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Research Article

Determinants of Improved Boset Teff Variety Adoption in Minjar Shenokora District, Amhara Region, Ethiopia

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Abstract

The current production system of teff cannot satisfy the consumers demand and this is due to backward agricultural mechanisms and lack of improved teff varieties. The governments of Ethiopia renew their interest on improved teff variety adoption to improve farmer's farm productivity. There are a number of improved teff varieties invested in Ethiopia in general and in the study area in particular. However, Mnijar shenkora district is well known boset teff variety have been disseminated and adopted in the district through the help of agricultural research centers to improve teff production in the area. Investigating the determinants of improved boset teff variety adoption is important. A sample of 245 farm households was considered for socio economic survey. The collected data were analysed through descriptive statistics and inferential statistics. The descriptive statistics indicated that, there is significance difference between boset teff adopters and non-adopters. Binary logit model was applied to identify the determinants of improved boset teff variety adoption. The result indicates that improved boset teff adoption is determined by different factors. Family size, fertilizer use and farming experience was negatively associated with adoption of improved boset teff variety. In contrast, education level, cultivated farm size and access to credit were positively associated with improved boset teff variety adoption.

Keywords

Minjar Shenkora, Boset Teff, Adoption

1. Introduction

Global agriculture will face multiple challenges over the coming decades. It must produce more food to feed an increasingly affluent and growing world population that will demand a more diverse diet [2]. Sub-Saharan Africa (SSA) is one of the regions in the world that is mainly characterized farm households whose livelihood depends primarily on agriculture and millions of people living under extreme poverty [16].

The role of agricultural research intervention programs in transforming the lives of rural farming households, primarily in developing countries is well documented in the literature on economic and social development and this has led governments and other development organizations around the world to implement a variety of intervention initiatives aimed at increasing agricultural yields over time. Investing in agricultural technology has contributed to improved farm production, increased household farm income, and a decline in hunger [5, 12].

The current production system of teff cannot satisfy the consumers' demand this is due to backward agricultural

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practice and lack of improved teff varieties (Mesfin et al., 2018). In another way teff accounts first in area coverage and second in total annual production next to maize and ranks the lowest yield compared with other cereals grown in Ethiopia [8]. The agricultural sector in Ethiopia would continue to be the main source of economic development and the growth of this sector would initiated from smallholder farmers, and the main reason for low productivity of teff is the low new improved teff varieties adoption by farm households [1]. Improved teff variety adoption is an important means of adapting to climate change, improving agricultural productivity and income and facilitate the transition from subsistence agriculture to market-oriented agriculture [3]. And also studies conducted by [9] showed that beginning from 1970, a number of improved varieties of teff seed have been produced and distributed for farmers' utilization in Ethiopia.

A number of studies have demonstrated the determinants of improved crop varieties. For instance According to the study of [15] showed that improved teff varieties adoption has been determined by access to training and information on new improved teff varieties.

Studies reviewed by [13] evaluated that there was high and positive correlation between extension contact and improved teff variety adoption. Furthermore the extension service to farmers enables the farmers in getting valuable knowledge, training and information that help in not only increasing awareness to the benefit of the new released variety but also in reducing uncertainty, transaction cost of accessing information, and risk associated with the improved crop teff varieties adoption [10].

Education level of household head had a significant positive relation on the adoption of improved teff varieties significant at level of significance [4]. In another studies conducted that Proportion of cultivated land allocated for teff had a positive and significant association on the adoption of improved teff varieties at significant level of significance [14]. In addition, According to [11] in his study conducted that Agricultural new teff technologies are the factors of production which have undergone some form of amendment from their original state with the intent of enhancing their performance but total production of teff is relatively low due to the reasons low access to such factors of production.

In addition to this the major covariates associated with the released teff variety adoption by farmers comprised of age, education level, training and demonstration access, family size, tropical livestock unit, market distance, gender, farm size, improved infrastructure access, extension service provision, credit access, farm experience, were conducted to association with positively [6, 7].

Debre ziet agricultural research centre released improved boset teff verities from 2012 up to now to the minjar shenkora district by the support of government but researches are limited about the determinants of boset teff variety adoption. Therefore investigated this research helps in order to identify the determinants of improved boset teff variety.

