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Does Contract Farming Improve Smallholder Farmers Income? The Case of Avocado Farming in Kenya

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ABSTRACT
Contract farming is seen by its proponents as a tool for creating new market opportunities as well as for providing credit and training, leading to increased incomes of smallholder farmers. Critics, however, argue that contract farming encourages unequal bargaining relationships with agribusiness firms and is likely to pass risks to farmers, thus favouring large scale farmers at the expense of smallholders. Another school of thought contends that the effect of contract farming on the livelihoods of smallholder farmers is context specific and depends on the enterprise in question. Yet, there is a dearth of empirical evidence from such studies in Sub-Saharan Africa. We use data collected in 2012 from 100 smallholder avocado farmers in Kandara district in Kenya, obtained using multistage sampling technique, to examine the effect of contract farming on household income. Because of lack of pre-treatment data and the possibility of selection bias due to observable characteristics, we use propensity score matching technique to construct controls for the treatment group. The results indicate that contract farming has a positive and significant effect on avocado income. However, further analysis reveals that contract farming does not have any significant effect on the total household income of smallholder avocado farmers. Instead, support services such as interlinked credit and provision of information should be taken into consideration in contract farming because of their potential benefits for smallholders.

Key words: Contract farming; Smallholder; Household income; Avocado; Impact; Sub-Saharan Africa

1.0 Introduction

To the extent that about 70% of the population in sub-Saharan Africa live in rural areas and depend on agriculture for their livelihoods (Nnadi et al., 2012), improving smallholder farmers' access to markets both locally and internationally could be one of the strategies to achieving the 8 millennium development goals. Kenya in particular has 90% of smallholder farmers in all but the arid regions engaging in the production of horticultural products (Mutuku et al., 2004). Yet, fewer than 2% do so directly for export (Bawden et al., 2002). The low participation in the export market has been attributed to challenges related to increased consumer demand for high quality products linked to the rising number of supermarkets in developed countries (Dolan et al., 2002; Henson et al., 2008) and food safety regulations.

Smallholder farmers can be empowered to take advantage of new market opportunities for high value agricultural products which have emerged as a result of increasing global consumption of these products, particularly vegetables and fruits (Temu and Temu, 2006). With most of the world's rural poor engaging in agriculture, encouraging smallholder's access to global export markets of high value products is vital in increasing incomes and hence alleviation of poverty, which is predominant in Sub-Saharan Africa.

The production and supply of high quality products often require financial investments which most smallholder farmers cannot afford. Smallholders further face other disadvantages including poor infrastructure and lack of capital (Omosa, 2006), lack of access to up-to-date market information, difficulty in accessing technical advisory services and agricultural inputs (World Bank, 2008). Additionally, engagement in agricultural activities requires post-harvest

facilities for supply of quality produce. Lack of these amenities limits smallholder participation in the market value chain (Ibid, 2008).

Measures have been put in place to enhance farmers' access to markets. For instance, globalization and the use of internet have created new opportunities for smallholders to improve their position in the international market place. However, it has been noted that globalization favours large scale farmers who are considered reliable business partners and generate lower transaction costs (World Bank, 2008). The Government of Kenya has also played a regulatory role through the Horticultural Crops Development Authority (HCDA) and with the support of extension officers to improve smallholders' participation in the horticultural export market. However, lack of multi-skilled extension agents has led to piece-meal extension service delivery to clients usually faced with multiple problems, resulting in low rates of technology adoption (Republic of Kenya, 2012). With the inefficiency of government extension services, the private sector is being viewed as an alternative to promote smallholder farmers access to technology and training, which is key in increasing productivity and stimulating growth (Daniel and Hanson, 2013) hence market access.

