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Adoption of Improved Variety Maize Seed Production Among Rural Farm Households of Western Nepal

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Abstract **– Seed production, processing and distribution through reliable seed value chain is an important intervention for increased production and productivity of cereal crops and to achieve the goal of food security and poverty reduction among farming population. The proper functioning of such seed value chain largely depends on adoption of improved variety seed production practices by small-holders in Nepal. Two hundred farm household adopting improved variety maize seed production practices and two hundred farmers growing maize for grain purpose, selected through purposive random sampling, were interviewed from four mid hill clusters in western Nepal to determine the factors influencing adoption of seed production practices and profitability. Enterprise budgeting tool was used to determine the profitability of improved variety maize seed production against maize production for grain purpose. The net return per ha for seed producer farmers is found three times higher than normal maize growers although the seed production cost per ha was 12% higher. The B/C ratio for seed producer farmer was found 1: 1.45 in comparison to 1: 1.11 for non-seed producers. The logistic regression model was employed with dependent variable, adoption of improved variety maize seed production, to determine effects of explanatory variables on the decision to adopt maize seed production practices. The results revealed that the distance from road head and nearest market center, households with higher off farm income, larger land holding size limits the adoption of improved variety maize seed production by the farm households. The female headed households, household with higher number of full time farm workers and households regularly participating in village collective actions are more likely to adopt improved variety maize seed production. Other important positively contributing predictor variables are contact with extension worker, linkage with seed processor and availability of source seed.**

The major implication of this study is towards implementation of programs focusing training, promoting linkages, assuring availability of source seed and networking with processing industries to increase adoption of improved variety maize seed production which has many win-win outcomes in the areas of domestic seed business, poverty reduction, food security, agriculture trade balance and employment generation.

Keywords **– Adoption, Seed Production, Maize, Profitability.**

I. INTRODUCTION

Agriculture sector in Nepal contributes 33.13% to GDP [1] and employs 65.6% of economically active population [2]. Cereal crops contribute 49% and maize alone contributes 7% in national AGDP [1]. Maize is third staple crop cultivated in 0.88 million hectare area and total production is about 2.15 million tons with a yield rate of 2.431 mt per hectare [1]. The estimated annual demand of maize in the country for different purposes is about 2.43 million mt while its annual domestic supply is 2.15 million mt [1]. The average per year growth in area, production and productivity of maize during 1992-2015 is 0.7 %, 3% and 2% respectively.

The import of maize was 0.23 million mt during 2014/2015 and is increasing sharply with increased demand for feed and other purposes in domestic market. The import grew 16% annually in terms of quantity between 2010 to 2015 [3]; the annual domestic production growth was 3% during the period which shows annual total demand of maize is increasing by 19.5%. This shows that maize demand is increasing higher than projected (4-6%) by NMRP 2001 and 87% of demand of maize in feed industries is fulfilled from import basically from India [4].

The average yield of maize was 2.4 mt/ha during 2015, while attainable yield for maize with available recommended varieties is about 5.7 mt/ha [5], which shows a huge yield gap of 3.3 mt/ha. This high yield gap is largely wedged by poor and inconsistent availability of basic inputs like quality seed, fertilizer, irrigation and technology augmented with traditional production practices, marketing and processing infrastructures. Seed is most critical input for increased agriculture productivity and 20% yield can be increased by using quality seed [6]. Seed is considered relatively less expensive production input that determines the yield**.** The current seed replacement rate (SRR) for maize is about 14.48% which is far below than recommended rate of 33 % for cross pollinated crops [7]. The 91.5% of total maize area is under improved varieties and 79% of the area is covered by farm saved seed [1]. In Nepal more than 88% farmers use farm saved seeds [8]. The annual domestic seed production of maize by private and public sector is 2330 mt which is 13% of total national maize seed requirement [1]. The large number of farm population is still outside the access of improved quality seed and adoption rate of hybrid and improved varieties is low in order to fulfill the yield gap. The availability of improved quality seed provided with quantity, timeliness, accessibility and varietal options are very important factors to promote adoption of improved varieties and fulfill the yield gap. There are 20 non hybrid and 5 hybrid maize varieties developed by Nepal Agricultural Research Council (NARC) and available for seed production and extension. In addition, there are 52 hybrid varieties registered outside Nepal. The seed system in Nepal is complex with rigid

seed production and supply breeders seed-foundation seed-certified seed/truthful label seed-improved seed cycle involving different actors in each stage [9]. Seed producer farmers mostly involve in certified/truthful label and improved seed production for seed industries and processors. Production of certified and truthful label seed requires intensive application of recommendations made by seed authority in Nepal.

