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Technical Efficiency of Onion Seed Production of West Rukum District of Nepal a Stochastic Frontier Production Approach

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***Abstract*: In Nepal, the consumption of onion is increasing (15.4kg/head/year). There is a vast gap between demand and supply in the onion seed sub-sector. More than 80% of onion seed is being imported from foreign countries. In Nepal, West Rukum district has been known as one of the most potential districts for onion seed production based on area, production, and favorable agro-climatic condition. However, production and productivity are very low and farmers are facing weak market linkage and unstable market. This research tried to explore the technical efficiency of onion seed producers from West Rukum district of Nepal. The primary data was collected with 120 seed producer through pre-tested questioner, KII and, and group meeting. The stochastic frontier production of Cobb-Douglas production function with single-stage estimation procedure was employed to analyze the technical efficiency of seed producers. The mean technical efficiency of seed producers was 89.7% with a 1.29 return to scale of farm. The difference between actual yield and potential yield was decreased as increased the level of efficiency of seed producers. The age and training received by producers was significant to affect the technical efficiency of the producers. Likewise, the distance of cultivation plot and economic active family member's number were significantly negative to influence the level of seed producers. The seed producers were 10.3% below their potential capacity.**

***Keywords*: Onion seed, Rukum west district, Stochastic frontier analysis, technical efficiency, onion seed producer.**

1. Introduction

Nepal is a geographically divided by three main ecological belts viz mountain (35%), hill (42%), terai or flat (23%). The country has 21% land being cultivated with agricultural crops and 7% remained uncultivated. In national GDP, agriculture sector occupies 26.50% with an incremental 5.02% of growth rate, supporting 65.7% of the population's livelihood (MOALD 2019). Among various agriculture sectors, vegetable seed production is one of the important sub-sectors. The demand for vegetable seeds is increasing due to the increased area under vegetable production. The demand for the seed is being fulfilled by imported seeds (HVAP, 2011). The vegetable seed production area increased by increased by more than three folds, seed production increased by almost 23 folds and demand increased by 6 folds in 2016/17 as compared to 1977/78. Likewise, the private sector contribution increased drastically from 3.2mt in 1977/78 to 302.3 mt. in 2016/17. In the year 2016/17 the production of vegetable seed production was 1564.55 mt. and the demand was 1875 mt. which is around 310.4 mt. deficient in quantity. Among various vegetable seed produced within country, onion is one of the 4th ranks in terms of volume and production (Thapa & Paudyal, 2000).

In 2018, Nepal imported 308,984.68 metric tons of onions, while the national per capita consumption reached 15.46 kg per year. To meet the current production area, approximately 201.82 metric tons of onion seed is required; however, only 158 metric tons (78.28%) were officially imported (VDD, 2019). Since domestic production is only 16 metric tons, the remaining quantity is likely entering the country through informal channels. The import share of onion seed was also very high accounting 90% of the total demand (VDD, 2019).

Onion seed production is done mostly in mid hills of Nepal. West Rukum is one of the major districts with 162 ha area under seed production and 2030 Mt production volume with 12.53 Mt./hector productivity (MOALD, 2019). In 2013/14, Rukum district produced 80.1 metric tons of vegetable seed, including 11.77 metric tons of onion seed; by 2016, this had increased to 110 metric tons of total vegetable seed and 13.2 metric tons of onion seed (DADO, 2013; DADO, 2016). Although vegetable seed production is one of the potential and high value enterprise in the mid and hills of Nepal, the technical capability and production efficiency of onion seed sub sector has not been studied till date. This research on identification of technical efficiency of onion seed would be important aspect in supporting the onion seed producers.

A. Statement of the Problem

There is a significant gap between the demand and supply of onion seed, and seed prices fluctuate widely each year. This indicates substantial unmet demand and highlights the potential to promote local production rather than relying on imports. Farmers report limited access to market information and an inability to secure fair farm-gate prices. Although farmers in this district have been producing onion seed for many years, their livelihoods have not improved. Despite their continued

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involvement in onion seed production, they remain dissatisfied with the enterprise. Variations in production efficiency and an overall inefficient agricultural system further discourage farmers from expanding their output (Knife et al., 2012).

