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Research Article

Impacts of Mechanization and Improved Seed Adoption in Maize Production in Earthquake Affected Areas of Sindhupalchok, Nepal

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Abstract

The April 25, 2015 earthquake (with 7.6 Richter scale) and its subsequent aftershocks have had both direct and indirect impact on people's agriculture and livelihoods. Machine users after earthquake were increased in this territory. Machineries reduce the working load and human drudgery. Farmers are facing increased price of cost of inputs like organic fertilizers, seeds along with labor charge for weeding, sowing and harvesting because of poor adoption of mechanization. Farm mechanization refers to application of engineering and technology in farm to perform farm works in better and precise way and increase productivity of farm and reduce the cost of production. Hence the drastic need to improve living standard of farmers through the adoption and adaptation of improved agricultural technologies. The maize zone, Sindhupalchok areas under PMAMP program was selected for this study. The total 120 households of the three municipalities were select by using purposive and simple random sampling technique. The secondary data were collected from reports from DADO office, SQCC, MoAD and CBS. The primary data were collected from household survey from pre-tested semi structured questionnaire and Focus Group Discussion (FGD). The collected data analyzed by using Microsoft Excel, SPSS software and Stata. Descriptive statistics, benefit cost ratio, mean t-test, chi square test, etc. were computed and compared between machine user and bullock user. Probit regression model was used to analyze factors affecting mini-tiller adoption. Machine users included only the mini-tiller users for land preparation that means in hilly areas of Sindhupalchok mechanization is in transformation phase. Social status of both machine users and bullock users were found comparable with age and ethnicity had negative and positive significant difference respectively. Most of the farmers purchased machine with subsidies from district agriculture development office (DADO), Sindhupalchok. but farmers can't afford machineries directly from machineries supplier/dealer due to the high price of machineries. The average yield of maize was found to be 2.17 MT/ha in the study area from respondants response. Most of the mini-tiller users plow land two times and bullock users plow land three times. Both the users were in loss i.e. machine user's loss NRs.15311 and bollock user's loss NRs. 43125 in maize production in one hectare land with the B:C ratio of 0.88 and 0.63 respectively but farmers perceived their practice to be in profit as they did not consider the monetary value of two major cost of production, FYM cost and labor cost. Most of the farmer's perception, working load and human drudgery was decreased by 50 percent. This research revealed that insect pest was ranked first problems in machine user farmers and agri-mechanization was the first ranked problems in bullock user farmers in the study area.

Keywords: Machine; Bullock; Mini-Tiller; Maize; Seed

Introduction

The majority of Nepalese people about (65.6%) depend on agriculture for their livelihood [1], but only 27.6 percent of total GDP of the country is covered by agriculture and forestry sector in fiscal year -quarter of its population (25.6%) living below poverty line [2]. Out of total population, 25.40 percent in Sindhupalchok living below the poverty line [3]. Uplifting of agriculture is the only major means to combat poverty and hunger [2]. Poverty rate is declining over last few decades but it is still high with one the average national family size was 4.5 and the per capital income is $ 1004 (NRs. 103335). Average consumption of Nepalese household was NRs. 362617. Out of total consumption 52 percent consumption goes for food, 4.1 percent goes for education, 3.7 percent goes for alcohol/tobacco and remaining goes for non-food [4].

Maize is the second important cereal crops after rice in terms of both area and production in Nepal [5]. While in world, maize is third important crop after rice and wheat. Maize, the most versatile cash crop, is known as 'Queen of cereals' as it has very high yield potential than any other cereals and wider adaptability under varied agro climatic regimes. Maize production in hilly areas has many difficulties that are lack of Machinery, chemical fertilizer and good varieties of seed. The cultivation practices in hilly areas of Nepal are in the phase of modernization that is gradually increased in machineries and supply of improved seeds. Prime Minister Agriculture Modernization Project (PM-AMP) aims to increase the agriculture production and productivity by providing modern technological input, modernizing, processing and commercializing the agriculture commodities to make country self-reliant in agriculture sector

within a period of 10 years. It is a way of life for the hill farmers of Nepal with 60%, 25% and 3% of the grain being used as animal feed, food and seed respectively in hill district [6]. It is a principal food crop of the hilly farmers and source of animal feed for different feed industries in Terai region of Nepal [7].

