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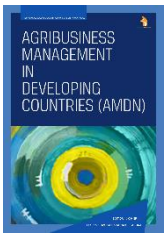

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RESEARCH ARTICLE

ASSESSMENT ON ADOPTION OF IMPROVED MAIZE VARIETY AND MAIZE PRODUCTION PRACTICES IN BAITADI, NEPAL

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ABSTRACT

The main objective of this study is to assess the status of adoption of improved maize varieties and cultivation practices of maize in Baitadi district. This study aims to identify the determinants of adoption of improved maize variety (IMV) among farmers and their cultivation practices in Baitadi district and subsequently ascertain the factors influencing the intensity of IMV adoption. The study areas; Dashrathchand-2, Dashrathchand-9, Patan-4 and Pancheshor-6 were selected purposively as these were under the command area of maize zone. Descriptive statistics, chi-square test, independent samples t-test, probit model and index score ranking method were used for the data analysis. The productivity of local variety was found 2mt/ha and improved variety was 3.51mt/ha. Majority of farmer preferred to cultivate local and improved variety with Manakamana being the most adopted improved variety. Membership of agricultural groups and training related to maize cultivation were the major determinants of improved variety adoption. Unavailability of seed in vicinity followed by higher cost of seed were the major constraints faced by the farmers in adopting improved maize variety. Distant market and gap between fragment and retail price are the major marketing problem faced by the farmers. Thus, the study concluded that improving farmers' education, expanding coverage and depth of extension services and firming up farmer associations are suitable policy actions for promoting adoption of improved maize varieties. It is also important to address availability, accessibility and affordability issues constraining adoption of improved varieties and technologies, enhance credit access for farmers and mitigate risk perceptions.

KEYWORDS

Maize; improved; adoption; production; marketing

1. INTRODUCTION

Nepal is an agriculture country and about 68% of total population is engaged in agriculture which has contributed about 34% of total GDP of the nation (ILO, 2022). The majority of Nepalese people depend on agriculture for their livelihood but only 34.1% of total GDP of the country is covered by agriculture and forestry sector (ILO, 2022). The annual growth of agriculture and forestry is 2.48% (MoALD, 2021).

Maize (Zea mays L.) is considered as the second most important crop in terms of area and production in Nepal and it is mainly grown in summer season. Maize is being cultivated in 9,79,776ha of land and the production of maize in fiscal year 2077/78 is 2,997,733 metric tons with the productivity of 3.06 mt /ha (MoALD, 2021).Globally, it is cultivated being as one of the most important cereal crops worldwide. Looking the data of 2021, the United States of America is the topmost country in maize production accounts for 31.77% of the world's maize production (USDA, 2021) .Of the total maize production, Province no.1, Madhesh Province, Bagmati province, Gandaki province, Lumbini province, Karnali province, Sudurpaschim province contribute to 29.5%, 6.18%, 23.06%, 15.03%, 14.33%, 7.79% and 4.08% of total maize production in Nepal respectively and the availability of the improved seed is still an issue, since the improved seed replacement rate of maize in Nepal is also low i.e. 13.41% (MoALD, 2021).The increase in maize production is only due to increase in the cultivation area of maize rather than increase in yield. Maize contributes 6.3% of agricultural GDP of nation (MoALD, 2021). In Nepal, more than 80% of maize cultivation is under rain fed conditions.

The feed demand in Nepal is increasing at the rate of 11% per annum (CDD, 2011). KC, (2015) reported that the demand of maize is shifting from food to livestock and poultry feed. But the productivity is only 3.06 t /ha (MoALD, 2021). Annually, 12537.89 mt. of maize seed of worth 85millions and 578404.416 mt. Maize (excl seed) of worth about 15 billion are being imported (MoALD, 2021).The factors causing lower yield of maize in Nepal are the use of low-quality seeds, poor crop management practices and low soil fertility. To achieve high quality, all the factors in production that will affect viability and genetic purity should be taken into account. For higher quality production the production techniques should be taken in account and the environmental conditions (soil fertility and climate) should be known. Seed is the most important input that determines the agricultural production (Karki, 2015). The productivity of other inputs and the upper limit of yield is determined by the seed. Thus, to sustain and increase the overall maize production, it is important to assure the farmer's access to improved and high yielding seeds .The newly released and quality improved seed contains various traits such as earliness, disease resistant and increased yield potential which governs the yield and high value commodity in the market (Setimela, et al., 2006). The adoption of new technology in the form of improved seed varieties has been increasing productivity and reduce poverty especially in rural communities.

