RESEARCH ARTICLE

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ADOPTION OF IMPROVED MANAGEMENT PRACTICES OF SUGARCANE IN BARA AND NAWALPARASI DISTRICTS

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ABSTRACT

Agricultural technologies have an important role to improve productivity as well as the quality of the crops. However, the adoption of improved technology has remained poor for sugarcane in Nepal. A research was conducted in Bara and Nawalparasi (Bardhaghat Susta west (BSw)) district of Nepal with a sample for 120 sugarcane growing farmers in the year 2019 to assess adoption of improved management practices of sugarcane. Descriptive statistics and inferential statistics were used to analyze the data. The logit model was used to identify the factors affecting adoption of improved management practices among farmers. Respondents were grouped into two categories, high adopter and medium adopter based on adoption index of each farmer. The average Adoption Index (AI) value obtained was 0.685. Around forty-nine percent of respondents were medium adopters and around fifty one percent were high adopters. The use of credit, ownership of agri-machine, and participation in training do have a significant influence on the adoption of improved practices. All variables had a positive relationship with the level of adoption of improved practices. The study revealed that farmers using credit, ownership of power-driven agri-machine, participation in crop related training increased the probability of farmer being high adopter. Agricultural machinery services, easy and cheap credit facilities and, easy access to extension services can help to increase in adoption of improved practices by sugarcane farmer.

1. INTRODUCTION

Technology adoption is among the most revolutionary and impactful areas in the agricultural sector. Agricultural innovations also play a crucial role in fighting poverty, lowering per-unit costs of production (Berresaw, Shieferaw, & Muricho, 2011), and increasing rural income (Maertens & Barrett, 2013). Improving the livelihood of rural households through improving agricultural productivity would remain a mere wish unless the level of technology adoption is improved (Ajayi, Franzel, Kuntashula, & Kwesiga, 2003). In such regards, adopting agricultural technology becomes a key concern of agricultural extension workers, policymakers, agricultural researchers, and other stakeholders especially in developing country like Nepal.

Sugarcane is main commercial crops cultivated in tropics and sub-tropics region of Nepal (MoALD, 2018). It is cultivated in mid hills and *Terai* region but is the major commercial cash crop in *Terai* region of Nepal. In Nepal, sugarcane is an important industrial crop, as it contributes 2.1% in AGDP and main source of income for 0.1 million farmers (MoALD, 2020; Pandey & Devkota, 2020). Many farmers of *Terai* are engaged in sugarcane cultivation. As it provides raw materials for a large number of industries, it is the major source of income in *Terai* (Neupane *et al*., 2017). Before the establishment of Morang Sugar Mill in 1946; farmers were cultivating sugarcane in subsistence levels. Only after the establishment of Morang Sugar Mill, modern cultivation methods were used for commercial production of sugarcane in the country (Koirala, 1984).

Sugarcane industry is the only organized agro-industry in Nepal which is the source of income of thousands of farm families and hence contributes to poverty alleviation in rural areas (Nepal Agriculture Research

Council, 1997). Compared to the global average, Nepal's sugarcane yield is very low, most probably due to poor varietal selection (Sapkota *et al*., 2019). Different biological and management factors like weeds, pests, disease, unscientific cultivation practices, selection of poor-quality sets are also major causes for low productivity of sugarcane in Nepal (Neupane *et al*., 2017; NSMA, 2018). The average yield of sugarcane in the NARC research center with improved practices is very high compared to farmer's field (MoALD, 2020; Sapkota *et al*., 2019). The productivity of sugarcane for Nepal is 49.48 t/ha and that of Nawalparasi and Bara district is 47.20 t/ha and 46.73 t/ha respectively (MoALD, 2022) whereas the productivity of India is 78.57 t/ha (FAOSTAT, 2021). This shows that there is poor adoption of improved technologies among the sugarcane growers, which is the main reason for the low level of productivity. Sugar recovery rate of Nepalese sugarcane is also lower than other global producers. The sugar recovery rate is around 10.5% in India and it is around 14 % in Brazil (Roy & Chandra, 2018). In Nepal, the recovery rate is 9.0 % (MoALD, 2020). The sugar recovery as a percent of cane crushed weight is affected by agronomic practices (cane quality) and post-harvest management (Roy & Chandra, 2018).

