HYBRID OR OPEN POLLINATED MAIZE VARIETIES? A SOCIO-ECONOMIC ASSESSMENT OF NEPALESE FARMERS' EXPERIENCES

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Abstract:

Analysis of factors affecting adoption of hybrid and open pollinated maize varieties had not been taken yet in Nepal. Viewing this fact, this study was undertaken consisting of four purposively selected VDCs from two central Terai districts, Bara and Sarlahi, of Nepal. A total of 110 maize growers including 86 adopters and 24 non adopters of hybrid maize varieties (adopters of open pollinated maize varieties) were interviewed with the help of structured questionnaire. Results of t-test showed that adopters of hybrid maize varieties had significantly larger farm size and, size of maize farm, were more experienced on maize farming, and used significantly higher amount of chemical fertilizers but lower amount of organic manures than the non-adopters. Further, more adopters used irrigation water, pesticides and hired labor than the non-adopters. The result showed that a substantial proportion of land area grown to maize was cultivated to hybrid maize varieties with an adoption rate of 81.9 % while the adoption rate for open pollinated varieties was estimated as 18.1%. The results of the binary logistic regression analysis showed that adoption of hybrid maize was positively influenced by farm size, irrigation availability, farmer's attitude towards insect and disease tolerance characteristics of hybrid maize, male headed family and credit availability in the surveyed area. However, farming experience on maize was negatively associated with the adoption of hybrid maize varieties.

Keywords: hybrid, open pollinated varieties, adoption, regression

1. Introduction

Maize is the second most important cereal crop after rice in terms of area and production and first staple food crop for the hills in Nepal. It is grown in 875660 hectare of land with average yield of 2.11 t/ha. The proportion of maize area consists of 70.23% in hills followed by 19.23% in Terai and 10.45% in Mountain [1]. Almost all quantity of the maize produced in the mid and high hills is utilized for human consumption and a very little portion is fed to animals. However, more than 80% Terai production is being utilized for poultry and animal feeds and remaining amount is used as industrial and human consumption [2]. This indicates that maize is emerging as a cash crop in Terai regions.

National Maize Research Programme (NMRP) under Nepal Agricultural Research Programme (NARC) has released 23 maize varieties, including 1 hybrid, over the last two decades. The potential productivity of these varieties, except Arun-2, ranges between 3 to 10.6 mt/ha [3]. Gaurav, the only one hybrid maize released in Nepal in 2003, could not be popularized in hybrid maize growing areas because of the difficulty in its seed production particularly in private sector. This situation has left no varietal options for growing hybrid maize in Nepal and farmers have to rely on seeds of multi-national hybrid companies based mostly in India. Realizing this situation, NMRP Rampur is making its effort towards production of hybrid maize seed along with open pollinated maize varieties and Rampur Hybrid-2 is in releasing process.

Literature shows that hybrid maize was introduced in Nepal long ago. About three decades back, most farmers used to grow open pollinated varieties, though a few farmers in the south used to grow Indian hybrids [4]. The rate of adoption of

hybrid maize seeds in southern Terai regions has been increased after launching Maize Mission Programme by Crop Development Directorate, Department of Agriculture under Ministry of Agriculture and Cooperatives (Now renamed as Ministry of Agricultural Development) in 2007. Since then, both positive and negative feedbacks have been received from farmers about the suitability of imported hybrid maize seeds in Nepal. Considering all these scenarios, this study has been carried out to explore socio-economic characteristics of farmers and their opinions associated with adoption of hybrid or open pollinated maize varieties. Further, this study aims to assess current adoption level of maize production technologies and sources of seed for hybrid and open pollinated maize varieties in central Terai region of Nepal, which is not yet well documented.

2. Material and Methods

2.1. The study area

The study was conducted in two central Terai districts, Bara and Sarlahi, of Nepal. These districts were selected purposively based on the potentiality of hybrid maize growing and availability of research institutions under Nepal Agricultural Research Council (NARC). The rainfall distribution in both districts is of unimodal type, 84% of the total rainfall falls during June to September. The average maximum temperature ranges from 22.7°C to 34.52°C and minimum temperature ranges from 8.54°C to 25.9°C with an average annual rainfall of 1550 mm [5]. The southern part of the both districts is connected with India. Main economic activities in the area include crop, livestock and fishery. Table 1 shows some additional information about geographic and demographic characteristics of these districts.