Farm mechanization refers to application of engineering and technology in farm to perform farm works in better and precise way and increase productivity of farm. Mechanization saves costs and resources (labor, energy) by reducing operational time in agriculture and improving timely farm operation [8]. Farm mechanization has been realized as an important input to increase commercialization and competitiveness in agriculture. Farm mechanization does not implies to use of large machineries and tractors rather it is a need based process that allows sufficient time gap for self-adjustment of the inputs without causing sudden impact of change. Mechanization allows farmers to complete farm operations such as; land preparation, seed sowing, harvesting, fertilizer application, irrigation etc. timelier and more precisely and thus increasing productivity and decreasing cost of inputs in long run. But in Sindhupalchok the mechanization pattern is partial, mostly used for land preparation (by mini-tiller).

The April 25, 2015 earthquake (with 7.6 Richter scale) and its subsequent aftershocks have had both direct and indirect impact on people's agriculture and livelihoods. The major effect of disaster was rained, risk-prone; subsistence and people livelihoods depend on agriculture and biodiversity of traditional crops. In hilly region of Nepal draft power used by bulls but the population of bullocks also decrease due to earthquake. The disaster had significant effect on the loss of animals (draft power) and agricultural infrastructure (damage of irrigation canal, grain storage structures, burial of stored seeds and damage of agricultural lands). The major effect of disaster was in hills and mountains parts of Sindhupalchok. All infrastructures were destroyed and make life more complicated. Agricultural products were destroyed and many people suffer from hunger due to lack of food. Many NGOs and INGOs are still working to recover life and increase living standard of affected people mainly rural farmers (N. R. Gurung, Agronomy Development Officer, PMAMP zone, Personal Communication, 15 March, 2019).

The affected areas also suffering from high cost of production as a result of loss of labor force by direct impacts of earthquake, youth migration and high input costs in agriculture. Hence the drastic need to improve living standard of farmers through the adoption and adaptation of improved agricultural technologies. For modernize agriculture, a strong support system involving input supplies and other services like marketing, transport, storage, processing etc. are inevitable. The earthquake have had major impact on the livelihoods of poor small holder farmers located in remote hilly parts due to chronic poverty, food insecurity and illiteracy. A significant negative impact has been observed in economy, agriculture and agro-biodiversity [9].

Recently in Sindhupalchok, farmers are interested in mini-tillers with rotavators for plowing. Mini-tiller is easy to handle and has a light weight that can carry easily everywhere. Single person can use this machine so, mini-tiller is popular in mid-hills (N. R. Gurung, Agronomy Development Officer, PMAMP zone, Personal Communication, 15 March, 2019).

The broad objective of this research was to investigate the mechanization and improved seed adoption in maize production in earthquake affected areas of Sindhupalchok district.

Methodology

This study was conducted in three local bodies of Sindhupalchok district. Sindhupalchok's terrain, with villages scattered across steep mountains and narrow, twisting roads, has drastically slowed rescue efforts that vehicles taking the 86 kilometer journey from Kathmandu need about three hours to get there. People of this district entirely depend on agriculture for their survival. Since the district is hilly, the land is not fertile, and the yield is very low. Almost every municipality has access to electricity, and roads connecting to the highway. There are 12 municipalities, out of which three are urban municipalities and nine are rural municipalities.

Figure 1: Map of Nepal showing Sindhupalchok district (study area).

This study was conducted in earthquake affected areas including command area of PMAMP, Sindhupalchok. Among command areas of PMAMP, Plan Implementation Unit, Maize Zone three municipalities were taken as study area.