2. Research Methodology

2.1. Description of the Study Area

The study was conducted at minjar shenkora district north shewa zone amhara region Ethiopia. Minjar shenkora is one of essential areas for teff production. The capital city of the district is Arerti, which is 136km far from the capital of Ethiopia of Addis Ababa. Minjar shenkora district (MSD) locating further to the southern part of north shewa zone and bounded by Hhgere mariam and berehet district in the north direction. The remaining boundary is shared with parts of oromia region in the west, south and east directions. The study area is located towards the south direction of debre berhan, which is the administrative town of north shewa zone with a distance of 260km.

2.2. Sample and Sampling Method

For research validity sample was needed so that the data used in this study comes from farm household survey in minjar shenkora district, north shewa zone, amhara region. Teff grower households were used as the universe of the study and sample households were sampling unit of the study. To select sample respondents from the population of 29 kebeles in the district multi stage sampling technique were applied.

The study was based on cross-sectional data of the production year 2021/2022 G. C. The sampling unit in the study was a household who cultivates boset teff crop at Kebele level. The procedures followed were three stages. At stage one, purposive selection of boset teff crop growing Kebeles of the Woreda was undertaken by using secondary data obtained from the Woreda agricultural and rural development office At the meantime, potential boset teff production area was considered.

At stage, two, out of identified boset teff growing Kebeles of the Woreda, households who cultivate boset with improved and traditional/ local seed were identified in collaboration with Kebele leaders and development agents of the respective Kebeles. Finally, among those sample kebeles boloselasie and kombolcha supported by government and non-government organizations to adopt improved boset teff variety were selected randomly.

Sample was determined by cochran Formula because of populations that are large and heterogeneous. Cochran (1963: 75) equation yields a representative sample for proportions.

$$n = \frac{Z^2 pq}{e^2} = \frac{1.96^2(0.8*0.2)}{0.05^2} = 245$$

Where,

1. n is the sample size.
2. Z is the abscissa of the normal curve that cuts off an area α at the tails and value for Z is found in statistical tables, which contain the area under the normal curve.

3. e is the desired level of precision or error term.
4. p is the estimated proportion of the adopters in the population and q is 1-p.

2.3. Types, Sources and Methods of Data Collection

In this survey, both primary and secondary data were collected from different sources. A structured interview schedule was developed to collect the necessary primary data in which both quantitative and qualitative data are gathered from the sample respondents through face-to-face interview. The questionnaire includes information on household's demographic characteristics. Data are also gathered from focus group discussion and informal discussions with farmers and personal observations.

In addition to the primary and secondary data focus group discussion were conducted to clarified support the research finding with qualitative information about improved boset teff variety adoption and used to combine the information generated from the structured interview method. Relevant documents and research reports were reviewed and utilized to support the primary data, to observe the research gap and used to get research methodology. The study was based on the data of the production year of 2021/2022.

2.4. Conceptual Framework

To identify the determinants of improved boset teff verities adoption and its impact on the household farm income as well as how demographic, social, and institutional factors that determine improved boset teff varieties adoption and its impact on household farm income.

According to the studies of Wake et al., (2019), the empirical evidence showed that land allocated to cereal and horticultural crops had negative and significance relation on area under improved teff varieties allocation, access to training and information on teff and social networks have contributed positively and significantly to improved teff verities adoption. According to the study of Susie et al., (2020) evaluated that the econometric model result indicated that level of education, off/non-farm income, and proportion of cultivated land allocated for teff production, frequency of extension contact, livestock holding, participation on demonstration, improved teff seed availability, and perception on yield were found positive and significant in the improved teff variety adoption.

According to the papers of Saron et al., (2020) studied that the variables significantly associated with the adoption of agricultural crop technologies are farmers are age, availability of training, education level, farm size, extension service provision, saving institution factor, and credit access. According to researches of Mesele (2021) conducted that, Educational level of the household head, family size, extension visit, credit access, advisory service, distance from market, distance from zonal town, and remittances are the major determinants of agricultural crop technology adoption with different level of probability of significance.

