non-insurers in cattle breed reared at 1 percent level.

Table 3. Cattle breed types by cattle insurance

Breed Types	Overall (N= 160)	Insurers (n=80)	Non-insurers (n=80)	Chi-square value
Local	31 (19.40)	5 (6.30)	26 (32.50)	28.664***
Holstein	21 (13.10)	18 (22.50)	3 (3.80)	(at 5 df and P=0.000)
Jersey	83 (51.90)	47 (58.80)	36 (45.00)	
Local*Holstein	7 (4.40)	3 (3.80)	4 (5.00)	
Local*Jersey	13 (8.10)	4 (5.00)	9 (11.30)	
Holstein*Jersey	5 (3.10)	3 (3.80)	2 (2.50)	

Note: *** indicates significant at 1% level. Figures in parentheses indicate percentages. Finance and institutional involvement

Institutional involvement refers whether the household have access to the facilities like loan, membership in co-operatives or community based organizations, their position in the organizations and access to technical service providers like DADO/DLSO, Agro-vet, co-operatives etc.

The chi-square test (Table 4) to determine which institutional variable had significant difference between insurers and non-insurers showed that there was significant difference between insurers and non-insurers in loan access at 1 percent level. Similarly, there was significant difference between insurers and non-insurers in taking loan for cattle rearing at 1 percent level. There was significant difference in position of respondent in organization between insurers and non-insurers at 5 percent level. Other variables namely media access membership in organization and technical assistance had no significant difference between insurers and non-insurers.

Table 4. Finance and institutional involvement of respondents by insurance

Variables	Overall (N= 160)	Insurers (n=80)	Non-insurers (n=80)	Chi-square value
Loan access				
No	14 (8.80)	1 (1.30)	13 (16.30)	11.272***
Yes	146 (91.20)	79 (98.70)	67 (83.70)	(at 1 df and P=0.001)
Loan for cattle rearing				
No	98 (61.30)	36 (45.00)	62 (77.50)	17.801***
Yes	62 (38.80)	44 (55.00)	18 (22.50)	(at 1 df and P=0.000)
Media access				
No	7 (4.40)	4 (5.00)	3 (3.80)	0.149
Yes	153 (95.60)	76 (95.00)	77 (96.30)	(at 1 df and P=0.699)
Membership in Organization				
No	32 (20.00)	13 (16.30)	19 (23.80)	1.406
Yes	128 (80.00)	67 (83.80)	61 (76.30)	(at 1 df and P=0.323)
Position in Organization				
Vital Post	20 (15.60)	15 (22.40)	5 (8.20)	4.878**
Member	108 (84.40)	52 (77.60)	56 (91.80)	(at 1 df and P=0.027)
Technical assistance				
No	98 (61.30)	50 (62.50)	48 (60.00)	0.105
Yes	62 (38.80)	30 (37.50)	32 (40.00)	(at 1 df and P=0.746)

Note: Figures in parentheses indicate percentage. ***and** indicate significance at 1% and 10% levels, respectively.

Probit Model for factors determining cattle insurance

To determine the factors that influence the decision to do cattle insurance, the probit regression model was used. The likelihood ratio chi-square (LR chi^2) for the model was statistically significant at 1 percent level which revealed the model has good explanatory power (Table 5). The Pseudo R^2 was 0.33, meaning 33 percent variation in the dependent variable is explained by the explanatory variables included in the model.

The resulting from the probit model revealed that the number of cattle, income from livestock, access to loan, and cattle breed had a significant and positive impact on the adoption of cattle insurance whereas household size and district of the respondent had a significant and negative impact on the adoption of cattle insurance. Keeping other variables constant the probability of joining cattle insurance decreases by 5 percent with an increase in household size by one unit, increases by 3.6 percent when the number of cattle increases by a unit, increases by around 15 percent when the income from the livestock increases by one unit, increases by around 37 percent when the household had access to loan insurance increases by around 44 percent when the cattle breed is improved and decreases by around 23 percent when the district is Nawalparasi.