In recent years, improving agricultural efficiency has become increasingly important. Smallholder farmers in West Rukum district are particularly vulnerable, with an average landholding of just 0.28 hectares, large household sizes, and low productivity levels (Timsina & Sivakoti, 2018). Expanding production areas and increasing productivity by motivating seed producers is one potential strategy, achievable through improving farmers' technical efficiency and strengthening value chains. Moreover, introducing new technologies is not the only way to enhance output; reducing existing inefficiencies can often be more cost-effective than adopting new technologies (Wondimu et al., 2014). The current system is insufficient to meet the rising demand for onion seed, making it essential for farmers to either adopt modern technologies or use existing resources more efficiently to optimize production.

The production of vegetable seed as an enterprise is focused in various plans and policies put forward by government of Nepal. The Prime Minister Agriculture Modernization Project (PMAMP), now renamed as National Agriculture Modernization Project (NAMP) has identified as one of the high value business enterprises. The agriculture ministry had also launched Onion Mission Program in the terai and mid hills region to uplift the production of onion and onion seed. The development of domestic seed industry through local production, processing, and marketing of high-quality seed with the active participation of public and private sectors is being envisioned in the seed sector strategy (MOALD, 2013). The study on increasing the technical efficiency of onion will definitely increase the profitability through increased production.

B. Literature Review

Onion is one of the most important vegetable crops in Nepal, widely consumed both as a spice and as a salad ingredient. It is cultivated extensively in the Tarai, river basins, and hill regions, covering 20,182 hectares and producing 250,463 metric tons, with an average productivity of 14.26 Mt/ha (VDD, 2019). However, the productivity of the onion seed per ha is very less when compared with the potential yield capability. There is need of increasing the efficiency (both technical and marketing) in order to make it more profitable.

Efficiency refers to a farm's ability to achieve maximum output from a given set of inputs (Farrell, 1957). Although closely related to productivity, efficiency and productivity are conceptually distinct, despite being used interchangeably by some scholars (Coelli, 1995). Since Farrell's foundational work in 1957, various methods for measuring efficiency have been developed. Two major approaches commonly used are the parametric Stochastic Frontier Analysis (SFA) (Aigner, 1977; Meeusen & van den Broeck, 1977) and the non-parametric Data Envelopment Analysis (DEA). The parametric approach is subdivided into the deterministic and stochastic models. In agricultural application, data envelopment analysis and deterministic model are not appropriate than the stochastic model, because data are strongly influenced by measurement errors, insect-pest, weather, and other cause in especially developing country case (Coelli, 1988).

There are two-stage and one-stage methodological approaches suggested by literature for the analysis of technical efficiency with regards to stochastic production functions. In a two-stage estimation procedure, first estimates the stochastic production and from which technical efficiency is derived. After that, derived efficiency is regressed on explanatory variables using the ordinary least square method of Tobit regression. However, this approach has been criticized that the producer's knowledge and its level of technical inefficiency affect its input choice, so inefficiency may be dependent on the explanatory variables. If the coefficients of the farm-specific factors are simultaneously equal to zero then the inefficiency effect would only be identically distributed. So one-stage maximum likelihood approach is the potential method to overcome this problem. (Battese and Coelli, 1995). In the one-stage estimation method, inefficiency effects are expressed as a straight forward function of a vector of farm-specific variables. The technical inefficiency is specified in the stochastic frontier model and is supposed to be independent but not identically distributed nonnegative random variables. $U_j = Z_j\delta$ is a technical inefficiency effect, where z is a vector of observable explanatory variables and δ is a vector of unknown parameters. So, the inefficiency model and parameter of frontier production function are estimated at the same time. The efficiency of seed producers is affected by various factors like socio-demographic, socio-economic, environmental factors, and non-physical factors. In this study, a one-stage estimation method was employed to measure the process of the whole technical efficiency.

Numerous studies have applied stochastic frontier models to assess technical efficiency and identify sources of inefficiency using maximum likelihood estimation, often relying on Cobb–Douglas or Trans log production functions. For example, Dessale et al. (2017) employed a Cobb–Douglas stochastic frontier model to estimate the technical efficiency of teff farmers in the Jamma District of Ethiopia, reporting a mean efficiency of 78 percent. Oxen, labor, and fertilizer were significant inputs, while six of thirteen determinants—including age, education, training, and access to credit—significantly influenced inefficiency.

Similarly, Obianefo et al. (2020) used a single-stage stochastic frontier model to analyse rice farmers in Anambra State, finding a mean technical efficiency of 84.76 percent, with sex, age, education, experience, and household size positively influencing efficiency. Wudinesh and Endrias (2016) applied a Tran slog stochastic frontier model to wheat farmers and reported a mean technical efficiency of 57 percent, with variables such as sex, age, education level, livestock ownership, and cooperative membership positively influencing efficiency, while distance to roads negatively affected it.