S. N.	Municipalities	Earthquake victims	Total Population	Area Sq. KM	Proportionate victims
1	Bhalephi Rural Municipality	6054	18903	62	32.03
2	Chautara Sagachowkgadhi Urban Municipality	13999	46890	165	29.85
3	Indrawati Rural Municipality	8389	28355	105	29.59
4	Melamchi Urban Municipality	13421	48753	158	27.53

Table 1: Earthquake victims in command areas of Maize Zone, Sindhupalchok.

Source: District Co-ordination Committee (DCC).

Out of total population 120 households were selected with 95 percent confidence level and 9 percent margin of error. Households of the three municipalities were selected by purposive and simple random sampling technique. A set of questionnaire is prepared for the collection of primary data. The field survey was conducted from March 15. The respondents should be interviewed by visiting their homes. The interview timing should be fixed as per the farmer's convenience. Regular checking and validation of the information was done immediately after filling the questionnaire. Key informants including former DADO officer, Cooperatives president, and representative of municipalities were interviewed with series of questions related to mechanization and the input adoption in Sindhupalchok. Four FGDs were carried out, each in Balefi and Indrawati rural municipalities and two in Chautara Sangachokgadi urban municipality to know the present situation of the farmers on mechanization and input adoption for maize cultivation system. Rapid market appraisal was carried out through co-operatives, farmer's group, machineries dealer and agro-vet by already prepared questionnaire.

In this study, data were analyzed using different quantitative and qualitative procedures and methods. After the collection of necessary information it was coded and entered in SPSS data entry sheet and analyzed by using SPSS (version 25), Microsoft EXCEL and Stata. Descriptive statistical tools were used to analyze the quantitative data. The important statistical measures that were used to summarize and categorize the research data were means, percentages and frequencies.

B: C ratio analysis

B: C ratio is the quick and easiest method to determine the economic performance of a business. It is a relative measure which is used to compare benefit per unit of cost. Undiscounted benefit cost ratio was estimated as a ratio of gross return and total variable cost [10].

It was calculated by following formula.

B:C ratio = Gross return/Cost of cultivation (total cost).

If the ratio is less than one then the costs exceed the benefit. However, if the Ratio is more than one then the Benefits exceed the costs [11].

Seed replacement rates of maize must improve the production and productivity. SRR can be determined by the formula

SRR = actual improve seed sow by farmers/actual seed required for cultivation of crops.

t-Test

Test for difference between the two means as the number of observations regarding partial mechanized (n1) is not equal to that of traditional farms (n2), therefore, two unpaired, independent samples t- test was used.

(t-test): $t = (X1 - X2)/(\delta\sqrt{1/n1+1/n2})$ distributed as $t(n1 + n2 - 2)$

Whereas δ is unknown and $= \sqrt{(n1S_1^2 + n2S_2^2)/(n1 + n2 - 2)}$

X1, X2 are the sample means of mechanized and traditional farms respectively and S_1^2 and S_1^2 are the respective sample variances.

Regression analysis

Probit regression model, an Econometric level

Probit model was used to investigate the determinants of adoption of mechanization.

Model specification

Machine user, $Y_i(yes=1) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + ei$

where,

Machine user (yes=1) = Probability score of adoption of machineries in maize production system

X_1 = Age of household head (years)

X_2 = Gender of household head (Dummy)

X_3 = Education of household head (Dummy)

X_4 = Occupation of household head (Dummy)

X_5 = Ethnicity of household head (Dummy)

X_6 = LSU (Number)

X_7 =Family size (Number)

$b_1, b_2 \ldots b_{12}$ = Probit coefficient

b_0 = Regression coefficient

Socio-demographic characters of continuous variables

The average age of the machine user (mini-tiller) respondents was 46.37 years and the average age of the bullock user was 50.00 years that was statistically significant at 10 percent level of significance. The overall mean of family size of respondents were 6.18 which was higher than that of average national and district family size. Machine user had 5.76 and bullock user had 6.60 family sizes which was statistically significant at 10 percent level of significance. In average, among the family member 4.13 was economically active household population. The active household member in farming was 2.26 in machine user and 2.86 in bullock user household that was statistically highly significant at 1 percent level of significance.