The same model used by (Falola, Ayinde, & Agboola, 2013) found similar positive and significant relation with access to loan but the result with farm income was contrasting i.e. farm income had a significant and negative relationship with the adoption of cattle insurance. This could be justified that farmers with higher income could easily buy insurance scheme than their colleagues with low income. High farm income improves the capacity to adopt agricultural innovations and the number of farmers is willing to pay for innovations as noted by (Filson, 2009). The study conducted by (Ali, 2013) also found that increase in household size had significant and negative relation with joining cattle insurance. Similarly, Mohammed and Otrmann (2005) also found that farm size had a positive relationship with the adoption of cattle insurance.

Table 5. Results from Probit Model for factors determining cattle insurance

Variable	Coefficient	Std. Err.	Z	P>|z|	dy/dx
AGE	-0.019	0.005	-1.47	0.141	-0.007
GENDER#	-0.295	0.118	-0.99	0.324	-0.116
EDUCATION	-0.025	0.016	-0.64	0.522	-0.010
HHSIZE	-0.126**	0.026	-1.97	0.049	-0.050
MIGRATION#	0.102	0.108	0.38	0.705	0.040
EXPRENCE	0.010	0.005	0.82	0.414	0.004
NO_CATTLE	0.092**	0.018	2.00	0.045	0.036
LOG_LIVEincome	0.368**	0.070	2.11	0.035	0.146
BREED#	1.225***	0.094	4.67	0.000	0.436
SHED#	0.331	0.110	1.20	0.232	0.131
MEMBER#	0.205	0.128	0.64	0.522	0.081
TECHNICAL_ASS#	-0.327	0.103	-1.26	0.207	-0.130
ACCESS_LOAN#	1.036**	0.165	2.23	0.026	0.368
DISTRICT#	-0.572*	0.124	-1.85	0.065	-0.228
Summary statistics					
Number of observations:	160				
LR Chi-square (14):	73.29***				
Prob > chi-square:	0.000				
Pseudo R^2:	0.3304				

Notes: dy/dx is Marginal effects after Probit. '#' indicates for discrete change of dummy variable from 0 to 1. ***, ** and * represent significant at 1%, 5% and 10% levels, respectively.

Income regression function model

The annual livestock income (natural log of livestock income) was regressed with the important socio-economic explanatory variables (Table 6). The R^2 of the model was 0.58 for livestock income. It indicates that about 58 percent of the variation in the livestock income was explained by explanatory variables in the model. The adjusted R^2 was found at 0.55. This indicates that the model fitness is satisfactory. The overall F value of the model was 26.16 and it was statistically significant at a 1 percent level. This implies that the explanatory variables included in the model are important for the explanation of the variation of the dependent variable (annual livestock income).

The variable insurance had a positive impact on livestock income and was significant at 1 percent level. The income from the livestock is 48 percent more for the insurer farmer as compared to non-insurer farmer.. The study conducted by (Aidoo, Mensah, Wei, & Dadson, 2014) also found that increase in income from agricultural sources had a positive relationship with the adoption of cattle insurance. Similarly, the variable number of cattle also had a positive impact on livestock income and was significant at 1 percent level. When the number of cattle increases by one unit the livestock income would increase by around 8 percent keeping other factors constant. Also, the variable district of the respondent had a positive impact on livestock income and was significant at 1 percent level. The income from livestock is 55 percent more for farmer in Chitwan district as compared to farmer in Nawalparasi district.