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In Nepal adoption of improved variety was found to be 75% and Mean area of maize cultivation in Nepal is 0.431 ha/HH. There are around 24 improved varieties of maize has been released. But only few improved varieties are being adopted in large scale and adopted in 70.60% of maize cultivating areas. The yield from improved seed is much better than local seeds as improved better-quality seed alone contributes about 20-30% increase in yield (SQCC, 2013). Improved maize seed has total production of 1067.86 Mt (MoALD, 2021). Indeed, rapid diffusion of improved maize varieties, can profoundly improve livelihoods by expanding maize yield per unit of land. Actually, involving in seed production demands a higher level of management skills and it requires more labor and consumes more time than grain production (Thomison, 2013).The limited supply of quality seed in Nepal has become one of the main problems on commercial scale production and better yield as there is limited domestic seed research and production (Pullabhotla, et al., 2011). The 20 years Agriculture Perspective Plan (1995-2015) of Nepal was unable to meet the target made on cereal sectors due to unavailability of inputs such as improved seeds, low quality and unaffordable chemical fertilizer (MoAD, 2015). Recently 20 years Agriculture Development Strategy ADS, (2015-2035) of Nepal has been launched in country with the target to raise AGDP growth rate from 3% in 2010 to 6% by 2035. There is a high demand of agricultural products for the rapidly growing population and at least for maize there is high potential to increase the yield by the use of quality seed or using improved varieties.

1.1 Status of Maize in Baitadi

In Baitadi maize is cultivated in the area 11,031 ha with the total production of 26,939 Mt having productivity of 2.44 Mt/ha in the year 2020/21. The productivity of the improved varieties of maize is 2.4 Mt/ha while that of local varieties is 1.51 Mt/ha (MOALD, 2021). PMAMP maize zone, Baitadi is focusing to commercialized, self-reliant and increase the maize production area with high price to the farmers to uplift their livelihood. As the topography is difficult there is no access to the mechanization for intercultural operation which result in majority of yield loss due to weed infestation and poor intercultural operation. Pest and weed infestation are being the major problem of low productivity of maize. Farmer mainly depends on the local seed in spite of improved due to their longer maturity period than local variety. But due to higher productivity of maize and subsidized seeds farmers are being attracted toward adoption of improved varieties.

1.2 Improved Maize Varieties

It would be a prudent decision to adopt improved varieties as it yields higher compared to local; also, unlike hybrids as the seeds of improved varieties could be stored for following year. Seed multiplication of improved maize varieties through CBSP groups was initiated in Hill Maize Research Project in 2000 which has been a very successful model in Nepal contributed to increase seed replacement rate (SRR) and also has helped to increase the adoption of improved maize varieties and technologies thereby improving food security and livelihoods of the hill people (KC, et al., 2013)

Adoption of improved varieties is the major key to increase the productivity of maize which aids in improving the livelihood farmers and their families by producing more and higher quality crops. From improved varieties, to modern crop protection solutions, to mobile technology for farmers in the fields, to making foods fresher, safer, and healthier along the food chain, the agricultural and food system of the future can be more productive, more sustainable, more efficient, and more interconnected. Adoption of improved varieties of maize meets the demand of growing population by

- Enhancing the nutritional value and safety of food to improve the health and wellbeing of people around the world.
- By producing more and higher quality crops improving the livelihood of farmers.
- Contributing to agriculture sustainability through reduced resource use.

1.3 Concept of Adoption

Adoption is the degree of practices of new innovation in long run equilibrium when a farmer perceives full information about the new technology and its potential benefits (Feder, et al., 1985). Adoption of many technologies is interrelated with each other (Feder, et al., 1985). According to Rogers(1983), "Innovation is an idea practice or object that is perceived by an individual or other unit of production". The rate of adoption process includes various interrelated personal, social, human behavioral and situational factors while planning the various programs and demonstration to transfer new and available technology to the farmers (Scott, 1992).The rate of adoption or diffusion of innovation differs for different people. There are many stages of adoption and people adopt the technologies only when they find positive results. The categories of adopters are: innovators, early adopters, early majority, late majority, and laggard. Innovators (2.5%) – had larger farms, were more educated, more prosperous and more risk-oriented, early adopters (13.5%) – younger, more educated, tended to be community leaders, less prosperous, early majority (34%) – more conservative but open to new ideas, active in community and influence to neighbors, late majority (34%) – older, less educated, fairly conservative and less socially active, laggards (16%) – very conservative, had small farms and least educated (Rogers, 1983).