Movement of improved open pollinated varieties has been constrained by the lack of active seed enterprise in the country and lack of knowledge of new varieties [10]. The National Maize Research Program (NMRP), government farms and private enterprises produce about 200 mt of foundation seed, which is available to seed growers through different channel [7]. The amount of source seed that enters in the market is not known, but the area sown with improved seed, including hybrids from India that are grown mainly in the Terai and seed of improved varieties that have been recycled for one or more seasons, is estimated to be between 54% and 58% [11]-[12].

Maize is largely grown as rainy season crop in upland areas basically in hilly regions. Winter and spring season maize is also grown in irrigated areas of river basins and Terai. The Maize production in Nepal largely affected by climatic variability and depends on onset of rainfall and availability of farm inputs. The large area under maize crop is in remote hilly regions where availability of external inputs is poor and production largely depends on traditional inputs and weather conditions. During 1990 to 2015 period yield fluctuation is minus 148kg/ha to 168 kg/ha which indicates higher influence of weather conditions in maize production [1]. In the hill areas maize comprises 78% of cultivated land and two third of production is used as household consumption. However in case of Terai, only 50% of production is used for household purposes and remaining is sold in the market [13]. This trend has been changed with increased road access. The larger proportion of production is sold in the market and rice is purchased for household consumption.

In this context, it has been a challenge for Nepal to increase production and productivity of maize in order to meet increasing demand of maize and balance agriculture trade deficit. The fundamental step to overcome this challenge is strengthening maize seed production and distribution system in the country. The availability of improved variety seed among maize growers largely depend on strong competitive maize seed value chain with wide and deep distribution network. Such value chain stem up from wider adoption of improved variety seed production practices by farmers linked with processing industries established in private, public and community sector. The future supply of improved variety quality seed of maize will largely depend on adoption of improved variety quality seed production practices and linkage with processing and distribution.

With this backdrop, government of Nepal has devised pro-seed business strategies to promote the adoption of improved variety seed production by farmers, processing and distribution by community, private and public sector seed enterprises.

Considering these facts, the present study aims to examine the socio-economic condition of maize seed growers, profitability of certified/truthful level (TL) seed production of maize in comparison to grain production, and to analyze the factors contributing the farmers' decision to adopt improved variety maize seed production in selected areas in western Nepal.

Previous studies conducted in Nepal and elsewhere have shown the effects of different farm and farmer specific variables on adoption. Among them, the education of the decision maker farmer has positive effect on the adoption of technology as more educated producers tend to adopt new technology more quickly [14]-[15]. Reference [16] found variables such as education of the decision maker and his/her experience and availability of extension services have significant effect on adoption of modern rice varieties in Nepal. Also farmers with better education are earlier adopters of modern technology and apply modern inputs more efficiently throughout the adoption process [17]. Foundation seed production practices adoption by farmers in Palpa district significantly contributed by schooling year of household head, family type, active members, farm category, and total income from maize seed production and training received [18]. The diffusion of innovation theory [19] suggests that having contact with extension agents and receiving services are expected to have a positive effect on adoption. Such contacts, by exposing farmers to information, expected to stimulate adoption [20]-[10]. The decision of the farmer on adoption of seed production was positively influenced by his/her education, age, land holding, irrigated land, number of crops grown, and extension contacts while family size was influencing negatively [21]. Studies of [22]-[23] suggest that farmer's decision to adopt agricultural technology depends on farm household characteristics such as socio-economic, institutional, and environmental factors. According to [24], individual household level analysis is the main approach to adoption studies, where the factors influencing farmers' behavior are analysed in understanding the reasons behind adoption of an improved agricultural technology under question. The adoption study assumption is that there exists an innovation and the study of adoption decisions evaluates determinants of its adoption. Reference [25] reported that improving skills and knowledge of farmers in aspects such as seed storage, seed quality management, marketing, accounting, and assessing new varieties could enhance uptake, spread of new varieties, and improved practices and will help to keep the small-scale seed production enterprises commercially viable. Diverse studies present a range of factors such as gender, age, education, land holding, livestock holding, and extension visits to explain the adoption of technology in farming [26]-[27].