Low productivity of sugarcane and low sugar recovery rate are the two major problems being faced by sugarcane farmers and sugar factory, respectively, in Nepal. MoALD has identified a number of factors for the low productivity of sugarcane including low adoption of improved technology, farming for subsistence, unavailability of inputs, and limited investment (MoALD, 2018). Research stations under NARC have developed various improved technologies on sugarcane production in Nepal. Proper adoption of those technologies is expected to increase productivity and resultant income of sugarcane farmers. However, the adoption level of those technologies by the farmer is low as evidenced by the low productivity. Moreover, poor adoption of improved agronomic practices and post-harvest management techniques have also been associated with the low recovery rate in Nepal. This study was carried out to find the level of adoption and factors affecting level of adoption of improved management practices of sugarcane in Bara and Nawalparasi-Bardhaghat Susta west (BSw) Districts.

2. MATERIALS AND METHODS

2.1 Study area and data collection

Ramgram Municipality and Triveni-Susta rural municipality of Nawalparasi (BSw) districts were purposely selected to cover the command area of sugar mills. Similarly, Jitpur-Simara sub-metropolitan city and Parwanipur rural municipality were selected form Bara district considering the location of as National Sugarcane Research Center and Sugar mills.

From each rural/municipality two wards were randomly selected. Sampling frame of each ward was prepared with the key informant survey. Individual sample was selected randomly with the lottery method from each sampling frame. Fifteen individuals from each ward were selected. Altogether 60 samples from the Nawalparasi (BSw) district and 60 samples from the Bara district were selected. Both the primary and secondary data were collected for the study.

2.2 Selection of improved management practices

The practices which are responsible for an increase in productivity and quality of production were mainly considered as major improved management practices for this study. The improved practices were those which are recommended by NARC, Nepal Industrial Crop Development Program (NICDP), and other related responsible agencies viz industry. Altogether eight such practices were selected for the study.

2.2.1 Varieties:

Score was given on the basis of the recommended variety was planted. The recommended varieties indicate the varieties recommended by NARC (Jitpur Lines) or the corresponding sugar industry Viz. Co 0232, Co 0238, selection of varieties for ratoon cropping.

2.2.2 Quality of sets and sets treatment:

The quality of sets indicates the disease and insect free sets and the part of the plant used to prepare sets, numbers of buds per sets. Score was given on the basis of quality sets used and treatment of sets done by fungicide or hot water.

2.2.3 Fertilizer application:

Fertilizer dose, time of application, split application of nitrogen, use of micronutrient and organic manure were considered under this practice. The recommended dose of NPK and Zinc from NARC was considered as the recommended fertilizer dose used as the standard for the study.

2.2.4 Irrigation management:

It indicates the frequency of irrigation. The standard was

fixed as recommended by NICDP (2018) and NARC.

***2.2.5 Weed management*:**

Number of weeding of the main crop was studied in this topic. The reference was taken from the recommendation made by NARC and sugarcane production manual of NICDP and NARC.

***2.2.6 Intercultural operation*:**

The intercultural operation included gap filling, earthling up, cane propping. Score was given on the basis of the adoption of these activities.

***2.2.7 Insect and disease management*:**

In this topic the regular monitoring of field to check the status of insect pest infestation was studied.

***2.2.8 Postharvest management*:**

Storage of harvested cane in a shade place and milling on time were considered important post-harvest technology for sugarcane.

2.3 Score assign to each selected practice

The total score for selected eight practices was identified i.e.90, based on the discussion of sugarcane experts from NARC, staff of sugar mill, other experts and leader farmers. Out of the total score; 90, the distribution of the scores for the each practices was done with respect to the relative importance of the practices on improvement of productivity and quality of product (Table 1). The above mention eight practices were further sub-divided into sub-practices and scores for each sub-practices were provided based on the marks allotted to each of the main eight practices by the same member of experts and leader farmers.

Table 1. Score assigned to each selected practice

S.N.	Improved Management Practices	Score allotted
1	Variety selection	17
2	Quality of sets and sets treatment	10
3	Fertilizer application	20
4	Irrigation management	15
5	Weed management	10
6	Intercultural operation	8
7	Insect and disease management	5
8	Post-harvest management	5
	Total	90

2.4 Data analysis

Data entry and analysis were done by using computer software package; Stata (Version 13.0) and Microsoft Excel. Both descriptive and analytical methods were used to analyze the data. Binary Logit regression model was used to identify the factors affecting adoption of improved management practices of Sugarcane.