Contract farming (CF) is one of the schemes involved in enhancing backward and forward market linkages in horticultural production in Sub-Saharan Africa, and in Kenya in particular. Contract farming is an agreement between a farmer and a purchaser established in advance of the growing season for a specific quantity, quality, and date of delivery of an agricultural output at a price or price formula fixed in advance (Setboonsarng, 2008). While there is evidence that contract farming can have a positive impact on farmers' welfare (Miyata et al., 2009, Olomola, 2010, Wainaina et al., 2012), there is paucity of empirical evidence on its impact on the income of smallholder avocado farmers in Kenya. This study aimed at examining the effect of participation in contract farming on the income of smallholder avocado farmers in Kandara District in Kenya.

2.0 Impact of Contract Farming on Income: A Review of Literature

The subject of smallholder farmers' participation in contract farming is principal for policy makers seeking to promote rural economic growth and development. In the preceding years, policies focused on macroeconomic and sectoral policies, which ignored the market failures constraining smallholders supply response (Barrett and Carter, 1999). This led to the emergence of microeconomic and institutional policies, mainly contractual arrangements, which boosted smallholder participation in agricultural value chains (Barrett et al., 2011). Specifically, contractual arrangements involving processors, agro-exporters and farmers organized in groups, are increasingly seen as a means of overcoming the market imperfections that led to the failure of macroeconomic and sectoral adjustment policies (Gow, 2000). Yet, smallholder farmers' involvement in agricultural value chains and access to markets is limited (Barrett et al., 2011).

Participation of smallholders in contract farming is influenced by socioeconomic and institutional factors. Smallholders are constrained in terms of asset ownership such as water for irrigation and land which often limit their production. Similarly, smallholder farmers' limited access to production technologies and institutional factors like credit, training and uncertainty regarding new risks deter their participation in such schemes. The welfare impact of smallholder participation in contract farming on income is controversial. Some authors

contend that the effect of contract farming on the livelihoods of smallholder farmers is context specific and depends on the enterprise in question (Gow, 2000). At its best, contract farming can significantly improve the income of smallholder farmers. Furthermore, contracts facilitate access to credit, farming inputs and technology necessary for increasing production of non-traditional lucrative crops and reduce marketing risk (Glover 1984, Williams and Karen, 1985). However, under some conditions, contract farming has been found to harm rural households or lead to limited gains (Glover and Kusterer, 1990). In addition, some contracts favour large scale farmers and consequently poorer growers may be left out of the development process (Runsten, 1992; Little and Watts, 1994). When farmers invest in specific assets and become over dependent on their contract crops, they may lose bargaining power vis-à-vis the firm, forcing them to accept less favourable or exploitative contract terms (Warning and Key, 2002). Over reliance on cash crops can make households more vulnerable to price fluctuations. Hence, participation in contract farming may subsequently lower household incomes.

Where contract farming has not been successful, cases of poor co-ordination among parties, unfavorable terms and conditions and post determination of prices which are dictated by export markets have been reported (Da Silva, 2005). Consequently, this has resulted in adverse selection, moral hazards and violation of contract. The mode of interaction between farmers, buyers and other stakeholders involved determines the efficacy of a contract scheme. Over the years, various models have been put across to explain these relations. Eaton and Shepherd (2001) suggested five models that can be adopted in contract farming arrangements including: nucleus, informal, centralized, multipartite, and intermediary model.

The centralized model involves a centralized processor and/or buyer procuring from a large number of small-scale farmers. The cooperation is vertically well integrated and most of the time several services such as pre-financing of inputs, extension and transport are provided. The nucleus estate model is a variation of the centralized model where the contractor not only sources from independent farmers but also has its own production facilities (an estate plantation). Multipartite model involves a company working with other institutions or NGOs. This type is particularly helpful when establishing a new venture. Once the cooperation between the firm and the farmers is working well, the link between the parties can be circumvented and so the multipartite slowly develops into the centralized model.

