The Impact of Agricultural Commercialization on Food Security in Amhara Region: The Case of Kobo Girana Valley Development Program

Mengesha Misgan

Abstract— Agricultural commercialization occurs in staple cereals as well as high value cash crops which lead to greater market participation. In Ethiopia in general and in Amhara region in particular agriculture is the backbone of the economy and there is a progress towards commercialization. The small holder's households' ability to meet their own food needs has placed as a major consideration in agricultural commercialization programs. This study, therefore, examines the impact of agricultural commercialization on food security in Amhara Region: The case of Kobo Girana Valley Development program using primary data source from a survey of a random sample of 297 (Commercialized-148 & Non-commercialized-149) smallholder households. To deal with this, the researcher used both descriptive and Propensity Score Matching econometric analyses as a tool. In the descriptive analysis part, based on Household Food Insecurity Access Scale Prevalence; 25.63%, 67.51% and 6.86% of Commercialized households are food secure, mildly food insecure and moderately food insecure respectively. On the other hand, 2.58% of the Non-commercialized households are food secure while the rest 33.37%, 47.37%, and 21.05% are mild, moderate and severely food insecure (access) consecutively. In the econometric analysis, variables like age, off-farm income, oxen and market have a significant effect on the probability of participation in agricultural commercialization. The average treatment effects on the treated (ATT) estimated result obtained using Propensity Score Matching method has proven that agricultural commercialization has a significant and positive impact on food security. The researcher has recommended that Polices that enhance agricultural commercialization of small holder households' is essential in the area.

Index Terms— Agricultural commercialization, food security, impact, smallholder households

1 INTRODUCTION

Agricultural commercialization in staple cereals as well as high value cash crops leads to greater market orientation of farm production. East Asian countries are found on the high stage of agricultural commercialization, while Southeast Asia and Latin American countries are moving into commercialization. However, south Asia and many sub-Saharan African countries are found at the lower level of agricultural commercialization [1].

The effect of the commercialization of subsistence agriculture on food security continues to be an important but debatable issue. Some scholars viewed that agricultural commercialization enables to create employment opportunities which leads to improve food security by raising the household income from cash and cereal crops [2], [3]. On the other hand, there were also other authors who claimed that due to the inequality to control over household income between men and women (it limits women's access to resource and control over household income and less to participate in the market), market failure, risk and uncertainty commercialization does not necessarily lead to improve food security at household or community level. Commercialization might make the poor small holder households to be more vulnerable and worse off in the accessibility of food crops [4], [5], [6].

In areas where cash crop production has increased, the food consumption of the small holder households has deteriorated. Poorly designed projects and lack of appropriate policies may result in deterioration of food security [7] .Most small holder farmers shifted from a wholly subsistence farming to commercialized agricultural production. However, smallholder farming in less developed countries based on low-input and inefficient traditional farming practices coupled with population pressure on land have impacted negatively on sufficient food production [8]. Most communities in Kenya growing cash crops are still struggling to put food on the table. The production

of cash crops comes at the expense of household food security [9], [10].

In Ethiopia, agriculture accounts about 42 percent of the gross domestic product (GDP), employs about 85 percent of the labor force and contributes around 90 percent of the total export earnings of the country. The sector is dominated by over 15 million smallholder households producing about 95 percent of the national agricultural production [11]. There was the process of smallholder commercialization in Amhara region in the past 15 years [12]. The study focuses on the impact of agricultural commercialization on food security in Kobo-Girana Valley Development Program (KGVDP), Amhara region by using 2019/2020 cross sectional data. KGVDP is established by the Amhara National Regional State (ANRS) in 1999 to make agricultural commercialization [13]. The program is situated in Raya Kobo Woreda, North Wollo Zone, Amhara National Regional State, Ethiopia. In this Woreda, the number of the population has reached 226,049 in 2019. From this population; 18,056 (7.99%) were require emergency food assistance. About 42,354 (18.74%) population were highly food insecure and they are under the safety net program. The rest 103,115 (45.62%) and 62,524 (27.66%) were medium food insecure and food secure respectively [14]. This Woreda is predominantly practiced subsistence farming where the shortage of rainfall together with drought problems causes extreme risk of household food security. Since the livelihood of these households is depending on this commercialization program, it is highly significant to examine the impact of the program on food security and to assess the extent or status of commercialization and food security in the area.

Few studies were made in Ethiopia to understand the impact of agricultural commercialization on food security. Most past empirical studies considered only one or a few selected crops to study the impacts of agricultural commercialization on food security; but the current study is based on a comprehensive household commercialization index (HCI) of households developed by considering all crops on the farm. Also, The previous researchers did not utilized the Propensity Score Matching/PSM/ model to analyze the commercialization impact on food security. For instance the study made by Nasir, Mulugeta, &Kassa [15] in Southwest Ethiopia had used a binary logistic regression model to analyze the impact of commercialization on food security in the area. But in this paper Propensity Score Matching /PSM/ model is utilized. PSM helps to create a comparison group that is similar to the treatment group based on a set of matching characteristics. PSM matches treatment individuals/households with similar comparison individuals/households, and subsequently calculates the average difference in the indicators of interest [16]. Therefore, this study attempts to fill the gap by conducting an empirical research on identifying, analyzing and understanding the impact of small holders' commercialization on food security in the area.

