A Comparative Economic Analysis of Improved and Local Maize Seed System in Udayapur, Nepal

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Abstract— *The primary aim of this study is to identify significant predictors affecting the deployment of upgraded seed in Udayapur, Nepal. With minimum prior study and insufficient information in the survey area, this research tries to fill the knowledge gap by investing socioeconomic, institutional, financial and technical factors affecting the adoption of improved seed. A sample size of 75 respondents were interviewed at farm level. Benefit Cost ratio, Binary Logistic regression and Scaling index techniques are employed for the research. The benefit-cost ratio (BC ratio) for improved seed adoption was found to be 1.37, which is higher than of local seed (1.10). The total area under cultivation (p = 0.010) and training status of farmers (p = 0.050) were significant factors affecting the adoption of improved seed. For every increase in one-unit, area (hectare) and trained farmer, the odds of planting improved seed increase by 15.1 % and 4.168% respectively. The untimely availability of improved seed (0.71), fragmented land holdings (0.65) and lack of technical knowledge (0.53) were top three ranked factors hindering the adoption of premium seeds. To further encourage the use of high graded seed, technical and financial assistance, timely supply of input, land consolidation, and cooperative's roles become crucial. To streamline the future plans and programs for maize cultivation in the research area, an endeavor is made to study possible pathways for interventions.*

Keywords— Adoption, Binary Logistic Regression, Improved seed, Scaling index.

I. INTRODUCTION

Increasing agricultural productivity is crucial for economic growth and food security (SQCC, 2013). There are numerous factors diminishing food security, one of which is inefficient inputs application (FAO, 2024). The impacts of climate change across the globe will exacerbate issues of alimentary security, famine and global hunger especially, notably for the resources poor developing countries, and more especially in South Asia, including Nepal (Masso, 2012). Studies show that the use of improved seed can increase crop yields by up to 30 %, emphasizing the importance of seed in agriculture (SQCC, 2013). An access to affordable high quality seeds is crucial for improving productivity (Sector & Strategy, 2013).

Maize, known as the "queen of cereals" for its high yield potential, cultivated across diverse regions, with notable variation in adaptation (Revilla et al., 2022; Prakash et al., 2019). It covers total production area of 985,565 hectares (ha), production 3,106,397 Metric ton (Mt), and 3.15 Mt/ha Yield. In Udayapur district, maize is grown on 17,945 hectares (ha), production 43,714 Metric ton (Mt), yielding 2.4 Mt/ha (MoALD, 2020). Maize, once a subsistence staple, is now increasingly cultivated on commercial level (Dhakal et al., 2015) due to increase in demand by 5 % annually, (Sapkota & Pokhrel, 2013) especially from poultry industry.

Nevertheless, its productivity in Nepal lags behind neighboring countries, despite increasing in its demand (Subedi, 2015). The introduction of superior maize type is one potential solution to enhance productivity and meet market needs (S. P. Adhikari et al., 2019). The preference of maize varieties is affected by various factors (Kalle Hirvonen, Elia Machado, 2024b) among which socioeconomic factor is studied in this paper.

Nepal is highly vulnerable to natural disasters (Masso, 2012), which pose significant risks to maize production. The areas such as Nepal, dependent on rain-fed agriculture, have been slower to benefit from Green Revolution technologies (Pingali, 2012).

Further marginal farms often devoid of the resources to completely adopts these advancements (George, 2015). The utilization of progressive farm practices, such employing progressive over traditional seeds can aid in enhanced productivity (Pandya-lorch, 2009).

The affordability, timeliness along with availability of quality seeds, and varietal options, is crucial for embracing superior maize strains and bridging the yield gap (Mishra, R., P., Joshi, G., R. dan Dilli K., 2017). The adoption rate of improved maize varieties in Nepal is about 64% with approximately 40% of the total maize plantation is performed with refined type seeds and the remaining proportion with local or traditional varieties (Paudel & Matsuoka, 2008). The rate of adoption is higher in Terai regions as compared with hilly areas of the country, as access to inputs and infrastructure is poor in these areas (MOAD, 2014). To remedy this, production of Maize in Udayapur district has been supported by HMRP, CBSP (MoALD, 2021) and more.

There is no prior research on the determinants influencing the incorporation of improved seeds in Udayapur, Nepal. This research aims to assess the cost of production, income, benefit cost ratio for farmers with improved and local seed usage, the socioeconomic variables affecting the integration and constrains in adoption of superior strains.