The distinction between the multipartite and intermediary model is that intermediaries organize everything on behalf of the final buyer starting with input supply, extension service, payment of the farmers and final product transport. Intermediaries handle several thousands of outgrowers. This is the type of model employed in avocado production in Murang'a where the Avocado Growers Association of Kenya (AGAK) is the intermediary. It organizes for the purchase of produce by Vegpro (K) Ltd, which is the buyer, and facilitates trainings and payment for several smallholder avocado farmers in the region. Informal arrangements vary between casual oral agreements and regularly repeated marketing transactions, which are characterized by the absence of written contracts.

3.0 Methodology

3.1 Data

The data used in this study were derived from household surveys carried out in 2012 over 100 smallholder farm households growing improved avocado varieties (Fuerte and Hass) in Kandara division. Kandara division, which is part of Kandara district in Murang'a County, has eight locations namely Kibage, Gaichanjiru, Ng'araria, Ithiru, Kagunduini, Muruka, Githumu and Ngurueini. Kandara district lies within four agro-ecological zones namely, Lower Highland (LH), Upper Midland (UM) 1, UM2 and UM3 (MoA, 2006). The rainfall pattern in the area is bimodal ranging from 800mm to 2600mm on average, while the type of soil is Humic Nitisols. Kandara district covers an area of 235km^2 out of which 193km^2 is under agricultural production. Maize production for subsistence and horticultural crops, mainly fruit production under small scale predominate the farming system in the study area. Nevertheless, horticultural marketing structure is not well organized despite the regions' close proximity to major urban markets such as Thika and Nairobi (Maina et al., 2010). Consequently, farmers are exploited by middlemen who buy farm produce at low prices and sell them at higher prices in the urban and export markets (Maina et al., 2010).

Multistage stratified random sampling was used to select the respondents for this study. Kandara district was purposively selected because it has the highest concentration of avocado and is the largest supplier of avocado for export and local markets compared to other avocado producing zones in the country (Kabbucho, 2004; USAID Kenya, 2008). In the selection of locations, existence of avocado farmer groups was considered crucial because farmers' engagement in contract farming in the area was tied to group membership. The groups were contracted to a buyer through a regionally based organization known as Avocado Growers Association of Kenya (AGAK)[1]. As a result, group members formed a sub-sample of the contract farming participants. Out of eight locations in the division, Muruka and Ngararia were selected purposively because they had well established avocado farming groups and a high concentration of avocado production and marketing. A total of seven out of ten groups was selected based on group size, group composition i.e. gender representation, group maturity and registration with AGAK. Sixty five respondents were selected randomly from the seven groups proportionate to the size of the group to form the treatment group. A comparison group comprising of thirty five households with similar socio-economic and bio-physical characteristics as participants except membership in avocado groups and contract farming were randomly drawn from the same locality as the treatment group.

However, although most groups were registered in AGAK, it was found that some of the farmers were passive group members and were not selling through the association as anticipated. This led to a reduction of the treatment (participants) sample size from sixty five to thirty eight. The remaining 27 passive group members who were also side-selling formed the non-participants' subsample, increasing the sample size for the control group (non-participants) from thirty five to sixty two.

Household surveys were conducted through a structured questionnaire, which captured information on the following aspects: demographic characteristics of household members,

[1] AGAK is an umbrella body that coordinates farmers groups engaged in avocado production and marketing. It is particularly charged with identifying prospective buyers and negotiating contract terms with the contracting firms on behalf of the farmers. The negotiation is done between the exporting company and AGAK

crop production, input and labour use, produce marketing, financial services (credit and savings) and contract farming. Information collected in the household questionnaire was restricted to the May 2011 to April 2012 production season. Propensity score matching was used to examine the impact of participation in contract farming on total household income. Total household income rather than farm income was used for this study since its overall objective was to determine the potential of contract farming for boosting farmers' total household income. In addition, in keeping with reallocation of resources among multiple enterprises in smallholder farming systems, contract farming was deemed to have multiplier or spill over effects beyond farm income. Nevertheless, the effect of CF on avocado income was also established to help in understanding the extent to which CF impacts on household income.