- *Mengesha Misgan was born in Ethiopia, Amhara Region, North Wollo Zone, Raya Kobo- Arbet on June 30, 1989.*
- *He has pursued master's degree program in Development Economics in Ethiopian Civil Service University, Ethiopia.*
- *He is part time instructor at Admas University.*
- *He is also working in Ministry of Revenues as Compliance Strategic Analysis and Preparation Senior Expert.*
- *Tell-+ 251 911 807331/+251 920241650*
- *E-mail: mengeshamisgan@mail.com*

2 AGRICULTURAL COMMERCIALIZATION

Agricultural commercialization is an assessment based on the proportion of output that households sell with respect to the quantity harvested, regardless of the type of crops [6]. Commercialization is not only restricted to the production of cash crops, but also includes the sales of cereal/food crops [5]. Also, it is the process in which smallholder households' shift

from a subsistence oriented production to more specialized production targeting input procurement and output supply markets. To attain structural transformation, there should be appropriate policies and strategies to improve the functioning of input and output market [17]. Commercialization is a strategy for the economic transformation [18]. Economic growth, withdrawal of labor from the agricultural sector and urbanization lead to the increment of agricultural commercialization. If commercialization of agriculture promotes economic growth and reduces poverty, it is an inherent to the development process. Due to structural adjustment and trade liberalization policies, the previous staple food self-sufficiency agricultural policies in developing countries are changed to start commercialization process. The issue of agricultural commercialization usually takes a long transformation process from subsistence to semi-commercial and then to a fully commercialized agriculture. In subsistence production, the farmer's objective is food self-sufficiency by using mainly non-traded and household generated inputs. The objective and the input sources change in semi-commercial farms into generating surplus agricultural outputs and using both traded and non-traded farm inputs. Inputs are predominantly obtained from markets and profit maximization becomes the farm household's driving objective in commercial agriculture [1].However, in subsistence agriculture there is also the existence of commercialization where farm households supply a certain proportion of their output to the market from their subsistence level [19]. The Smallholder agricultural commercialization occurs when a farmer participates in agricultural markets either as a seller or buyer. This can be achieved when a portion of the agricultural products produce from the farmers is marketed and/or when part of the inputs are acquired from the agricultural markets [20]. Commercialization can therefore be viewed from either the input or output side [21].

The current Ethiopian economy exercises transition from subsistence to semi commercial and fully commercial agriculture. Ethiopia is following to bring dynamic change to transform the traditional agriculture of smallholder households into more modernized commercial agriculture [22].

2.1 MEASUREMENT AND LEVELS OF COMMERCIALIZATION

Commercialization of agriculture was calculated as the ratio of the total value of crop m sold by the households to the total value of crop m produced by the same households expressed as a percentage. The entire crop subsector commercialization will be determined by using the commercialization index [23], [24]. The index measures the extent to which crop production oriented towards the market. A value of zero would signify a total subsistence and closer to the index is 100, the higher the level of commercialization. The present study adopted the Commercialization Index (CI) to determine the level of crop commercialization; the Index captures variation in terms of intensity of commercialization across different crops, thus the degree of commercialization were grouped into three categories of low commercialized (≤25% volume of output sold), medium commercialized (26% -50% volume of output sold) and high commercialized (> 50% volume of output sold) [25]. This measurement is important to measure the status and level of agricultural commercialization in the area and the researcher utilized this measurement to see the extent of commercialization.

3 FOOD SECURITY

The issues of food security started in the Conference of Food and Agriculture in 1943 which stated that every person has got a secure, adequate and suitable food. Food security, famine and hunger are not to be confused: food security refers to the availability of food, whereas famine and hunger are the consequence of the unavailability of food, in other words the results of food insecurity [26]. According to FAO [27] food security is defined as *"…access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life"*. So that there are four essential parts of food security are: food availability, food access, food utilization and stability

3.1 MEASUREMENTS OF FOOD SECURITY

Food security has a multi-dimensional concept and a complex issue, which is based on multiple dimensions such as physical, social, and economic

access, availability, amount, preferences for certain foods, security, and time [28]. Even if there are different measurements of food security, the researcher focused on Household Food Insecurity Access Scale (HFIAS), Daily Calorie Intake (CI), Food Variety Score(FVS), The Household Dietary Diversity Score (HDDS) and The Share of Household Food Expenditure(SHHFE).

Household Food Insecurity Access Scale (HFIAS) is introduced by the USAID-funded Food and Nutrition Technical Assistance Project (FNTAP) in 2006 and to measures the access component of household food insecurity in the country. The HFIAS has nine questions and it is important to estimate the prevalence of food insecurity (access). It is easy to use and applicable only with minor adaptations to different socio cultural contexts. There are four indicators of HFIAS; i.e. HFIAS-related Conditions, HFIAS-Domains, HFIAS-score, HFIAS-Prevalence. Among the HFIAS indicators, the household food insecurity access prevalence (HFIAP) indicator categorizes households into four levels of household food insecurity (access): food secure, mild, moderate and severely food insecure [28]. Developing countries status of food insecurity can be measured by HFIAS. It is applicable in Ethiopia and is a simple and valid tool to measure the access component of households in urban and rural areas [29]. This measurement is relatively easy and valid. Because it requires only monthly data to decide the status of the household food security (access) in which the respondents can easily answer the questions.

Daily Calorie intake (CI) is the amount of energy consumed via food and beverage measured in Kilocalories consumed by a household member. Daily caloric intake needs are determined by a variety of factors such as age, gender, height, weight, activity level, and genetics [30]. It can be computed either per capita (total household calories divided by the number of household members), or per adult equivalent (total household calories divided by the number of adult equivalents in the household).

To calculate the per capita daily calorie intake, the analyst must take the total energy (in calories) in the food consumed by a household over the survey reference period and divide it by the number of household members per capita approach. It will be necessary to convert the per capita calories to per day by dividing by the reference period during which the food was consumed. The demographic structure of a household cannot be considered in per capita daily calorie intake and this approach is not an adequate method. It is better to use per adult equivalents to compute the daily calorie intake. Because this method takes into account the fact that individual food needs vary by age and sex [31]. According to the Ethiopian Nutrition and Health Research Institute/ENHRI [32] the minimum daily requirement in Ethiopia is 2200 Kilocalories per day. It is better to use daily calorie intake per adult equivalents. Because of it considers the demographic (age and sex) structure of the small holder households.

