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Assess the Adoption of Improved Maize Production Technologies in Gulmi, Nepal

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Abstract

This study investigated the adoption of improved maize production technologies in Gulmi District, Nepal. Ninety-six maize-growing farmers supported by the Prime Minister Agriculture Modernization Project, Maize Zone, Gulmi were randomly selected and interviewed using a pre-tested semi-structured questionnaire. Data collected from the Household Survey were coded, tabulated, and analyzed using SPSS 16.0 and Microsoft Excel 2012. In the study area, most of the respondents were male and most of them belonged to middle age (37-60 years) group. Brahmin was the dominant ethnic group an average family size of 6.35. Lesser contact with agriculture service centers and poor mechanization were the major constraints of adopting new technologies. The findings revealed that improved maize varieties were the most preferred seed source, with 76.00% of respondents selecting them; among these Manakamana 3 was the most widely adopted variety. However, only a few proportion of respondents (16.70%) practiced improved cultivation techniques, such as soil testing, agricultural lime application, soil treatment, farm mechanization, and chemical pest control. Most respondents (63.50%) were categorized as medium adopters of improved maize production technologies, with the selection of recommended varieties being the most favored practice. Statistical analysis indicated significant relationships between the level of adoption and factors such as age, ethnicity of respondents, access to mass communication, participation in extension programs, membership to farmers' groups, visits to agricultural service centers, and subsidy receiving. Additionally, the fall armyworm was identified as a major pest, while black smut as a significant disease, primarily due to poor adoption of seed treatment practices.

Keywords: *Adoption, agriculture, improved technologies, maize, yield.*

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Introduction

Maize production around the globe was estimated to be 1,186.86 million tons in 2020 (FAO, 2020). The largest economic sector of Nepal is agriculture, which contributes more than 27% of the country's overall GDP (Poudel, Kharel & Upadhyay, 2021). In terms of area and production, maize (Zea mays) is the second-largest cereal crop in Nepal after rice (Subedi, Ghimire & Devkota, 2017), but productivity has been poor, at 3.01 mt/ha. Maize and its straw contribute around 8.85% to the national AGDP (MoALD, 2021). Maize is grown in all three regions of Nepal with a production share of 72.85%, 17.36%, and 9.79% in the Mid-hills, the Terai, and the High-hills respectively (MoF, 2019). Maize was grown in an area of 875,660 ha with an average yield of 2.21mt/ha in 2009/10 while the area and yield were increased by 81,990 ha and 0.75 mt/ha respectively in 2020/21 (MoALD, 2021). Out of the total seed grain produced, 60%, 25%, and 3% were used as grain crops for food, animal feed, and seed respectively (Timsina, Ghimire & Lamichhane, 2016). In hilly region, maize is the traditional crop grown as food, feed, fodder, and forage under rain-fed conditions. In Terai, valleys, lowlands, and river basins, maize can be grown under irrigation during the winter and spring seasons (Paudyal & Poudel, 2001). About 60% of poultry feed is made up of maize grains, which is regarded as a crucial and indispensable component of livestock and poultry diets. However, the ever-growing tendency in the poultry and animal industries, together with population growth and rising incomes, has increased the demand for maize grains. The demand for feed industry in Nepal cannot be met by indigenous production (Thapa, 2021). The current poultry industry in Nepal requires roughly 6.46 million mt of feed, but only about 0.5 million mt of feed have been produced annually by the feed industries (Govind et al., 2015). The production of maize is insufficient and declining despite the strong demand. Insect-pest infestation is one of the main causes of the loss in maize productivity. The amount of crop loss brought on by insects varies from one country to another (Pandey et al., 2019). In mid-hills of Nepal, the biggest issue with maize production was the shortage of inputs, which was followed in severity order by insect pest attacks, harsh weather, a lack of irrigation facilities and lack of proper production technology (Katel, Dahal & Bhatta, 2020). Traditional agriculture farming methods are being used by farmers in the Gulmi District to produce maize. The major obstacles to the adoption of improved maize production technologies in this area includes farmer's poverty level, illiteracy, fragmented land use, and unfavorable geographical condition (Gurung et al., 2011). When the productivity of Gulmi District is compared to the national average, it is found to be even lower at 2.5 mt/ha (MoALD, 2017), suggesting that there is significant scope to boost maize production. The majority of farmers in Nepal do not use improved technology for maize production (Pandey et al., 2019). The adoption of more efficient maize production technologies was the result of a number of factors including: focused extension services, affordable input costs, timely fertilizer delivery and application, timely seed delivery, access to communication and credit facilities, and high levels of farm experience (Gecho & Punjabi, 2011). Farmers' education and farming experience increase their capacity to utilize information related to adoption and aid in evaluating the benefits of the technology under consideration (Obayelu & Ajayi, 2018). There is a discrepancy between present practices and recommended ones in the western hills of Nepal with regard to practices like chemical fertilizers, seed rate, and sowing techniques (Lamichhane et al., 2015) and the majority of farmers were medium adopters and the Technology Adoption Index (TAI) was shown to be at 63%, suggesting that there is still a lot of significant amount of space for yield enhancement (Katel et al., 2020). The primary component of all agriculture-based technologies is seed and the timely and local availability of high-quality seed has helped to increase grain yield production and combat the world's ubiquitous poverty (Bajracharya, Sapkota & Dhungana, 2016). Farmers in the mid hills adopted more technologies owing to aggressive subsidies for upgraded, open-pollinated varieties and dealerships to register agro-vets in rural areas (Subedi et al., 2017). In rural areas of Nepal, adoption patterns were aided by off-farm