Adoption of seed production has multiple gains among actors, farmers get higher price in comparison to normal maize and other involved in value chain generate business and employment. Seed production is profitable business for farmers the B: C ratio for foundation seed production

is 1.16 as compared to certified seed 0.96 in Palpa district [18]. Similarly while studying economic analysis of pigeon pea seed production technology and its adoption behavior in Indian context found pigeon pea certified seed production resulted in a win-win situation for the farmers with higher yield and increased returns [21]. Reference [21] further elaborated that higher yield and profitability associated with seed production can be effectively popularized among farmers, resulting in increased certified seed production and recommended adoption of quality seed production targets to meet existing regional demand for new and promising varieties of various crops.

1.1. Maize Seed Production and Distribution System

The improved varieties of maize in Nepal are developed by NMRP under NARC and after formal varietal release process, released varieties available for seed production and distribution by different agencies. Source seed production and multiplication is authorized to certain agencies both in public and private sector.

District Seed Self Sufficiency Program (Disspro)

This program was initiated during 1998 with a view to establish district level seed production and distribution system in order to make districts self-sufficient in seed required. The fundamental idea behind this is to promote localized seed production and distribution of improved varieties seed and their faster dissemination in a cost effective way. Source seed was supplied by District Agriculture Development Offices and seed producer farmers are generally not connected directly with source seed producers. The seed production largely depends on supply of source seed. There is no mechanized processing facility and established linkage with market to develop seed value chain. However it had laid foundation for the current seed value chains being developed in Nepal. DISSPRO is a major contributor for increasing formal seed supply in Nepal and currently implemented in more than 63 districts. This programme coordinates and provides necessary technical support in production, processing, storage and distribution of seeds. Currently there are 100 cooperatives involved in seed production under this system.

Community Based Seed Production (CBSP)

The development and dissemination of improved crop varieties and other technologies through CBSP and Participatory Variety Selection (PVS) approach was initiated during 2000. This was similar to DISSPRO but tried to establish community based seed value chain. Linkages were developed among traders, public sector agencies, nongovernmental organization and other development partners for promotion of improved maize varieties to make a complete maize seed value chain. Local farmers can purchase seed from such seed producer farmer groups. Currently there are 1000 CBSP groups involved in seed production and seed marketing. Seed production through CBSP groups in Hill Maize Research Program (HMRP) has been a very successful model in Nepal, and has significantly contributed to increase the seed replacement rate [28]. This approach has significant contribution to increase SRR from 5.81% in 2007 to 9.5% in 2011 increase maize productivity by 36% from 1.8 mt/ha in 2000 to 2.2 mt/ha in 2010 [28].

Community Seed Bank (CSB)

Seed producer groups were formed small seed storage and processing facility developed to produce and sell quality seed. This was established as community seed enterprise and sell improved quality seed on their own brand during 2009. It was also based on value chain concept and linked with the entire stakeholder involved in seed production, processing, and distribution and quality control aspects of the seed business.

Private Seed Companies

The first seed company was Seed Entrepreneurs Association Nepal (SEAN) seed company private limited established in Nepal. The private sector increased participation in seed business after 2009 when government started to support private seed companies through different windows. Currently there are 47 registered seed companies established and 3408 registered seed entrepreneurs involved in seed production and marketing [29].

1.2. Maize Seed System

Breeder's Seed

This is produced by NARC farms under direct super vision of breeders and it is not authorized breeders seed production to private and community sector. Breeder's seed is supplied to authorized public, private and community sector agencies/enterprises to produce foundation seed.

Foundation Seed

The foundation/source seed is produced by NARC system, government farms, certain authorized companies, farmer groups and cooperatives. The source seed is made available to seed multiplication firms, companies, groups and cooperatives. Source seed of different varieties is always in short supply and not openly available in the market. The distribution of source seed is regulated by Seed Quality Control Center (SQCC).