Food Variety Score (FVS) quantifies the number of different foods consumed, and are expressed over a time period or base which may be a day, a week, a month, or a year. There are a number of rationales for the development of a quantitative food variety score. Firstly, one of the main reasons is to demonstrate a greater food variety is associated with better nutrient adequacy. Food variety has been included as a dietary guideline because it is believed that a greater food variety results in better nutrient adequacy [33]. The second one is recognize the omnivorous nature of the human species [34]. The third is to include non-nutrient components of food in a quantitative assessment of the human diet. Foods that offer various non-nutrient components could be important to health. Many non-nutrient food components have been identified, and some are yet to be identified [35].The non-nutrients may be part of the food itself, or introduced into the food. The relationship between most of these non-nutrients and health are largely unknown, but several nutrients may be related to better health. A measurement of food variety can serve as a statement about the range of non-nutrients present in the diet. Fourthly, to take into account the psycho-socio-cultural value of food, as well as the physiological value, by providing a more complete description of the human diet than is provided by individual foods or nutrients [36].Therefore, the FVS is very important to measure the status of food security. Because of it takes into account different indicators like nutritional status, different varieties of food and the psycho-socio-cultural value of food.

A household who scored more than 30 food variety per week considered as very good dietary adequacy, 25-30 per week considered as good, 20-

24 per week considered as faire, less than 20 per week considered as poor and less than 10 are considered as very poor [37].

The Household Dietary Diversity Score (HDDS) is calculated by summing the number of unique food groups consumed during the last 24 hours [38]. The range of HDDS is from 0 to 12, in which lowest HDDS value signifies higher food insecurity status and vice versa. Even though there is no international consensus on which food groups to include in the scores, the HDDS denotes 12 food groups in which the following are considered in this study: cereals; root and tubers; vegetables with tubers; vegetables which are leafy; fruits; meat, poultry, offal; eggs; fish; pulses/legumes/nuts; milk and milk products; oil/fats; and sugar/honey [39]. The empirical studies made by Ruel [40] and Faber, Schwabe, & Drimie [41], the cutoff point for the HDDS indicate that HDDS ≤5represents low dietary diversity, HDDS 6–7 medium dietary diversity, and HDDS ≥ 8 high dietary diversity. This categorization could signify most food insecure, medium food insecure, and food secure, respectively. According to Faber, Schwabe, & Drimie [41] HDDS is important to measure the quality of food security.

The Total Share of Household Food Expenditure (SHHFE) spent on food is an indicator of household food security because it is widely believed that poor households spent a larger share of their income to food expenditure. The Engel's law, states that as incomes raise, both within a country and across countries, expenditure on food increases while expenditure on other things increases and then the total amount of income spent on food declines. Given this observation, the Share of Household Food Expenditure (SHHFE) is important to understand the impact of food price fluctuations on both the quality and quantity of household food consumption. Therefore, poor households consuming the lowest cost foods will be unable to substitute cheaper foods and will be forced to spend more on basic staples, reduce the quality of their diets while also reducing nonfood expenditures that may be equally needed (e.g. On health and education) [42]. The monetary value of non-purchased items, including consumption from own production and in-kind payments and transfers, must be imputed from available pricing information. The household spending over 75% of their income on food are considered very vulnerable and consequently food insecure, whereas people spending 65-75%, 50-65%, <50% are considered to have high food insecurity, medium food insecurity and lower levels of food insecurity respectively [31].

4 Empirical Literature Review

Unless checked by the study and its variability in different places, the impact of agricultural commercialization on food security is the unknown. The study made by Kennedy & Cogill [8] in Southwest Kenya indicated that commercialization has an extremely positive effect on the income of small holders and improves the nutritional status. In this study, the income of farmers who are participating in sugarcane production is higher than those who are non-sugar producers. Also, Joosten et al. [43] had stated fruits and vegetables sector in food insecure developing countries like Ethiopia, Rwanda, Ghana, Uganda, Kenya, Indonesia and Viet Nam have increased over the past 10-15 years. In these countries, the overall effects of fruits and vegetables have increased the levels of income thereby leads to improved food security. In addition, equitable introduction of cash crops will have both efficiency and equity benefits which lead to an improvement in food security [44]. Nasir, Mulugeta, & Kassa [15] aimed to investigate the impact of commercialization on rural household food security in major coffee growing districts of south west Ethiopia: The case of Jimma Zone. The result indicated that about 68% of the smallholder farmers were food secure household. So that commercialization has a positive effect on food security level of smallholder farmers. On the other hand, commercialization may deteriorate the improvement of food security. Most communities in Kenya growing cash crops are still struggling to put sufficient food on the table [10].

5 Conceptual Framework

Commercialization is not something that households can choose to do freely. Instead, whether households can commercialize their landing activities is influenced by demographic and socioeconomic characteristics like age, sex, education, household size, education, off-farm income, oxen owned and the accessibility of the market and they affect both Commercialized and Non-commercialized households. Finally, Commercialized and Non-commercialized

households affect food security through the production of Cereal and/or Cash and Cereal crop production respectively. The above demographic and socioeconomic characteristics can also affect food security directly. In this paper, food security is measured by Household Food Insecurity Access Scale (HFIAS), Daily Calorie Intake (CI), Food Variety Score (FVS), Household Dietary Diversity Score (HDDS) and the Share of Household Food Expenditure (SHHFE).