In Nepal, (Bajracharya, & Sapkota, 2017) used a Cobb–Douglas stochastic frontier model to study certified maize seed producers in Palpa district, reporting an average technical efficiency of 70 percent. Dahal et al. (2019) examined cauliflower production in peri-urban Kathmandu, finding a mean efficiency of 64.36 percent. Their study showed that gender and age negatively affected efficiency, while schooling, training, and cooperative membership had positive effects. There is lack of study in studying technical efficiency in onion seed production. Using the research tools as indicated above, the technical efficiency of onion seed production with reference to Rukum West district of Nepal will open a new pathway for intervention from government and non-government organizations.

2. Methodology

To study the technical efficiency of onion seed production, the variables (both dependent and independent) need to be taken in consideration. The socio-economic factors, trainings, technology adoption, the plans and policies hindering the technology adoption etc. are taken into consideration. The following conceptual framework is applied to meet the objective

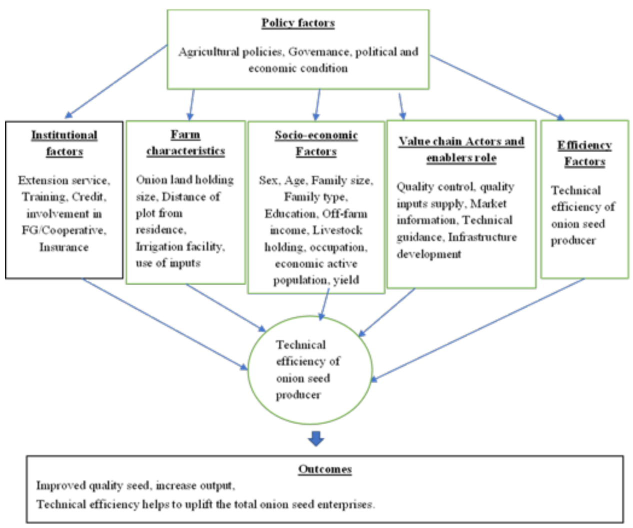

Fig. 1. A Conceptual framework of technical efficiency analysis of onion seed

The technical efficiency of seed producers can influence the onion seed enterprises, so assess the technical efficiency of onion seed farmers is the main concern of this study. Production inputs such as farm area, amount of seed, labor, fertilizer, and bullock power are used as inputs into onion seed production. It is expected that more inputs used by the farmers up to the recommended level lead to higher onion seed productivity. Also, onion seed production enterprises are affected by technical efficiency because for a production to be effective, how available inputs are utilized is crucial. However, the technical efficiency of farmers is also influenced by farmer's characteristics, cultivated land characteristics, crop-specific factors, institutional and socio-economic characteristics of farmers. A technically efficient farmer is expected to realize higher onion seed productivity compared to that of less efficient in onion seed production.

A. *Selection of Study Area and Sample Size*

To fulfill my objectives purposively was selected the west Rukum district because it accounts for the highest-ranking for the production of onion seed in Nepal (MOALD, 2013). As the potentiality and number of onion seed growers were selected the two municipalities named Musikot (being district headquarter) and Chaurjahari (Far from district headquarter).

According to the district agriculture development office (DADO, 2015), 645 households have been producing onion seed out of a total of 1000 vegetable seed producers. A total of 120 household seed producers has randomly selected and each municipality has 60 households.

B. *Methods and Techniques of Data Analysis*

Collected data were coded and entered in an excel sheet in tabulated form and data arrangement was done with proper coding. The STATA version 14 software program, and excel office program were used to analyze the collected data. Descriptive and inferential statistics were used for proper data analysis.

To assess the technical efficiency of onion seed production, data were analyzed using the stochastic frontier approach of the Cobb-Douglas production function by using a single-stage estimation procedure. A stochastic production frontier was applied since this tool has a probability of being affected by uncontrollable factors of the decision-making unit. The stochastic frontier model divides the error term into two-part controllable factors and out of control factors or technical inefficiency factors of farm and random shocks (white noise) like bad weather, measurement error, and omission of variables.