1.4 Factors Influencing the Rate of Adoption of Improved Varieties and Technologies

Previous studies have reported that farm technology including improved maize variety (IMV) adoption is explained by farmer's socioeconomic characteristics, and institutional variables such as gender, age, education, extension services, membership of agricultural organizations, farmer's attending training and demonstration farms (Adeoti, 2009; Mendola, 2007; Simtowe, 2011; Sisay, 2015). There are constraints to adoption of improved varieties in farming communities. The constraints are access to information, access to credit, illiteracy, subsidies and cultural and numerous socio-economic factors. Factors influencing the adoption of improved varieties of maize can categorized as:

- Personal factors include age, education, motivation, attitude, beliefs and their needs.
- Social factors include social structure, group participation, and contact with extension workers and so on.
- Economic factors include family size, resource availability, inputs etc.
- Cultural factors include norms, religions and local traditions (Roger, 1983)

Age:

Age of farmers can influence the adoption of improve varieties and technologies in several ways. The experiences, resources, and authority of older farmers allow them to adopt new varieties and technologies. Age is not the sole factor affecting the adoption. It acts along with education of the farmers and available resources (CIMMYT, 1993). The farmers of middle age proclaim a greater tendency to adopt improved technologies and varieties (Pyakurel, 1971). However, some studies evince there is not any significant relationship between age of farmers and adoption (Khating, et al., 2018).

Level of education

Education paves ways to information that helps to improve human capital, management capacity, and the ability to understand and adopt innovations (Rogers, 1983). Education makes person more receptive to advise from different sources or improves ability to deal with different technical recommendations. Educated farmers are more likely to adopt improved technologies than less educated farmers. With increase in education level of respondents the likelihood of adoption of recommended agricultural practices is more likely to be observed (Khanal, 2016)

Training

Farmers may obtain information from different sources and may learn from extension programs (Scott, 1992). However, unless they obtain handsome knowledge through training, they could not perform any activities fluently. So, those farmers who received training, are more willing toward new technologies and recommendation (Huang, 2016). Training is meant to provide knowledge and skill which people can apply in practical (Dangol, 2004). Exposure to training help people to increase the adoption of practices by raising likelihood of receiving information about various practices (Kumar, et al., 2020).

Membership of Agricultural groups

Membership of any agricultural groups is positively correlated with the adoption of different practices as they participate in its different activities (Shamsudeen, 2018). Membership in agriculture related organizations helps farmers in decision making process for adoption and practices of any recommended technologies (Subedi, et al., 2019).

Extension services

The rate of adoption is affected by the linkage between extension services and farmers (Rogers, 1983). There is an association between extension services obtained by farmers and the adoption of improved varieties (Budhathoki, 2016). Various agriculture technologies and recommended varieties are more likely to be adopted by those farmers who have access to extension services as well as membership of agriculture group (Kumar, et al., 2020).

Impact on Adoption of Improved Maize Varieties among Farmers:

Adoption of improved varieties is the major key to increase the productivity of maize which aids in improving the livelihood farmers and their families by producing more and higher quality crops. From improved varieties, to modern crop protection solutions, to mobile technology for farmers in the fields, to making foods fresher, safer, and healthier along the food chain, the agricultural and food system of the future can be more productive, more sustainable, more efficient, and more interconnected. Adoption of improved varieties of maize meets the demand of growing population by

- Enhancing the nutritional value and safety of food to improve the health and wellbeing of people around the world.
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- Contributing to agriculture sustainability through reduced resource use.

2. Research Methodology

2.1 Research Site

The district under study is Baitadi which lies in the hills of far-western development region. The research was conducted in Dashrathchand municipality ward no. 2: Gurukhola, Dashrathchand-9: Gwallek, Pancheshor-6: Bijula, and Patan-4. These areas were purposively selected as they are the command area of PMAMP maize zone Baitadi, possessing highest potential of maize production in the district. Also, for the extension of maize area PMAMP is working on these areas.

2.2 Sample and Sampling Techniques

A list of maize growers was prepared from different local bodies separately (3 rural municipality); Pancheshor-6, Dashrathchand(2 wards), Patan, which was provided by maize zone, PMAMP Baitadi. The list was used as the sampling frame to select the respondent farmers. Total of 75 respondent 27 respondents were selected from Dashrathchand-9, 14 from Patan-4 and 17 from remaining each local bodies of maize growing households. Sample size was calculated using formula:

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Where, P= population size e = Margin of error (percentage in decimal form)

z = z-score e=10% level of confidence=95%

2.3 Research Instruments/Designs

Data collection were done through household survey. Based on the interview schedule and checklist, questions were asked to the selected respondents to obtain the aimed information. Key informant interviews (KII) and focus group discussion (FGD) were carried out primarily for generalizing the data and information obtained from scheduled interviews and secondarily to obtain additional qualitative information regarding our survey topic.