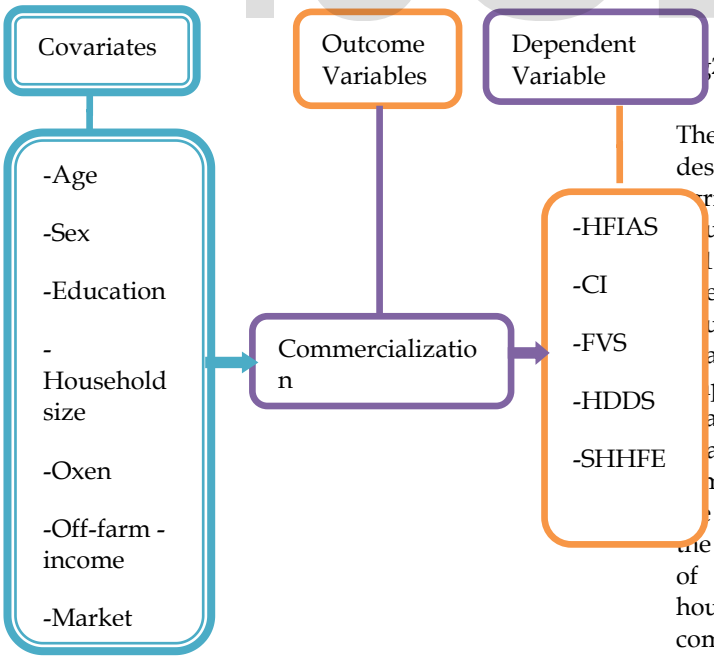
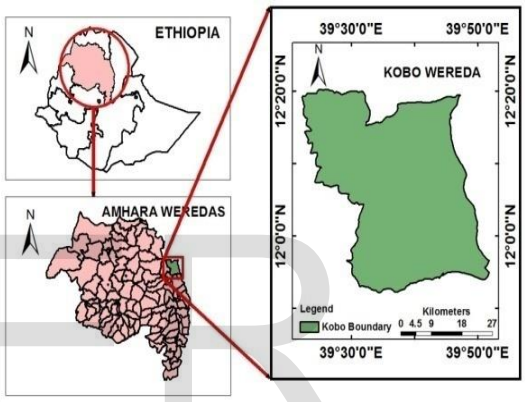


Fig1. Conceptual framework of commercialization impacts on food security

6 METHODOLOGY

The study is conducted in Kobo Girana Valley Development Program /KGVD/, North Wollo Zone, Amhara Region. The Program office is located in Kobo town about 570 km from Addis Ababa along Dessie - Mekele highway. It is found in the lower flat plain of Raya Kobo Woreda which extends from $12^0 0' 0''$ to $12^0 20' 0''$ North latitude to $39^0 30' 0''$ to $39^0 50' 0''$ East longitude and bounded by Raya Alamata Woreda from North, RobitKebelefrom South, Mendefera, Nedi and GedemeyuKebeles from the East and Arbet, Tebelet and BewaKebeles from west of Raya Kobo Woreda , Amhara Region [45].



2. Location map of the study area

The study has used quasi experimental research design. It determines and reports the impacts of ricultural commercialization on smallholder usehold food security in the area by using 19/2020 cross sectional data while using estionnaires and interview from small holder useholds as the appropriate tool. Both antitative and qualitative methods are ployed. The researcher has used purposive, atified and simple random sampling for both atments (Commercialized) and control (Non-mmercialized) groups. In the treatment group researcher purposively selects the program in the area. The researcher has used the sample size of 148 from the Treatment (Commercialized households) and 149 from the Control (Non-commercialized) households with a total sum of 297 respondents to make descriptive and inferential analysis.

The descriptive analysis focused on the description of both dependent and independent variables. It helped as to analyze the socio economic and demographic characteristics of the respondents, the measurement and level of agricultural commercialization and food security by using percentage, mean, standard error and so forth. The statistical significance of continues and categorical explanatory variables are tested by using t-test and chi-square test respectively. The statistical significance of the outcome variables is checked by t-test. Both descriptive and econometric analyses will be performed by using STATA computer software version 14.

In econometric analysis, the researcher has used the propensity score matching (PSM) to investigate the impacts of the agricultural commercialization on food security. PSM is developed by Rosenbaum and Rubin in 1983, is one of the most commonly used techniques for dealing with biases associated with observable factors when evaluating the impact of the program. It helps to create a comparison group that is similar to the treatment group based on a set of matching characteristics [16].PSM matches treatment individuals/households with similar comparison individuals/households, and subsequently calculates the average difference in the indicators of interest. In PSM, an individual is not matched on every single observable characteristic, but on their propensity score – that is, the likelihood that the individual will participate in the intervention (predicted likelihood of participation) given their observable characteristics. In other words, PSM ensures that the average characteristics of the treatment and comparison groups are similar, and this is deemed sufficient to obtain an unbiased impact estimate [46].

Logistic regression is a unit or a multivariate technique which allows for estimating the probability that an event occurs or not occurs, by predicting a binary dependent outcome of a set of independent variables. In this paper this regression allows to predict the probability of a small holder household to be participated in agricultural commercialization or not and predict propensity scores, based on which, the treatment and control groups of households will matches using the matching algorithms [47]. According to Gujarati [47] the binary logit model is specified as follows:

The response probability of a given commercialized smallholder households Pi is expressed as:

$$Pi=E(Y=1/Xi)$$

$$= \frac{1}{1+\exp^{-(B1+B2xi)}}$$

$$= \frac{1}{1+\exp^{-zi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where zi = B1+B2xi,

Let Pi is the response probability of Commercialized small holder households and given by:

$$Pi=\frac{1}{1+\exp^{-zi}}$$

The non-response probability of a given small holder households who is Non- commercialized :

$$(1\text{-}Pi)=\frac{1}{1+\exp^{zi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

The odds ratio of the response to non - response

$$\frac{pi}{1-pi} = \frac{1+\exp^{zi}}{1+\exp^{-zi}} \ldots\ldots\ldots\ldots\ldots \quad (3)$$

Taking the natural logarithm we obtain;

$$Li = Ln\left(\frac{pi}{1-pi}\right) = Zi= Bo+B1X1+B2X2+\text{-----}BnXn \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where Pi is the probability of commercialized small holder households that ranges from 0 to 1; Zi is a function of n explanatory variables (Xi);#

Bo is intercept, B1, B2, ---, Bn are slope parameters in the model.