The model is expressed as,

$$\ln Yi = \beta o + \sum \beta i \ln Xij + ecp\ ei \quad (1)$$

C. *Functional Form of Model*

In this study, the technical efficiency of onion seed production in the Rukum west district was assessed by output obtained per household as a dependent variable considered and output of onion seed production was measured from 2020 production year in a kilogram. For the independent variable, the inputs (factors) of production used in the same production year were employed. The following given inputs were considered as independent variables.

Y = the total amount of onion seed produced in Kilogram by the i^{th} farmer;

X1= the total area covered by onion seed production in hectares of the i^{th} farmer;

X2=the total labor (family and hired) in man-days used for onion seed production by the i^{th} farmer;

X3= the total number of bullock-power used for onion seed production in bullock-days by the i^{th} farmer;

X4 = the total farmyard manure (FYM)/compost used for onion seed production by i^{th} farmer,

X5 = the total amount of fertilizer in kilogram applied for onion seed production by the i^{th} farmer;

X6=the total quantity of onion foundation seed in kilogram used for onion seed production by the i^{th} farmer;

X7= the total quantity of pesticide used to control the insect-pest of onion seed in a bottle of 100ml by i^{th} farmer.

The Cobb-Douglas form of stochastic frontier production is stated as follows;

$$linY = \sum_{j=1}^{6} \beta j linXij + Vi - Ui \quad (2)$$

Where:

For i^{th} farmer, Y is the total quantity of onion seed produced, x is the quantity of input j used in the production process including bullock labor, Human labor, land, seed, farmyard manure/compost, and quantity of fertilizer; Vj is the two-sided error term and Uj is the one-sided error term (technical inefficiency effects).

There was another part also considered that was inefficiency. The inefficiency estimated by subtracting the technical efficiency (TE) from one and its effect is defined by a linear function of socio-economic and management factors and the following given model was estimated.

$$linY = \delta_0 + \sum_{n=1}^{12} \delta nZni \quad (3)$$

The technical inefficiency is defined as following also.

$$Ui = \sum_{k=1}^{12} \delta kZjk \quad (4)$$

Whereas,

Zi = variables which represent the socio-economic characteristics of the farm introducing inefficiency of the i^{th} farmer.

Ui = Technical inefficiency effect

δk = Coefficient of independent variables

Zi1 = Sex of the household (a dummy variable. It takes a value of 1if male, 0 otherwise

Zi2 = Age of the household head (years)

Zi3 = Household size (total numbers of the family member who lives in one roof)

Zi4 = Education (number of years of schooling of the farmer)

Zi5 = Experience of the farmer (continuous in years)

Zi6 = Distance to onion seed production plot from residence measured in km

Zi7 = Number of livestock measured by TLU

Zi8 = Training (A dummy variable. It takes a value of 1 if yes, 0 otherwise)

Z9= Crop insurance (A dummy variable. It takes a value of 1 if yes, 0 otherwise)

Zi10 = Extension contact (frequency of extension service during the farming year)

Zi11 = off/nonfarm income (total amount of off/nonfarm income)

Zi12 = economically active family member (family member's age group between 16 years to 59 years)

$$\text{Technical efficiency TE} = Yi/Yi^* \quad (5)$$

(TE= Technical efficiency of the i^{th} household in onion seed production, Yi* the frontier output of the i^{th} household in onion seed production, Yi = the actual output of the i^{th} household in onion seed production.)

$$Yi^* = Yi/TE \quad (6)$$

3. Results and Discussions

A. *Descriptive Analysis of Variables*

Table 1 reflects the summary statistics of the sampled onion seed producer's, the area was 0.08ha, human labor use 381.45day/ha, bullock power use 42.42day/ha, FYM/compost use 21183KG/ha, Chemical fertilizer use 248.51KG/ha, foundation seed 5.73KG/ha, and pesticide 74.79 bottle/ha (7.47 liter/ha). The onion seed producers are 48.57 years of age with 6 (6.09) classes of formal education, 13.66 years of experience, household size is 5.73, and 3.78 economic active family members. They were rearing 7.19 TLU livestock with NPR 135.91 thousand non-farm income and seed production plot distance was o.41 kilometers from home. Another distribution was 78.33% male, 56% received training, 15% received crop insurance, and 87.5% received extension service.

B. *Maximum Likelihood Estimation of Parameters*

The result revealed that six productions input parameters were significant except chemical fertilizer and all parameters showed the positive sign except seed quantity used. The coefficients of cultivation area, human labor, and FYM/compost were positively significant at 1% level of significance, pesticide at 5% level of significance, bullock power, and used seed was negatively significant at 10% level of significance.