Certified Seed/Truthful Level Seed

This is produced by authorized government farms, seed companies, cooperatives and farmer groups. They can sell certified/truthful level seed in the market which is ultimately available to farming communities.

II. METHODOLOGY

2.1. Study Site

This study was conducted in four districts of western Nepal Dadeldhura, Doti, Surkhet and Dailekh. These are the main districts where maize seed production is being practiced in different clusters by farm population. Out of these four districts Dadeldhura, Doti, Dailekh are mid-hill districts having sub-tropical climate and Surkhet inner terai valley but selected site also dominate sub-tropical climate. All the sites are accessible to nearby road connection, small market centers and extension service out lets. The selected sites are hilly terrains with poor irrigation facility and maize is grown only in rainy season. In the past maize was grown for food and livestock feed,

in recent years after development of transportation facility maize is produced for seed, food and feed purposes as well. The dominant cropping patterns are cereal based and only small area is under vegetable crops and oilseed. The seed production activities were started after intervention of HMRP which established community based seed banks in these sites. Community seed banks established in these sites are now linked with seed companies and some time they carry primary processing and sell their own in the market, public sector agencies and nongovernmental organizations.

Table 1. Agro ecology and production environment of the study sites

Characteristics	Sites			
	Amargadi Dadeldhura	Laximi Nagar Doti	Narayan municipality Dailekh	Kalayan VDC Surkhet
Landscape	mountain terrace	mountain terrace	mountain terrace	mountain terrace
Climate	sub tropical	Subtropical	sub tropical	sub tropical
Altitude	1400-1700	1000-1500	1200-1600	1000-1300
Major agriculture crops	maize, wheat paddy, soybean, potato and vegetables	maize, wheat paddy, soybean, and vegetables	maize, wheat paddy, soybean, potato and vegetables	maize, wheat paddy, potato and vegetables
Dominant cropping pattern	maize-wheat soybean-wheat paddy –wheat maize + soybean-fallow	maize-wheat soybean-wheat paddy –wheat maize + soybean - fallow	maize-wheat soybean-wheat paddy –wheat maize + soybean-fallow	maize-wheat paddy wheat/ mustard
Access to road	nearby	nearby	nearby	nearby
Access to market	nearby	nearby	nearby	nearby
Seed production started	2011	2012	2011	2014

There are NARC centers in Doti, Dailekh and Surkhet to carry research activities; supply source seed for maize seed multiplication and provide technical information to growers. In selected districts 40% area is under maize crop out of total rainy season cereal production area [1]. These districts have number of maize seed producing farmers and linked with different seed processing enterprises within region or outside. Farmers in these areas not only involved in maize seed production but they are also involved in vegetable seed, fresh vegetable, and spices production and other agro based enterprises.

2.2. Data Collection and Sampling Design

The data used in the study were collected from four sites Amargadi Municipality Dadeldhura, Laxminagar VDC ward no 3, 4, 5, 9 Doti, Narayan Munacipality ward no 7 and Belpata VDC ward no 5 Dailekh and Kalayan VDC ward no 4 Surkhet during November to March 2015. The four districts and maize seed production clusters were selected purposively based on available information on maize seed production from crop development directorate. Farmers in these districts are involved in maize seed production. Separate list of maize seed growers and non-seed growers prepared for each cluster and random sampling method was used to identify two hundred farmers 50 from each site involved in maize seed production and 50 for each site involved in maize production grain purpose in total 400 farmers were interviewed. Maize seed production farmers involved in improved variety maize seed production irrespective of area planted and duration of involvement.

Table 2. Survey sites and sample

Development region	District	VDC/ Villages	Number of household sampled		Total
			Adopter	Non adopter	Total
Far Western	Dadeld-hura	Amargadi Municipality	50	50	100
	Doti	Laxmi nagar VDC	50	50	100
Mid Western	Dailekh	Narayan Municipality, Belpata VDC	50	50	100
	Surkhet	Kalayan VDC	50	50	100
Grand Total			200 (50%)	200 (50%)	400 (100%)

Improved maize varieties are developed and released by NARC and recommended for growing in the areas. Non maize seed producers are those who did not involve in improved variety maize seed production at all.