2.4.1 Technology adoption level

Rate of adoption refers to the full or partial use of recommended production technologies by the respondents during the last two year. The respondents were asked whether they adopted a particular practice or not, if they adopted, they were given a score, if not, they were not given any score. The individual farmer's overall adoption score was calculated by adding response components of improved technology. The extent of adoption of improved technology was determined by using the following formula (Dongol, 2004).

$$\text{Adoption Index} = \frac{\text{No of adopted technology in last two years}}{\text{Total no of technology recommended}}$$

Based on the level of adoption farmers were classified under two categories either medium adopter or high adopter based on their adoption index (Dhital & Joshi, 2016). From the adoption index, we can assess the level of adoption of each respondent.

Medium Adopter**:** For this study, medium adopter refers to the farmers who had got the value of Adoption Index below the average level of total farmers.

High adopter**:** High adopter means that the farmers who adopted the improved practice more than medium adopter does or whose AI is above or higher the average of the total farmer.

2.4.2 Factors affecting adoption of improved technology

The adoption of a new technology depends upon different factors such as age, gender, level of education, experience, land holding, nature of farming and participation in training, income, livestock holding, access of credit, tenure status and perception of farmers toward the crop. A logistic regression model was used to know the important factors responsible for adoption of improved sugarcane production technology. The level of adoption function is given as:

Y_i (high adoption=1) $=b_0+b_1X_{1i}+b_2X_{2i}\ldots\ldots\ldots+b_kX_{ki}+e_i$

Where

Y_i = ith observation of the dependent variables, $Y_{i=}$ Adoption (dummy): 1 if high adopter and 0 for medium adopter.

$X_{1 \ldots\ldots} X_{14}$= explanatory variables explained as below

b_0= intercept term (constant)

b_j= coefficient for each of the independent variables

e_i= error term

X_{ji} = ith observation of jth independent variables

i=n= number of observations=120

Table 2. Description of variables and data used in the Logit model of regression

Variables	Description	Value	Type
Age	Age of farmer	year	continuous
Education	Years of education	year	continuous
Family size	Family size	number	continuous
Credit	Use ofW credit	If yes=1, no=0	Dummy
Occupation	Occupation	If only agriculture=1, agriculture+ off-farm =0	Dummy
Farm size /land holding	Total land holding	Area in ha	Continuous
Income	Annual HH income	Rs. in thousand	Continuous
Experience	Years of experience in sugarcane cultivation	years	Continuous
Agriculture machinery	Ownership of power-driven machine	If yes=1, if no=0	Dummy
Training	Participation in sugarcane related training or workshop	If yes=1, if no=0	Dummy
Group	Involvement of farmers in farmer in farmers group or cooperatives	If yes=1, if no=0	Dummy
Personal localities	Contact with personal localite sources of information	If yes=1, if no=0	Dummy
Personal cosmopolite	Contact with personal cosmopolite sources of information	If yes=1, if no=0	Dummy

3. RESULTS AND DISCUSSION

3.1 Demographic and Socio-economic Characteristics of Farmers in Study Area

Family size (7.5) of study area is more than national average (4.37) (NSO, 2023), and land holding (2.25 ha) is also more than national average (0.68 ha) (CBS, 2011a). Credit use household (25%) is quite similar to national (21%) scenario (CBS, 2011b). Majority of respondent have only agriculture occupation (89.17%) which is also more than national average (NSO, 2023). Most of the respondents (86.67%) were literate with the average year

of schooling 6.74 years which is higher than the national literacy rate (76.2 %) in 2021 (NSO, 2023). The study sample comprised more Bramin, Chhetri and other caste group (61.67%) but the national scenario is quite different (Bramin: 12.2%; Chhetri: 16.6%, Yadav: 3.98%; Thakuri: 1.61%) (CBS, 2011b). Training participation of farmers (21.67%) was very low as compared to Pokherel *et al*. (2019) who found that 76.20% farmers were participated in sugarcane related training in eastern region of Nepal. Though group/cooperatives approach is promoted by government, only 40% respondent were associated with group/ cooperatives.

3.2 Adoption index and level of adoption

The average adoption index was 0.685 and it ranges from 0.403 to 0.916 having standard deviation of 0.1306. The respondents were categorized into two categories on the basis of average adoption index, i.e. high adopter having adoption index more than average and medium adopter having adoption index less than average.