The output of onion seed is an elasticity of the coefficient of input variables. It implies that the production inputs used in onion seed production cultivation area, human labour, bullock power, FYM/compost, the pesticide has positive production elasticity where 1 % increase of each, the level of onion seed production can increase by 0.458, 0.557, 0.031, 0.245, and 0.027 percent, respectively. Whereas the quantity of seed used for onion seed production has negative elasticity that means a 1% increase in seed quantity can decrease the quantity of onion seed production by 0.027 percent. This implies that the elasticity of seed in onion seed production indicates a decrease of output if we used more than the recommended quantity. It is because the yield depends on the density of plants per hectare and the population of the plant is in direct relation with seed quantity used or due to high competition for nutrients. This result was similar to (Beyan and Geta, 2013). The model also shows the increasing return to scale of 1.291 in onion seed production in the study area. That means an increase in the use of inputs in onion seed production by 1 unit can give more than 1 unit of onion seed yield.

1) *Technical Efficiency of Seed Producer*

The results revealed that the mean efficiency level of seed producers was 89.7% with a minimum of 53.5% and a maximum of 99.9% level of technical efficiency. From this, there was a big difference in the level of technical efficiency so there is a space to increase the level of onion seed yield through uplifting the level of producing farmer technical efficiency.

Table 1
Descriptive analysis of input variables, inefficiency variables

Variables	Minimum	Maximum	Mean
Dependent variables			
Yield (KG/ha)	275.24	1179.60	563.37±146.39
Inputs dependent variables			
Cultivation area (ha)	0.02	0.18	0.08±0.04
Human labor (day/ha)	152.37	857.18	381.45±132.56
Bullock power (day/ha)	7.86	157.28	42.42±23.52
FYM/Compost (KG/ha)	4437.54	75581.78	21183.98±9627.68
Chemical fertilizer (KG/ha)	64.04	664.87	248.51±126.56
Foundation seed (KG/ha)	1.47	14.75	5.73±3.24
Pesticide (bottle of 100ml/ha)	9.83	196.60	74.79±39.53
Inefficiency variables			
Age (Year)	25	69	48.57±8.90
Household size (Number)	2	13	5.73±1.85
Education (Class)	1	16	6.09±3.36
Experience (Year)	2	30	13.66±5.35
Plot distance from home (Km)	0.03	1	0.41±0.23
Livestock (TLU)	1.5	50.3	7.19±7.92
Non-farm household income (NPR thousand)	1	520	135.91±110.30
Economic active family member (Number)	1	11	3.78±1.78
Dummy variables	**Response**	**Frequency**	**Percentage**
Gender	Male	94	78.33
	Female	26	21.67
Training	Received	68	56.6
	Not received	52	43.33
Insurance	Received	18	15
	Not received	102	85
Extension service	Received	105	87.5
	Not received	15	12.5

Source: Field survey (2020)

Table 2
Maximum likelihood estimates for Cobb-Douglas production function

Production variable	Coefficient	Std. Err.	z-value	P>|z|
Constant	1.734814***	0.119756	14.490	0.000
Cultivation area(ha)	0.458***	0.016405	27.890	0.000
Human labour (day)	0.557***	0.03458	16.100	0.000
Bullock power(day)	0.031*	0.015949	1.920	0.055
FYM/Compost (KG)	0.245***	0.020376	12.030	0.000
Chemical fertilizer (KH)	0.0021	0.020275	0.100	0.918
Foundation seed (KG)	-0.027*	0.015212	-1.81	0.071
Pesticide (bottle of 100ml)	0.027**	0.012745	2.130	0.033
Return to scale	1.291			
Log-likelihood	124.9615			
Mean technical efficiency	0.897			
Total sample size	120			

***, **, * represents significance at 1%, 5% and 10%probability levels, respectively
Source: Field survey (2020)

Also, the mean technical efficiency was 89.7% and it can imply that there is a potentiality to increase the level of output by about 10.3% of mean production if they can improve their level of technical efficiency or efficiently use those inputs without introducing external inputs and practices.