income, larger households, intensified extension services and access to public information, such as radio and mobile phone services, which forced farmers to adopt agricultural technology (Danso-Abbeam et al., 2017). Agricultural lime and the recommended amount of inorganic fertilizers both had a significant part in the rising level of farm income (Nielson, 2012). This research is carried out to assess the current production practices to adopt the improved and new technology to increase the total crop production through commercialization.

Research Methodology

Study area

The study was carried out in Gulmi District of Lumbini Province in Nepal. It extends from 28.0663˚ N latitude to 83.2479˚ E longitude while the highest and lowest altitudes of the district being 3,000 masl and 400 masl respectively (Source: DAO, Gulmi). The data were taken from four local government bodies (Madane Rural Municipality, Isma Rural Municipality, Dhurkot Rural Municipality and Resunga Municipality) in Gulmi District falling under command area of PMAMP-PIU Maize Zone, Gulmi.

Sample and Sampling techniques

A list of maize growers of the study area was obtained through PMAMP, PIU, and Maize Zone's farmer profile. Out of the total maize growers, ninety-six respondents were selected randomly from four local bodies under the command area of Maize Zone. The area was selected purposively for the data collection. An equal sample (24) from each area was selected for the study and the sample was selected by a simple random sampling technique. Interview schedule was prepared to collect the information by using the following instruments for both qualitative and quantitative data. Pre-testing was carried out before the final questionnaire preparation for the relevancy of questionnaire.

Research instruments

Household survey

Household surveys were conducted through an interview schedule by using a semi-structured pre-tested interview schedule. A total of 96 maize growers in the study area were interviewed. Respondents were interviewed with questions seeking demographic, educational, socio-cultural, behavioral, adoption level, and other information regarding decisions and perceptions of farmers on problems and production practices. This study was designed by using quantitative followed by qualitative data, so the Household Survey was taken for collection of the data relevant to demographic, socioeconomic, adoption categories, risk and uncertainties of the maize production in study area and for qualitative design respondents perception were collected through Interview Schedule. And for supporting these data Key Information Interview (KII) and Focus Group Discussion (FGD) were undertaken from the respondents who are actively engaged in community development and agriculture programs (Laurie & Sullivan, 1991).

Data analysis

Primary data collected from the field survey and other means were first coded, and tabulated and then the analysis was done with the help of computer software packages- The Statistical Package for Social Science (SPSS 16.0) and Microsoft Excel 2012. Descriptive statistics; mean comparison, standard deviation, frequency distribution, percentile, and chi-square analysis were done to analyze the data. For qualitative data, frequency distribution, percentile, chi-square design, problem indexing methods were used for the data analysis. The findings were represented and demonstrated by using tables, bar diagrams and pie charts.

Socio-economic and demographic information

Simple statistic tools like mean, frequency, percentage, standard deviation, minimum, and maximum value were used to analyze the age of respondents, gender of respondents, education level of respondents, family size, occupation, income of the respondents' family, etc.

Production practices

Descriptive statistics were used to analyze the different production practices of maize in the study area. Field preparation, seed sowing, manure and fertilizer applications, irrigation, major pest and disease identification, harvesting, storage, participation in training, purchase inputs, and availability of improved seed were analyzed and quantified using frequency, percentage, mean, standard deviation, etc. The adoption level of farmers on different production practices was categorized into high adopters, medium adopters, and low adopters by using mean and standard deviation.