II. RESEARCH METHODOLOGY

2.1 Data Source and methodology:

The study district for the comparative economics of improved and local seed system was decided purposively. The random sampling technique was applied to a sample size of 75 respondents**.** Data were collected by using a structured interviewer-administered questionnaire. The questionnaire covered socioeconomic, demographic and related characteristics of two seed system. Focused group discussions and key informant's interview were done to validate the survey statistic. The data was conducted using IBM SPSS (Version-27.0) and MS-Excel.

2.2 Model Specification

Benefit-Cost ratio was calculated for comparative economics of improved and local seed system. The Binary logistic regression model was applied for identify variables affecting the integration of superior maize seeds strain. The model has a binary outcome for seed adoption, assigning '1' to hybrid and '0' to non-hybrid or local seed. The equation for the model is

$$\text{Log}\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 \text{ education} + \beta_2 \text{ years of farming} + \beta_3 \text{ cultivation area} + \beta_4 \text{ training} + \beta_5 \text{ market proximity} \quad (1)$$

Note:

$\text{Log}\left(\frac{P}{1-P}\right)$ = log odds

P = Probability of adopting improved seeds ($0 \leq P \leq 1$)

1 – P= Probability of not adopting improved seeds

B_0 = Constant term

β_i = Regression coefficient for each independent variable (i = 1,2…5)

Scaling technique is employed to study factors hindering the adoption of improved seeds,

$$I = \frac{\sum SiFi}{N} \quad (2)$$

Where,

I = Index value which ranges between 0 and 1.

S_i = Value obtained by i^{th} category

F_i = frequency of the respondent

N = total survey respondents

III. RESULT AND DISCUSSION

TABLE 1
ECONOMIC COMPARISON OF HYBRID AND LOCAL SEEDS IN UDAYAPUR, NEPAL

A. Production cost	Improved	Local Seed
1. Average variable cost	(ha)	(ha)
Human Labor	18,847	14,429
Bullock Labor	6,429	3,102
Machinery cost	19,662	20,233
Seed cost	2,099	2,200
Manure Cost	1,391	1,330
DAP Cost	1,503	1,478
Urea Cost	1,398	1,049
Pesticide Cost	690	663
Other Cost	1,007	921
2. Fixed cost		
Land Cost	41	42
Farm Equipment, Depreciation and Maintenance	95	87
Total cost of production	53,162	45,544
B. Marketing at nearest market		
Yield	3,100	24,07
Market Price	23.5	21
Income	72,850	50,547
B.C ratio	1.37	1.1

The table presents the comparative economic analysis of maize production with two seed types. The outcomes show that production cost and the productivity (ton/hectare) for improved seed is higher than that of local seed by 0.27 units. In the research site, the B:C ratio for superior seeds and local seeds were 1.37 and 1.10 respectively.

TABLE 2
BINARY LOGISTIC REGRESSION FOR THE ADOPTION OF SUPERIOR SEEDS IN MAIZE CULTIVATION, UDAYAPUR, NEPAL

Predictors	β	S.E.	Wald	Sig.	Exp(β)
Educational status	-0.065	0.53	0.015	0.902	0.937
Years of farming	0.017	0.022	0.615	0.433	1.018
Cultivation area	0.141	0.055	6.549	**0.01**	1.151
Training	1.428	0.731	3.813	**0.05**	4.169
Market proximity	-0.09	0.547	0.027	0.869	0.914
Constant	-2.613	1.187	4.847	0.028	0.073
Omnibus test of model coefficient					
Model significance = 0.023					
- 2 log likelihood = 89.504					
Nagelkerke R square = .512					

The table demonstrates the findings from the Binary Logistic Regression for incorporation of superior seeds strains (0-local seed, 1-improved seed). The predictors for the model are educated (0-no, 1-yes), years of farming, cultivation area (katha), training (0-unskilled, 1-skilled) and market proximity (0- far, 1-near) were employed as predictors. The table examines the

relation between the predictor variables and likelihood of adoption of improved seed. Education has -0.065 beta coefficient, indicating that higher education decreases the odds of the implementing superior hybrid strains. However, this effect is not statistically significant (p=0.902). The years of farming has a coefficient of 0.017, indicating that higher the farming experience, the odds of employing improved seed increases, but this association is not statistically significant (p=0.433). The cultivation area has an affirmative and statistically significant effect (p = 0.010), indicating the larger cultivation areas increase the odds of improved seed use. This implies, for every increase in one unit (hectare) area, the odds of adopting improved seeds increase by 15.1%. Trained farmers and employ of superior seed were found to have affirmative and statistically significant relationship (p = 0.050), suggesting that training increases the odds of the outcome by a factor of 4.169 %. Market proximity has a coefficient of -0.090, indicating that closer market proximity decreases the likelihood of the employing superior seeds, but the effect is insignificant (p=0.0869).

