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RESEARCH ARTICLE

PRODUCTION ECONOMICS OF MAIZE (*ZEA MAYS*) IN SURKHET, NEPAL

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ABSTRACT

A study was undertaken on the economics of producing maize in the major maize-growing areas of Lekbeshi and Gurbhakot Municipality in Surkhet, Nepal. The study's overarching goal was to assess and analyze the economics of producing maize in Surkhet A few specific goals were to identify the socio-demographic features of maize growers, as well as maize production and productivity. Many variables affect maize yield, including weed control, irrigation, insect and pest damage, and fertilizer use. Production economics examines the link between inputs and outputs, including labor, all economic investments, seeds, fertilizer, and irrigation, as well as outputs such as the price of produced maize. The required information was obtained with the help of a pre-tested questionnaire and 2 focus group discussions. Regarding the gender of the household head, most of them were male 75% and female 25% denoting a male-dominated society. Most of the respondents were female 52%. The fact that maize is primarily grown for self-consumption in this area makes it difficult to calculate costs, investments, returns, and benefits. Key problems that affect maize production include pests, diseases, marketing, fertilizer costs, low-quality seed, seed scarcity, and the lack of efficient technology. Fertilizers, seeds, and prepared fields were discovered to increase maize output. To improve maize production, key factors should be considered and limits reduced.

KEYWORDS

Productivity; Fertilizers; Questionnaire; Benefit-Cost; Respondents; Focus group

1. INTRODUCTION

Maize (Zea mays), an individual from the Gramineae family, is the world's third most farmed cereal crop after wheat and paddy. Maize is grown throughout the country and thrives mainly in the mid-hills and Terai regions of Nepal. However, it is predominantly grown in the hills and the farm sizes are also quite smaller compared to the Terai region (Gairhe et al., 2021), therefore maize farming is considered subsistence farming in Nepal. Maize has high productivity and low environmental sensitivity which can help to provide sufficient food and reduce food scarcity (Mwambo et al., 2020). Maize is thought to have evolved from a wild version of pod corn that used to be and possibly is still, indigenous to South America's lowlands (Bryant, 2007). It is photo insensitive and can grow in both short and long day periods (Coles et al., 2010). If all the required materials are used in the right way, following the right pattern and use of fertilizer, insecticide, and weeding at the right time with appropriate intervals, maize production can be increased to potential production levels (Jaidka et al., 2020). The kernel is used both for human consumption and for livestock feed. It is a very nutritious food since it is low in energy and high in fiber (Schepers, 1989). It is regarded as a staple food of hill people.

Staple commodities such as rice, wheat, potato, and vegetables have higher commercialization rates (30-50%) than maize and fruits (15-25%) (Gairhe et al., 2021). Problems like lack of irrigation water, insect pests like stem borer, armyworm, grasshopper, aphid, etc. and diseases like common rust, bacterial stalk rot, southern leaf blight, etc., poor access of farmers' produces up to the markets, lack of quality seed, lack of fertilizer at right time, topographical barrier, lack of mechanization, land fragmentation, lack of storehouses, etc. are the major problems in maize production (Sithanantham et al., 2002). The shortage of agricultural labor has a detrimental effect on productivity (Thapa, 2021).

2. RESEARCH MATERIALS AND METHOD

2.1 Study Site and Sub-Sector

The investigation was conducted in the vicinity of the major maize-growing area of the Surkhet district which lies in Karnali Province. Lekbeshi and Gurbhakot Municipality of Surkhet district were selected purposively as their largest share of maize production and area.

2.2 Sample Size and Sampling Technique

91 farmers were selected out of 112 maize farmers using Slovin's Formula:

$[n = N/ (1+Ne^2)]$;

Where, n = size of sample, N = size of population, e = margin of error (5%)

2.2.1 Pre-Testing of Questionnaire

The questionnaire was pre-tested before the field survey for checking its reliability and validity. Then, necessary adjustment was made as per requirement after administering the questionnaire to the 5% farmers of in the vicinity area.

2.3 Research Design

2.3.1 Household Survey (HH Survey)

Household survey using a personal interview schedule (PIS) was carried out among maize farmers. The age group of 25-60 years was interviewed for reliable data collection.