Li is log of odds ratio which is not only linear in X but also linear in parameters and Xi is a vector of the relevant sample small holder households' characteristics.

The logistic regression model can be expressed including the disturbance term as:

$Zi=\beta 0+\beta 1X1+\beta 2X2+\ldots+\beta nXn+Ui$…….. (5)

.The four most commonly used matching algorithms that are employed to examine the impacts of commercialization on food security are: Nearest neighbor matching (NNM), Radius matching (RM), Kernel and local-linear matching (KLM) and Stratification matching(SM). Then after, the Average Treatment Effect on the Treated (ATT) households will be analyzed.

7 RESULTS AND DISCUSSIONS

7.1 THE EXTENT/LEVEL OF COMMERCIALIZATION

It is important to determine the extent or levels of commercialization for Commercialized households and Non-commercialized households. Because of it helps to understand the status of commercialization. To see the extent or level of commercialization; the researcher used Household Commercialization Index (HCI), which is dividing the gross value of sales by the gross value of production. If the smallholder households sell most their agricultural outputs to the market, they will become more commercialized and vice versa.

The mean HCI of Commercialized households are 0.65 while Non-commercialized households have 0.09. This indicates Commercialized household have sold about 65% of their total agricultural outputs and Non-commercialized households have sold about 9%. Based on the categorization made by Martey [25] the extent or level of commercialization of Commercialized households are medium (13.51%) and higher (86.49%) while Non-commercialized households have low levels of commercialization or they are non-commercialized. Because their volume of output sold is less than or equal to 25%.

7.2 The status of food security

7.2.1 FOOD SECURITY AS MEASURED BY HOUSEHOLD FOOD INSECURITY ACCESS SCALE (HFIAS)

HFIAS is one the qualitative and quantitative measurements of food security. It helps to determine the access components of food security. HFIAS is based on nine generic questionnaire that represent increasing level of food insecurity (access) and nine "frequency-of-occurrence" questions that are asked as a follow-up to each occurrence question to determine how often the condition occurred. The questions are asked with a recall period of four weeks (30 days). The frequency-of-occurrence question is skipped if the respondent reports that the condition was not experienced in the previous four weeks (30 days). The occurrence questions, inquire about the respondents' perceptions of food vulnerability or stress and the respondents' behavioral responses to insecurity. The respondent is first asked an occurrence question - that is, whether the condition in the question happened at all in the past four weeks (yes or no). If the respondent answers "yes" to an occurrence question, a frequency-of-occurrence question is asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past four weeks. The occurrence questions include anxiety and uncertainty about the household food supply, insufficient Quality (includes variants and preferences of the type of food) and insufficient food intake and its physical consequences [28].

According to Coates, Swindale, &Bilinsky [28] there are four indicators of HFIAS. These are HFIAS-related conditions, HFIAS-related domains, HFIAS-related scale score, and HFIAS-related prevalence. The HFIAS is better interpreted when used to assess Household Food Insecurity Access Prevalence (HFIAP) [48]. The HFIAP indicator categorizes households into four levels of household food insecurity (access): food secure and mild, moderate and severely food insecure. Secure households experience none of the food insecurity (access) conditions, or just experiences worry, but rarely. Mildly food insecure (access) households worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable, but only rarely and it does not cut back on quantity nor experience any of three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating). Moderately food insecure smallholder households sacrifice quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or have started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes. But it does not experience any of the three most severe conditions. Severely food insecure households have graduated to cutting back on

meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely. In other words, any household that experiences one of these three conditions, even once in the last four weeks (30 days) is considered severely food insecure [28].Thus, households are categorized as increasing food insecure as they respond affirmatively to more severe conditions and/or experience those conditions more frequently.

According to Coates, Swindale & Bilinsky [28] a HFIA category variable is calculated for each household by assigning a code for the food insecurity (access) category in which it falls. The data analyst should have coded frequency-of-occurrence as 0 for all cases where the answer to the corresponding occurrence question was "no" (i.e., if Q1=0 then Q1a=0, if Q2=0 then Q2a =0, etc.) prior to assigning the food insecurity (access) category codes. The four food security categories should be created sequentially, in the same order as shown below, to ensure that households are classified according to their most severe response.

To calculate the Household Food Insecurity Access category for each household; first we have to code the status of food security i.e., 1 = Food Secure, 2=Mildly Food Insecure Access, 3=Moderately Food Insecure Access, 4=Severely Food Insecure Access

HFIA category = 1 if [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

HFIA category = 2 if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

HFIA category = 3 if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0]

HFIA category = 4 if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]

Then, the prevalence of different levels of household food insecurity (access) is calculated.

$$\text{HFIA Prevalence} = \frac{\text{Numberofhouseholds with HFIA category}=4}{\text{Totalnumberofhouseholds with HFIA category}} * 100 \quad \text{------ (6)}$$

The HFIAS - score is calculated for each household by summing the codes for each frequency-of-occurrence question [28]. Now, we can calculate the HFIAS-score of both Commercialized and Non-commercialized households. Based on HFIAS - score the finding shows the mean score of HFIAS for the Commercialized households is 7.82 with a standard error of 0.33, while the minimum and the maximum score were 0 and 12 respectively. Besides, the Non-commercialized households have a mean score of HFIAS 20.28 with a standard error of 0.11, while the minimum and maximum score were 18 and 21 consecutively. Based on the categorization made by FAO [49] on a study conducted in Mozambique to determine the cutoff point, a score of 0–11 was taken as "most food secure"; 12–16 medium food insecure; and a score above 17 most food insecure. Accordingly, it was found in Commercialized households, 67.57% (n = 100) were most food secure; 32.43% (n = 48) were medium food insecure. On the other hand, all Non-commercialized households were most food insecure.