2.4 Statistical Analysis

The data collected were entered and analyzed using MS Excel , SPSS and STATA. Mean, Standard Deviation, frequency and percentage were computed. Chi square and t-test were used to test the significance difference between the variables. Probit model was used to determine the factors affecting adoption of Improved varieties. Scaling technique: Scaling technique was used for indexing and to rank the major constraints faced by the farmers in the study area.

3. Result and Discussion

3.1 Sociodemographic Characteristics

It was found that majority of Household 64% were male and 36% were female. This suggest that majority of the families were male dominated in Baitadi district. All the respondents followed Hinduism. The majority of respondents were Brahmin(72%) followed by Chhetri(16%), Thakuri (8%) and Dalit (4%). The average age of household was 43.2 years with standard deviation 13.1 years. The study shows that 24% of household were illiterate, 24% were able to write their name only, 5.33% attained up to secondary, 18.67% upto SLC, 5.33% had intermediate,5.33% had bachelor above from which we can infer that majority of household can read and write.

From study, it was found that 63.98% of population in the study area were economically active with mean 4.03 and standard deviation 1.59 whereas 36.02% were economically inactive with mean 2.62 and standard deviation 1.19. Majority 48% of family were involved in agriculture, 28% in public services, 21.3% in remittance and 2.7% in business. Total 63.2 hectares of land were under cultivation with mean 0.84 hectare. Among the cultivatable land 58.40% (37 hectare) were used for maize cultivation. There 73.14% of maize cultivated land were under local variety cultivation whereas only 26.86% land were being used for improved varieties cultivation. From this we can infer that majority of land was used for local maize variety cultivation.

Table1: Total Land Distribution of Surveyed Area

	Land (ropani)	Mean	Std. Deviation
Local variety	531(73.14)	7.27	7.01
Improved variety	195(26.86)	3.82	3.08
Land for maize cultivation	726(58.40)	9.68	8.10
Total cultivable land acquired	1243	16.57	36.24

Figures in parenthesis represent percentages. Source: Field survey,2022

3.2 Maize Cultivation Practices

Maize was produced for both subsistence and selling purpose in Baitadi. 41.3% of farmer cultivate maize for subsistence while 58.7% grow it for selling purpose. All the respondents sow the maize during first week of Jestha.

92.5% of respondents prepare land using bullocks and 22.6% has access to minitillers. 85.4% responses were for the use of bullocks and remaining for minitillers for preparing land for local maize, whereas 80.3% responses were collected for use of bullocks and 19.7% for minitillers for land preparation of improved varieties. Respondents who used plough for land preparation performed line sowing behind the plough and those who used minitillers broadcast the seed. Line sowing behind the plough (80%) method was the most widely used method of sowing maize seed. However, only 20% follows broadcasting. From this, we can infer that people show slow proclivity of adopting technology.

Most of the respondent reported no need of use of chemical fertilizers as they follow organic farming. Only 36% of respondent uses chemical fertilizers and 64% uses only organic manures. The major chemical fertilizers used by respondent were urea and DAP. Among chemical fertilizer adopters 16% of respondents give special preference for improved varieties. The amount of fertilizers being adopted by the respondents in different surveyed areas was: for local varieties 60kg urea, 40kg DAP. 12 mt FYM per hectare were used for local varieties. Similarly, for improved varieties the mean dose of fertilizers adopted by them was 80kg urea, 40kg DAP and 14mt FYM per hectare. All the respondents *apply organic manures 1week prior to land preparation making heap over field and incorporate to soil during land preparation as basal dose. They top dress*

chemical fertilizer (urea and DAP) when plant reaches knee high stage. The study shows that 25.74kg/ha seed rate of local varieties and 23.18mt/ha of improved varieties was adopted in Baitadi district.

All the maize farmers perform hand weeding two times throughout the growth of maize. Initially after 10 to 15 days after sowing and another weeding is done after 15 to 20 days of initial weeding. Majority of respondents 84% use nothing for controlling pests, 12% of them use indigenous practices such as uses of ash and only 4% use chemical named Emmamectin Benzoate for control of FAW. All the respondents reported that non shelled maize was stored by making heap over stake (Lutto). Shelled maize was stored using different structures. Respondents might use either one or more structure for storage. The use of storage structure varied significantly among adopters and non-adopters. Among total responses 32.9% was for use mud vessels, 44.1% use sacks, 21% use metal bin and 2.1% use bamboo mat.

Table 2: Purpose of Maize Cultivation by Adopters and Nonadopters

	Purpose of maize cultivation		Total	Chi value	P value
	Subsistence	Selling			
Adopter	16(31.37)	35(68.63)	51(100)		
				6.521**	0.013
Non-adopter	15(62.5)	9(37.5)	24(100)		
Over all	31(41.3)	44(58.7)			

Figures in parenthesis represent percentages. *,**and *** indicates level of significance at 10%, 5%, 1% respectively.