Out of the total, high adopters and medium adopters were approximately equal, 50.83 percent of respondents were high adopters and 49.17 percent were medium adopters.

Table 3. Distribution of farmers based on their location on the basis of their adoption index

Districts	Medium adopter	High adopter	Total	Chi-squire value
Bara	16(26.67)	44(73.33)	60(100)	24.3***
Nawalparasi (BSw)	43 (71.67)	17 (28.33)	60(100)	
Total	59 (49.17)	61(50.83)	120(100)	

Figures in the small parenthesis indicate percentage. *** indicates significant at 1% level (Source: Field Survey, 2019)

More than two third of the farmers of Bara were high adopters but about only one third of sugarcane farmers of Nawalparasi(BSw) were high adopter. The difference might be due to the existence of National Sugarcane Research Program in Bara districts, which facilitates farmers of Bara to have easy access for technical information and supports.

The average adoption index of study area was 0.685. It is lower than sugarcane farmers of Sri Lanka with average AI 0.72 (Peiris *et al*., 2012). Similarly, it is also lower than average AI of couliflower farmers of Nepal with average AI 0.741 (Dhital & Joshi, 2016).

3.3 Characteristics of high and medium adopter

Table 4. Socioeconomic and demographic characteristics of high adopter (HA) and medium adopter (MA) of improved management practices of sugarcane

Variables	HA n=61	MA n=59	T test	Chi squire
Age	47.95	46.83	0.52NS	
Caste/ethnicity (BC=1)	43 (61)	31(59)		4.08**
Year of education	7.91	5.52	3.48***	
Family size	7.47	7.69	-0.32 NS	
Use of credit (Yes=1)	(25)61	(5)59		16.9***
Land holding	2.85	1.64	2.28**	
Occupation (only agriculture=1)	54(61)	53(59)		0.053NS
Total -income	817.21	393.47	4.60***	
Experience	15.81	11.11	2.98**	
Ownership of Agri-Machine (yes=1)	46 (61)	25 (51)		13.54***
Membership (Yes=1)				2.362 NS
Training/workshop (Yes=1) (Yes=1)	25(61)	1(59)		0.0***
Personal _ Localite Yes=1	56	53		0.14NS
Personal Cosmopolite (Yes=1)	53	36		10.47***

Figures in the small parenthesis indicate percentage. *** indicates significant at 1% level and ** indicates significance at 5% level

(Source: Field Survey, 2019)

3.4 Factors affecting the adoption of improved management practices of sugarcane

This study was focused on the factors affecting the level of adoption of improved management practices. The association of selected variables (Table 2) and level of adoption was studies using logit model. To test the problem of multicollinearity, an estimate of the correlation between explanatory variables used in the regression model was carried out, showing no correlation between and among the variables that have been used in linear regression. Overall, the model predicted 79.17 percent of the sample correctly. The wald test (LR chi^2) for the model indicated that the model had good explanatory power at the 1% level. The Pseudo R^2 was 0.3905. For the interpretation of the model, marginal effects were driven from the regression coefficients, calculated from partial derivatives as a marginal probability. The result from the Hosmer-Lemeshow' goodness fit showed a chi square with large P -value which indicates that this model presents a good adequacy and fits the data well.

Table 5. Factors affecting the level of adoption of improved management practices of sugarcane in the study area using logit model

Variable	Coefficients	P>|z|	Standard error	dy/dx[b]	S.E[b]
Age	-0.0113	0.696	0.029	-0.0015	0.0040
#Caste/ethnicity	0.7069	0.253	0.618	0.097	0.084
Years of education	0.035	0.645	0.077	0.0049	0.0049
Family size	-0.0472	0.531	0.075	-0.0065	0.010
#Use of Credit***	2.012	0.006	0.737	0.2788	0.089
Landholding	-0.163	0.264	0.146	-0.0225	0.019
#Occupation	-0.611	0.530	0.814	-0.0708	0.1121
Total-income	0.0014	0.227	0.0011	0.0001	0.0001
Experience	0.0492	0.184	0.037	0.0068	0.005
#Mechanization**	0.9469	0.015	0.388	0.1311	0.048
#Membership	0.1195	0.831	0.559	0.0165	0.077
#Training/workshop**	2.835	0.018	1.19	0.3927	0.152
#Personal_ Localite	-0.4108	0.629	0.850	-0.0569	0.117
#Personal cosmopolite	0.7868	0.216	0.635	0.1089	0.085
Constant	-2.105	0.252	1.83	-	-