Based on the nine generic questions of the access-related conditions, it is only 34.46% (n = 51) who never worried having not enough food, whereas the remaining 65.54% (n = 97) of surveyed households have experienced problems of both economic and physical access to food at varying levels of food insecurity. Looking at the finding on the basis of the severity level, out of the total score of 386, it can be observed that 59.59% of households encountered access problems "rarely," 35.49% "sometimes," and 4.92% "often" during the last 1 month of the study period. Whereas in 149 Non-commercialized sample households, the findings show all households have worried having not enough food. These households have experienced problems of both economic and physical access to food at varying levels of food insecurity. Out of the total score of 1007, it can be observed that 31.58% of households encountered access problems "rarely," 47.37% "sometimes," and 21.05% "often" during the last 1 month of the study period. The frequency occurrences of access problems in Non-commercialized households are higher than Commercialized households.

63% of the respondents of Commercialized households are food secure; i.e., such households experience none of the food insecure conditions, or just worry, but rarely. To the contrary, 67.51%, and 6.86% of the respondents are mildly food insecure (access) and moderately food insecure (access) respectively.

There were only a few (2.58%) of the Non-commercialized respondents are food secure while the rest 33.37%, 47.17%, and 16.88% are mildly, moderately and severely food insecure (access) consecutively.

7.2.2 Food security as measured by Daily Calorie Intake (CI)

In Ethiopia, people who consumed more than 2200 kilocalories are food secure and below this level are food insecure [32]. The average daily CI of Commercialized household has 2649.98 Kilocalories while Non-commercialized households have 2275.40 Kilocalories. There is a significant difference of daily CI per adult equivalent between Commercialized and Non-commercialized households at 1% level of significance. 77.03% and 22.97% of Commercialized households are food secure and insecure respectively. On the other hand, 36.49% and 63.51% of Non-commercialized households are food secure and food insecure consecutively. The Commercialized households are two times more secure than Non-commercialized households.

7.2.3 Food security as measured by Food Variety Score (FVS)

Accordingly the categorization made by Savige, Hsu-Hage, &Wahlqvist [37] the result shows that all sample households are food insecure. Because of they have scored <20 FVS per week. The average FVS of Commercialized households are 12.74 food variety score per week while Non- commercialized households have 10.72 food variety score per week. The t-test indicates the mean of FVS between Commercialized and Non-commercialized households have a significant difference at 1% level of significance.

7.2.4 Food security as measured by Household Dietary Diversity Score (HDDS)

Based on the categorization of HDDS made by Ruel [40] and Faber, Schwabe, & Drimie [41] only less than 1% of Commercialized and Non-commercialized households have medium dietary diversity. The rest respondents were found to consume less dietary diversity, implying they are more food insecure due to lack of the means to acquire and consume a variety of foods. The finding of the HDDS per day shows Commercialized respondents were found to have consumed an average of 3.84 dietary diversity score with a standard error of 0.072. Besides, Non-commercialized households have an average of 3.53 dietary diversity score with a standard error of 0.075. The statistical test made on the results of the overall HDDS shows there is a statistical significant difference across Commercialized and Non-commercialized households at $p < 0.001$.

7.2.5 Food security as measured by the Share of Households Food Expenditure (SHHFE)

Based on the categorization made by Smith & Subandoro [43]62.16%, 35.81% and 2.03% of Commercialized households are food secure, medium food insecurity and high food insecurity respectively. On the other hand, 25.50%, 34.23%, 34.22% and 8.05% of Non-commercialized households are secure, medium food insecurity, high food insecurity and very high food insecurity respectively. Commercialized households spent an average of 49% on food out of total expenditure while Non-commercialized households have spent 60%. The statistical test made on the results of the overall SHFE shows there is a statistical significant difference across Commercialized and Non-commercialized households at $p<0.001$.

7.3 Econometric Analysis

The logistic regression model was used to estimate the propensity score of Commercialized and Non-commercialized households. The first stage in the propensity score matching is to model the probability of participating commercialization in the program. Table4 shows the estimation results of the logit model. It reports the estimated coefficients, Z-value, standard error, and some goodness of fit measures for the model. The

estimated coefficient results indicate that probability of participating in commercialization is significantly influenced by four explanatory variables. These include age, off-farm income, the oxen and the accessibility of the market. Age and off-farm income affect the probability of participation in agricultural commercialization at 5% level of significance. More aged households are more experienced to participate in agricultural commercialization than inexperienced households. Besides, households who have more off-farm income are less likely to engage in the program. Oxen and the accessibility of market have positive and significantly affect the probability of participation in agricultural commercialization at 1% level of significance. Households who have more oxen are found to have strong and positive relationship with the participation in the commercialization program. Access to market demonstrates relationship with the probability of participating in agricultural commercialization. Smallholder households with nearer to local market are more likely to participate in agricultural commercialization. Households with more distant in the local market are reluctant to engage in agricultural commercialization.

The Pseudo R^2 indicates how well the covariates explain the participation probability. The Pseudo $R^2$is found about 0.3629. A low pseudo R2 value means that participant households do not have much distinct characteristics overall. After matching there should be no systematic differences in the distribution of covariates between both groups and, therefore, the pseudo-R2 should be fairly low [50]. The overall model is proven as it's statistically significant at a p-value of 0.000.