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2.3.2 Key Informant Interview (KII)

The persons who have been living in a particular village/ward since years ago were identified and interviewed. They were the source of in-depth knowledge, experience, and history of past activities. They were local resource persons, progressive farmers, social workers, agriculture-related organizations, members of ward committees, local political leaders, and other concerned stakeholders on the concerned subject matter. The information collected from such sources was more reliable and contextual.

2.3.3 Direct Field Observation

Regular field observation and verification were done at the sites to witness the situation which was assistive to validate the information got from the household survey.

2.3.4 Focus Group Discussion (FGD)

Focus group discussion was conducted for subjects that were difficult to understand by the farmers so that they can easily understand at the group. So, FGD was carried out after the survey for the validation check of the survey data. It usually involved group interviews, with a small group of 8 to 12 people being taken. Participants in Focus Group Discussions were free to converse with other group members; unlike other research methods, it encourages discussions with other participants. The FGD group was formed inclusively, and it operated in a participatory manner. The group's makeup and the group sessions were neatly stacked to provide a relaxed atmosphere where individuals felt comfortable speaking candidly and openly. Focus groups encouraged participants to actively express their thoughts as well as to respond to other group members' and the facilitator's questions, which gave the conversation depth, richness, and variety that surveys did not. FGD moderators sought participation from all members of the group and avoided allowing any individual or group to dominate.

2.4 Data and Data Types

Both quantitative and qualitative information was collected from primary and secondary sources.

2.4.1 Primary Data

The HH survey questionnaire, focus group discussions, and key informant interviews were used to collect primary data.

2.4.2 Secondary Data

The secondary data was collected through statistical sources such as zone profiles, the yearbook of MOALD, CBS, NARC publications, journals, newspapers, Krishi dairy, etc.

2.5 Methods and Techniques of Data Analysis

After the collection of necessary data, it was coded and entered into the computer for analysis. Data was fed to SPSS and analysis was done by using MS Excel and SPSS. Mean, standard deviations, frequency, percentage, percentage function, regression, t-test, and the scaling technique was used to derive the inference needed.

2.6 Qualitative Data Analysis

The qualitative data obtained from the field survey were qualitatively analyzed.

2.7 Quantitative Data Analysis

The collected quantitative data was analyzed using both descriptive and analytical statistics.

2.8 Descriptive Analysis

The respondents' socio-economic and farm characteristics, such as gender, family size, age, occupational pattern, education level, land holding size, labor user, and years of farming, were described using the descriptive mode of statistics like frequency, percentage, and mean standard deviation.

2.9 Regression Analysis

The effect of numerous parameters on the production of maize grain and seed was calculated using the regression technique. The equation for the multiple linear regression model is Y income = + 1 X 1 + 2 X 2 + 3 X 3 + 4 X 4 + 5 X 5 + 6 X 6 + 7 X 7 + 8 X 8 + 9 X 9 + 10X 10+. .....(i) where, Y income is the household's annual agricultural revenue, and is the regression plane's intercept, X 1, X 2, X 3, X 4, X 5, X 7, X 8, X 9, and X 10 indicate the farmers' category, gender, age, education, and access to extension and training services for household heads.

3. Result and Discussion

3.1 Socio-Economic Characteristics

The socio-economic characteristics include the age distribution, gender, family structure, education level, and occupation of the respondents. Socioeconomic factors include work, education, wealth, earnings, and residence.

3.1.1 Age Distribution of the Interviewee

The standard deviation and mean of respondent age in the surveyed area were 40.32 and 8.331 respectively. The interviewees were within the range of 18 to 61 years (Table 1).

Table 1: Average Age of the Interviewee at the Study Site

Variable	Minimum	Maximum	Mean	Std. Deviation
Age of Respondent	18	61	40.32	8.331

Source: Field Survey, 2022

According to the distribution of respondents based on their ages, the majority of respondents (78.2%) were between the ages of 25 and 45, while 5.2% of respondents were under 25 and 13.58% were over 45.

3.1.2 Sex of the Household Head

The survey showed that higher percentages (76%) of the Household head were male and (24%) were female members of the Maize producing Family (Table 2). It indicates that males are dominating females in resource possession and decision-making power at the household level.