Socio-demographic of Categorical variables

Below table revealed that the total male population was 70 percent and the total female was 30 percent. In machine user household the total number of male and female was 73.30 percent and 26.70 percent respectively. The total number of male population and female population in bullock user was 66.70 percent and 33.30 percent respectively. This data was collected from three municipalities.

In the study area out of total 75.80 percent farmers fully depends on agriculture and remaining farmers had major occupation in government service (9.20 %), non-government service (7.50%) and others (7.50%). Occupation of machine user and bullock user was also found to be statistically significance at 1 percent level of significance. Most of the machine user household was Bhramin

Socio-demographic variables	Overall (N=120)	Machine user (mini-tiller) n=60	Bullock user n=60	Mean difference	T-value	P value
Age (years)	48.68	46.37	51.00	-4.63	-1.962*	.052
Family size	6.18	5.76	6.60	-0.83	-1.914*	.058
Economic active HH members (age group 15-59 years)	4.13	4.15	4.11	0.03	.098	.992
Active HH member in Farming	2.56	2.26	2.86	-0.60	-3.076***	0.003

Table 2: Socio-demographic characteristics of respondents (Continuous variables) by machine user and bullock users.

*indicate statistically significant difference at 10% levels, respectively.

Source: Field survey, 2019.f

(70.00%) and most of the household of Janajati (55.00%) was bullock user. The ethnicity of household head was statistically significance at 1 percent level. In average 51.7 percent household head can read and write (basic level of education[1]) in the study area. Education status of machineries user had more than the bullock user that was clearly we can say the adoption of technology is directly affected by education status of household head. Among machine user 38.40 percent household head had attended higher secondary level of education but among bullock user only 16.70 percent had attended higher secondary level of education. The education status of machine users and bullock users are statistically significance at 5 percent level of significance.

Socio-demographic variables	Overall (N=120)	Machine user (mini-tiller) n=60	Bullock user n-60	Chi-square value	P value
Gender of HH (Male)#					
Male	84 (70.00)	44 (73.30)	40 (66.70)	0.635	0.426
Female	36 (30.00)	16 (26.70)	20 (33.30)		
Municipalities#					
Chautara sangachokgadi	60 (50.00	25 (41.70)	35 (58.30)	27.400***	.000
Balefi	30 (25.00)	27 (45.00)	3 (5.00)		
Indrawati	30 (25.00)	8 (13.30)	22 (36.70)		
Education level#					
Can read and write	62 (51.70)	26 (43.30)	36 (60.00)	8.766**	0.033
Primary school	25 (20.80)	11 (18.30)	14 (23.30)		
Secondary school	29 (24.20)	19 (31.70)	10 (16.70)		
Graduated	4 (3.30)	4 (6.700)	0 (0.00)		
Major occupation#					
Agriculture	91 (75.80)	45 (75.00)	46 (76.70)	5.657	0.130
Government service	11 (9.20)	6 (10.00)	5 (8.30)		
Non-government service[1]	9 (7.50)	7 (11.70)	2 (3.30)		
Others[2]	9 (7.50)	2 (3.30)	7 (11.70		
Ethnicity composition#					
Brahmin/Chhetri	62 (51.7)	42 (70.00)	20 (33.30)	16.487***	0.001
Janajati[3]	47 (39.20)	14 (23.30)	33 (55.00)		
Dalit	9 (7.50)	3 (5.10)	6 (9.80)		
Other[4]	2 (1.70)	1 (1.70)	1 (1.70)		

Table 3: Socio-demographic characteristics of respondents (categorical variables) by machine user and bullock users.