7.3.1 IMPACT ESTIMATION OF AGRICULTURAL COMMERCIALIZATION ON FOOD SECURITY OUTCOME INDICATORS

Before doing impact estimation; we have to see whether the outcome indicators (HFIAS -score, CI, FVS, HDDS and SHHFE) of food security are used by other Authors in PSM model. The study made by Ntakyo & Berg [51] titled on 'the effect of market production on rural household food consumption: Evidence from Uganda' had used the PSM model. In this paper, the researchers had used Per adult equivalent CI, HFIAS-score and HDDS as the outcome indicators of food security. We can use FVS as the outcome indicators of food security. Because of it shares some properties of HDDS. FVS measures the number food varieties per week. But in HDDS, it measures dietary diversity score per 24 hours. Also, Haji &Legesse [52] made a research on 'Impact of sedentarization program on the livelihood and food security of Ethiopian pastoralists used the SHHFE as the outcome indicators of food security in PSM model. Therefore, the outcome indicators of food security are realistic to be used in PSM model.

The program's impact on the outcome variables (HFIAS -score, CI, FVS, HDDS and SHHFE) are produced from the ATTs estimations of Stratification, Radius, Kernel, and Nearest neighbor matching methods. Most of matching method indicates agricultural commercialization has a positive and significant impact on food security.

I. IMPACT ESTIMATION OF ATT FOR AGRICULTURAL COMMERCIALIZATION ON THE HOUSEHOLD FOOD INSECURITY ACCESS -SCORE (HFIAS-SCORE)

Table 1 indicates the results of the matching techniques are statistically significant at ($p<0.01$) probability level of significance. The ATT of Commercialized households has scored an average of 12.86 which indicates the frequency of the occurrence of food problems of Commercialized households' are less than Non-commercialized households by 12.86. This shows Commercialized households are more food secure than Non-commercialized households. Agricultural commercialization and HFIAS-score have a negative relationship. If there is a low frequency of occurrence of food problems, there will be an improvement in the status of food security. Hence, agricultural commercialization has a significant impact on the HFIAS - score.

Table1. Propensity Score Matching ATT result: Impacts of agricultural commercialization on HFIAS- score.

Matching type	No. Treated	No. Control	ATT	Std. Err.	t-value
Stratification	148	135	-12.930	0.299	-43. 628***
Radius	148	135	-12.671	0.386	-32. 813***
Kernel	148	135	-12.903	0.307	-42.018***

Nearest neighbor	148	42	-12.953	0.379	-34.138***
Average			-12.86		

Source: Computed from own survey, 2020

Note: ***, indicates statistically significant at 1% probability level of significance

II. IMPACT ESTIMATION OF ATT FOR AGRICULTURAL COMMERCIALIZATION ON FOOD DAILY CALORIE INTAKE (CI)

Table 2 shows the machining techniques are statistically significant at (p<0.01) probability level of significance. The ATT result lies between 482.088 Kilocalories in Radius matching to 582.522 Kilocalories in Kenel matching. Besides, the ATT result in Nearest neighbor and stratification matching algorithm is 509.332 and 525.106 Kilocalories per day respectively. The average ATT result indicates Commercialized households have got 524.762 Kilocalories higher than Non-commercialized households in 2020 surveyed year. The results witnessed that narrowing the gap between Commercialized and Non-commercialized households are crucial to increase the daily calorie intake thereby certify food security at a household level.

Table2. Propensity Score Matching ATT result: Impacts of agricultural commercialization on food calorie intake (CI)

Matching type	No. Treated	No. Control	ATT	Std. Err.	t-value
Stratification	148	135	525.106	180.087	2. 916***
Radius	148	135	482.088	68.024	7. 087***
Kernel	148	135	582.522	101.011	5. 767***
Nearest neighbor	148	42	509.332	129.744	3. 926***
Average			524.762		

Source: Computed from own survey, 2020

Note: ***, indicates statistically significant at 1% probability level of significance

III. IMPACT ESTIMATION OF ATT FOR AGRICULTURAL COMMERCIALIZATION ON FOOD VARIETY SCORE (FVS)

The third outcome indicator of the program is food variety score (FVS), i.e., the average treatment effect on the treated was found to be positive and statistically significant. Commercialized households consumed an average of 2.69 food varieties per week higher than Non-commercialized households as shown in table 4.20. The results are statistically significant at (p<0.01) probability level of significance.

Table3. Propensity Score Matching ATT result: Impacts of agricultural commercialization on food variety score (FVS)

Matching type	No. Treated	No. Control	ATT	Std. Err.	t-value
Stratification	148	135	2.699	0.510	5. 294***
Radius	148	135	2.457	0.343	7. 169***
Kernel	148	135	2.770	0.388	7. 145***
Nearest neighbor	148	42	2.831	0.598	4. 731***
Average			2.689		

Source: Computed from own survey, 2020

Note: ***, indicates statistically significant at 1% probability level of significance

IV. IMPACT ESTIMATION OF ATT FOR AGRICULTURAL COMMERCIALIZATION ON FOOD HOUSEHOLD DIETARY DIVERSITY SCORE (HDDS)

The fourth outcome indicator of the program is household dietary diversity score, HDDS i.e., the average treatment effect on the treated was found to be statistically insignificant in Stratification and Nearest neighbor matching type. But in Radius and Kernel matching method, commercialization has statistical significant impact on participants at p<0.01 probability level of significance. Commercialized households consumed about an average of 0.425 dietary diversity score per 24

hours higher than Non-commercialized households in Radius and Kernel matching.

Table4. Propensity Score Matching ATT result: Impacts of agricultural commercialization on household dietary diversity score (HDDS)

Matching type	No. Treated	No. Control	ATT	Std. Err.	t-value
Stratification	148	135	0.206	0.267	0.772
Radius	148	135	0.418	0.151	2.769***
Kernel	148	135	0.432	0.166	2.605***
Nearest neighbor	148	42	0.135	0.273	0.495
Average ATT of Radius and Kernel matching			0.425		

Source: Computed from own survey, 2020

Note:***, indicates statistically significant at 1% probability level of significance

V. Impact Estimation of ATT for Agricultural Commercialization on the Share of Household Food Expenditure (SHHFE)

Table 5 shows the ATT result lies between 10.9% in Kernel and 13.1% in Nearest neighbor and statistically significant at (p<0.01) probability level of significance. Besides, the ATT result in Stratification and Radius matching algorithm is 11.10% and 11.70%.Commercialized households have less spent an average of 11.70 % than Non-commercialized households at 2019/2020 surveyed year. This means Commercialized households are more food secure than Non-commercialized households.