The questionnaires were pre-tested among 15 respondents of Amargadi Municipality of Dadeldhura district and required adjustment was made in survey questionnaires. Key informant survey was carried out with district agriculture development office (DADO) staffs and seed collectors to get explanatory information regarding adoption of improved variety maize seed production. Similarly one focus groups discussion was held for each site with the involvement of seed producer, collector, processor and retailer to make broader understanding of maize seed production and distribution.

Profitability analysis of maize seed production was analyzed by using enterprise budgeting tool and standard format [30]. Reference [31] employed enterprise budgeting as a tool to study profitability analysis of bean production in Honduras.

The possible explanatory variables were selected based available literatures reviewed [18]-[21]-[32]-[5] with special focus on seed production adoption for different crops. These are mainly related to household characteristics, farm characteristics, institutional and support services and market.

2.3. Theoretical and Empirical Framework

The adoption of new technology and innovations in farming is largely studied area in the available literature. The technology adoption by farming population is largely determined by various socio economic, individual, market, and institutional attributes. The adoption of agriculture technology is analyzed using different models utility function subject to different constraints [33]. In the adoption behavior studies the dependent variable technology adoption is constrained to lie between 0 and 1. Reference [34] in his study stated that in such case the model used for exponential functions univariate and multivariate logit and probit models including their modified forms have been used widely. Reference [35] recommended probit model for functional forms with limited dependent variables that are continuous between 0 and 1 and logit models for discrete dependent variables.

In this study dependent variable adoption of improved variety maize seed production is discrete, dichotomous and mutually exclusive in nature and followed binary logit model. This model contains one dependent variable with two categorical outcome adoption of maize seed production or not adoption. The prediction of the decision whether to adopt improved variety maize seed production or not is examined with 11 independent variables. The logit model which is based on cumulative logistic probability functions is computationally easier to use than other type of models and it also has the advantage to predict the probability adopting any technology [34].

Logit model

Equation 1

$$\pi(X) = \frac{e^{\beta 0+\beta 1X1+\beta 2X2+\cdots.\beta pXp}}{(1+e^{\beta 0+\beta 1X1+\beta 2X2+\cdots.\beta pXp}} \ldots\ldots\ldots.. (1)$$

$\pi(X)$is the probability that the farmers will adopt the improved variety maize seed production.

The dependent variable = 1 if the farmer adopted the improved variety maize seed production, 0 if they adopted maize production for grain purpose.

X is a vector of explanatory variables,

β_0 and β_1 are parameters of the model.

e = Base of natural logarithms.

Equation (2)

$$logit\ [\pi(X)] = \beta 0 + \beta 1X1 + \beta 2X2 + \cdots. + \beta pXp \ldots\ldots\ldots\ldots (2)$$

Table 3. Definition of variables used in empirical model

Independent Variable	Definition and measurement	Mean	SD	Hypothesized sign
HHHEAD	Household head (male 1, female 0)	0.78	0.41	+
AGEHH	Age of the household head (years)	47.11	11.61	+
FULLFARMWKR	Full time farm worker (no)	1.60	1.36	+
TRNGYN	Training Received or not (yes , no)	0.52	0.49	+
OFFINC	Off farm income (NRs per year)	249836	196453	-
FARMSIZE	Farm Size (ropni)	8.74	4.52	+
DISTANT	Distance to market/road head (hr)	0.85	0.42	-
CONTEXT	Contact with extension agents (yes, no)	0.55	0.49	+
PCA	Participation in collective action (yes, No)	0.52	0.49	+
AVSOUSED	Source seed availability(yes, no)	0.52	0.49	+
CONTPROCESS	Contact with processor (yes no)	0.55	0.49	+

2.4. Empirical Logit Model Specification

The probability of improved variety maize seed production adoption is a function of economic, social and market factors which is represented as follows.

$$ln\left[\frac{P_i}{(1-P_i}\right] = b_0 + b_1HH_i + b_2AGE_i + b_3FFW_i + b_4TR_i + b_5OFI_i + b_6CE_i + b_7FS_i + b_8DTM_i + b_9PCA_i + b_{10}SA_i + b_{11}CP_i + U_i$$

Where p_i is the probability that is adopter of improved variety maize seed production, *1- p_i* is the probability that the i_{th} farmer is non adopter of improved variety maize seed production. b_i is the logit coefficients (j = 0, 1, 2,……..,11) and U_i is random disturbances (i = 1, 2, 3, 4 …….., 100).