Table 6. Determinants of annual livestock income using income function regression

Variables	Coefficients	Standard error	t-value	p-value
Insurance (#)	0.475***	0.126	3.77	0.000
Age of the household head (years)	-0.010*	0.006	-1.67	0.098
Gender of the household head (#)	0.236	0.145	1.63	0.106
Education of the household head (years)	0.001	0.019	0.08	0.938
Land holding (ha)	0.159	0.175	0.91	0.366
Number of cattle	0.074***	0.010	7.23	0.000
District of respondent (#)	0.544***	0.135	4.03	0.000
Shed type (#)	0.032	0.135	0.24	0.813
Constant	11.086***	0.406	27.26	0.000
Summary statistics				
No of Observations	160			
F (8,151)	26.16			
Prob>F	0.000			
R-squared	0.580			
Adj R-squared	0.558			

Note: ***, ** and * indicate significant at 1%, 5% and 10% levels, respectively.

Instrumental variable model for endogeneity bias

During the analysis, it was found that the annual livestock income had a positive and statistically significant effect on cattle insurance, and on the other hand, cattle insurance had a positive and statistically significant effect on livestock income. Thus there was a problem of endogeneity, so to combat the problem of endogeneity, the instrumental variable model was used. The variable insurance type dummy (Insured=1) was instrumented and the variable loan access was used as instrument variable and the dependent variable was annual livestock income (natural log).

The overall measures F value was 11.29 and were highly significant at 1 percent level (Table 7). This indicates that the selection of explanatory variables in the model was enough to describe the variation in the dependent variable. The value of R^2 was 0.238, this implies that around 24 percent of the variation in the dependent variable is explained by the explanatory variable included in the model.

The variables insurance type, number of cattle, district, education, age, gender, and technical assistance were found to have a positive relationship with the livestock income, and the variables cattle shed, migration, and membership were found to have a negative relation with livestock income. After solving the endogeneity bias it was found that when the respondent had adopted cattle insurance the livestock income increases by around 187 percent. If the number of cattle increases by one unit the livestock income would increase by 4.5 percent, keeping other factors constant. Similarly, if the district of the respondent was Chitwan the livestock income increases by around 61 percent as compared to that of Nawalparasi.

Table 7. Effect on income from livestock using instrumental variable model

Variables	Coefficients	Standard error	t-value	P-value
Insurance type (#)	1.868**	0.802	2.33	0.021
No of cattle	0.045**	0.021	2.11	0.036
District (#)	0.609***	0.179	3.40	0.001
Shed (#)	-0.139	0.206	-0.67	0.502
Education	0.019	0.028	0.68	0.497
Age	0.001	0.010	0.12	0.903
Gender (#)	0.330	0.205	1.61	0.110
Migration (#)	-0.065	0.181	-0.36	0.721
Membership (#)	-0.109	0.208	-0.52	0.602
Technical Assistance (#)	0.181	0.176	1.03	0.304
Constant	10.032***	0.893	11.24	0.000
Summary statistics				
Observations	160			
F (10, 149)	11.29			
Prob>F	0.000			
R-squared	0.2385g			
Adj R-squared	0.1874			
Instrumented	Insurance type (Insured=1)			
Instrument variable	Access to credit/loan			

Note: ** and *** indicate significant at 5% and 1% levels, respectively. "#" indicates dummy variable.

CONCLUSION

Among various sources of household income, income from milk sell and remittance were found significantly different among cattle insurers and non-insurers. The average cattle holding was found significantly higher in cattle insurer farmers than that of non-insurers. Significant difference between insurers and non-insurers was found with respect to the cattle breed reared, loan access and position of respondent in social organization. Study revealed that cattle breed, access to loan, income from livestock, and number of cattle were positively significant factors determining cattle insurance whereas household size and district were negatively significant. Adoption of insurance, number of cattle and district of the respondent were found to have a significant and positive impact on livestock income. Based on the findings from this study, programs to motivate farmers for rearing improved cattle breed, improving farmer's access to financial services, agricultural credit and agricultural extension through the involvement of microfinance institutions, agriculture cooperatives and financial non-government organizations would be recommended to make cattle insurance scheme as a well acceptable tool for risk management and to avoid economic loss among cattle rearing farmers.

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