Based on mean technical efficiency and their corresponding standard deviation, respondents can be divided into three groups (Stevenson, 1980; Dessale et al., 2017). Behind these techniques, they assumed as less efficient if technical efficiency respondents were less than mean technical efficiency minus standard deviation, moderately efficient if technical efficiency of respondents were in between mean efficiency minus standard deviation to mean efficiency plus standard deviation, and highly efficient if technical efficiency of respondent were greater than mean efficiency plus standard deviation. In this study, respondent farmers were divided based on their technical efficiency score into two groups less efficient and moderately efficient because of mean technical efficiency plus standard deviation was higher than 1 and technical efficiency is always between zero to one range so there was no highly efficient group. In the study area, 18.33% of respondents were in less efficient (< 78.3% level of technical efficiency), 81.67% were in moderately efficient category (> 78.3% of technical efficiency). It implies that the majority of seed-producing farmers were moderately efficient because the onion seed production is an intensive enterprise and the majority of farmers might be using available inputs in a good manner based on the technical recommendation of Nepal agriculture research council Kathmandu-NARC and Sub tropical vegetable seed production center Reuku-VSPC.

2) Input Use and Technical Efficiency of Seed Producers

The yield of onion seed and used inputs were categorized across the group of efficiency. The results showed that land, bullock power, and pesticide were used more by a moderately efficient group of respondents than less efficient whereas labor, seed, compost, chemical fertilizer were used more by less

Table 3
Technical efficiency of onion seed farmers

Efficiency unit	Household number	Percent
Less efficient (< 0.783)	22	18.33
Moderately efficient (>=0.783)	98	81.67
Minimum	0.535	
Maximum	0.999	
Mean	0.897	

Source: Field survey, 2020

Table 4
Technical efficiency of onion seed farmers and input use status

Efficiency category	household (%)	Yield (KG/ha)	Area (ha)	Labor (Day)	Seed (KG)	Bullock (Day)	Compost (KG)	Fertilizer (KG)	Pesticide (Bottle/100ml)
Less efficient (< 0.80)	18.33	439.24	0.075	387.47	5.86	37.63	24488.26	255.00	69.74
Moderately efficient (>=0.80)	81.67	591.23	0.078	380.10	5.70	43.50	20442.21	247.05	75.92
Overall	100	563.37	0.078	381.46	5.74	42.43	21183.98	248.51	74.80

Source: Field survey (2020)

Table 5
Comparative study between actual yield and potential yield with regarding TE

Efficiency group	Mean actual yield (Kg/ha)	Mean potential yield (Kg/ha)
Less efficient (< 0.783)	439.24±87.04259	632.47±110.7531
Moderately efficient (>=0.783)	591.23±142.733	624.26±129.337
Overall (0.897)	563.37±146.3938	625.76±125.7727

Source: Field survey (2020)

efficient respondents than moderately efficient respondents. The yield was high received by a moderately efficient group of the respondent as compared to less efficient. It means big land size makes it easy to do cultivation practices, more bullock power use means soil makes well pulverized, and more pesticide used means there were more insect and pest problem, so more use of these inputs might help to increase efficiency. On other hand, less efficient respondents used more labor, seed, compost, and fertilizer than moderately efficient respondents. It can make sense that those inputs weren't used by less efficient respondents in a good manner.

3) Actual and Potential Yield of Onion Seed

The potential yield of onion seed was estimated using equation as below.

$$\text{Technical efficiency TE} = Yi/Yi^{*} \quad (7)$$

(TE= Technical efficiency of the i^{th} household in onion seed production, Yi* the frontier output of the i^{th} household in onion seed production, Yi = the actual output of the i^{th} household in onion seed production)

$$Yi^{*} = Yi/TE \quad (8)$$

The actual and potential yield were categorized with technical efficiency groups. There was a difference between the potential yield and actual yield. On an average, the overall actual yield was 562.37 KG/ha whereas the potential yield was 625.76 KG/ha. The less efficient respondents received 439.24 KG/ha actual yield with 87.04 standard deviations and 632.47 KG/ha potential yield with 110.75 standard deviations. In moderately efficient respondents, they received 591.23 KG/ha actual yield with 142.73 standard deviations and 624.26 KG/ha potential yield with 129.337 standard deviations. It implies that the difference between actual yield and potential yield was more in less efficient respondents as compared to moderately efficient respondents, so less efficient respondents have to do more effort to meet the potential yield than moderately efficient respondents.