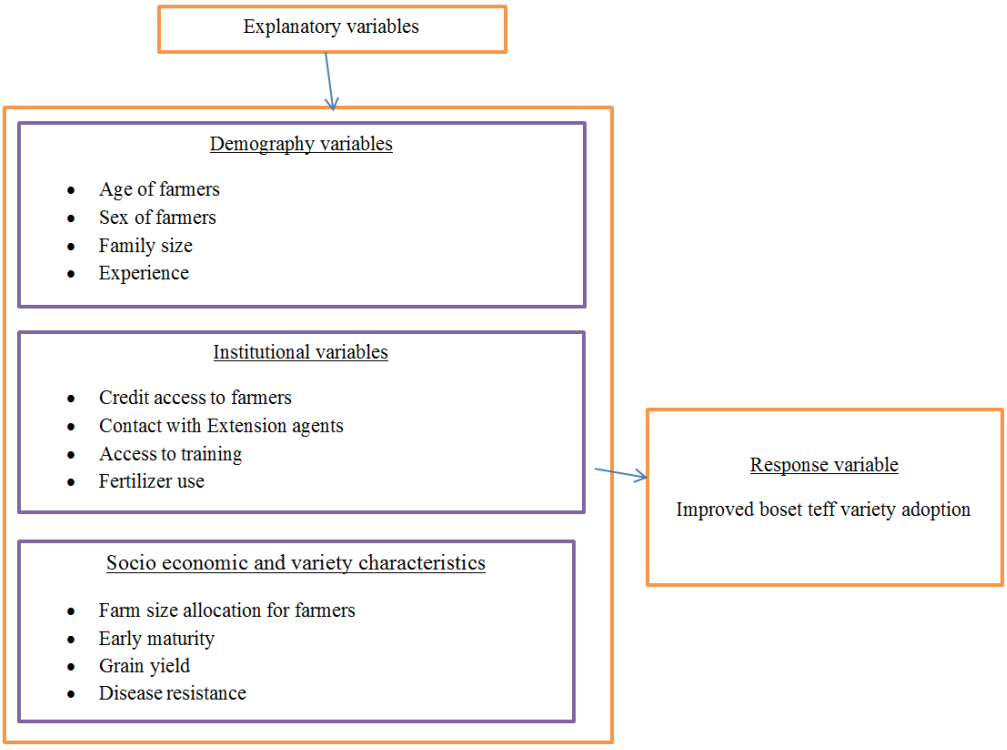

Figure 1. *Conceptual framework.*

2.5. Method of Data Analysis

The study used both descriptive statistics and econometric model for evaluating the data. Descriptive statistics such as mean, standard deviation, frequencies distribution and percentage were employed in order to have clear information about the socio-economic, institutional and demographic characteristics of sample households. Chi-square test and independent sample t-test were used to see the presence of systematic association between those who adopt and those who do not in terms of hypothesized variables.

Various researchers used different models for analysing the determinants of crop variety adoption. In principle, the logit and probit models are the most frequently used models when the dependent variable is dichotomous (Gujarati, 2004; Verbeek, 2004; Green, 2003; Woodridge, 2002). The probit and logit models are quite similar, so they usually generate predicted probabilities that are almost identical.

We apply binary logit model and its marginal effect to identify the determinants of improved boset teff variety adoption. In order to fulfil objectives the following econometric model specification used for analysis.

$$Y = \beta_{\circ} + \beta_1 X_1 + \cdots + \beta_{10} X_{10} + \mathrm{e} \quad (1)$$

Where Y-is dependant variable representing boset teff variety adoption, $\beta_{\circ}$- is constant, $\beta_1, \beta_2 \ldots\ldots \beta_n$ - are parameters to be estimated $X_1 X_2 \ldots \ldots X_n$ - is independent variables used during analysis, e- Denotes to the error term, which has an independently distributed random variable with a mean of zero.

Dependent variable (TEFFADOPTION) the dependant variable of the study which is the improved boset teff variety adoption and is dichotomous representing farmers adoption on improved boset teff varieties the variable takes the value of 1 that cultivated improved boset teff variety at least for 3 consecutive years during survey time and 0 otherwise.

Covariates are variables that can potentially affect and expect to correlate with the determinants of improved boset teff variety adoption. In this study, the independent variables compromised the demographic, socio-economic and institutional factors. Based on past research findings, the researchers' knowledge and informal survey, variables that simultaneously affect the decision to use boset teff variety and outcome variable of farm income are presented as follows.