Table 2: Distribution of Sampling Population

Gender	Frequency	Percentage (%)
Male	69	76
Female	22	24
Total	91	100

Source: Field Survey, 2022

3.1.3 Family Size and Members Actively Involved in Acid-Lime Cultivation

526 people were living in the 91 households that made up the research region, which was slightly more than the 4.6 people per family average for the country (Central Bureau of Statistics, 2022). Among the sampled households, the minimum family size was 1 and the maximum size was 9. Out of 91 households, 178 persons were actively engaged in maize growing.

Table 3: Family Size and Members Involved in Agriculture

Description	Minimum	Maximum	Mean	Sum
Total Family Size	1	9	5.78	526
No. actively involved in maize cultivation	1	4	2.55	232

Source: Field Survey, 2022

3.1.4 Education Status of the Respondent

Education is crucial for increasing agricultural productivity because it exposes farmers to new ideas and concepts. In this study education level was categorized into 6 groups: illiterate, literate only, SLC pass,+2 pass, bachelor's and Master's degree as defined by the Nepalese education system. From the study, 16.5% of the respondents were found to be illiterate and 83.5% were literate. It shows that the majority of the maize farmer's families were educated. In 2018, the adult literacy rate for Nepal was 67.9 %. The adult literacy rate of Nepal increased from 20.6% in 1981 to 67.9 % in 2018 growing at an average annual rate of 36.06% (Literacy Rate, 2022).

Table 4: Education Status of Household Head		
Education Level	**Frequency**	**Percentage (%)**
Illiterate	15	16.5
Literate	34	37.3
SLC pass	24	26.4
+2 pass	13	14.3
Bachelor's degree	4	4.4
Master's degree	1	1.1
Total	91	100

Source: Field Survey, 2022

3.1.5 Distribution of Sources of Household Income

The occupation was categorized as agriculture, service (government job, teacher, bank job), business (shop, enterprise, import-export), NGO/INGO, wages, and Private Service. Service and agriculture were the primary sources of income for the households in the surveyed area followed by business and remittance. 44.6% of the people depended mainly on agriculture, 30% of the total family worked for governmental service, 7.7% also engaged in private service whereas 6.6% people depended on Daily wages (Figure 1). The majority of households state that their primary occupation is in agriculture (58.51%) (Distribution of Household Heads by Occupation, 2018).

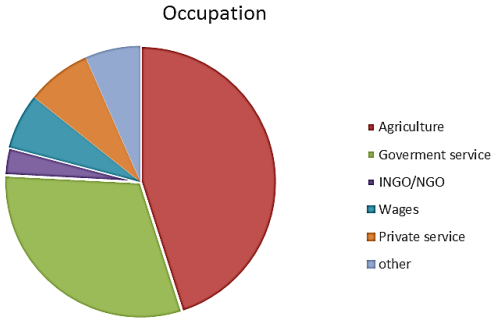

Figure 1: Distribution of source of family income

3.1.6 Socio-Demographic Characteristics by Ethnicity Composition

Age and education average was 40.3 2 and 1.26 respectively, which were significant at 5% and 1% levels of significance by ethnicity composition. Ethnic groups in Nepal are Chhetri (Khas) (16.59%), Brahmins (12.17%), Magar (7.12%), Tharu (6.56%), Tamang (5.81%), Newar (4.99%), Kami (4.75%) (Dahal, 2003). The mean annual household income and family size were 611052 and 3.38, respectively, and neither was statistically significant.

Table 5: Socio-Demographic Characteristics by Ethnicity Composition		
Ethnicity	**Frequency**	**Percentage**
Brahman/Chhetri	50	56
Janajati	11	11
Dalit	30	33
Total	91	100

Source: Field Survey, 2022

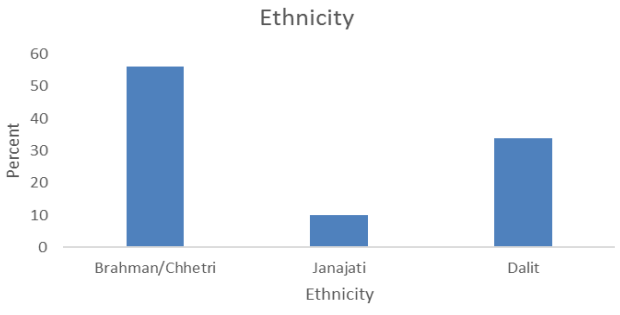

Figure 2: Graph of the ethnicity of respondents

3.2 Farm Characteristics

3.2.1 Landholding of the Interviewee

According to the survey, respondents owned an average of 9.516 kattha of land, of which 2.73 kattha were used on average by each farmer to grow maize. Maximum maize cultivation was done in 9 kattha and a minimum of 1 Kattha was used for the cultivation (Table 6).