Notes: Figures in parentheses indicate percentage. # resembles categorical and dummy variables used Chi-square test. ***, **, *indicate statistically significant difference at 1%, 5% and 10% levels, respectively. Source: Field survey, 2019.

[1]Non-government services were private sector job, foreign employ and driver.

[2]Others occupation included business, wages and freelance workers.

[3]Janajati ethnicity were shrestha, tamang, gurung and magar.

[4]Others ethnicity was Dashnami sanyashi.

[1]Basic level of education was adult education (proud shikshya) and basic level of education.

Access to subsidy in improved seed supply

The status of improved seed supply with subsidy (65%) was higher than the seed supply without subsidy (35%). Machine user farmers were progressive farmers they got subsidies from government in seed but the bullock user got comparatively less subsidy in seed. In the case of machine user 73.30 percent household got subsidies and 26.70 percent did not got subsidy and in the case of bullock user 56.70 percent household got subsidy and remaining (43.30%) did not got subsidy that was the seed supply with subsidy and without subsidy were statistically significance at 5 percent level of significance.

Particulars	Response	Overall (N=120)	Machine user (mini-tiller) n=60	Bullock user n=60	Chi-square value	P value
Access to Subsidy	Yes	78 (65.00)	44 (73.30)	34 (56.70)	3.663**	.0.056
	No	42 (35.00)	16 (26.70)	26 (43.30)		

Table 4: Access to subsidy in improved seed supply.

Notes: Figures in parentheses indicate percentage.

* indicate statistically significant difference at 10% level

Source; Field survey, 2019.

Role of organization in improved seed supply

Government offices provided subsidies for farmers for seed. Government offices included PMAMP maize zone and local state/municipalities distributed the seed with subsidy. In the study area PMAMP maize zone (82.10%) distributed more seed as compared to the local state/municipalities (17.90%). In the case of machine user 11.40 percent improved seed distributed by local state and 88.60 percent improved seed distributed by PMAMP maize zone distributed improved seed.

In the case of bullock users 26.50 percent seed distributed by local state and 73.50 percent of improved seed distributed by PMAMP maize zone. The role of government organization in improved seed supply was statistically significance at 10 percent level of significance.

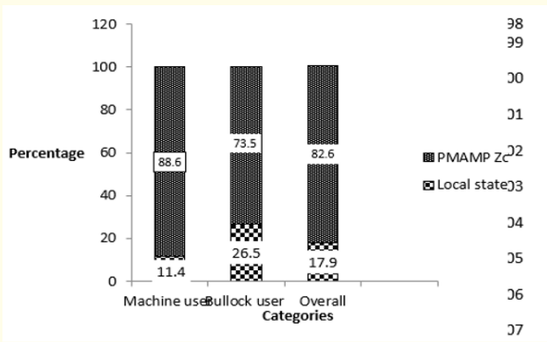

Figure 2: Role of organization in improved seed supply.

Seed replacement rates

In case of machine user the SRR was found more than the bullock user. Most of the seed producer farmers used the machine so the SRR of machine user and bullock user was found to be statistically significant at 1 percent level of significance.

Status of ownership machineries

Most of the farmers in the study area used machineries (mini-tiller) in rent. Out of total, 53.30 percent household use machineries in rent and remaining 46.70 percent had their own machine (mini-tiller).

Land holding	Overall (N=120)	Machine user (mini-tiller) n=60	Bullock user n=60	Mean difference	t-value	P value
SRR	63.90	78.28	48.70	29.58	3.843***	0.000

Table 5: Seed replacement rates of maize.

***indicates statistically significant at 1% level.

Source: Field survey, 2019.

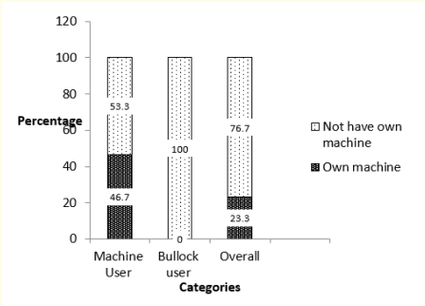

Figure 3: Status of ownership of machineries.