Problem indexing

Indexing was used in the ranking of maize production problems. Indexing was computed by using the following formula given by Miah (1993).

$IProb= (\Sigma (SiFi))/N$

Where,

Iprob = Index value for intensity

Σ = Summation

Si = Scale value of ith intensity

Fi = Frequency of ith response

N = Total number of respondents

Results and Discussion

Results

Socioeconomic and demographic information

Gender of respondents

The majority of the respondents (61.46%) were male out of total respondents. Only 38.54% of the respondents were female in the study area. This might be due to male-dominated community in the study area. If females were requested to answer the question they would ask their male counterparts to respond (see Table 1).

Table 1: Gender distribution of respondents in PMAMP, Maize Zone, Gulmi

Gender	Frequency	Percentage
Male	59	61.46
Female	37	38.54
Total	96	100

Age of the respondents

The respondents involved in this study belonged to the age group of 22 to 72 years. The average age of the respondents was found to be 48.98 years with a standard deviation of 11.38. Using mean and standard deviation age of respondents was divided into different categories. This reflects most of the respondents (58.30%) in the study area were in their middle age group (37-60 yrs.) with decision-making responsibility of farm and family (see Table 2).

Table 2: Age of respondents in PMAMP, Maize Zone, Gulmi

Age	Frequency	Percentage
<37	20	20.80
37-60	56	58.30
>60	20	20.80

The education level of the respondents

The education level of the respondents was enumerated from the interview schedule and categorized into 5 different levels. Most of the respondents were found to be illiterate (35.42%). The number of respondents having primary and secondary level education was found to be 28.13% and 30.21% respectively. Only 6.21% of respondents were found to have a higher-level education. It suggests that agricultural extension and technology transfer should be carried out through local language, verbal communication, pictures, and poster demonstrations for the better transfer of technology (see Table 3).

Table 3: Education level of respondents in PMAMP, Maize Zone, Gulmi

Educational level	Frequency	Percentage
Illiterate	34	35.42
Primary level	27	28.13
Secondary level	29	30.21
Higher level	6	6.21
Total	**96**	**100**

Family size of the respondents

The average family size of respondents in the study area was found to be 6.35 which was higher than the average family size, i.e., 5.45 of Gulmi District determined through the national census 2011/12 (CBS, 2013). It was found that average family size was higher than the national average i.e., 4.88 in the study area (MoALD, 2018). The minimum and maximum members of the family were found to be 3 & 15 respectively, as both joint and nuclear families were included in the study (see Table 4). Family members were mainly involved as human labor resources in their farms to save hired labor costs.

Table 4: Statistical representation of family size in PMAMP, Maize Zone, Gulmi

Family Distribution	Min.	Max.	Mean	S.D
Size of family	3	15	6.35	2.243

Ethnicity of the respondents

Most of the respondents in the study area were found to be Brahmin (46.88%) while Janajati (4.17%) were found to be the least populated. Chettri and Dalit respondents represented 37.5% and 11.46% of total respondents, respectively. This study summarizes data from the four major ethnic groups of the district. Representation of all ethnic groups made the study unbiased in socioeconomic aspects between the communities (see Table 5).

Table 5: Ethnicity of respondents in PMAMP, Maize Zone, Gulmi

Ethnicity	Frequency	Percentage
Brahmin	45	46.88
Chettri	36	37.50
Janajati	4	4.17
Dalit	11	11.46
Total	**96**	**100**

The major occupation of the respondents

The majority of the respondents (93.00%) depended on agriculture as a source of income within the study area followed by service with only 5.00%. The study found that equal numbers of respondents (1.00%) were economically dependent on business and remittance from foreign countries (see Figure 1).

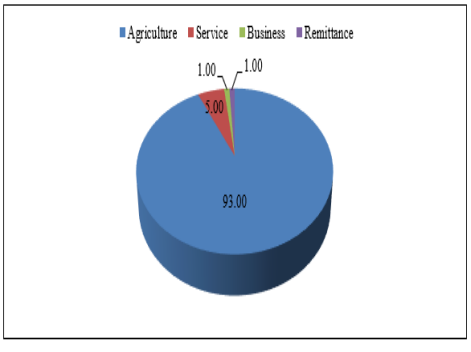

Figure 1: Major occupation of respondents in PMAMP, Maize Zone, Gulmi

Socio capital in maize sub-sector

Participation in extension training

Most of the respondents in the study area didn't participate in the agriculture training programs. Only 47.92% of the respondents had participated in training related to maize cultivation and insect pest management. Training is an important tool to transfer technical knowledge in agriculture extension. So for scientific and improved practices, training-related programs should be prioritized in the study area (see Table 6).