3.2 Analytical Framework

Any attempt to attribute specific outcomes to specific interventions faces the fundamental problem of missing data owing to the inability to observe an individual's outcome in both the counterfactual and the treatment state (Ravallion, 2001; Cameron and Trivedi, 2005; Imbens and Wooldridge, 2009). Yet, the counterfactual is necessary to observe the effects of an intervention on an individual population unit. A simple approach in estimating the impact of participation in a program on income would be to compare the outcome of participants and non-participants if participants were a random sample of all those qualified (Bryson et al., 2002). However, where requirement is not fulfilled, selection bias may render the simple approach unfeasible.

Several authors have come up with approaches to overcome the aforementioned challenge chief of which include randomised designs, the double difference estimator, instrumental variable estimation, propensity score matching, regression discontinuity and pipeline methods[2]. In this paper, we adopt a quasi-experimental design and use propensity score matching (PSM) method to estimate the effects of participation in contract farming on household and avocado income. The choice of PSM for this study was motivated by the lack of observational data on the control group, thus requiring construction of a statistical comparison group based on a model of the probability of participating in the treatment (contract farming) using observed characteristics. Compared to experimental design, PSM reduces selection bias and gives robust results since it only evaluates individuals within the common support region. Yet, the validity of PSM depends on two conditions, namely (a) conditional independence (i.e. unobserved factors do not affect participation) and (b) sizeable common support or overlap in propensity scores across the participant and non-participant samples. There are two main drawbacks of PSM that are related to the two requirements. The first drawback relates to Conditional Independent Assumption, in which case PSM only estimates treatment effects where there is support for the treated individuals among the non-treated. However, there is evidence that controlling for bias due to observable characteristics is more important than controlling for bias due to unobservables (Heckman et al., 1998).

[2] See Rubin (1974, 1977); Angrist and Imbens (1991); Abadie (2003); Heckman and Vytlacil (2005); Cameron and Trivedi (2005); Imbens and Wooldridge, 2009; Shahidur et al. 2010 for a comprehensive review of the approaches.

Second, PSM is a 'data hungry' estimation method since it requires a large number of variables to estimate participation and outcomes as well as a large and roughly equal number of participant and non-participant observations so that a substantial region of common support is found. Nonetheless, there is evidence that small samples can suffice where a single- treatment programme is being evaluated, as in our study, than where a multiple treatment programme is being evaluated, because the support problem is more demanding in the multiple treatment case (Bryson et al., 2002)

The first step in the PSM model involves estimation of a binary model in this case the Logit, which enables us to estimate the farmers' probability of participating (propensity scores) based on their basic characteristics. The model is specified as follows:

$$p(X \equiv Pr(D = 1|X) = E(D|X)) \quad \text{..... (1)}$$

Where D = {0, 1} is the indicator of exposure to treatment, in this case participation in contract farming, and X is the multidimensional vector of pre-treatment characteristics such as age, gender, household size, farm size, access to credit, distance to extension and road status. A smaller set of variables was preferred to ensure that the results obtained are robust (Pirracchio et al., 2012) and to reduce the problem of larger variance due to some treated cases being discarded from the analysis or control units being used more than once (Augurzky and Schmidt, 2000).

After estimation of the propensity scores, the potential outcomes are then defined by Y^1 (D^1) for the total population. The treatment effect for the population is written as:

$$\tau = Y^1 - Y^0 \quad \text{..... (2)}$$

A problem arises because only one of the potential outcomes is observed for each individual. Therefore estimating the individual treatment effect τ is not possible and one has to concentrate on average treatment effects (Roy 1951; Rubin 1974). Three parameters of interest for measuring average treatments effects namely Average Treatment effect on the Treated (ATT), Average Treatment effects on the Untreated (ATU) and Average Treatment Effect (ATE) have been used in literature. The Average Treatment effect on the Treated (ATT) gives us the expected treatment effect of contract participation, which is the difference between the actual income and the income if households did not participate in contract farming. ATT is defined as:

$$ATT = E(Y^1 - Y^0|D = 1) = E(Y^1|D = 1) - E(Y^0|D = 1) \quad \text{..... (3)}$$

where:

Y^1 is the income when the farmer participates in a contract, Y^0 is the income when he does not participate in contract and D denotes participation in contract, where D=1 if a farmer participates and 0=otherwise.