Access to subsidy during machine and seed purchased

There were 28 household with their own machineries. Out of 28 household 3 household purchased machine (mini-tiller) without subsidy that indicates the attraction towards mechanization is high in the study area.

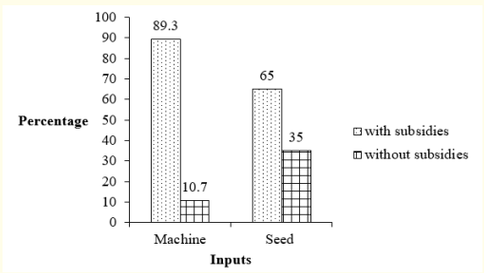

Figure 4: Status of machine purchased with subsidy.

Source: Field survey, 2019.

Frequency of tilling by machine and bullock

The machine user mostly use two times of tilling and bullock user used three times. Below table revealed that, 91.80 percent farmers plough land two times by machine and 8.20 percent farmers plough land three times.

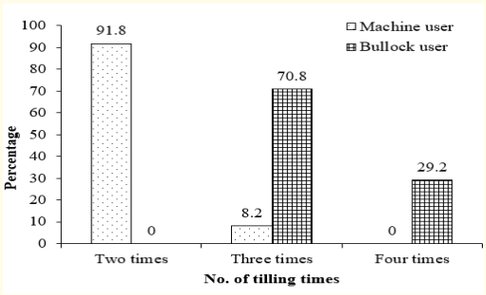

Figure 5: No of times tilling by machine and bullock.

Source: Field survey, 2019.

Average cost of maize production

Human labor was an important and largely used input for growing maize crop. It was required for different operations such as land preparation, seed sowing, weeding, fertilizer application, earthing up harvesting, threshing etc. It was computed in terms of man day and converted to monetary term valuating at prevailing wage rate. The total variable cost of maize cropping system per hectare was estimated at about NRs. 326467. FYM application by machine user and bullock user was found to be statistically significance at 5 percent level of significance. Also the land preparation cost by using bullock (NRs.25991) and machine (NRs. 14140) was found to be statistically significance at 1 percent level of significance. In the case of sowing, most of the farmers use bullock. Bullock use was costlier than the machine (mini-tiller) user. Below table revealed that the cost of sowing by using machine (NRs. 22181) and bullock (NRs.26904) was found to be statistically 5 percent level of significance.

Items of cost (NRs/ha)	Overall (N=120)	Machine user (mini-tiller) n=60	Bullock user n=60	Mean difference	t-value	P value
Seed cost	2807	3003	2610	393	0.664	0.508
FYM cost	9880	11735	8025	3709	2.53**	0.012
Fertilizer cost	5790	5284	6296	-1012	-1.330	0.186
Land preparation cost (human+oxen/machine)	20066	14140	25991	-11851	-8.130***	0.000
Sowing cost (human+oxen/machine)	245443	22181	26904	-4723	-1.849**	0.067
Weeding cost and Fertilizer application (Human)	18445	18358	18532	-173.90	-0.151	0.880
Earthig up cost (Human)	12023	12090	11955	135	0.179	0.858
Harvesting cost (Human)	7716	7644	7788	-144	-0.286	0.775
Thresing cost (Human)	4297	4262	4332	-70	-0.270	0.787
Total cost for production (in NRs.)	326467	98697	112433	-13752	-2.922***	0.004

Table 5: Average cost of maize production.

** and *** indicate statistically significant difference at 5% and 10% levels, respectively.

Source: Field survey, 2019.

Above table show the total variable cost of production by using machine (NRs. 98684) and bullock (NRs. 112433) was found to be statistically significance at 1 percent level of significance.