Table 6: Participation in extension training by the respondents in PMAMP, Maize Zone, Gulmi

Response	Frequency	Percentage
Yes	46	47.92
No	50	52.08
Total	**96**	**100**

Visiting Agriculture Service Center

Most of the respondents (29.17%) reported visiting the agricultural service center once a month, while 13.54% and 17.71% visited the center twice a month and once a year, respectively. The remaining 39.58% of respondents didn't visit the agricultural service centers at all (see Table 7).

Table 7: Visiting of respondents in the Agriculture Service Centre in PMAMP, Maize Zone, Gulmi

Schedule	Frequency	Percentage
Once a month	28	29.17
Twice a month	13	13.54
Once a year	17	17.71
Never	38	39.58
Total	**96**	**100**

Technical assistance

Technical assistance is one of the important resources to adopt any new and advanced practices more effectively. Only 11.46% of respondents had easy access to the technical assistant. Most of the respondents (75%) were found to have more or less access to technical assistance. Only 13.54% of the respondents were found to have difficulties accessing technical assistants for assistance in maize production (see Table 8).

Table 8: Proportion of respondents showing access to technical assistance in PMAMP, Maize Zone, Gulmi

Response	Frequency	Percentage
Easy	11	11.46
More or less	72	75.00
Difficult	13	13.54
Total	**96**	**100.0**

Access to inputs

In the study area, most of the respondents (65.63%) were found to be satisfied moderately with the availability of agricultural inputs. Only 17.71% of the respondents were highly satisfied with access to agriculture inputs. Out of the total, only 16.67% of respondents were having difficulties getting inputs and responded to be unsatisfied with their access to agricultural inputs (see Table 9). Maize Zone was found to be the main source of improved seeds in the past few years. Cooperatives, farmer's groups, and a few agro-vet traders were contributing to increasing access to agricultural inputs.

Table 9: Satisfaction level of respondents on access to agricultural inputs in PMAMP, Maize Zone, Gulmi

Response	Frequency	Percent
Highly satisfied	17	17.71
Moderately satisfied	63	65.63
Unsatisfied	16	16.67
Total	96	100.0

Access to mass communication

Most of the respondents (75.00%) had access to mass communication facilities in the study area. Most of the farmers were using radio and television as a source of mass communication to get agriculture-related information (see Table 10). Weather information, epidemic condition of insect pests, notice of government agencies, inputs availability, and different new technological ideas were disseminated through mass media.

Table 10: Access to mass communication in PMAMP, Maize Zone, Gulmi

Response	Frequency	Percentage
Yes	72	75.00
No	24	25.00
Total	96	100

Current production practices

Seed rate

The average seed rate of maize in the study area was found to be 1.7 Kg per Ropani with maximum and minimum to be 3 Kg per Ropani and 1Kg per Ropani, respectively (see Table 11). Variation in the seed rate of maize was found between the farmers residing in the same area. There is no exact measuring unit of farmers to determine seed rate. They quantify seed in the Mana unit. The volume of Mana might differ from one farmer to another.

Table 11: Seed rate (Kg/Ropani) of maize in PMAMP, Maize Zone, Gulmi

Maximum	Minimum	Mean	Standard deviation
3.0	1.0	1.7	0.64

Varietal use pattern

Improved maize varieties were found to be used by most of the maize growers (76.00%) in the study area. Only 13.00% of the respondents were using hybrid varieties as a source of maize seed. Enumerated improved, hybrid, and local seed users were classified and presented (see Figure 2). Local varieties of maize seeds were difficult to be specified and only 11.00% of the respondents were listed as local seed users. Among the improved varieties, the white kernel-colored late maturing variety (Mankamana 3) was found to be grown by 44.00 % of the respondents which dominated all improved varieties grown in the study area. The 19.00% of respondents were found to have grown the Arun 2, which is short duration and matures at 80-90 days after sowing and is suitable in mid hills. Hybrid varieties were grown by 11.00% of respondents; they mostly preferred Rampur composite, Resunga composite, Khumal hybrid, and Indian varieties. Only 5.00% of respondents were grown Deuti as recommended by Krishi Diary in a higher altitude which resembles the study area.