2.2. The study design

The study used mainly primary data. Two village development committees (VDCs) from each district were selected randomly. The only criteria for selection were the farmers cultivating maize for at least the last two years. A total of 120 households, 30 from each VDC, was targeted; however, the study could interview only 110 household heads, 86 (78%) were adopters and 24 (22%) were non-adopters of hybrid maize. The survey was conducted during June 2012.

Table 1: Geographic and demographic characteristics of sample districts

Characteristics	Bara	Sarlahi
Area covered	1,190 Sq. Kms	1,002 Sq. Kms.
Elevation	152 m - 915 m	61 m - 808 m
Number of VDCs	99	101
Population	726,998	800,574
Male / Female ratio	139	135
Population Density per Sq.Km	611	636
Average Household size	8	7
Literacy rate	55	46
Language (major)	76.09 % Bhojpur	54.43 % Maithili

Source: Intensive study and Research Centre. District and VDC profile of Nepal – 2010 (Website: www.nrrc.gov.np).

Table 2: Distribution of respondents by districts and VDCs

District	VDC	Number of respondents
Bara	Chhatara	24 (21.8)
	pipara	29 (26.4)
	Inarwa sira	31 (28.2)
Sarlahi	Barahathwa	26 (23.6)
	Netragunj	
Total	4 VDCs	110 (100)

2.3. Data analysis

Data analysis was carried out using software of Statistical Package for Social Sciences, 20 version (SPSS 20). Frequency, percent, and standard deviation were used for the descriptive analysis of data while adoption index was estimated for each of the maize varieties grown in the surveyed area. For inferential analysis of data t-test and binary logistic regression model were used.

Adoption rate:

The adoption rate is estimated as follows [adapted from 6]:

Adoption rate = Adoption coefficient multiplied by 100. Adoption coefficient = land area grown to a

maize variety by farmer/s divided by the total land area grown to maize in the surveyed area.

Binary logistic regression model

The binary logistic model is the standard method of analysis, when the outcome variable or dependent variable is dichotomous in nature taking the value 1 and 0 [7, 8]. The value 1 is indicated as farmers adopting hybrid maize seed, while 0 indicates farmers not adopting hybrid maize seed. The model uses Maximum Likelihood Estimation (MLE) procedure.

A review on factors affecting adoption of improved maize varieties in developing countries reveals a number of factors associated with farmers' adoption decisions. If broadly categorized, these are socio-economic characteristics of the respondent farmers, farmers' perception on improved maize varieties and agro-ecological characteristics of the study area [9]. In the surveyed area, it was hypothesized that a farmer's decision to use or not use a hybrid maize technology is influenced by the characteristics of the household head (gender, age, formal education, off-farm income, farmer group membership, experience on maize, and access to extension), family size, farm size, use of credit, large animals, land tenancy, irrigation availability, use of hired labor, and perceived attributes of hybrid maize technology (drought tolerance, incidence of insects and diseases, and profitability).

The effect of a set of explanatory variables on adoption of hybrid maize is specified using the following expression:

Adoption = f (X1, X2, X3……. X17)

$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \ldots\ldots\ldots\ldots\beta 17X17 + \mu$

Where

Y = a dichotomous response variable such that; Y = 1, if a farmer adopts hybrid maize and 0 if a farmer does not.

X1 to X17 = explanatory variables

Description of explanatory variables used in the regression analysis is given in Table 3.

μ = disturbance term or error term which is normally indicated as zero mean and variance.

$\beta 1$ to $\beta 17$ are coefficients of the independent variables.