The second parameter is the Average Treatment effect on the Untreated (ATU) which is the average response to treatment for non-contract farmers (untreated group) stated as:

$$ATU = E(Y^1 - Y^0|D = 0) = E(Y^1|D = 0) - E(Y^0|D = 0) \quad \text{..... (4)}$$

The third parameter of interest is the Average Treatment Effect (ATE) which is the average response to treatment for a random sample from the population. This is given as:

$$ATE = E(Y^1 - Y^0|D = 1) = E(Y^1|D = 1) - E(Y^0|D = 1) \quad \text{..... (5)}$$

Since the aim of the study is to find out whether it is worthwhile for the smallholder avocado farmers to participate in contract farming, i.e. if indeed participation improves their income, the treatment effect of interest in this case is the ATT, because it answers the policy question of whether farmers should continue participating in contract farming or not. This parameter gives the expected income for participants.

After estimating propensity scores, matching of controls to each treatment using selected matching algorithm is done. Common matching algorithms used are Nearest-Neighbour Matching, Radius Matching, Kernel Matching, and Stratification Matching. In this study, kernel, nearest neighbour and calliper matching were used because they have been found to give limited bias in estimation. Nearest neighbour matching was implemented using five nearest neighbours with replacement and calliper (0.03). Kernel based matching was done using a band width of 0.01 while calliper matching used a calliper of 0.05.

4.0 Results and Discussion

4.1 Farm Household Characteristics

Table 1 provides summary statistics of the sampled households. According to the results, the sampled households are on average 64 years old, with no significant difference in age noted between participants and non-participants. Sixty five percent of the sampled households were male headed with no significant differences in gender observed between participants and non-participants. Further, the results indicate that the sampled household heads attained an average of seven years of formal education and that those participating in contract farming have significantly higher levels of education than non-participants ($p<0.01$), thus suggesting that education could be an important determinant of participation in contract farming. On average, the sampled households have four members per household, of which about 54% are economically productive while the rest are dependents aged between 0-14 and above 64 years. According to the data, there is no significant difference in household size and household composition between participants and non-participants. About 56% of the sampled households are found to belong to an agricultural group, with the statistical analysis indicating a strong association ($p<0.001$) between group membership and participation in contract farming. Groups provide farmers with information on production and marketing and other services like credit which are essential for participation in contract farming. With regard to access to agricultural services, the households are on average 4.1 km away from the nearest agricultural extension service and neither participants nor non-participants are significantly closer or further away from the extension service providers.

Table 1: Socioeconomic Characteristics of the Sampled Households

Variables	Units	Participants (n=38) Mean	Non-participants (n=62) Mean	Total (N=100) Mean	Test statistic
Age	Years	63.24(11.52)[a]	64.55 (10.52)	64.07 (10.87)	-0.584
Proportion of male farmers	%	71.05	61.29	65	0.987
Education	Years	8.79(4.78)	6.57 (4.46)	7.41 (4.69)	2.356**
Household size	Number	3.71(2.00)	3.98 (2.18)	3.88 (2.10)	-0.628
Dependants	Number	1.37(1.08)	1.65 (1.24)	1.54 (1.18)	-1.136
Economically productive members	Number	2.16(2.10)	2.08 (1.64)	2.11 (1.82)	0.205
Agricultural group membership	%	82	45	59	12.917***
Distance to the nearest extension	Km	3.87(2.99)	4.30 (3.91)	4.14 (3.58)	-0.590
Access to credit	%	81.58	62.9	70	3.913***
Total Household asset	KES	48467.16(29619.38)	46834.37 (29252.31)	47454.83 (29253.47)	0.27
Farm size	Acres	2.30 (1.80)	2.02 (1.38)	2.13 (1.86)	0.715
Fuerte productive trees	Number	6.16 (4.40)	6.56 (4.61)	6.41 (4.51)	-0.436
Hass productive trees	Number	8.68 (5.26)	6.05 (5.63)	7.05 (5.61)	2.330**
Total productive trees	Number	14.84 (7.24)	11.85 (7.53)	13.46 (7.21)	1.510*
Average price per piece of Fuerte	KES	1.98 (1.08)	1.29 (0.56)	1.55 (0.88)	4.555***
Average price per piece of Hass	KES	2.98 (1.25)	2.33 (0.71)	2.55 (0.97)	2.844**
Total household income	KES	134487.6 (62331.84)	134297.9 (62055.98)	134370 (61845.61)	0.015