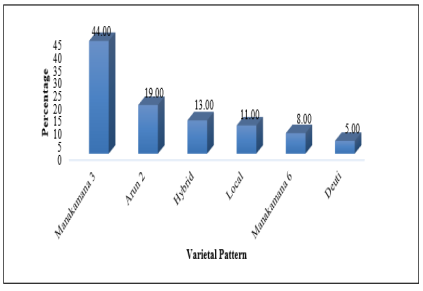

Figure 2: Preferred maize varieties by the respondents in PMAMP, Maize Zone, Gulmi

Chemical fertilizer application

In the study area, most of the respondents (82.11%) were using chemical fertilizers in maize farms and only a few respondents (17.89%) were not using chemical fertilizers (see Table 12).

Table 12: Use of the chemical fertilizer in PMAMP, Maize Zone, Gulmi

Response	Frequency	Percentage
Yes	78	82.11
No	18	17.89
Total	96	100.00

Urea, DAP, and MoP are the major chemical fertilizers used in maize farming in Nepalese agriculture. It was found that 80.00% of the respondents used urea, 65.00% used DAP, and only 22.00% used MoP as chemical fertilizers in maize farming. Most farmers applied urea, DAP, and MoP at the rate of 3-4 Kg per Ropani, 3-4 Kg per Ropani, and 1-2 Kg per Ropani, respectively, for the production of maize in the study area. Only a few respondents (22.00%) used all three types of chemical fertilizers during maize production (see Table 13).

Table 13: Proportion of respondents using different doses (Kg/Ropani) of the chemical fertilizers

Doses	Urea	DAP	MoP
No	20.00	36.00	78.00
1-2	21.00	30.00	16.00
3-4	46.00	32.00	6.00
5-6	10.00	3.00	0.00
>6	3.00	0.00	0.00

Agricultural lime application

Agricultural lime application in maize farms is applicable in acidic soil that helps to maintain the soil PH level and sustain the soil fertility status and availability of nutrients to the crops. Liming also helps to detoxify the soil in order to reduce disease and soil insect pest infestation. In the study area, only 27.08% of the respondents applied agricultural lime in maize field (see Table 14).

Table 14: Use of the agricultural lime in PMAMP, Maize Zone, Gulmi

Response	Frequency	Percentage
Yes	26	27.08
No	70	72.92
Total	96	100.00

Use of farm mechanization

Mechanization is a key driver for increasing production efficiency, which leads to the commercialization of maize farming. Only 35.40% of respondents reported using machinery, while 64.60% did not use any kind of machinery in maize production (see Table 15). The most frequently used equipment included Mini Tillers for ploughing, Corn Shellers for grain separation, Jyap planters for sowing, and Sprayers for applying chemical pesticides.

Table 15: Use of the farm mechanization in PMAMP, Maize Zone, Gulmi

Response	Frequency	Percentage
Yes	34	35.40
No	62	64.60
Total	96	100.00

Adoption of improved practices

Preference for improved production practices

In the central region of Nepal, knowledge of new improved varieties was the least adopted practice of maize production (Ransom, Paudyal & Adhikari, 2003). The availability of seeds in the local market, which especially benefits poor farmers, had a positive impact on the adoption of improved maize varieties in developing countries (Ghimire & Huang, 2015).

Different improved practices used for maize production were ranked using scoring techniques and calculation of individual weightage value. Selection of recommended varieties was ranked first as the most preferred practice adopted with an index value of 0.432 while seed treatment was ranked as the least adopted practice in the study area with an index value of 0.104 (see Table 16).

Table 16: Ranking of different improved practices adopted for maize production in PMAMP, Maize Zone, Gulmi

Improved cultivation practices	Index	Rank
Selection of recommended varieties	0.432	I
Use of recommended seed rate	0.391	II
Use of recommended fertilizer doses	0.318	III
Crop geometry	0.276	IV
Farm mechanization	0.271	V
Soil test	0.182	VI
Irrigation at critical period	0.172	VII
Agricultural lime application	0.172	VII
Chemical pest control	0.13	IX
Grain storage	0.12	X
Line sowing	0.12	X
Seed treatment	0.104	XII

Adoption level of improved production practices

The majority of the respondents (63.50%) were found to be medium adopters of improved maize production practices while 19.80% of the respondents were low adopters and only 16.70% of the respondents were high adopters in the study area (see Figure 3). The finding indicates that there was a lower level of adoption of improved maize production practices.