Table 3: Land Preparation Methods

	Improved varieties		% of Cases	Local varieties		
	N	%of responses		N	% of responses	% of Cases
Using minitillers	12	19.7%	22.6%	12	14.6%	16.4%
Using bullocks	49	80.3%s	92.5%	70	85.4%	95.9%
Total	61	100.0%	115.1%	82	100	112.3%

Table 4: Different Methods Adopted for Sowing Seed of Local and Improved Varieties

	Method of seed sowing	
	line sowing of seed	broadcasting of seed
Adopter	55.6%	16.75%
Non-adopter	24.4%	3.3%
Total	80.0%	20.0%

Table 5: Seed Rate of Different Cultivated Maize in Surveyed Area

Seed rate(kg/ha)	Address of respondents				Seed rate
	Pancheshor,6	DCM,9	Patan,4	DCM,2	
Local seeds	23.38	28.88	22.99	27.90	25.74
Improved seeds	19.65	27.12	19.65	26.72	23.18

Table 6: Distribution of Responses Based on Storage Structure of Maize

	Storage structures				Chi value	P value
	Mud vessels	Sacks	Metal bin	Bamboo mat		
Adopter	31(21.7)	45(31.5)	23(16.1)	3(2.1)	43.778***	<0.001
Non-adopter	16(11.2)	18(12.6)	7(4.9)	0(0)		
Total	47(32.9)	63(44.1)	30(21)	3(2.1)		

Figures in parenthesis represent percentages based on responses. Source: Field survey, 2022

*,**and *** indicates level of significance at 10%, 5%, 1% respectively

Table 7: Sources of Seed for Different Varieties

	sources of seed		
	Remnants of previous year	Cooperatives	Agriculture office
Adopter	44(58.7)	39(52)	16(21.3)
Non-adopter	24(32)	2(2.7)	0(0)
Total	68(90.7)	41(54.7)	16(21.3)

Table 8: Total Annual Production of Maize in Surveyed Area

Production of maize (metric tonnes)	Address of respondents				
	Pancheshor,6	DCM,9	Patan,4	DCM,2	Total
Local variety	20.7(2.66)	7.4(2.08)	7.7(1.68)	16.7(1.6)	52.5(2)
Improved variety	8.5(3.22)	10.6(3.66)	5.3(3.44)	8.0(3.74)	32.4(3.51)
Total	29.2	18.0	13.0	24.7	84.9

Figures in parenthesis represent productivity in Mt/ha.

3.3 Institutional Factor

Institutional factors such as extension services, membership of cooperatives or agricultural organizations and farmer's attendance to trainings or demonstration fields are assumed to influence farmer's adoption decisions (Pandey, et al., 2019).

3.3.1 Membership of Agricultural Organization or Cooperatives

It was found that 50.7% respondents have access to membership of agricultural organization. Study shows that 64.8% adopters have access to membership whereas only 21% of non-adopters has access to membership. Around 49% of respondents still have no access to membership of agricultural groups.

3.3.2 Participation in Training

It was observed that 72.54% of adopters had participated in training whereas only 8.33% of non-adopter had participated in training. About 91.67% of non-adopters had never participated in training whereas only 27.46% of adopters had never participated in training. over in study area 52% of respondent have participated in maize training.

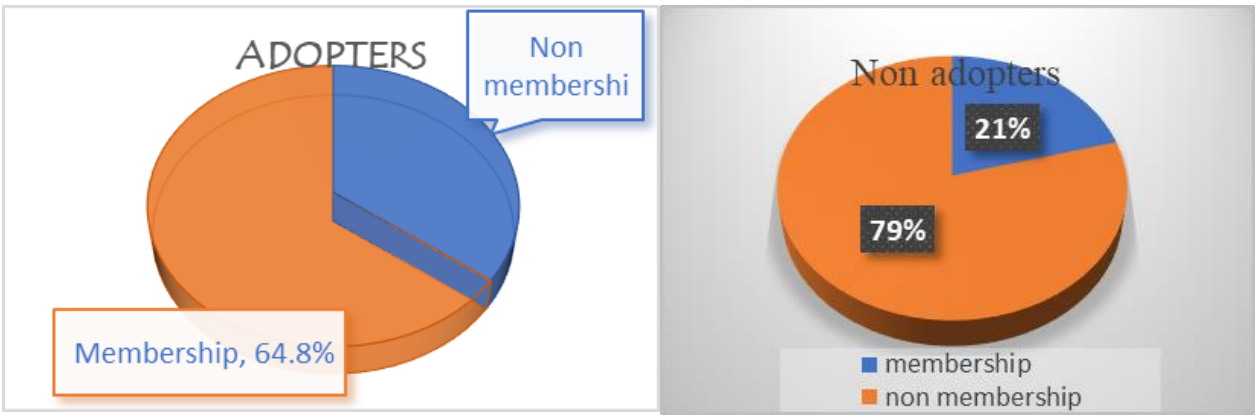

Figure 1: Access of Respondents to Membership of Agricultural Group or Cooperatives