Table 3: Description of explanatory variables used in the regression analysis

Variable name	Variable type	Description
Gender (X1)	Dichotomous	Male = 1, female = 2
Age (X2)	Continuous	Respondent's age (years)
Education (X3)	Multiple category	Education level of household head (Illiterate = 0, Primary schooling = 1, 6-10 class = 2, SLC through highest = 3)
Off farm income (X4)	Dichotomous	Off farm income of household head (Yes = 1, No = 0)
Membership (X5)	Dichotomous	Membership to farmers' group and cooperatives (Yes = 1, No = 0)
Family size (X6)	Continuous	Number of members in the family
Farm size (X7)	Continuous	Farm size (Hectare)
Large animals (X8)	Continuous	Number of cattle and buffaloes
Extension contact (X9)	Multiple category	Frequency of visits to extension agents (Frequently = 2, Occasionally = 1, No contact = 0)
Credit (X10)	Dichotomous	Receipt of credit (Yes = 1, No = 0)
Irrigation (X11)	Dichotomous	Irrigation provided to maize (Yes = 1, No = 0)
Land tenancy (X12)	Multiple category	Forms of land tenancy with respect to maize farm (Rented in = 1, Owned = 2, Both = 3)
Hired labor (X13)	Dichotomous	Yes =1, No =0
Experience (X14)	Continuous	Farming experience (years) on maize
Insect-disease resistance (X15)	Multiple category	Insect and disease resistance rating relative to OPV (Higher = 3, Similar =2, Lower = 1)
Drought tolerance (X16)	Multiple category	Disease resistance rating relative to OPV (Higher = 3, Similar =2, Lower = 1)
Profitability (X17)	Multiple category	Profitability rating relative to OPV (Higher = 3, Similar =2, Lower = 1)

3. Results and Discussion

3.1. Socio-economic characteristics of adopters and non adopters of hybrid maize

Table 4 shows the socioeconomic characteristics of sampled households for adopters and non-adopters of hybrid maize. Average age of the farmers was 46 years with experience in maize production spanning over 13 years while average farm size was 1.07

hectare and size of maize farm was 0.46 hectare. Maize cultivated area, according to the present finding, was about 43% of the total agricultural land. Adopters of hybrid maize had significantly lower years of experience on maize farming ($p<0.01$ and $t=-5.466$) with larger farm size ($p<0.1$ and $t=2.46$) and size of maize farm ($p<0.1$ and $t = 1.892$). Further the adopters were younger, had larger family size and smaller size of large animals but these relations were not significant. Adopters of hybrid maize varieties with larger farm size and lower years of experience were also reported in a study carried out in Punjab [10].

The study site was, generally, male dominated. About 92% of adopters and 63% of non-adopters were male-headed households. Literacy rate was about 49% and the proportion of literate farmers was more among the non-adopters. Although a minority of the family head and family members had secondary occupation (40.9% and 23.6% respectively), more family head among adopters had secondary occupation than the non-adopters while it was inverse in case of secondary occupation of family members.

Less than half proportion of the maize growers had access to secondary occupation (40.9%), farmers' group (25.4%), extension contact (37.2%) and the credit (30%). If compared, adopters were found better than the non adopters in terms of secondary occupation of family head and access to credit. Similarly, more non-adopters had extension contact, secondary occupation of family members and group membership than the adopters. Only about 4.5% of maize growers had participated in maize related training. That indicates the need of trainings to the maize farmers on improved maize technologies.

A high majority of the maize farmers (86% of adopters and 75% of non-adopters) were owner operators. More adopters (83.7%) had irrigation facility than the non-adopters (12.5%). Similarly, more adopters (68.6%) hired labor compared to non-adopters (45.8%).

Table 4: Socio-economic characteristics of adopter and non adopter of hybrid maize, 2012

Variable	Adopter (N=86)		Non-adopters (N=24)		All farmers (N=110)	
	Mean	SD	Mean	SD	t- value	Mean
Age	45.12	13.897	49.25	13.241	-1.30	46.0
Family size	8.06	3.952	6.91	3.322	1.30	7.8
Farm size (ha)	1.07	1.42	0.51	0.30	2.46*	1.07
Size of maize farm (ha)	0.49	0.43	0.35	0.25	1.892*	0.46
Large animals	2.01	1.894	2.16	1.464	.92	2.0
Experience in maize	10.6	8.131	21.3	9.521	-5.466**	13.0
Sex (% male)	91.8		62.5			85.4
Education:						
Illiterate (%)	52.3		45.8			50.9
Literate (%)	47.7		54.2			49.1
Secondary occupation-Head (%yes)	41.9		37.5			40.9
Secondary occupation-family (%yes)	22.1		29.2			23.6
Group membership (%yes)	19.8		45.8			25.4
Training (%yes)	4.7		4.1			4.5
Extension contact (% yes)	36		41.7			37.2
Credit (%yes)	33.7		16.7			30
Irrigation (%yes)	83.7		12.5			68.1
Tenancy:						
Own (%)	86		75			83.7
Rented (%)	14		25			16.3
Hired labor (%yes)	68.6		45.8			63.6