Table 6: Total Land Holding and Maize Cultivation Area			
Description	**Minimum**	**Maximum**	**Average**
Total land holding in ropani	1	38	9.516
Total land used for maize production in ropani	1	9	2.73

Source: Field Survey, 2022

3.2.2 Livestock Calculation and Analysis

Livestock and agriculture have inseparable relation in the traditional way of farming because livestock provides manure, FYM, and agricultural by-product can provide fodder and feed. The average annual income from livestock was 30,835 and the total livestock income from all survey households was 2,80,60,00 rupees. Very few people were doing commercial livestock farming.

Table 7: Livestock in Respondent's House		
Livestock	**Total**	**Average per house**
Cattle	44	0.48
Buffalo	49	0.56
Goat	294	3.26
Pig	15	0.06
Poultry	1544	16.96

Source: Field Survey, 2022

3.3 Economics of Maize Seed

3.3.1 Seed Requirement

The "seed rate" is the total amount of seed needed to grow any crop in a given area of land. $Sowing\ rate\ (kg/ha) = (Target\ plant\ population(p/m2) * Thousaand\ Grain\ Weight\ (g) * 100)/\ (\%\ germination * \%\ emergence)$

3.3.2 Factors Determining Seed Rate

The time of planting, seed quality, and management parameters all influence the plant population intended to develop for the crop, the thousand-grain weight of the seed, the germination percentage (%) of the seed, and the anticipated crop emergence.

The average seed rate in the survey area was 1.03 kg/kattha.

The average seed required per house was 2.27kg/house.

3.3.3 Variety Of Maize Used For Cultivation

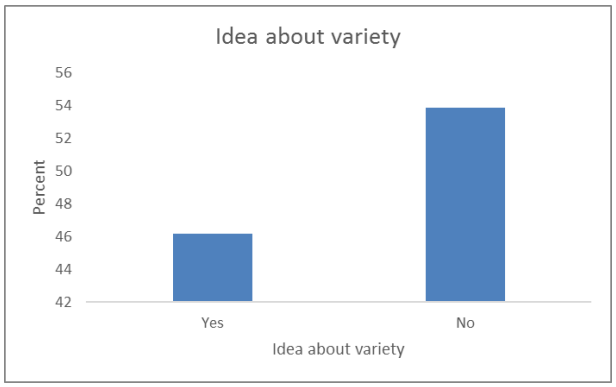

Figure 3: Farmers with varietal knowledge

Popular recommended Maize varieties in Nepal are Manakamana -3, 4, Rampur composite-1, Ganesh -2, Arun- 2, 4, 6, Deuti, etc. Around half of the

people don't know about suitable variety and varietal differences in characteristics and production. In this survey, respondents who knew about the variety of maize cultivated were only 48%. The remaining 52% of respondents cultivate either regional varieties or unidentified market varieties.

3.3.4 Cost of Maize Seed and Maize Cultivation

In this survey area, the average cost of producing maize was 4758.7 NRs/Kattha. Maize production requires hoeing 2-3 times, thus its production was costly due to high labor costs and lack of use of herbicide and insecticide which is cheaper than manual force.

3.4 Economics Of Maize Cultivation

3.4.1 Cost of Maize Production

The cost of labor, organic manure, micronutrients, harvesting, hoeing, and irrigation was added to determine the overall cost of maize. As per the survey, labor costs, excluding land rent, represented the largest share of the cost of production. According to the study, 55.99% of the total cost of production was used in land revenue which was the highest of all other costs. The second highest cost of production was labor which covered 12.71%. Human laborers were paid on the basis of working days. The cost per day of labor used ranged from NRs 450 to 600. Mainly labor was used in the intercultural operation, manure, and harvesting while other works like irrigation, application of nutrients, and training pruning were done by family members. The average cost of labor was 525.34 NRs/Kattha. 9.9% of the entire production cost was spent on manure. FYM was primarily used as a source of nutrients at the study location. The cost per doko for FYM, which was used, varied from Rs. 200 to Rs. 300. Chemical fertilizer was not used. On average 1552 NRs/Kattha/ha was used for buying FYM.