Table5. Propensity Score Matching ATT result: Impacts of agricultural commercialization on the share of household food expenditure (SHHFE)

Matching type	No. Treated	No. Control	ATT	Std. Err.	t-value
Stratification	148	135	-0.111	0.035	-3.186***
Radius	148	135	-0.117	0.018	-6.515***
Kernel	148	135	-0.109	0.028	-3.878***
Nearest neighbor	148	42	-0.131	0.025	-5.283***
Average			-0.117		

Source: Computed from own survey, 2020

Note: ***, indicates statistically significant at 1% probability level of significance

So, all of the matching techniques are crucial and significant in the matching estimates and at the end the result of each estimate becomes statistically significant at (p<0.01) probability level of significance. However, HDDS in Stratification and Nearest neighbor matching are not significant. This means the impacts of agricultural commercialization on food security is insignificant.

8 Conclusions and Recommendations

This research was motivated to examine the impacts of agricultural commercialization on food security in Kobo Girana Valley Development Program (KGVDP), Amhara region. It is also intended to evaluate the extent or status of commercialization and food security in the area. A cross- sectional data were collected from a total of 297 sample households each (148 treated and 149 controls) used for the analysis of the research in the area and both descriptive and econometric analysis was used.

In descriptive statistics, there is a significant difference in the mean of age, off-farm income and oxen between Commercialized and Non-commercialized households at 1% probability level of significance. The accessibility of the market had also a significant difference at p<0.001. On the other hand, sex and educational status of both groups have no statistically significant difference.

The extents of Commercialized households are medium and high where as Non-commercialized households have low levels of commercialization.

In Commercialized households the HFIAS of the access-related conditions, the finding shows it is only 34.46% (n = 51) are food secure, whereas the remaining 65.54% (n = 97) of surveyed households have experienced problems of food insecurity. Looking at the finding on the basis of the HFIAS severity level, 59.59% of households encountered access problems "rarely," 35.49% "sometimes," and 4.92% "often" during the last 1 month of the

study period. In HFIAS score, 67.57% (n = 100) were most food secure and 32.43% (n = 48) were medium food insecure. Also, in HFIAS prevalence, 25.63%, 67.51% and 6.86% of the respondents are food secure, mildly food insecure and moderately food insecure (access) respectively. Besides, in Non-commercialized sample households of the HFIAS of the access related conditions, the findings show all households are food insecure. Based on the findings of HFIAS severity level, it can be observed that 31.58% of households encountered access problems "rarely," 47.37% "sometimes," and 21.05% "often" in the last 1 month of the study period. Based on HFIAS score, all Non-commercialized households were most food insecure. With HFIAS Prevalence, 2.58% of the respondents who are food secure while the rest 33.37%, 47.37%, and 21.05% are mild, moderate and severely food insecure (access) consecutively.

Based on CI; 77.03% and 22.97% of Commercialized households are food secure and insecure respectively. On the other hand, 36.49% and 63.51% of Non-commercialized households are food secure and food insecure consecutively. In FVS and HDDS; almost all Commercialized and Non-commercialized households are food insecure. Based on the SHHFE; 62.16%, 35.81% and 2.03% of commercialized households are food secure, medium food insecurity and high food insecurity respectively. On the other hand, 25.50%, 34.23%, 34.22% and 8.05% of Non-commercialized households are secure, medium food insecurity, high food insecurity and very high food insecurity consecutively.

From the econometric analysis, variables like age, off-farm income, oxen and market have a significant effect on the probability of participation in agricultural commercialization. Age and off-farm income were statistically significant at the 5% level of significance whereas oxen and the accessibility of the market were statistically significant at the 1 % level of significance. The PSM model results the impacts of agricultural commercialization on food security based on the outcome variables of food security (HFIAS score, CI, FVS, HDDS, SHHFE and). In HFIA-score; The ATT of Commercialized households have scored an average of less than Non-commercialized households by 12.86. In CI, the result witnessed that Commercialized households have consumed an average of 524.762 Kilocalories per day higher than Non-commercialized households. Based on FVS: Commercialized households have consumed an average of 2.69 food varieties per week than Non-commercialized households. The SHHFE of the ATT result indicates Commercialized households have spent on food an average of 11.70% less than Non-commercialized households. In Stratification and Nearest neighbor matching method; Commercialization has no significant impact on HDDS. However, in Radius and Kernel matching agricultural commercialization has significant impact on HDDS. In this case, Commercialized households have more dietary diversity by 0.425 than Non-commercialized households.

In general, agricultural commercialization has a significant and positive impact on food security in the area.

Based on the overall result and conclusion of the study, the following policy recommendations are forwarded. Agricultural commercialization and food security are strongly and positively related to most outcome indicators of food security in the area. Polices that enhance agricultural commercialization of small holder households' is essential in the area. Also, the accessibility of the market and oxen are positively and significantly affect the probability of participating in agricultural commercialization. Therefore, improving smallholder households' access to the market by providing adequate infrastructure should be supported, as well as measures that ensure farmers' access to improved inputs and technologies like Tractor that can potentially raise Cereal and Cash crop production thus promotes agricultural commercialization of households and ultimately improves food security.

However, using cross sectional data to examine the impacts of agricultural commercialization on food security might not make it possible to identify the long run impact of agricultural commercialization. Thus, making a research based on time series data analysis is advisable.

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