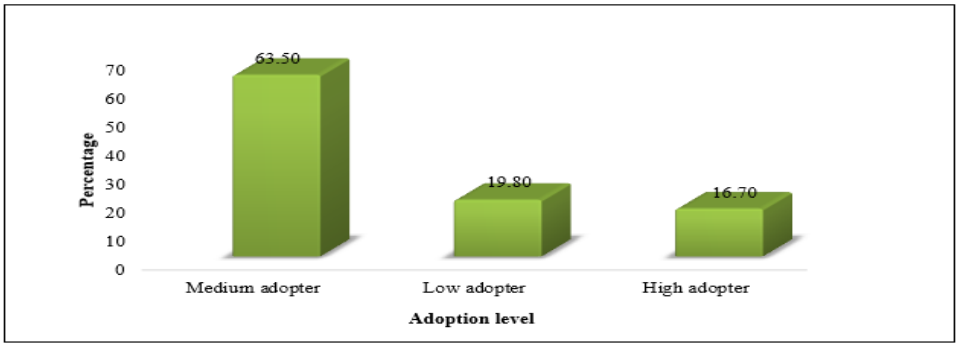

Figure 3: Adoption level of farmers based on improved maize production practices in PMAMP, Maize Zone, Gulmi

Influence of independent factors on adoption level

Gender

It was observed that males and females were indifferent to different levels of adoption of improved practices in maize production. This signifies that there was no association between gender and adoption level of improved maize production practices in the study area as it was statistically insignificant summarized (see Table 17).

Age

The distribution of farmers' age to that of adoption level of improved maize production practices was categorized as high adopters, medium adopters, and low adopters and it was found to be statistically significant at a 10% level of significance as age group had an influence towards adoption level in the study area. The age group 37-60 was found to have a higher proportion in the medium adoption category (see Table 17).

Ethnicity

The distribution of respondents among different ethnic groups to the adoption level of improved practices was statistically significant at a 10% level of significance. There was a slight association between ethnicity and adoption level of improved practices in the study area (see Table 17).

Educational level

The distribution of the education level of farmers to the adoption level of improved practices in maize production was categorized into different levels of adoption. There was no association between the education level and adoption level of improved practices in the study area (see Table 17).

Table 17: Association of adoption level with sociodemographic characteristics in improved maize production technologies in PMAMP, Maize Zone, Gulmi

Factors	Low adoption	Medium adoption	High adoption	Chi-square value	P-value
Gender					
Male	12(12.50)	35(36.50)	13(13.50)	3.08	0.21
Female	7(7.30)	26(27.08)	3(3.15)		
Age					
<37	8(8.30)	11(11.50)	1(1.00)		
37-60	8(8.30)	36(37.50)	14(14.60)	8.011	0.091
>60	1(1.00)	12(12.50)	3(3.10)		
Ethnicity					
Brahmin	6(6.20)	34(35.40)	5(5.20)		
Chettri	8(8.30)	19(19.80)	9(9.40)	10.71	0.098
Janajati	0(0.00)	3(3.10)	1(1.00)		
Dalit	5(5.20)	5(5.20)	1(1.00)		
Education level					
Illiterate	5(5.20)	21(21.60)	8(8.30)	2.202	0.333
Literate	14(14.60)	40(41.70)	8(8.30)		

Note: Figures in parentheses indicate percentage

Access to mass communication

The distribution of farmers' access to mass communication to the adoption of improved maize production practices was categorized into different adoption levels. Access to mass communication had a positive impact on the adoption of improved maize production technology which is highly associated with improved maize production technology (significant at 1% level of significance). This result was supported by the finding of Norton & Alwang (2020) reported that there is a positive association between the use of information and communication technologies with the adoption of innovative practices resulting in the creation of pluralistic, cost-effective advisory services that involve both public and private sector (see Table 18).

Participation in the extension program

The distribution of farmers' participation in extension programs to the adoption of improved maize production technology was categorized into different adoption levels (see Table 18). Trained farmers were more likely to adopt improved production practices (significant at 1% level of significance). This result signifies that the association between the farmers' participation in the extension program and the adoption of improved maize production technology was statistically significant. Farmers' training, memberships in a farmers' group, off-farm practices, and socioeconomic factors- age, education, household size, and proximity to an extension office encouraged participation in extension programs that help to adopt the improved technologies (Ghimire & Huang, 2015).