***, **, * denote significance at 1%, 5%, and 10% respectively; [a] Figures in parentheses are standard deviations

On average, approximately 70% of the households have access to credit[3], with significantly more participants than non-participants having access to credit, thus indicating that there is an association ($p<0.001$) between credit access and participation in contract farming. Credit alleviates liquidity constraints that majority of smallholder farmers in Sub-Saharan Africa face. Thus, credit enables farmers to purchase inputs such as fertilizer and certified seedlings, for the production of quality avocado fruits.

The total value of household assets is estimated at KES 47454, but there is no significant difference in the value of assets owned by participants and non-participants. On average, the sampled households own 2.13 acres of land and have about 14 productive trees of mainly Fuerte and Hass avocado varieties. The average number of productive trees of Fuerte and Hass is 6 and 7 respectively. Fuerte and Hass are export varieties with Hass being the most preferred variety in the international market, which perhaps explains why farmers participating in contract farming have significantly higher number of productive trees of Hass than do non-participants. Likewise, contract farmers have significantly higher number of productive trees in general than do non-participants.

With regard to prices, farmers receive an average of KES 1.55 per piece of Fuerte sold while Hass variety fetches them an average of KES 2.55 per piece. However, participants receive significantly higher price per piece of Fuerte and Hass varieties as compared to non-participants implying that contract buyers offer better prices for farmers produce. The sample households derive income from crops, livestock and off-farm activities and the average total household income is KES 61845 per year. However, the results suggest that there is no significant difference in the amount of total household income received by contract and non-contract farmers.

4.2 Effect of Contract Farming on Household Income

The logit results provided in Table 2 indicate that the model was fit at 5% level of significance. Further, the results suggest that factors such as education, access to credit and road status were significant in determining farmers' participation in contract farming. The significant and positive effect of access to credit is probably because farmers who can access credit are able to purchase farm inputs as well as proper storage and transport facilities. This ensures that they deliver fresh quality fruits, which fetch better prices and hence boost their income. Likewise, education is a positive and significant determinant of participation in contract farming, which is consistent with conventional economic theory on the role of literacy in improving conceptualization of information and making economically viable decisions in financial markets. This finding is corroborated by empirical results from a study by Owuor (2009) where education was found to determine farmers' participation in micro-credit schemes. Lastly, road status has a positive and significant influence on farmers' participation, albeit the relationship is weak. The results suggest that farmers who have access to better roads are more likely to participate in contract farming than those who do not.

[3] Access to credit is used in this paper to refer to households who reported to have applied for credit whether they received it or not. Likewise, households who did not apply for credit because they did not need the credit are considered to have access to credit. Note that our definition of access to credit differs from the usual definition which considers only households who received credit as those with access to credit. The decision to construct a proxy for credit was to overcome the challenge of endogeneity of credit access, which is inherent in the latter definition.

Good roads facilitate transportation of fruits to designated collection points and finally to the airport, which ensures that fruits reach the market in good condition and on time. Moreover, exporters could be attracted by the good infrastructure, which facilitates rapid transportation of the fruits to the pack house thereby reducing post-harvest losses.