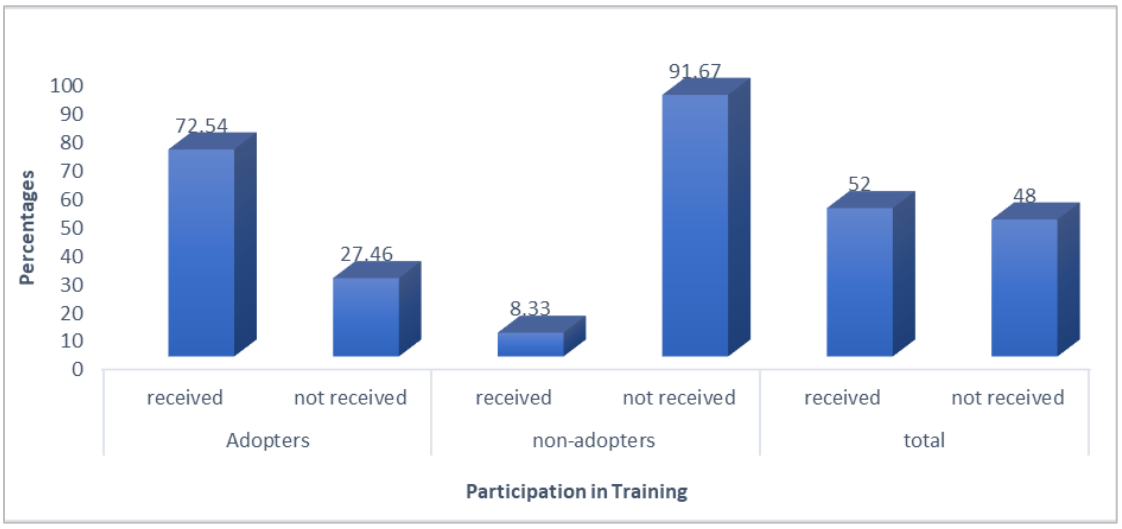

Figure 2: Distribution of respondents based on participation in training

Table 9: Sources of Information and Advices to Farmers			
	Adopter	Non-adopter	Total
Direct contact with extension workers	16 (31.37)	6(25)	22(29.33)
Advice from Agri technicians or agro dealers	19(37.25)	6(25)	25(33.33)
No contact with any source	16(31.37)	12(50)	28(37.34)

Figures in parenthesis represent percentage Source: Field survey, 2022

3.3.3 Source of Advices

The study shows that those who have contact with technicians used to report their problems and acquire knowledge and information about training, subsidies that are available to farmers.

3.4 Comparison of Different Variables Between Adopter and Non-Adopter of Improved Maize Varieties in Baitadi

The average age of adopters (48.18 years) was more than non-adopters (46.79 years). Although this difference is marginal, it was indicative of the predilection for older farmers to embrace improved practices which resulted due to more field experience acquired by older farmers. The difference in mean of ethnicity was found statistically significant at 1% level of significance. Total cultivable land acquired by farmers increases the adoption of improved maize varieties. The mean cultivated land was also significant at 10% level of significance. The means total cultivable land acquired by adopters was 11.61 ropanies and by non-adopters was 27.13 ropanies and mean difference between them was 15.52 ropanies. Furthermore, the majority of improved maize varieties adopter has access to the membership of Agricultural groups and provision for training related maize cultivation.

3.5 Association of Dependent and Independent Variables of Adoption of Improved Varieties and Cultivation Practices

It was inferred that there is statistically significant association of gender with management of insect/pest, ethnicity with use of chemical fertilizers, management of insect/pest, variety cultivated and land preparation, education status with seed sowing technique and storage structure, source of income with land preparation and seed sowing techniques, membership of agricultural groups with variety cultivated, extension worker with management of pest, land preparation and seed sowing technique, training with variety cultivated via chi square test analysis.