*Note: ***Significant at: P≤0.001; **Significant at P≤0.05; and *Significant at P≤ 0.10*

3.2. Production systems

Table 5 shows that majority of the hybrid maize growers were engaged in winter maize production in irrigated lowland while the OPV maize producers were engaged in spring and summer maize production in rain-fed upland.

Maize was commonly grown as a sole crop (90%), although intercropping with potato was also common to some extent. A high majority of hybrid maize farmers (76.8%) had planted single variety in a season. However, still a considerable proportion of hybrid maize adopters (23.2%) had planted two to three hybrid varieties in a season. This indicated that some of the adopters of hybrid maize were not fully convinced upon a single variety.

Table 5: Production system adopted by maize farmers, 2012

Production systems	Hybrid adopters (N=86)	OPV adopters (N=24)	Total (N=110)
Type of maize grown			
Upland	1 (1.1)	12 (50)	13 (11.8)
Lowland	13 (15.1)	9 (37.5)	22 (20)
Irrigated upland	5 (5.8)	2 (8.3)	7 (6.4)
Irrigated lowland	67 (78)	1 (4.2)	68 (61.8)
Cropping systems			
Sole	76 (88.3)	23 (95.8)	99(90)
Intercropping	10 (11.7)	1 (4.2)	11 (10)
Season			
Winter	80 (93)	2 (8.3)	82 (74.6)
Spring	6 (7)	12 (50)	18 (16.4)
Summer	0	10 (41.7)	10 (9)
Variety per season			
Single	66 (76.8)	22 (91.7)	88 (80)
Two	13 (15.1)	2(8.3)	15 (13.6)
Three	7 (8.1)	0	7 (6.4)

3.3. Adoption of hybrid and open pollinated maize varieties

The estimated adoption level of the different maize varieties identified by the farmers is shown in Table 6. The result shows that a substantial proportion of land area grown to maize was cultivated to hybrid maize varieties with an adoption rate of 81.9 % while the adoption rate for open pollinated varieties was estimated as 18.1%. Explicitly, the hybrid maize varieties grown by the farmers included DKC 9081 (18.7%), X-92 (17.9%), V-92 (7.8%), Sandhya (7%), Pioneer (6%), 10V10 (4.5%), Pinnacle (3.8%), Tropical 9696 (2%), 940 (1.9%), Srestha (1.4%), 992 (1.3%), Tropical 9081 (1.3%), Seedtech -92 (1%), Seedtech (1%), Challenger (1%), CP-808 (1%). Similarly, Sunny, Seedtech-950, Seedtech X-81, Raja 909, 8192, 3JP85, V-11, Swampa, and Ganga Kaberi were other hybrid maize varieties having adoption rate less than 1%. The OPV varieties included local yellow (10.1%), Rampur composite (5.4%), Sathiya (1.2%), Local white (1%), and Arun-2 (0.5%). The table also shows that both the hybrids and OPV have higher adoption rate in Sarlahi district than in Bara district.

It should be noted that in the year of 2011, 8 Indian hybrid maize varieties have been registered in the Gazette of Nepal Government (2011). The varieties are: Bio-9681, Rajkumar, Nutan, Super-900M, DKC-7074, All Rounder, 30P30 and 30B11. This study shows that none of these varieties is in adoption at farm level. This clearly states that farmers are massively adopting the unregistered hybrid seeds.