Table 6: Distribution of Various Costs in Maize Cultivation

Items of cost	Mean (NRs/kattha)	Percentage of the total cost
Human labor	525.34	11.04
Organic Manure	2231.23	47.26
Irrigation system	341	7.2
Seed	136.73	2.5
Fertilizer, insecticide, and pesticide	1524.4	32
Total	4758.7	100

Source: Field Survey, 2022

3.4.2 Production of Maize

Farmers get a low return from agriculture in comparison with other sectors. Only 11 % contribute from agriculture and Maize contributes 23.4% to cereal crops. Farmers can get a return from maize at different stages: as fodder at the early stage, milky stage, instantly after harvest, and sometimes after harvest.

Piechart of contribution of different sector

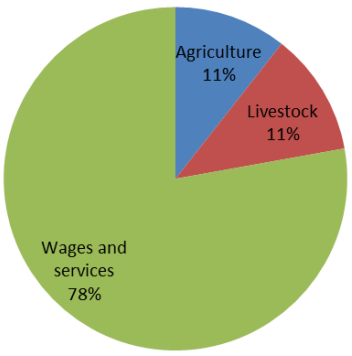

Figure 4: Pie chart of contribution of different sector in income

3.4.3 Infrastructure For Irrigation

Infrastructure is required to bring water from a source or reservoir of water (source of water) like kulo, cemented kulo, pipe and rainwater harvesting pond, etc. These types of infrastructure building require community participation or government involvement.52.2% of farmer irrigate their land by using kulo which is easy to construct but require regular management. With the help of local government and co-operatives along with PMAMP, cemented kulo constructed respondents who use cemented kulo are 31.6%. Other people used pipes for irrigation.

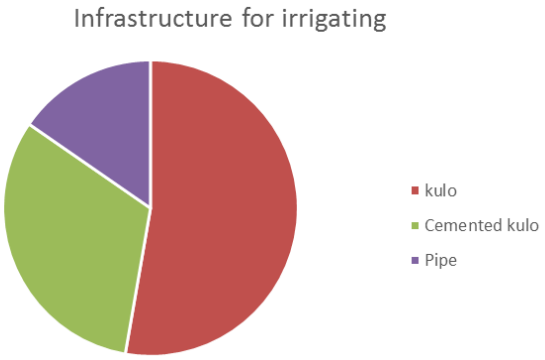

Figure 4: Pie-chart of different irrigation structure uses

3.4.4 Instrument Use For Irrigation

In the survey, the questionnaire was asked about instruments used in irrigation with options of Surface irrigation, Sprinkler irrigation, Drip irrigation, and others. Drip irrigation wasn't used at all by farmers in the maize field. The majority of the people used sprinklers (pipe) and surface irrigation.

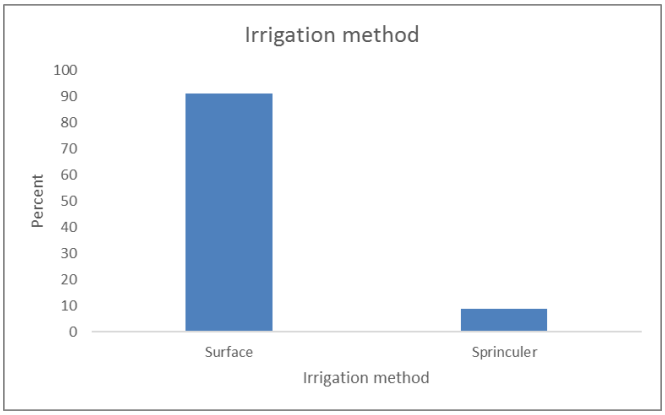

Figure 5: Graph of various irrigation methods used by farmers

3.5 Production Storage and Marketing

The major problem encountered during the survey.

3.5.1 Problem Ranking

There were many problems faced by Maize growing farmers during the cultivation of maize among these diseases and pest was the major problem faced by maize-growing farmer.