3.6 Factors Explaining the Adoption Of Improved Maize Variety

From the study, it is revealed that Maize cultivated land, Access to membership of agricultural groups, and provision of training were found to have significant influence on adoption of improved varieties of maize which was similar to the result given by (Pandey, et al., 2019). Other factors were found to have insignificant influence on adoption of improved varieties. Age had direct relation with the adoption of IMV which conforms to the finding of Islam,(2012) in Bangladesh that older and hence experienced farmers readily adopt new technologies. Economically active members have positive impact in adoption of improved variety although it has insignificant impact on adoption of IMV. The result shows that there was 1.32% probability of adopting IMV with increase in one economically active members in family. Gender had negative impact on adoption as the presence of male inplace of female decreases the adoption of IMV.For the gender variable not being significant here is possibly because, in general, most of the household decisions in farming operation including varieties selection are made in discussion with female members, so men are not the sole decision maker for making adoption of crop varieties in Nepalese context. This result conforms the inference of earlier study in Nepal (Gauchan, et al., 2012). Effect of education is consistent with the assertion that educated farmers can easily assimilate information and therefore adopt improved technology much more comfortable than the uneducated farmers (Kumar, et al., 2020). The study shows that education had positive

although had insignificant impact on adoption of Improved maize variety.

It was found that with the increase in maize cultivated land there is 1.39% probability of decreasing the adoption of improved variety and have significant impacts on adoption at 10% level of significance. This contrast with the result of Mariano et al. (2012) and Chandio and Jiang (2018), who found positive association between farm size and adoption of new technology in Pakistan. In a similar vein, there is a positive and significant (1% level of significance) relationship between adoption of IMV and training. Farmers who get the opportunity to attend agricultural trainings, seminars and training organized by different agricultural organization and cooperative were exposed to these varieties, their benefits and cultivation process which boost up their knowledge level and their morale of adoption. Thus, farmers with farm seminar and training records tend to have a probability of 56.31% of switching from local to IMV. This result conforms the findings of that farmers with farm seminar or workshop records tend to have a higher probability of adopting IMV (Pandey, et al., 2019).

Institutional variables such as extension services and farmer's membership of agricultural groups and cooperatives are essential sources of information. From the results, being a member of an agricultural groups and cooperatives increases the probability of a farmer to adopt an IMV and had significant impact(5% level of significance) on adoption of IMV. It might be due to accessibility of farmers to information about improved varieties of maize which are subsidized and distributed through such groups. In this research it was found that probability of adopting improved variety increased by 27.3% by those who has access to membership of agricultural groups and cooperatives. The accessibility to farm inputs and subsidy for those who are involved in cooperative help them to adopt technology earlier than those who are not involved (Neupane, et al., 2015)

Table 10: Comparison of Different Variables Between Adopters and Non-Adopters

Variables	Adopters	Non adopters	Mean difference	t-value	P value
Age	48.18	46.79	-1.387	-0.425	0.672
Gender	0.63	0.67	0.039	0.326	0.745
Ethnicity	1.24	1.88	0.640	3.415***	0.001
Education status	3	3.29	0.292	0.628	0.532
Family type	0.65	0.50	-0.147	-1.208	0.231
Source of income of family	1.90	1.75	-0.152	-0.661	0.511
Total cultivable land acquired	11.61	27.13	15.52	1.754*	0.084
Access of membership of Agricultural groups	0.65	0.21	-0.439	-3.833***	<0.001
Acquire advices regarding cultivation and contact with extension workers	0.54	0.50	-0.043	-0.251	0.803
Provision for training related maize cultivation	0.73	0.08	-0.642	-6.401***	<0.001

*,**and *** indicates level of significance at 10%, 5%, 1% respectively

Table 11: Association Between Dependent and Independent Variables of Adoption of Improved Varieties of Maize

	Chi-value (P-value)					
Variables	Chemical fertilizer	management of insect/pests	Variety cultivated	land preparation	seed sowing techniques	storage structure
Gender	0.130 (0.718)	5.56* (0.062)	0.11 (0.741)	1.64 (0.44)	1.96 (0.375)	6.869 (0.143)
Ethnicity	14.96** (0.002)	13.095** (0.042)	23.683*** (<0.001)	26.654*** (<0.001)	9.411 (0.152)	11.266 (0.506)
Education status	7.23 (0.405)	17.39 (0.236)	5.26 (0.629)	17.672 (0.222)	29.417* (0.009)	56.50*** (0.001)
Source of income of family	5.06 (0.168)	4.460 (0.615)	1.598 (0.660)	22.734*** (0.001)	18.688** (0.005)	15.675 (0.207)
Membership of groups	1.663 (0.197)	1.463 (0.48)	12.57*** (<0.001)	0.247 (0.884)	0.602 (0.740)	3.275 (0.513)
Extension workers	2.446 (0.118)	5.274* (0.072)	0.066 (0.797)	19.32*** (<0.001)	11.216** (0.004)	7.325 (0.120)
Training	0.251 (0.617)	3.139 (0.208)	26.962*** (<0.001)	0.858 (0.651)	1.224 (0.542)	4.509 (0.341)
Age	0.206 (0.902)	1.295 (0.862)	0.644 (0.725)	2.538 (0.638)	2.639 (0.620)	9.434 (0.307)

Figures in parenthesis represent p-value. *,**and *** indicates level of significance at 10%, 5%, 1% respectively.