Several possible independent variables were surveyed with hypothetical assumption of their influential capability in adoption of improved variety maize seed production but only above mentioned variable carry determining capacity in farmers decision of adoption of improved variety maize seed production.

III. RESULT AND DISCUSSION

3.1. Descriptive Statistics of Variables and Hypothesized Effects for Improved Variety Maize Seed Production Adoption

Background information's are analyzed to understand the difference between socio economic characteristics between improved variety maize seed producers and non producers in the selected area. There is not much difference among adopters and non adopters in terms of education level of household head, family size, economically active population and available farm worker. The annual off farm income, average land holding size, number of parcels, total livestock holding is higher among non seed producers as compared to seed producers. The non seed producers are more male headed (7%) in comparison to seed producers.

The average land holding size of sampled population is 0.48 ha which is scattered in 3 parcels with average size of 0.16 ha for each. The land holding size for improved variety maize seed producers is about 0.48 ha and 0.55 ha for non-producers. The average area of seed production is about is 0.21 ha among seed producers and remaining area is under millet, paddy, soybean, vegetables and other

homestead production. Regarding normal maize producers the area under maize is the same 0.21 ha but they grow more paddy and soybean. Among hill farmers paddy is considered as cultural crop must be grown even in small area and soybean is considered as more profitable, less labor intensive cash crop.

Table 4. Characteristics of improved variety maize seed production adopters and non adopters

Definition and measurement	Seed producer	Non seed producer	Difference
Household head (male%)	75	82	-7
Age of the household head (years)	48	46	2
Full time farm worker (no)	2	1	1
Training Received or not (yes %)	69	35	34
Off farm income (Rs per year)	214270	285403	-71133
Farm size (ropni)	7.5	11	3.5
Distance to market/road head (hr)	0.8	0.8	
Contact with extension agents (yes %)	72	38	38
Participation in collective action (yes %)	67	37	30
Source seed availability (yes %)	77	34	43
Contact with processor (yes %)	73	31.8	41.2

The average allocation of area for different crops during rainy season is 21% paddy, 63% maize (seed and non seed), 18% soybean (mixed cropping with maize), 9% cash crop, 3% millet. There is no difference in number of parcels and average size of parcels among adopter and non adopter groups. This shows improved variety maize seed production is popular among small holders with low income groups. The involvement of small holders in improved variety maize seed production was supported by government policy as tool for income generation and food security improvement.

3.2. Economics of Improved Variety Maize Seed Production

Enterprise budgeting tool was employed to analyze the profitability of improved variety maize seed production against normal maize cultivation. The two main varieties grown for seed production purposes are Deuti and Mankamana-3 in some cases Arun -2 also grown. Here cost of production is analysed for Deuti variety growers which is recommended high yielding variety for mid hills and inner Terai area for rainy season.

The 99% of the cost involved in both maize seed and normal grain production is under variable cost category. Among the variable cost items human labor and bullock labor are major items. In case of seed production human labor constitutes 54% while it is 50% in case of normal maize grain production. There is no difference in the share of bullock labor use. The higher percentage of human labor for seed production farmers is due to more use of human labor during inspection, rouging, cleaning and threshing. There is no such variation in other variable cost items between two categories. Most of the farmers use farm yard manure (FYM) for production purposes and non seed producers follow mixed cropping pattern with soybean so they use less urea per ha in comparison to seed producers. Plant protection chemicals are rarely used during early growth of plants.