Membership in farmers' group

The distribution of farmers' participation in the farmers' group to the adoption of improved maize production technology was categorized into different groups (see Table 18). Respondents involved in the farmers' group were higher adopters of improved maize production practices. This result signifies that there was a high association between the farmer's membership in the farmers' group and the adoption

level of improved maize production technology (significant at 0.1% level of significance).

The finding is supported by the finding of Mignouna et al. (2010) which shows that extension services and participation in farmers' groups were highly associated with improved maize production technology.

Visit to agriculture service center

The distribution of farmers' visits to agriculture service centers to the adoption level of improved maize production technology was categorized into different categories (see Table 18). Respondents visiting to agriculture service center frequently were the most likely adopters of improved maize production practices (significant at 0.1% level of significance). This indicates that there was a high association between the visit to the agriculture service center to the adoption level of the farmers in improved maize production technology.

Subsidies received

The distribution of farmers' subsidies to the adoption level of the improved maize production technology was categorized into different categories (see Table 18). Among the respondents, those who were receiving subsidies were higher adopters of improved maize production technology in the study area. This result signifies that the association between the subsidies received to the adoption of improved maize production technology by the farmers was statistically significant at a 1% level of significance. This means there was a high association between the subsidies received to the adoption of improved maize production technology. These results are in line with the findings of Gecho & Punjabi (2011) which report that the adoption of improved maize technologies is associated with targeted extension services, access to mass communication, inputs availability, credit facilities, and subsidies received by the farmers.

Table 18: Association of adoption level with factors affecting improved maize production technologies in PMAMP, Maize Zone, Gulmi

Factors	Sub categories	Low Adoption	Medium Adoption	High Adoption	Chi-square value	P- value
Access to mass communication	Yes	9(9.4)	50(52.10)	13(13.5)	9.64	0.008**
	No	10(10.4)	11(11.5)	3(3.1)		
Participation on the extension program	Yes	3(3.1)	32(33.3)	11(11.5)	11.15	0.004**
	No	16(16.7)	29(30.20)	5(5.2)		
Membership to farmer's group	Yes	1(1.0)	53(55.1)	16(16.7)	56.01	<0.001***
	No	18(18.8)	8(8.3)	0(0)		
Visit to agriculture service center	Yes	2(2.1)	43(44.80	1(1.0)	30.23	<0.001***
	No	17(17.7)	18(18.8)	15(15.6)		
Subsidies received	Yes	3(3.1)	30(31.2)	11(11.5)	10.57	0.005**
	No	16(16.7)	31(32.3)	5(5.2)		

Note: Figures in parentheses indicate percentage

Problems in maize production

Insect pest of maize

Insect pests and disease severity were determined as the major problems in maize production from FGD conducted in farmers group. Six major insect pests were listed and put forward in the interview schedule to rank them according to severity as obstacles in increasing production and productivity. Problem indexing was done to rank them, 1 to 6 based on their importance presented. Fall armyworm was ranked as the major insect pest problem with an index of 0.82 in the study area. Maize stem borer was found as second most important insect pest problem with an index value quite equal to the first one (0.8). It was followed by cutworm (0.73), white grub (0.53), and termite (0.36). Wireworm was ranked as the least severe insect pest problem in the production of maize with an index of 0.17 in the study area (see Table 19).

Table 19: Farmer perception on major insect pest problems in PMAMP, Maize Zone, Gulmi

Insect-pest problem	Index	Rank
Fall armyworm	0.82	I
Maize borer	0.80	II
Cutworm	0.73	III
White grub	0.53	IV
Termite	0.36	V
Wire worm	0.17	VI

Disease of maize

Disease was determined major problem along with insect pests. Five major diseases were listed through FGD and put forward in the interview schedule and disease problems were ranked as the severity of the disease obstacles in the production and productivity of maize. Black smut was ranked as a major disease problem with an index of 0.89 followed by northern leaf blight (0.65), ear rot of maize (0.52), and downy mildew (0.44). Stalk rot was ranked as the least severe disease problem in the production of maize in maize Zone Gulmi with an index 0.42 (see Table 20). Black smut was a highly problematic disease problem due to the poor adoption of seed treatment practices (McMullen & Lamey, 2000).