Table 2: Marginal Effects of Variables Used to Estimate Propensity Scores

Variable	Marginal Effect	Standard Error	Z
Age	0.0003665	0.0054807	0.07
Household size	-0.0080553	0.024373	-0.33
Education	0.0331572	0.0108342	3.06***
Farm size	-0.0650976	0.0641564	-1.01
Access to credit	0.2227028	0.1030233	2.16**
Distance to extension	-0.011476	0.0126773	-0.91
Road status	0.1944104	0.0997874	1.95*
Ownership of mobile phone	-0.1692947	0.1386534	-1.22
Number of observations	100		
LR Chi2 (8)	16.31**		
Pseudo R2	0.1222		

***, **, * denote significance at 1%, 5%, and 10% respectively

After running the propensity score, the common support was satisfied (Figure A.1) as well as balancing the distribution of covariates between the two groups as indicated by the low pseudo R^2, high total bias reduction and the insignificant p-value of the likelihood ratio test after matching (Table A.1).

4.2.1 Effect of Contract Farming on Avocado Income

Results of the effect of grower participation on avocado income are presented in Table 3. As shown, participation in CF has a positive and statistically significant effect on avocado income where participants are expected to increase their income by KES 5386 to KES 7441 per year. The findings are consistent with those of Wainaina et al. (2012) which found that CF had a positive and significant effect on farmers' income from poultry production in Kenya. Increase in avocado income of contract farmers in this study can be attributed to the benefits that come along with CF. It could be that contract farmers had better access to technical advice that improved their production in terms of quality and positively influenced household decision making on marketing. Another possibility could be that farmers might have received better prices from CF which led to increase in avocado income. Further, it is likely that contract farmers had access to ready market for their produce which reduced post-harvest losses. Tripathi et al. (2005) reported that there was reduced price and yield uncertainty in potato contract farming in Haryana, India, whereas in the non-contract farming system price uncertainty existed in a large extent. Given the mode of contract farming in Kandara, where AGAK is the intermediary, it is definite that AGAK played a chief role in linking farmers to the market and had greater bargaining power on avocado price per piece offered by the buyer to contract farmers as revealed in earlier discussion that contract farmers receive significantly higher prices per piece of Fuerte and Hass than non-contract farmers.

Table 3: Effect of Contract Farming on Avocado Income

Matching Algorithm	Observations	ATT	Standard Error	t test	ATE	ATU
Kernel Based	95	6645.77	3094.78	2.150**	6795.13	6650.47
Calliper	95	7441.23	2855.73	2.606**	6828.08	6547.57
Nearest Neighbour	100	5386.30	21944.88	1.530*	7590.90	7683.07

***, **, * denote significance at 1%, 5%, and 10% respectively

4.2.2 Effect of Contract Farming on Total Household Income

Table 4 shows results of the effect of contract farming on total household income. Results for all matching methods indicate that participation in contract farming has no significant effect on total household income of the sampled households. Similarly, Benfica et al. (2006) found that total crop and household incomes between participants and non-participants in tobacco sector in Mozambique were not different. With regard to this, analysis by Benfica et al. (2006) indicated that there were insignificant returns to participation in tobacco contract farming in Mozambique at low landholdings, but significant returns were realised at highest land holdings threshold for the crop and total household income levels. The results in this study imply that CF does not have spill over effects on other farm and non-farm enterprises. Possible reasons could be because both contract and non-contract farmers had similar land sizes implying that contract farmers could not expand agricultural production even though they had higher avocado income. Further, owing to old age, there is a possibility that farmers may not have benefited from spill-over effect associated with increase in avocado income since they were not able to invest in off-farm work which require their labour, skills and knowledge. Another prospect is that perhaps contract farmers spent most of their time tendering avocado trees and hence could not invest in other sectors, which could boost total household income.