The total cost of cultivation for improved variety maize seed production per ha (NRs 86141) was found 11% higher than common maize grain production (NRs 76445) while the gross return was about 40.8% higher (NRs 123040.0) in case of seed producer farmers than grain producer farmer (NRs 87377.6). The higher gross return for maize seed producers is due to higher farm gate price (NRs 32/kg) of seed. The average rejected grain during initial grading and shelling on weight basis is estimated 10%. The net return at the farm gate is three times higher for maize seed growers (NRs 35662.4/ha) in comparison to non seed growers (NRs 11432.6/ha). Hence improved variety maize seed production is profitable farm enterprise having larger implication to create foundation for robust and resilient maize seed value chain.

However focus group discussion with seed traders and seed producer farmers showed profitability of maize seed production is highly sensitive to government and non-governmental sector maize promotion programs.

Table 5. Cost and Benefit for seed and non seed producer farmer

Cost /return items	Seed producers				Non seed producers		
	Unit	**Quantity**	**Rate (NRs)**	**Total**	**Quantity**	**Rate (NRs)**	**Total**
Variable cost				**85289**			75593
Human labor	Day	118	400	47200	98	400	39200
Bullock Labor	Day	15	1200	18000	15	1200	18000
Seed	Kg	24	100	2400	24	60	1440
Manure	Kg	2000	5	10000	2000	5	10000
Fertilizer							
DAP	Kg	30	50	1500	20	60	1200
Urea	Kg	50	30	1500	20	30	600
Potash	Kg		0			0	
Plant protection chemicals	Rs		0	0		0	0
Inspection cost	Rs		0	0		0	0
Interest on Variable cost	Rs			4689			5153
Communication	Rs			500			0
Fixed cost				352			352
Land tax			52	52		52	52
Water tax							
Depreciation on farm equipment				100			100
Repair and maintenance				200			200
Total cost				**85641**			**75945**
Total production	**kg**	**3900**			**3840**		
Seed	Kg	3510	32	112320			
Grain	kg	390	20	7800	3840	22	84480

Cost /return items	Seed producers				Non seed producers		
	Unit	Quantity	Rate (NRs)	Total	Quantity	Rate (NRs)	Total
By product	kg	3650	0.8	2920	3622	0.8	2897.6
Gross income at farm gate				123040			87377.6
Gross Profit at farm gate				37399			11432.60
Cost of seed production/kg				22.0			19.78

3.3. Logit Model Result

The dependent variable adoption of improved variety maize seed production is regressed with major possible explanatory variables. The effects of each of the individual independent variables on the decision to adopt maize seed production are shown in Table. The results of the logistic regression equation (Table 6) shows that predictor variables dummy of household head, age of household head, number of full time farm worker, training obtained, annual off farm income, farm size, distance to road and nearest market, contact with extension worker, participation in village collective action, availability of source seed and contact with seed processor are significant. Other factors hypothesized to influence adoption did not have significant coefficient and are not included in model. They included age of household head, family size, education level of household head and farm income.

In the specified logit model, the likelihood ratio chi square value of 309.81 with a p value of < 0.0001 shows that the model fits well. The most significant negatively contributing predictors of the maize seed production adoption are the distance from market and road head, off farm income, farm size and dummy variable of household head. The higher the distance from road head and nearest market center there is difficulty in input and output transportation, and higher transportation cost limits the adoption of improved variety maize seed production. Similarly households with higher income from nonfarm business and off farm employment are less likely to adopt improved variety maize seed production. Agriculture is less profitable business and people with higher off farm income generally not interested in drudgery full and less profitable farm enterprise. With this it can be predicted that increased off farm income in rural areas can shrink improved variety maize seed production and new support measures to be devised to sustain seed production and make seed value chain resilient. The larger land holding size has negative contribution in adoption of maize seed production, they have other options to grow more profitable cash crops, and they are generally food secure and look for off farm employment. This finding is consistent with argument small farmers utilize the limited resources more efficiently and adopt new technologies at a faster rate [36]-[27]. In this case pro small holder policy in seed production promotion has also supported the faster adoption of improved variety maize seed production by small holders.