Table 1. *Description of Variables.*

Dependant Variable	Description of variables	Measurement	Expected sign of equations
TEFADOPTION	Dummy, boset teff variety adoption	1 adopter 0 otherwise	
Covariates			
AGE	Continuous, age of household	Number of years	No effect
EDUN	Dummy, education level of household	1 if literate0 illiterate	Positive
FAMSZ	Continuous, number of family	Number of persons	Negative
LANDSZ	Continuous, size of land owned	hectare	Positive
CREDIT	Dummy, access to borrow money	1 if yes 0 otherwise	Positive
EXTENSION	Dummy, access to extension contact	1 if yes 0 otherwise	Positive
FERTILIZER	Dummy, access to fertilizer in	1 if yes 0 otherwise	Positive
SEX	Dummy, sex of household heads	1 if male 0 otherwise	Positive
TRAINING	Dummy, take new skill and capacity	1 if yes 0 otherwise	Positive
MATUR	Dummy, maturity period	1 if yes 0 otherwise	Positive
D-RESIST	Dummy, disease resistance capacity	1 if yes 0 otherwise	No effect
G-YIELD	categorical, yield performance of variety	1 high, 2 medium3 low	Positive
EXPERIENCE	Continuous, participate in years	Number of yeas	Positive

3. Result and Discussion

3.1. Descriptive Statistics

The results were executed based on the cross sectional data collected from a total of 246 households during 2021/2022 production year. The descriptive statistics presented mean, standard error, standard deviation, tabulation, maximum, minimum, and percentage. Also p-value and t-test statistics were employed to adopter and non-adopter groups concerning the hypothesized explanatory variables.

P-value/Chi2 test was used to test whether there is statistically significance difference between adopter and non-adopter groups for dummy variables. Accordingly the t-test is used to test the significance of the mean values of continuous variables of both adopter and non-adopter groups.

Table 2. *Summary statistics for continuous variables.*

Variable	Adopter		Non-adopter		Difference		t-test	Max	Min
	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.			
Age	46.09	0.77	48.84	1.67	2.75	1.73	1.58	82	22
Family size	3.94	0.124	4.17	0.26	0.233	0.278	0.83	9	1
Farm size	1.2	0.04	0.56	0.029	-0.64	0.082	7.82 [a]	4	0.19
Experience	4.91	0.18	10.11	0.84	5.2	0.56	9.325 [a]	30	3

Source (own survey result 2022) [a] represent significant at 1% level of significance.

Cultivated farm size: is considered the most important factor of production in rural area. In the study area own land, rented land, shared cropping lands and gift lands were used for production. The executed data results show that the average farm size of adopter groups was 1.2ha with compared to 0.56ha of non-adopters with maximum of 4 and minimum of 0.19ha. Meaning that it is statistically significance between them. The life of the rural household in the studied woreda is in line with cultivated farm size.

Farm experiences: according to the executed data results indicated that teff farming experience of farmers was statistically significance at 1% level of significance. The average farming experience of households was 4.9 and 10.11 years for adopter and non-adopter groups respectively with maximum of 30 and minimum of 3 years. The mean difference of farm experience was 5.2 years (Table 2).

Table 3. *Summary statistics for dummy variables.*

Variable		Adopter Percent	Non-adopter Percent	Chi2	p-value
Sex of household	Male	93.33	94.12	0.04	0.84
	Female	6.67	5.88		
Education level	Literate	97.44	33.33	47	0.00 [a]
	Illiterate	2.56	66.67		
Early mature	Yes	68.2	84.31	5.15	0.023 [b]
	No	31.79	15.68		
Disease resistance	Yes	68.2	64.7	0.22	0.63
	No	31.79	35.29		
Grain yield	High	2.05	25.49	42.4	0.00[a]
	Medium	64.62	29.41		
	Low	33.33	45.10		
Fertilizer use	Yes	77.94	82.35	0.47	0.49

Variable		Adopter Percent	Non-adopter Percent	Chi2	p-value
Access to extension service	No	22	17.64	0.001	0.95
	Yes	80	80.39		
Access to training	No	20	19.63	0.53	0.46
	Yes	69.23	74.5		
Access to credit	No	30.76	25.49	8.11	0.00[a]
	Yes	49.74	25.46		
	No	50.25	72.54		

Source (own survey, 2022) [a and b] represents significant at 1% and 5%level of significance.