Table 20: Farmer's perception on major disease problems in PMAMP, Maize Zone, Gulmi

Disease problems	Index	Rank
Black smut	0.89	I
Northern leaf blight	0.65	II
Ear rot of maize	0.52	III
Downy mildew	0.44	IV
Stalk rot	0.42	V

Summary

The study was conducted in four domain areas of PMAMP Maize Zone Gulmi, Nepal. Major criteria for the selection of these areas are due to the lack of research activities related to the adoption of improved practices, since long before many agriculture development programs have been launched. For this study, ninety-six respondents from the maize Zone area were randomly selected by simple random sampling. A Household Survey (HS) was used to collect the primary information and additional Focus Group Discussion (FGD) and key informant interviews (KII) were carried out to get qualitative data to support the objectives of this study. Secondary sources of data were taken through the publication

of government, research papers, and reports of different government organizations. It was found that the majority of the respondents (61.46%) of the study area were male. Most of the respondents were middle-aged belonging to 37-60 years of age. The majority of the respondents in the study area were illiterate (35.42%). The average family size was 6.35 which is greater than the average national family size. The study area was dominated by Brahmin (46.88%) and Chettri (37.50%). Agriculture was found to be the main occupation of most of the respondents in this study area. The number of farmers who participated in training related to agriculture was only 47.92%. The majority of the respondents (39.58%) were not visiting the agriculture service center, while only 29.17% of respondents were found to be a once-month visitor. The majority of the respondents (75.00%) were found more or less in contact with agricultural technicians. About 65.63 % of the farmers were moderately satisfied with the access to agricultural inputs. Most of the respondents (75.00%) had access to mass communication facilities. The average seed rate of maize was found to be 1.7 Kg/Ropani. The majority of the respondents (76.00%) in the study area used improved maize varieties mostly preferred variety was Manakamana 3. Almost all the farmers were using FYM and chemical fertilizers. Urea and DAP were mostly used fertilizers. Only 27.08% of the farmers used agri-lime in maize fields. And 35.40% of farmers used farm machines like Mini Tillers, Corn Sheller, Jyap Planter and Sprayer. The majority of the respondents (63.50%) were medium adopters of maize production in the study area. The most adopted practice was the selection of recommended varieties, while seed treatment was the least adopted by the respondents. Adoption of improved maize production technology was insignificant to gender and education levels. Age and ethnicity groups were significantly associated with the adoption of improved maize production technologies. The highly significant association was found with the access to mass communication, participation in extension program, membership to farmers group, visit to agriculture service center, and subsidies received. Insect pests and disease were the major constraints of maize production in the study area, fall armyworm and black smut were ranked major insect pests and diseases respectively in the study area.

Discussion

The education level of respondents and accessibility of agri-inputs were the major factors in the adoption of improved maize production technologies (Morris, Tripp & Dankyi, 1999). In our findings education level showed no relationship with adoption level, it might be due to their high rate of illiteracy. Farmers who are engaged in training facilities and schooling can adopt new technologies which occur longer term and also lead to an increase in production efficiency (Ogada et al., 2014), likewise, our findings also showed a positive relationship with communication and training facilities. Government subsidies and intervention also help to adopt improved production technologies to enhance total production (Groote et al., 2002). Engaged to farmer groups, subsidies provided by the government, access to mass communication, and ethnic groups also affected the adoption of technologies related to increasing the production of maize farming (Kumar et al., 2018), which also showed a similar effect to our findings which also illustrated the positive relation of adoption technologies with subsidies received, membership to farmers group and access with communication.

Conclusion

This study aimed to assess the adoption of improved maize production technologies. The findings show that there is still lacking the adoption of improved maize production technologies in Gulmi, District of Nepal. The used of improved varieties and chemical fertilizers were identified as the main production practices among maize growers while, line showing method and seed treatment were the poor practiced technologies which leads to the occurrence of disease and pest. Membership in farmer groups, visits to agricultural service centers, participation in extension training programs, and receiving subsidies were key determining factors for the adoption of improved maize production practices. Black smut and fall armyworm were ranked as the most significant disease and insect

pest respectively in the production of maize. These finding suggest the need for improved technologies in maize production, while there are significant challenges to address the improved production technologies. Therefore, further research and strategic planning are required for the introduction of these technologies to improve maize production in Gulmi District, Nepal.

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