Table 4: Effect of Contract Farming on Total Household Income

Matching Algorithm	Observations	ATT	Standard Error	t test	ATE	ATU
Kernel Based	95	5590.54	13756.70	0.406	-4841.46	-10806.61
Calliper	95	6107.52	15183.04	0.465	-3404.24	-9169.11
Nearest Neighbour	100	8883.08	21944.88	0.399	1284.65	2401.74

5.0 Conclusion and Recommendations

The objective of this paper was to examine the effect of contract farming on income of smallholder avocado farmers in Kandara district. Using PSM method on 100 households, our results indicate that participation in contract farming had a positive and significant effect on avocado income but did not significantly affect farmers' total household income. Instead, other factors that significantly influence participation in contract farming and the extent of participation may be critical when designing an intervention that aims at improving the livelihood of smallholder incomes. Since farmers had similar land sizes, signifying the limited potential for expansion of avocado sector, the government and private sectors should

consider providing improved avocado varieties to contract farmers at affordable prices to increase production. Credit facilities are necessary in improving farmers' participation in contract farming and access to inputs. Policies should be put in place to encourage provision of inputs under contract. Inputs can be given at lower interest rates to promote participation. Furthermore, education was significant in determining farmers' participation. Farmers can be trained on avocado tree husbandry, such as spraying and grafting to ensure production of quality fruits which might fetch better prices in the global market and eventually lead to increased income. The government and other entities should improve the rural infrastructure, especially roads which significantly influenced participation so as to improve market access. Further studies should focus on the contractual arrangements between farmers and contractors which might be crucial in affecting farmers' income. In addition, since there were more men than women in the avocado sector as noted above, future research should concentrate on the role of gender in the avocado value chain and the effects on intrahousehold income.

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Appendices

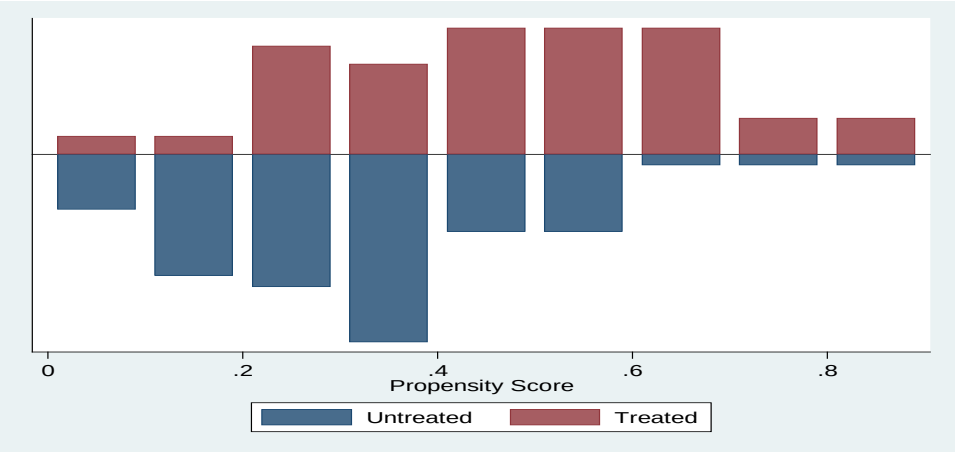

Figure A.1. Histogram of Estimated Propensity Scores

Table A.1. Quality Indicators Before and After Matching

Matching Algorithm	Pseudo R2 before Matching	Pseudo R2 after Matching	LR Chi2 (P-value) before Matching	LR Chi2 (P-value) after Matching	Mean standardized bias before matching	Mean standardized bias after matching	Total % |bias| reduction
Kernel Based	0.12	0.10	15.97 (0.043)	13.26(0.103)	21.3	7.0	67.14
Calliper	0.12	0.09	15.97(0.043)	12.40 (0.134)	21.3	5.9	72.30
Nearest Neighbour	0.12	0.08	15.97 (0.043)	11.60 (0.170)	21.3	9.0	57.74