The final equation after logistic regression results,

$$\text{Log}\left(\frac{P}{1-P}\right) = -2.613 - 0.065 \text{ education} + 0.017 \text{ years of farming} + 0.141 \text{ cultivation area}$$

$$+ 1.428 \text{ training} - 0.090 \text{ Market proximity} \quad (3)$$

The Omnibus test of model coefficient has p value of 0.023, imply that the predictors in the model is statistically significant and explains substantial effects on the adoption of improved seed. The -2-log likelihood and Nagelkerke R square values are 89.504 and 0.512 respectively, suggesting that model is fit and explains approximately 51.2% of the variance in the adoption is explained by the model.

TABLE 3
CONSTRAINTS IN THE INTEGRATION OF IMPROVED SEEDS IN MAIZE CULTIVATION, UDAYAPUR, NEPAL

S. No.	Constraints	Index value	Rank
1	Untimely availability	0.71	I
2	Fragmented and small land holdings	0.65	II
3	Lack of technical awareness	0.53	III
4	Crop management	0.46	IV
5	High price of seeds	0.29	V

This table highlights the primary challenges faced by farmers in adoption of improved seeds. The highest ranked constraint was found to be untimely availability of improved seed with the index score of 0.71. Fragmented small land holdings and lack of technical awareness were key hinderance factors with 0.65 and 0.53 index values. Crop management and high seed price were other constraints in the adoption of improved seed.

IV. CONCLUSION

The research offers clear evidence that the employing superior seeds over the traditional, is associated with greater Benefit-Cost ratio by 0.27%. Additionally, two predictor variables, cultivation area and training status of farmers were found to have an affirmative and significant linkage on the adoption of enhanced seeds. This implies, for every increase in one unit (hectare) area and trained farmer, the odds of employing superior seed strains increase by 15.1%. and 4.169 % respectively. The untimely availability of improved seed, small land holdings and lack of technical knowledge were top ranked hindering factors in the adoption of improved seed.

To remedy the major barriers in adopting improved seeds, several recommendations are propose based on the study. There is an urge to supply adequate high qualities seeds on time through a robust distribution network. Establishing efficient supply and distribution network by interlinking all the channels of value chain should be promoted. Supporting marginalized farmers with target specific programs such as land consolidation, farmers' cooperative, subsidies and incentives, is pivotal. The financial and technical assistance, and disseminating technical knowledge at grass root level will encourage the adoption of

improved seeds. Implementing these programs and policies will incentivize better adoption of improved seeds by pooling available resources, increasing, encourage bulk supply, strengthening community seed banks and increasing bargaining powers of farmers.

DECLARATIONS

I, Saroj Dhakal, declare that the research entitled "A Comparative Economic Analysis of Improved and Local Seed Systems in Udayapur, Nepal" is our original work and has not been submitted previously in any form to any other university or institution. To the best of my knowledge and belief, this work is free from plagiarism. I understand that my research may be used as a reference in future research or publications, and I have no objection to its use in that context.

AUTHOR CONTRIBUTION STATEMENT

- S. Dhakal*: Conceptualization, Methodology, Data Collection, Data Analysis, Writing - Original Draft, Writing - Review & Editing.
- P. Gyawali: Methodology, Data Analysis, Supervision, Writing - Review & Editing.
- S. Pandey: Conceptualization, Resources, Writing - Review & Editing.
- B. Sharma: Data Collection, Visualization, Writing - Review & Editing.
- S. Dhakal: Project Administration, Funding Acquisition, Writing - Review & Editing.

CONFLICTS OF INTEREST

The authors certify no conflicts of interest concerning the research, authorship, and publication of this report. We have conducted the study without any biasness.

ETHICS CONSENT

All contributors provided their informed consent before their inclusion in the study, ensuring their voluntary participation. The confidentiality and anonymity of participants were maintained throughout the research process, and all data were securely stored.

CONSENT FOR PUBLICATION

We provide consent to the publication of materials related to our participation in the research study titled 'A Comparative Economic Analysis of Improved and Local Seed Systems in Udayapur, Nepal'. We understand that our information will be used for research purposes and that our identity will remain confidential.

DATA AVAILABILITY

Additional data, questionnaire, data entry or any other requirements will be provided upon request.

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