3.4. Farm inputs used and the yield

The farm inputs considered are seed, chemical fertilizers, farm yard manure (FYM), irrigation water, pesticides, and use of labour. Table 7 depicts the fact that adopters used significantly higher rate of chemical fertilizers than the non-adopters while non-adopters used significantly higher rate of FYM than the adopters. Further, more adopters used irrigation water, pesticides and hired labor than the non-adopters. Maize yield was significantly higher among adopters of hybrid maize varieties than the non-adopters.

The certified amount of chemical fertilizer for open pollinated maize is 220 kg/ha (120:60:40 kg N, P, K) and the rate of organic manure is 10 ton/ha [11]. The result from our study shows that chemical fertilizers @ 154.3 kg/ha (85.5:47.6:21.1 kg N,P,K) was applied to the hybrid maize while the amount was

34.2 kg/ha (23.4:8.2:2.5 kg N,P,K) for OPV maize. It indicates that though the hybrid maize growers are using higher amount of chemical fertilizers than the OPV maize growers, still the rate is much lower than the recommended one. Since chemical fertilizer is not produced in Nepal and is exported from India, fertilizer may not be available at the market when farmers have its high demand. This reason may attribute to the lower rate of fertilizer use in Nepal. The amount of organic manures used for maize is also lower than the recommended dose.

A perusal of Table 7 reveals the fact that although the hybrid maize varieties have significantly higher yield than the OPV, they are more susceptible to insects and diseases, since more number of adopters of hybrid seed used pesticides compared to non adopters.

Table 6: Adoption coefficient for maize varieties cultivated by farmers, 2012

Variety	**Bara**			**Sarlahi**			**Total**		
	N	Area	Adoption coefficient	N	area	Adoption coefficient	N	Area	Adoption coefficient
Open pollinated varieties									
Rampur composite	1	0.06	0.001	8	2.7		9	2.76	0.054
local white	-	-	-	3	0.48	0.010	3	0.48	0.010
local yellow	-	-	-	13	5.16	0.101	13	5.16	0.101
Arun-2	-	-	-	1	0.23	0.005	1	0.23	0.005
Sathiya	-	-	-	4	0.63	0.012	4	0.63	0.012
Sub -Total	**1**	**0.06**	**0.001**	**29**	**9.21**	**0.180**	**30**	**9.28**	**0.181**
Hybrid									
X-92	5	1.56	0.030	17	7.6	0.148	22	9.16	0.179
V-92	8	4.01	0.078	-	-	-	8	4.01	0.078
Tropical -9696	3	1.03	0.020	-	-	-	3	1.03	0.020
Tropical -9081	1	0.66	0.012	-	-	-	1	0.66	0.013
Sunny	-	-	-	1	0.26	0.005	1	0.26	0.005
Seedtech-92	1	0.26	0.005	1	0.24	0.004	2	0.5	0.010
Seedtech-950	2	0.46	0.009	-	-	-	2	0.46	0.009
Seed tech	-	-	-	2	0.5	0.009	2	0.5	0.010
Seed tech X-81	-	-	-	1	0.3	0.005	1	0.3	0.005
Sandhya	6	1.85	0.036	6	1.76	0.034	12	3.61	0.070
Raja-909	-	-	-	1	0.1	0.002	1	0.1	0.002
DKC 9081	6	3.26	0.064	12	6.33	0.123	18	9.6	0.187
Pioneer	6	1.65	0.032	5	1.43	0.028	11	3.08	0.060
Pinnacle	1	0.5	0.009	4	1.43	0.028	5	1.93	0.038
992	1	0.66	0.012	-	-	-	1	0.66	0.013
940	5	1	0.019	-	-	-	5	1	0.019
8192	1	0.13	0.002	-	-	-	1	0.13	0.003
3JP85	1	0.33	0.006	-	-	-	1	0.33	0.006
10V10	1	0.43	0.008	4	1.9	0.037	5	2.33	0.045
V-11	1	0.1	0.001	-	-	-	1	0.1	0.002
Swampa	-	-	-	1	0.33	0.006	1	0.33	0.006
Srestha	2	0.73	0.014	-	-	-	2	0.73	0.014
Challenger	1	0.5	0.009	-	-	-	1	0.5	0.010
Ganga kaberi	1	0.16	0.003	-	-	-	1	0.16	0.003
CP-808	-	-	-	1	0.5	0.009	1	0.5	0.010
Sub –Total	**53**	**19.35**	**0.377**	**56**	**22.7**	**0.442**	**109**	**42.05**	**0.819**
Total	**54**	**19.41**	**0.378**	**85**	**31.92**	**0.622**	**139**	**51.33**	**1.00**