4) Determinants of Technical Inefficiency

The parameter of technical inefficiency determinants was estimated through the maximum likelihood estimation method using a single-stage estimation procedure with the estimation of technical efficiency. In the technical inefficiency model, the variables show the influence included upon farmer's ability to efficiently utilize production input that is termed technical inefficiency. The study was major focused on the identification of the determinant of inefficiency after measuring the technical efficiency because it helps to do the development and research work to improve the existing efficiency. In the study of determinants, the negative coefficient value relates the negative contribution to inefficiency but positive contribution to the efficiency level. Accordingly, the positive value of the determinant coefficient contributes positively to the inefficiency and negatively to the efficiency level.

In the table gender, age of respondent, household size, education, the experience of the respondent, training received by the respondent, non-farm household income has negative coefficient value, whereas plot distance from home, insurance received, and economic active family member have the positive coefficient value. However, only age and training were negatively significant at 10%, and 5% level of significance

Table 6
Maximum likelihood estimates of technical inefficiency determinants

Inefficiency variables	Coefficient	Std. Err.	z-value	P>|z|
Constant	9.5537*	5.71053	1.67	0.094
Gender	-0.0096	0.53106	-0.02	0.986
Age	-2.7679*	1.67984	-1.65	0.099
Household size	-0.6463	0.79181	-0.82	0.414
Education	-0.5764	0.42145	-1.37	0.171
Experience	-0.4799	0.63485	-0.76	0.450
Plot distance from home	2.81478***	0.74995	3.75	0.00
Livestock (TLU)	0.38509	0.27296	1.41	0.158
Training	-1.046**	0.52844	-1.98	0.048
Insurance	0.60045	0.53856	1.11	0.265
Extension service	0.47282	0.78713	0.6	0.548
Non-farm household income	-0.0919	0.11435	-0.8	0.421
Economic active family member	1.19012*	0.70795	1.68	0.093
Log-likelihood	124.9615			
Total sample size	120			

***, **, * represents significance at 1%, 5% and 10%probability levels, respectively
Source: Field survey (2020)

respectively. Accordingly, only plot distance from home and an economically active family member were positively significant at 1% and 10% level of significance respectively.

It suggests that the respondents' age had a negative and significant relationship, indicating that older individuals were more efficient than younger ones. This may be attributed to their greater maturity, better understanding of input use, and enhanced skills developed over time (Liu and Zhung, 2000; Dessale et al., 2017). Moreover, farmers' knowledge, skills, and physical capability enable them to make better decisions when selecting inputs at optimal levels (Evaline et al., 2014; Dessale et al., 2017).

The training plays a vital role in onion seed production practices because it increases the skill and knowledge and makes more capable to perform the seed production activity and selection of inputs. In the study, results revealed a coefficient of training received was negatively significant at a 10% level of significance. That means technical inefficiency can decreases if respondents got the training or contrary technical efficiency of respondents will increase if they got the training related to onion seed production. It was also significant in Wudineh and Endrias 2016.

The onion seed production needs to intensively perform the cultivation practices so, plot away from the home makes it difficult to do cultivation practices. The distance of the plot from home was positively significant at a 1% level of significance; it implies that more distance of cultivation plot from the home of respondent increase the technical inefficiency or more distance decreases the technical efficiency of onion seed producers.

Economic active family members were considered as the age group of 16 years age to 59 years of age; this group of family members can actively participate in economic activities. In this result, economically active family members were positively significant at a 10% level of significance. It implies that those group family members contribute in inefficiency part, and couldn't contribute to the efficiency part. It might be due to more economically active family members engaged in other non-farm activities and can't pay the time for onion seed production activities.

4. Conclusion

The study analyzed the technical efficiency of onion seed producers in Rukum West, Nepal. Technical efficiency is crucial for improving Nepal's onion seed self-sufficiency. Demand for onion seed is rising, but current production cannot meet national needs. The study found an average technical efficiency of 89.7%, meaning producers operate 10.3% below potential. Age and training significantly influenced efficiency, highlighting the need for targeted training, technical guidance, and regular extension support. Increasing returns to scale (1.29) and reduced yield gaps with higher efficiency suggest strong potential for productivity gains.

To improve the technical efficiency of seed production, the study recommends inputs suppliers should supply the inputs in timely and District agriculture development office-DADO, agriculture section of municipalities should increase the extension services as well as training to the younger producer older seed producers to increase the decisive capacity of inputs selection/uses because training and age of respondents were positively influenced to the technical efficiency of onion seed producers might help to increase the technical efficiency. So the better option is deliver programs and activities prioritizing to increase to increase technical efficiency rather than discovering new one. Future research should investigate factors driving onion seed price fluctuations.

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