Table 9: Problem Ranking of Maize Production

Variable	Index value	Rank
Seed quality	0.82	2
Pest and insect damage	0.91	1
Irrigation	0.76	3
Price fluctuation	0.72	4
Marketing System	0.56	6
Storage	0.68	5

3.5.1.1 Diseases and Pests in Maize Fields and Stores

Diseases and insects that were damaging maize crops were smut (*Sphacelotheca reiliana*), turcicum blight (*Helminthosporium turcicum*), stem borers (*Chilo partellus*), leaf firing in some regions, blights (banded leaf; sheath)(*Rhizoctonia solani*), gray leaf spot, white grubs (*Phyllophaga sp.; Cyclocephala spp.),* armyworms (*Spodoptera sp., Mythimna sp.*),

cutworms (*Agrotis sp.* and other species), termites (*Microtermes sp.*; *Macrotermes sp.*), aphid (*Rhopilosiphum sp.*), locust, red ant, and tassel beetle, etc.

3.5.1.2 Weed infestation

Weeds generate large yield losses despite weed management strategies, with an average loss of 12.8% and a loss of 29.2% if no weed treatment is used (Oerke and Steiner, 1996). Depending on the type and severity of the weed flora, maize yield loss might range from 40 to 70% (Mandal et al., 2000). Farmers are just manually weeding maize and using none of the other weed management techniques. Similar circumstances were seen in the survey region, although it was impossible to estimate the real production loss caused by weeds. Weed infestation is considered a significant issue by 76.3% of respondents.

3.5.1.3 Irrigation

Water stress caused by drought is arguably the most important abiotic factor affecting plant and crop growth and development (Khalilli et al., 2013). Half of the survey area was near the river but in higher land area water supply was very hard and spring maize requires 5 to 9-time irrigation. Most farmers only irrigate the early stage of the maize crop.

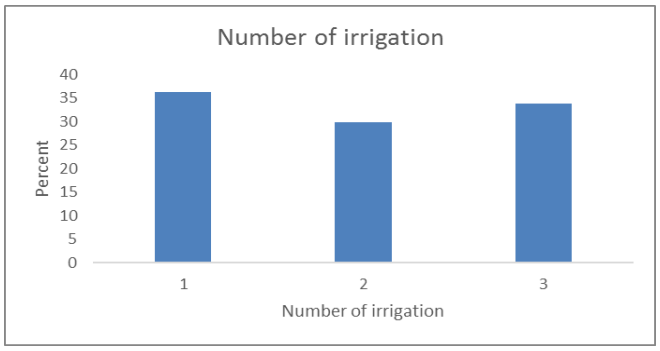

Figure 6: Number of irrigation in a maize season

3.5.1.4 Seed quality

Especially in the neighboring regions, poor quality hybrid and other seeds were imported in large quantities from India and given to farmers through agro-vets, resulting in the occasional failure of crops in the past. Local varieties are cultivated in a majority but few farmers purchased random varieties which might not be suitable for that environment. Some hybrid varieties came into the market and give good production but the next year these were not to be found in the market.

3.5.2 Source of Technical Guidance For Maize Cultivation

The government bodies like the Ministry of Agricultural Development (MoAD), Department of Agriculture (DoA), District Agriculture Development Office (DADO), Nepal Agricultural Research Council (NARC), Municipalities and Rural Municipalities, Non-government bodies like NGOs, Prime Minister Agriculture Modernization Project, and Agriculture Co-operatives provide technical guidance.

3.5.2.1 Rank of technical guidance for maize cultivation provided to survey area farmer

Table 7: Rank Of Technical Guidance Provided For Cultivation

Institutions	Index value	Rank
DADO	0.49	4
PMAMP	0.61	2
NARC	0.57	3
NGOs	0.21	6
Co-operatives	0.81	1
Agrovets	0.36	5

3.5.3 Equipment Used in Land Preparation

Plough is the frequently used tillage equipment which turns the soil, cuts trash, and buries them inside the soil. Different types of plough were used, but wooden plough (animal plough) was dominant. 92% of the respondent said that they use animal plough for land preparation, whereas mini-tiller was used by 6.88% of respondents, and tractors were used by 1.12% of respondents for land preparation.