Average returns from maize production (per hectare)

Above table revealed that the average income from maize production was more in machine users as compared to the bullock users. That was due to the most of the machine user farmers in the study area produced maize seed for sell. The rate of seed was more than the grain so the incomes of machine users were more as compared to the bullock users. The average income from maize production in one hectare in case of machine users was NRs. 83386 and bullock users was NRs.69308 that is found to be statistically significant at 5 percent level of significance. Overall income from maize cultivation in this area was NRs. 76347.

B:C ratio

In average overall B:C ratio was found to be 0.76. The B:C ratio of machine user (0.88) was more than the b:c ratio of bullock user(0.63) that was due to the reduction in tilling cost by using mini-tiller machine. Virtually, farmers perceived their practice to be in profit as they did not consider the monetary value of two major cost of production, FYM cost and labor cost. They obtained FYM free of cost from their sheds and most of the labors in the farms were family labors whose opportunity costs were not considered. Maize farming did not fulfill the investment if all the inputs were considered in monetary value.

Working load and drudgery

Most of the farmers were realized that the machineries reduced the working load by 50 percent (half of labor). 11.67 percent farmers said that machine reduce more than 50 percent working load

and drudgery. 1.67 percent farmers was found there is no differences between bullock and machine. Rest of the farmers 22.50 percent farmers said that the machine reduce working load and drudgery by less than 50 percent.

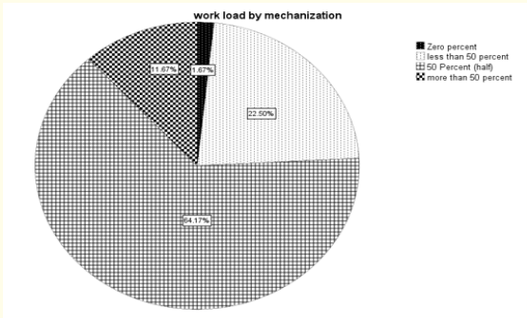

Figure 6: Perception of farmers in reducing working load by machineries. Source: Field survey, 2019.

Problems ranking

Based on field survey (face to face), focus group discussion and KII, major five problems associated with maize production in the study area were identified. Major five problems were disease and pest, agri-mechanization, labor shortage, source seed and shortage. Farmers were asked to rank those problems. The forced ranking method was used for scaling by giving a score of 1 to the most severe problem and 5 to the less severe problem. Index value was calculated and ranking was done based on the highest index value. Ranking of the problem was done separately for both machine user and bullock user.

Labor shortage was the second-ranked problem for machine user and third ranked problems for bullock user. Due to the current trend of foreign migration of young people lead only the children and old people at home. It had created the labor shortage in the agriculture sector. Also the household members were migrated to Kathmandu for higher education and occupation due to capital city near from the study area.

Insect and pest infestation was ranked top most severe problems for machine user while second problem for bullock user as shown in table. Most frequently seen diseases were stem rot, pollen rot, root rot, leaf blight and most severe insect problem were white grub, cut worm and stem borer.

Machinery shortage was first most problems for bullock user while third most problem for machine user as shown in table. Machinery shortage comprises the machine unavailability at time of field preparation and other cultural operation.

Lack of storage problem was least problems for bullock user and fourth ranked problem for machine user. Most of the farmers have no house for the storage but for some seed producer farmers JICA constructed the seed storage house but grain storage was directly in floor. Due to the moist floor, funguses grow in the cob of maize.

Source seed problem was least problems for machine user and fourth most problems for the bullock user. Most of the machine user farmers got subsidies from government in machine and source seed (table). But bullock user did not got source seed from government. And also most of the machine user farmers were seed producer that clearly showed the source seed was not a major problems for machine user.

Problems	Machine user		Bullock user	
	Index	Ranking	Index	Ranking
Labor Shortage	0.36	II	0.33	III
Insect pest infestation	.037	I	0.37	II
Machineries shortage	0.32	III	0.39	I
Storage problem	0.25	IV	0.18	V
Source seed problems	0.21	V	0.23	Iv

Table 7: Major problems in maize cultivation.