Summary statistics

Number of observation (N)	120
Log likelihood	-50.68
LR chi2(14)	64.95***(Prob>chi2 = 0.000)
Pseudo R2	0.3905
Goodness of fit test	Person chi2(105) = 102.20 (Prob> chi2 =0.559
Area Under RoC	0.8789
Overall Correct Prediction	79.17%

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. dy/dx indicates marginal change in probability (marginal effects after logit). # indicates dummy variables (1=Yes)

The result showed (Table 5) three variables were statistically significant for the level of adoption and they were; use of credit, ownership of agri-machine, and training participation. Eleven other variables namely age, ethnicity, year of education, family size, Occupation, landholding, annual income, year of experience, membership in groups, personnel localite, and cosmopolite source of information were statistically non-significant.

The study revealed that the use of credit for purposes of farming was positively associated with technology adoption and the level of association was highly significant (at p=0.01). From the table 5 it is observed that the probability of a farmer being high adopter is increased by 27.88 percent when he/she have access of credit facilities for sugarcane cultivation. This finding was somewhat similar to the findings of Dixon *et al* (2006); Mohamed and Temu, (2008); Ullah, Khan, Zheng and Ali, (2018); Jerop *et al*. (2018), showed availability of credit increased the probability of adopting new technologies. It is believed that access to credit facilitates the adoption of risky technologies through relaxation of the liquidity constraints as well as increasing household risk-bearing abilities (Simtowe & Zeller, 2006). Sugarcane is long duration crop; farmers have to wait for long period to get income from crop. In present situation, Sugar mills are also not paying to farmers on time. In such situation, credit amount facilitates farmers to purchase of seed/ set, fertilizer, payment to labour and to perform other activities, as credit improve the liquidity position of farmers.

Ownership of power-driven agri-machine was positively and significantly (p=0.05) associated with adoption of improved management practices of sugarcane. The probability of farmers being high adopter is increased by 13.11 percent as they owned power driven agriculture machinery.

It was similar to Ullah *et al*., who (2018) showed that ownership of machnary confirmed the positive and significant effect on improved cultivar adoption. Ownership of machinary increased the probability, which might be due to these machines facilitate in the operationalization of different management practices viz. weeding, irrigation management, intercultural operation as well as post-harvest management. Adoption of mechanization is itself adoption of innovation.

Participation in training/workshop related to sugarcane production also has positive relationship with technology adoption (p=0.05). If a farmer participates in training/ workshop related to sugarcane, the probability of farmer being high adopter is increased by 39.27 percent.

Participation on training/workshop had positive and significant relation with adoption of improved practices. Several research studies found training has positive and significant impact on adoption of technology (Bhusal, 2012; Ghimire, 2013; Ghimire & Kafle, 2014; Li *et al*., 2019). This is anticipated that training impacts knowledge and skill, and provide an opportunity to farmers to learn importance of improved technology and help to learn the way of best use of innovation.

The study revealed that though non-significant, age was negatively associated with technology adoption but the influence of age on technology adoption is very negligible. Similarly, family size, farm size, occupation, and personnel localite source of information were also negetively associated with adoption level of technolgoy but their influences were non-significant.Moreover, ethnicity, year of education, year of experience, total income, memberrship in a group,and personal cosmopolite source have positive but non-significant relationship with the level of adoption.

4. CONCLUSION

This research shows that farmers in study area were partially adopting the recommended improved practices of sugarcane production and post harvest management. On an average 68.5 percent of receommended practices were being adopted by the sugarcane farmers. This can partially explain the low productivity of sugarcane and low recovery rate prevailing in the study area. However, presence of most of the high adopters in Bara, reveals that location of sugarcane research station, indicates the technology spill overthrough demonstration effect in nearby farming population of agriculture research and development institution.

The study suggests that in study area, sugarcane farmers who have an access to institutional credit; owns farm machineries to perform basic farm operations including ploughing, planting, harvesting etc. and often participates in related training and workshop tend to adopt improved practices in sugarcane. So the policy related to agricultural credit, agricultural machinery services and knowledge and skill development program to farmers helps in the adoption of improved practices and hence improve the productivity and quality of sugarcane.

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