3.6 Hoeing at A Different Stage

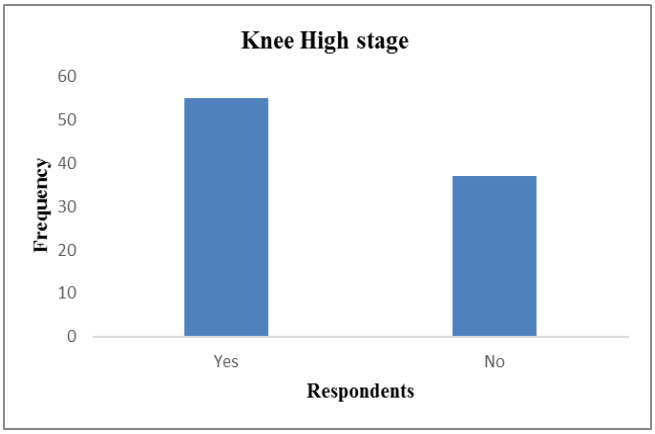

Figure 7: Hoeing at knee high stage

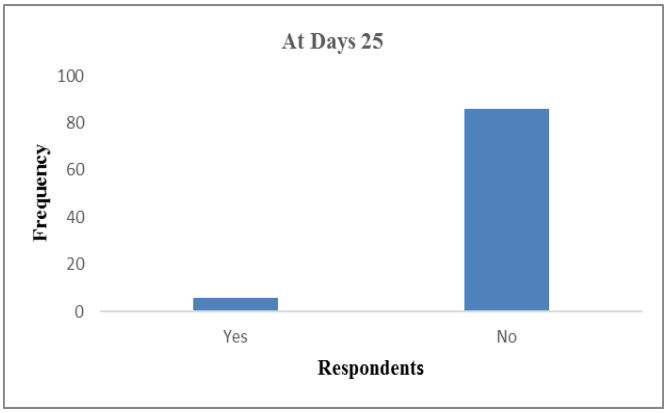

Figure 8: Graph of farmer hoeing after 25 days

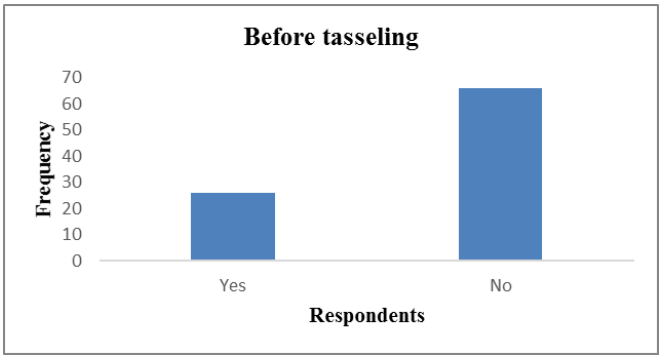

Figure 10: Graph of farmers hoeing before the tassel stage

4. SWOT ANALYSIS OF MAIZE PRODUCTION

Table 11: Swot Analysis of Maize Production

Strength	Weakness
1. Favorable climate. 2. Rich in nutrient and food content. 3. Provide more feed for livestock than any other cereals. 4. Farmers can get a large return from seed production.	1. Less knowledge about insects and pests. 2. Fewer trained technicians in the area that produce seeds. 3. Outmigration of working labor. 4. Segregation of land 5. Lack of technical support from concerned authorities.
Opportunities	**Threats**
1. Higher production than other cereal 2. Youth employment at the local level. 3. Increase saving and easy-to-fulfill household needs.	1. High Pest infestation at an early stage 2. Require high labor costs. 3. Highly fluctuating price. 4. Highly use of fertilizer deteriorates soil fertility

5. Conclusion

It can be concluded from the study that among the different determinants of maize production fertilizer, irrigation, protection from disease and pests, and proper land preparation were found to affect production. Incidences of pests and diseases, marketing systems, price variations unavailability of fertilizer, and unavailability of quality seed were found to be major constraints in maize cultivation. As a result of the absence of commercialization of maize cultivation, the majority of the study area's farmers made very little from the crop. Thus, focusing on the determinants such as fertilizer, irrigation, hoeing at the different stages, land preparation, and mitigating the problems of pests and unavailability of fertilizers and insecticides is a must for improving maize production which will further help in fulfilling household and market needs.

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