Education level of the household head: Based on the above table (Table 3) the education level of household head had significance difference between adopter and non-adopter groups. The executed data results presented that literate adopters and non-adopters were 97.4% and 33.33% respectively. While for illiterate, 2.56% and 66.67% were adopter and non-adopter groups respectively.

Early maturity: this study also tried to assess maturity period of the improved input teff seed and the inferential statistics results indicated that early maturity of boset seed was statistically significant at 5% level of significance. 68% and 84% of adopter and non-adopter groups used early-matured input teff seeds.

Grain yield of teff: based on the above table (Table 3) executed inferential statistics results presented that Majority of adopters (64.62%) and non-adopters (45.10%) were under medium and low grain yield category respectively.

Access to credit: was the main source of finance for farmers to purchase input like improved seed and fertilizer. In the study area saving institutions and saving cooperatives which were the main source of credit. The survey result showed that both adopter and non-adopter groups get low access to credit from formal (microfinance) and informal (traders) saving institutions. It was only 49.7% of adopter and 25% of non-adopters get access to credit.

3.2. Determinants of Improved Boset Teff Variety Adoption

Before starting the data analysis we test multicollinearity to determine whether association between within explanatory variables. Variance inflation factor (VIF) shows the variance of estimator is inflated by multicollinearity (Gujarati, 2003). There are two types of measurement employed to check multicollinearity. Those are variance inflation factor and contingency coefficient for continuous and dummy variables respectively that shows the existence of multicollinearity (Gujarati, 2003). Statistical package known as STATA 16 was also employed to this study to compute VIF values. If the value of VIF for individual variable exceeds 10 and above in addition to this if the mean VIF value of the variable exceeds 5 and above this indicates multicollinearity is a serious problem. In this research, there is no multicellularity problem.

To identify the determinants of improved boset teff varieties, a logit model is estimated. Based on the results of binary logit model analysis, a model containing 13 selected predictor interaction terms were included. Six of the thirteen-predictor variables (family size, Education status, farm size, fertilizer use, access to credit and working experience) have a significant association for the determinants of improved boset teff variety adoption. The overall model is proven, as it is statically significant at a p-value of 0.000.

The LR test of indep. chi2 is 128.65 with a P- value (Prob>ch2) 0.000 also tells the logit model as a whole is statically significant. The signs of the regression coefficients of the model (Table 4) fulfil the underlying assumption and the corresponding p-values imply that the predictor variables included in the binary logit model have a significant relationship.

Family size: family size of the household head was found to have a negative significant correlation with adoption of improved boset teff variety. The family size of respondents were 9.9% more likely to adopt at ($p<0.099$) level of significance, ceteris paribus. This implies that households being an increase in family size, the adoption of the improved boset teff variety decreases. The possible suggestion is that family size less empowers individuals with technological skill and knowledge that will accelerate individual to adopt the technologies.

Education status: education status of the household head was found to have a positive significant correlation with adoption of improved boset teff variety. Educated respondents were 9.9% more likely to adopt at ($p<0.099$ level of significance, ceteris paribus. This implies that households being an educated the adoption of the improved boset teff variety increases. The possible suggestion is that education empowers individuals to adopt improved teff varieties. Education is also associated with adoption because it is believed to increase farmers' ability to obtain, and analyse information that helps him/her to make appropriate decision.

Farm size: is considered the most important factor of production in rural area. In the study area own land, rented land,

shared cropping lands and gift lands were used for production. The executed data results show that the farm size the household was the main factor to determine the adoption of improved boset teff variety. Based on logit model result being other things constant, cultivated farm size also associated with improved boset teff variety adoption at 1% level of significance. The life of the rural household in the studied district is in line with cultivated farm size.

Fertilizer use: application of fertilizer use was statistically significant at 10% level of significance and negatively associated with improved boset teff adoption. Meaning that the use of improved fertilizer does not help to adopt improved boset teff variety. Hence this further indicated that too much fertilizer (applied too often or too much) can ultimately affect the plants negatively But, fertilizers do a lot of good by providing macro and micronutrients that enhance the health and performance of plants. In line with this result intensive soil fertilization with mineral fertilizers has led to several issues such as nitrate pollution and loss of soil carbon and fertilizer must be properly handled and managed.