The female headed households are more likely to adopt improved variety maize seed production with imparting training, contact with extension agents and supply of source seed in comparison to male headed households. Generally household decision making is carried out by males in western Nepal, as males are outward looking and always trying to migrate for off farm employment. Female headed households can make their own decision and focus on profitable farm enterprise provided with training as they have less opportunity to go outside for employment. Increasing trend of feminization in agriculture will have positive role in seed production adoption provided with support incentives in future. Furthermore households with higher number of full time farm worker are more likely to adopt seed production as seed production demands more labor in comparison to grain purpose maize production.. There is shortage of agriculture labor in rural areas that leads to costly and inconsistent supply during high demand. Thus only the household having higher numbers of own full time farm worker can carry out medium sized commercially profitable farm enterprise like maize seed production. Extension and training are important determinants positively contributing in adoption of maize seed production and thus increased training can promote adoption of seed production by the rural farm households. The households regularly participating in village collective action have more social capital and higher tendency to follow the villagers, group and cooperative in the village. It is an inherent attribute of household to follow neighbors and positively contribute in adoption of maize seed production. Other important positively contributing predictor variables are contact with extension worker, seed processor and availability of source seed. Availability of source seed is critical predictor for adoption of improved variety seed production by farm household.

Table 6. Logit model result

Variables	Coefficient.	Std error	Z	P>IZI	95% conf.
Household head (male or else)	-0.8651841	0.4240178	-2.04	0.041	-1.696244
Age household head	0.038281	0.015664	2.44	0.015	0.0075802
Full time farm worker	0.9847005	0.1516605	6.49	0.000	0.6874513
Training received	1.299732	.3342229	3.8	0.000	0.6446671
Off farm income	-2.16	8.7	-2.48	0.013	-3.8
Farm size	-0.1849067	0.0406052	-4.55	0.000	-0.264495
Distance from the market	-2.307598	0.7053465	-3.27	0.001	-3.690051
Contact with extension worker	1.579053	0.3423983	4.61	0.000	0.907965
Participation in collective action	0.5767836	0.3384812	1.7	0.088	-0.0866273
Source seed availability	1.72066	0.464778	3.70	0.000	0.8091119
Contact with processor	0.832031	0.4513492	1.84	0.065	0.0525971
Cons	-2.537306	0.9967593	-2.55	0.011	-4.490919

IV. Conclusion and Policy Implication

Increasing production and productivity of maize to fulfill the increasing demand in domestic market and reduce agriculture trade deficit has been a crucial issue in Nepal. One of the most cost effective ways to increase production and productivity is increased availability and access to improved variety quality seed among farming population so as to increase adoption rate of improved variety maize seed production practices and strengthen maize seed value chain. This study identified factors influencing adoption of improved variety seed production practices by the farmers of western Nepal. Furthermore profitability of any agriculture enterprise largely determines its sustainability and wider adoption by farming population under modernizing agriculture environment. Overall findings in these two aspects may help in strengthening of public sector efforts directed towards increased production and productivity of maize in the future.

The majority of the farmers are small holders and operating in rainfed condition. The maize production is a major farm enterprise for them. The cost of production is quite similar for grain and seed purpose but the net return for improved variety maize seed production is three times higher than maize production for grain purpose. Higher return in seed production is mainly attributed to better market price of the output. The cost of production for seed production is 11.7% higher than normal maize production which is due to higher labor requirement for production and post-harvest activities and higher price of source seed. Promotion of labor saving technologies through mechanization and government support to source seed can easily increase profitability of improved variety maize seed production and enhance competitiveness against other farm enterprises.

The binary choice model with dichotomous decision to adopt seed production or not and logit procedure to fit the model resulted the probability of adoption of improved variety maize seed production increased with targeting to senior farmers, women headed households, low off farm income households, accessible areas with market and road. Similarly provision of seed production training, easy and assured source seed supply also increase seed production adoption by the farming households. Further deploying extension workers, making use of information communication technologies to enhance linkage with them and promotion of collective action through groups and cooperatives, and linkage with seed processors can expedite the rate of seed production by the farm households.

This study suggests that higher profitability in seed production may be popularized among the farming community through effective extension efforts for increasing adoption rate of improved variety seed production among farming population. The major implication of this study is towards implementation of programs on awareness raising, capacity building through trainings, promoting linkages, enhancing source seed availability and networking with processing industries to increase adoption of improved variety maize seed production. This has many win-win outcomes in the area of reducing poverty, improving food security and agricultural trade balance and generating employment opportunities.

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