Source: Field survey, 2019.

Econometric models

Probit model: to investigate factors influencing adoption of mini-tiller adoption

Variable	Description of variables	Obs.	Mean	Max.	Min
Age	Age of the household head	120	48.68	80	17
Sex	1 male and 0 female	120	0.70	1	0
Education	1 if the farmer has informal education and only read and write; 0 others	120	0.51	1	0
Occupation	1 agriculture and 0 otherwise	120	0.75	1	0
Ethnicity	1 Bhramin/chhetri and 0 others	120	0.51	1	0
LSU	Numeric	120	9.81	243.7	0
Family size	Numeric	120	6.18	14	2

Table 8: Summary statistics.

Variable	Coef.	Std. Error	p	dy/dx
Age	-0.023**	0.011	0.035	-0.010**
Sex	0.096	0.295	0.744	0.038
Education	-0.211	0.283	0.456	-0.083
Occupation	0.002	0.307	0.995	0.001
Ethnicity	1.140***	0.272	0.000	0.429***
LSU	0.036	0.022	0.111	0.014
Family size	-0.50	0.561	0.370	0.019
Constant	0.685	0.581	0.238	

Table 9: Factors affecting mini-tiller adoption.

** and *** indicates statistically significance at 5 % and 10 % levels of significance respectively.

Source: Field survey, 2019.

Age has negative and significant impact on mini-tiller adoption at household level. If age increases by 1 year, the probability of adoption of mini-tiller will be decrease by 1percent.Younger people are more likely to adopt the technology than older once [12]. Ethnicity has positive and statistically significant at 1 percent level on mini-tiller adoption. If the HH of Bhramin/Chhetri increases by 1 unit the, the probability of adoption of mini-tiller will be 42.90 percent. That indicates the ethnicity of farmers affected the adoption of mini-tiller [13,14].

From the survey it was found that the command area of zone is in stage of transformation from conventional farming system to modern system. As high cost of machineries and low buying capacity of farmers was found major constraint in use of machineries and most of farmers are poor, low cost machineries should be introduced at first and for those machineries which demand high capital investment; custom hiring provision coupled with soft loan linked with commercial bank should be made. The adoption of new technology was affected by Ethnicity, Age, LSU, Family size, total variable cost, economically active population and active population in farming significantly. Machineries supplier also determined the adoption of new machineries. The study area was near from Kathmandu and also supplier branch supply machineries from Chautara (headquarter of district). The B:C ration of the maize cultivation was less than one but farmers perceived their practice to be in profit as they did not consider the monetary value of two major cost of production, FYM cost and labor cost. Seed replacement rate of OPVs in the command areas of zone was found to be 61.12 percent and of hybrid was 100 percent. The adoption of mini-tiller was affected by different factors that were age and ethnicity significantly. The income from maize was higher in machine user that was due to increase in productivity of maize. Most of the farmers said that by the use of machineries working load and drudgery was decreased by 50 percent.

Conclusion

From the survey it was found that the command area of zone is in stage of transformation from conventional farming system to modern system. As high cost of machineries and low buying capacity of farmers was found major constraint in use of machineries and most of farmers are poor, low cost machineries should be introduced at first and for those machineries which demand high capital investment; custom hiring provision coupled with soft loan linked with commercial bank should be made. Machineries supplier also determined the adoption of new machineries. The B:C ratio of the maize cultivation was less than one but farmers perceived their practice to be in profit as they did not consider the monetary value of two major cost of production, FYM cost and labor cost. Seed replacement rate of OPVs in the command areas of zone was found to be 61.12 percent and of hybrid was 100 percent. The adoption of mini-tiller was affected by different factors that were age and ethnicity significantly. The income from maize was higher in machine user that was due to increase in productivity of maize. Most of the farmers said that by the use of machineries working load and drudgery was decreased by 50 percent.

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