Credit access: credit access was statistically significant at 10% level of significance in the logit regression. Credit was the main source of finance for farmers to purchase input like improved seed and fertilizer. In the study area saving institutions and saving cooperatives which were the main source of credit. The survey result showed that being other thing things constant if availability of credit increases, it increases adoption of improved boset teff variety.

Farming Experience: Also at 5% level of significance, farming experience of farmers was significant and negatively associated with improved boset teff adoption. Having more farming experience not help to get new knowledge and skill to adopt new improved boset teff variety. It further indicated that farmers had general farming experience without crop technology adoption experience (Table 4).

Table 4. *Binary logit model result.*

Variable	mfx	Std. Err.	P>|z|
Sex	0.0613	0.121	0.612
Age	0.0009	0.00	0.457
Family size	-0.0146	0.00	0.099 [c]
Education	0.3012	0.185	0.099 [c]
Farm size	0.2126	0.052	0.000 [a]
Early maturity	-0.0273	0.028	0.329
Disease resistance	-0.0382	0.025	0.138
Grain yield	0.0437	0.027	0.106
Fertilizer use	-0.0477	0.025	0.064 [c]
Extension	-0.0065	0.034	0.847
Training	-0.0067	0.030	0.821
Credit	0.0551	0.031	0.083 [c]
Experience	-0.0122	0.006	0.041 [b]
Number of obs	246		
LR test of indep. chi2	128.65 [c]		
Prob > chi2	0.0000		

4. Conclusions and Recommendations

4.1. Conclusions

Teff plays great role towards ensuring to increase farm income, which is a major concern for the country. In Minjar Shenkora district, boset teff variety technologies were introduced and promoted by government and non-governmental institutions. However, from the study area it s possible to understand that improved boset teff adoption is determined by different factors. Family size, fertilizer use and farming experience was negatively associated with adoption of improved

boset teff variety. In contrast, education level, cultivated farm size and access to credit were positively associated with improved boset teff variety adoption.

Farm size has a multidimensional role on crop technology adoption and farmers primarily allocate their land for mainly for teff crops. The result shows that, the positive and significant relationship between farm size and adoption of improved boset teff varieties. too much fertilizer (applied too often or too much) can ultimately affect the plants negatively But, fertilizers do a lot of good by providing macro and micronutrients that enhance the health and performance of plants. In line with this result, intensive soil fertilization with mineral fertilizers has led to several issues such as nitrate pollution and loss of soil carbon and fertilizer must be properly handled and managed (Roger, 2015).

Credit access is an important element in the agricultural production system. The reason is that the tendency that farmers will adopt new innovations because majority of them had access to credit and use it. It enables them to purchase inputs and pay for labor required in the adoption of new varieties. Having more faming experience not help to get new knowledge and skill to adopt new improved boset teff varieties. It further indicated that farmers had general farming experience without crop technology adoption experience. In general, there are important and significant differences between farm households who did and do not used improved boset teff variety.

4.2. Recommendations

1. Expanding the access improved boset teff variety and creating additional access is important to increase boset teff adoption.
2. Forcing households to adopt any kind of agricultural technology will not bring the expected outcome rather it may aggravated their rigidity not to accept any new farming technologies. At the same time in order to increase the support from family members, the kebeles' educational and agricultural bureaus in collaboration should train students in the school about the benefits of improved boset teff variety; this may increase labor support that household heads obtained from their family.
3. Infrastructures like all-weather roads, training centers and access of credit systems in rural areas should be in place with a minim interest for purchase of input and low cost technologies.
4. Give training to farmers about fertilizer application in-order to avoid too low or too high use of fertlizer.

Abbreviations

MSD	Mnijar Shenkora District
SSA	Sub Saharan Africa

Author Contributions

Alebachew Molla is the sole author. The author read and approved the final manuscript.

Conflicts of interest

The author declares no conflicts of interest.

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Research Field

Alebachew Molla: Adoption, Impact assessment, Monitoring and Evaluation, Food Security, Value chain, Poverty