Table 7: Comparison of adopters and non adopters in terms of farm inputs and yield of maize, 2012

Parameter	Unit	Adopters (N=24)		Non adopters (N=27)		t-value
		Mean	SD	Mean	SD	
Seed rate	Kg/ha	25.14	5.85	25.62	9.70	-.231
Rate of urea use	Kg/ha	256.7	145.50	43.7	26.30	7.117***
Rate of DAP use	Kg/ha	189.0	103.5	18.0	26.88	7.987***
Rate of MoP use	Kg/ha	54.84	35.31	4.28	9.57	6.922***
Rate of FYM use	Ton/ha	2.42	5.53	7.45	5.68	-4.672***
Irrigation	Dummy	.8372	.37134	.1250	.33783	8.465***
Use of pesticides	Dummy	.7442	.43888	.0417	.20412	7.597**
Hired labor	Dummy	.6860	.46682	.4583	.50898	2.072**
Yield of maize	Ton/ha	6.11	2.56	2.47	1.39	6.663***

*Note: ***Significant at: P≤0.001; **Significant at P≤0.05; and *Significant at P≤ 0.10*

3.5. Sources of seed

Table 8 shows that agro-vet was the principal supplier of hybrid seed, supplying 90.7% of the total while local market supplied 9.3%. For OPV seeds, over 58% of the farmers used their own seeds while the sources of purchased seeds included fellow farmers (25%), NARC institutions (12.5%), and DADO and ASC (4.2%). The finding indicates that OPV maize varieties are not available at the private organizations like agrovets.

3.6. Factors influencing adoption of hybrid maize varieties

The description of the socio-economic variables and farmers' perception towards hybrid maize considered in the estimation of the binary logistic regression model is shown in Table 9. The overall predictive power of the model (96.4%) and explanatory power (86.7%) are quite high that means the fit of the model is satisfactory. The estimated coefficient for the likelihood ratio chi-square was significant (P<.001), with chi-square value of 91.117.

Table 8: Source of hybrid and open pollinated maize seed, 2012

Source	OPV Maize		Hybrid maize	
	Frequency	Percentage	Frequency	Percentage
Fellow farmers	6	25	-	
Local market	-		8	
Agro-vet	-		78	
NARC institution	3	12.5	-	
DADO and ASC	1	4.2	-	
Home	14	58.3	-	
Total	24	100	86	100

Note: NARC = Nepal Agricultural Research Council, DADO = District Agriculture Development Office, ASC = Agriculture service centre

The results of the Maximum Likelihood Estimates showed that the decision on whether or not to cultivate hybrid maize varieties was significantly influenced by 6 factors such as gender, farm size, credit, irrigation, experiences on hybrid maize and insects-disease tolerance. The Wald chi-square indicating the individual effect of the variables shows that the most important variable influencing adoption of hybrid maize was farm size followed by use of irrigation to maize, experience on maize, attitude towards insect and disease tolerance attribute of hybrid maize, gender and credit availability.

The influence of farm size

As expected, farm size had strong positive influence on adoption of hybrid maize which is in agreement with a number of studies [10, 12, 13]. The significant contribution of farm size to the adoption behavior of farmers indicated that the farmers of large-sized farms had the economic resources, and could afford to take the risk involved in hybrid maize farming.

The influence of irrigation

The result showed that adoption of hybrid maize was favored by availability of irrigation. Though, both hybrid and OPV maize require substantial irrigation, at least during their critical stages, hybrids require

more fertilizers and subsequently irrigation to explore their high yielding potentiality. Therefore among the farmers having source of irrigation, a vast majority (96%) were adopters and among the farmers without any source of irrigation, 60% were non-adopters of hybrid maize. It indicates that hybrid maize farming is popular in the areas where irrigation is available.