Table 12: Factors Explaining the Adoption of Improved Maize Variety

Variable	dy/dx	Std. err.	z	P>z	X
Age	0.0025	0.00523	0.48	0.628	47.7333
Economically active members	0.0132	0.03197	0.41	0.679	4.0267
Gender	-0.1476	0.12159	-1.21	0.225	0.64
Education status	0.0035	0.03445	0.10	0.918	3.09333
Source of income	0.0332	0.06783	0.49	0.624	1.85333
Maize cultivated land	-0.0139	0.0077	-1.82	0.069*	9.81333
Access to membership of agricultural groups/cooperatives	0.2725	0.1138	2.39	0.017**	0.50667
Extension workers	0.2159	0.14881	1.45	0.147	0.62667
Provision of training	0.5630	0.10453	5.39	<0.001***	0.52

*,**and *** indicates level of significance at 10%, 5%, 1% respectively.

3.7 Constraints Encountered in Maize Production

Unavailability of seed in vicinity, high cost of seed, unaware of seed type, small land holding, high cost of labor, and high fertilizer demand was ranked as 1st, 2nd, 3rd, 4th, 5th & 6th major constraints encountered in adopting improved maize variety.

Distant market, gap between farm gate, lack of marketing knowledge, and retail price and low seasonal price were ranked as 1st, 2nd, 3rd & 4th major marketing constraints.

Table 13: Ranking of Constraints Encountered in Adopting Improved Varieties of Maize

Adoption constraints	score	Index	Rank
High cost of seed	44.638	0.87	II
Unaware of seed type	28.142	0.55	III
Unavailability of seed in vicinity	47.147	0.92	I
Small land holding	26.81	0.53	IV
High cost of labor	16.65	0.33	V
Higher fertilizer demand	14.246	0.28	VI

Table 14: Ranking of Constraints in Marketing of Maize in Baitadi

Marketing constraints	score	Index	Rank
Lack of marketing knowledge	47.5	0.63	III
Distant market	52	0.69	I
Gap between farmgate and retail price	48	0.64	II
Low seasonal price	40	0.53	IV

4. Conclusions

Agriculture plays an important role in the economies of developing countries in terms of food supply, employment, income generation, and source of raw materials for industries (NAERLS, 2009). However, despite the immense agricultural production aptitudes of this zone, many production constraints still exist. The zone is characterized by rainfall erraticism, especially late onset and early cessation of rains, often resulting in shorter growing season. Attributable to difficult topography farmers were still compelled to adopt the orthodox method of cultivation. Almost all of them use bullocks for land preparation. They considered no need for chemical fertilizers application and still practice the tedious method for weeding purpose. Also, most of them have no access to subsidies and cannot afford improvised storage structure such as metal bins.

The huge yield gap of maize in Nepal shows the immense possibility of increasing the production of maize. It is essential to use the improved and high yielding seeds by the farmers. Farmers used the improved seeds only, local seeds only or the combination of both improved and local seeds for the maize cultivation. The productivity of maize was found to be substantially greater for the farmers using the improved seeds rather than the local seeds. However, the adoption of improved seeds is lower in Nepal. The adoption is found to be significantly higher among those farmers who receive the support regularly from agricultural organization, cooperative and acquire information from training on maize cultivation. Prominent constraints of improved maize varieties adoption in Baitadi include, unavailability of seed in vicinity, inefficient marketing system, and higher cost of seed. Thus, it is very crucial to improve and strengthen the seed production and supply system in order to ensure the timely availability of improved seeds to the farmers at a reasonable price.

Suggestions and Recommendation

In order to extend the area of improved maize cultivation in Baitadi district, some aspects must be keenly changed and some actions must be taken. As those who adopt IMV were observed to have access to agricultural offices, cooperatives and participated in training, frequency of membership and training programs including majority of farmers could be conducted at different maize growing area. Concerned authorities should ensure the timely availability of inputs required i.e., seed, fertilizers in vicinity. As the major constraints were reported to be lack of irrigation, extension of small irrigation project could be effective in those major maize production acreages. For the marketing of the produced seed, concerned authorities in collaboration with different agro-dealers could collect seed and provide platform for farmers to sell their seed at reasonable price.

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