The influence of experience on maize farming

The finding revealed that farming experience has negative influence on adoption of hybrid maize. This finding is in against to some studies [13, 14] in which farming experience was positively associated with adoption of improved varieties. Both positive and negative influence of farming experience on adoption of improved varieties was demonstrated by [15]. They explained that if farming experience is viewed in terms of accumulation of knowledge, then it stimulates improved technology use. Experienced farmers may have had the opportunity to experiment with new varieties and observed their superiority over the local ones. However, if experience is associated with the aging process, it may then have a negative impact on technology adoption as older farmers are set in their ways and tend to stick to "old" technologies.

Table 9: Maximum likelihood estimates of logistic model for factors affecting adoption of hybrid maize

Variable	B	S.E.	Wald	Significance
Gender (X_1)	-5.152	2.890	3.177*	.075
Age (X_2)	.238	.178	1.797	.180
Education (X_3)	1.308	1.508	.752	.386
Off farm income (X_4)	-1.643	2.208	.554	.457
Membership (X_5)	-1.156	1.711	.457	.499
Family size (X_6)	.202	.405	.248	.618
Farm size (X_7)	.144	.067	4.564**	.033
Large animals (X_8)	-1.230	1.044	1.389	.239
Extension contact (X_9)	-1.103	2.437	.205	.651
Credit (X_{10})	4.538	2.579	3.097*	.078
Irrigation (X_{11})	7.907	3.860	4.196**	.041
Land tenancy (X_{12})	-.194	1.726	.013	.911
Hired labor (X_{13})	.259	1.801	.021	.886
Experience (X_{14})	-.257	.131	3.828**	.050
Insect-disease tolerance (X_{15})	4.727	2.557	3.419*	.064
Drought tolerance (X_{16})	1.092	1.894	.333	.564
Profitability (X_{17})	-.691	2.118	.107	.744
Constant	-10.900	16.656	.428	.513

Note: ***Significant at: P≤0.001; **Significant at P≤0.05; and *Significant at P≤ 0.10
-2 Log of likelihood function = 24.294 X^2 = 91.117***
Nagelkerke R Square = 0.867 Cox & Snell R Square = 0.563
Overall Correct predictions = 96.4%.
Adopters (N = 86) = 96.5% Non Adopters (N = 24) = 95.8%

The influence of farmer's attitude towards insect and disease tolerance

The positive and significant influence of farmers' attitude towards insect and disease tolerance characteristics of hybrid maize on its adoption indicated that both adopters and non-adopters of hybrid maize had positive attitude towards the insect and disease tolerance characteristics of the maize varieties they had grown.

The influence of gender

In the study area, more male headed households were the adopters of hybrid maize than the female headed households. This finding indicates that male farmers had more risk bearing capacity than the female farmers in the surveyed area.

The influence of credit availability

Positive influence of credit on adoption of improved maize varieties has been reported in several studies [13, 16, 17, 18]. As farmers' access to credits enabled them to buy inputs like seed, fertilizer, irrigation, labor and etc. required for hybrid maize, credit returned a positive and significant in the present study.

4. Conclusion and implications

The study has identified the factors influencing adoption of hybrid and open pollinated maize varieties

along with their adoption rate. A high majority of farmers in the study area (78.2%) have adopted the hybrid maize. The adoption rate was very high (81.9%) for the hybrid maize as compared to the open pollinated varieties (18.1%). Socio-economic and perceptional factors such as farm size, irrigation, farmer's attitude towards insect and disease tolerance characteristics of the adopted variety, male headed household and credit availability have positive influences on adoption of hybrid maize varieties while farming experience has negative influence. Private institutions such as agro-vets and local markets are the prime source of hybrid maize seed while open pollinated maize seeds are limited to public agricultural institutions such as Nepal Agricultural Research Council and District Agriculture Development Office, and fellow farmers.

Adopters of hybrid maize varieties have used more inputs such as fertilizers, labor, irrigation and pesticides than the adopters of open pollinated maize varieties. Farm yard manure has become the major source of organic manure for open pollinated maize varieties. Viewing the findings, it is concluded that the adoption rate of NARC released open pollinated maize varieties is very low as compared to the hybrids in the study area. So, NARC should trigger release of hybrid maize varieties suitable for Terai region of Nepal.

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