Smallholder Avocado Contract Farming in Kenya: Determinants and Differentials in Outcomes

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Abstract:
Avocado is a non-traditional export crop of economic importance in Kenya. Commercialization of the fruit through contract farming is a viable alternative for improving the welfare of majority of smallholder farmers involved in its production. This paper explores factors influencing the participation of smallholder farmers in avocado contract farming and decomposes those contributing to differentials in quality and quantities of fruit harvested and sold by contract and non-contract farmers. Findings from a probit analysis indicate that adoption of *Hass* and *Fuerte* varieties, hired labor, and information on production and marketing significantly influenced participation in contract farming. Results from gap analysis, using Oaxaca-Blinder decomposition, showed that differences between contract and non-contract farmers in quality and quantities of harvested and sold were due to endowment and structural differences. The results imply that closing the observed gap will require policies aimed at facilitating better access to land and training of farmers in good agricultural practices among other support services.

Key Words*:* Avocado, contract farming, gap analysis, Oaxaca-Blinder decomposition

JEL: Q 10, Q11, C 13

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1. Introduction

In Kenya, avocado is a non-traditional export crop whose auspicious market demand can be exploited to build a robust and dynamic agricultural sector (Knopp and Smarzik, 2008). The production of avocado is dominated by smallholder farmers who constitute 85% of total growers of the fruit in the country (HCDA, 2010). Kenya is an important supplier of avocado to the European Union. Compared with many other avocado exporting countries, Although Kenya enjoys a unique position due to its production season, with additional advantage emanating from the more competitive shipping costs relative to South Africa, which is its African competitor (HCDA, 2010). Survival in the global avocado market, however, depends on the establishment of a strong link between rising demand for the fruit and the GlobalGap[2] certification requirement (Goedhuys and Sleuwaegen, 2016). Moreover, Kenya's inability to adjust her production profile to the evolving global demand for *Hass* variety poses a treat for maintaining her market share (ITC, 2016). This unfolding offers a strong case for contract farming as a potential tool for integrating smallholder avocado farmers into national and global value chains.

The government of Kenya, in collaboration with partners such as USAID and Embassy of the Kingdom of the Netherlands, has implemented several programs to improve avocado production, quality and the overall export performance of the sector by providing farmers with quality seedlings on credit, training them in Good Agricultural Practice (GAP), and linking them to exporters through formal contracts. The programs also found that with the new requirement for Global Gap certification, marketing constraints, and high production costs, contract farming offers an opportunity through which farmers could benefit from production while also ensuring that the country remains competitive in the global market (Solidaridad, et al. 2016). Furthermore, the National Agribusiness Strategy (RoK, 2012) has identified contract farming as an important pathway for enhancing smallholder access to markets.

In spite of these interventions, many smallholders are still losing out on the benefits of avocado production due to their non-participation in contract farming. Omolo et al. (2011) noted that about 94 percent of farmers sell their fruit to middle men or brokers who offer relatively low prices. Besides the low price, farmers also experience loss in fruit quality due to poor harvesting. The reasons for farmers' participation or non-participation in avocado contract farming are not clear. The high percentage of farmers losing out from the benefits of avocado production shows that interventions to ensure farmer's linkage to market through contract farming have not yielded much fruit. This suggests that research should go beyond investigating factors influencing participation and non-participation to include underlying differences between contract and non-contract farmers.

The general literature and various studies on Kenya (Wainaina et al., 2012); Mwambi et al., 2013; Warning and Key, 2002; Birthal et al., 2008; Man and Nawi, 2010; Cahyadi and Waibel (2013) and Tatlidil and Akturk (2004) exploring contract farming incentives did not investigate differences between contract and non-contract smallholder farmers in avocado production outcomes. Production outcomes such as quality and quantities of avocados produced sold are important performance indicators that show the productivity, efficiency and competitiveness of

[2]GlobalGap is B2B pre-farm gate standard that covers the whole agricultural production process with a 13-digit number that uniquely identifies each producer and individual member of a producer group in the GLOBALGAP database

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smallholder avocado production. These outcomes are also planning instruments that could be used to improve avocado production, project new markets and the overall sector's growth rate. Increase in avocado production and volume of sales while maintaining avocado quality, increases farmer's income and improves their welfare.

Given that the quality and quantities of avocados produced and sold are indicators that demand driven growth in avocado will create employment opportunities and increase the income of rural households, investigating differences between the two groups in these production outcomes and identifying underlying factors for these differences provides important additional information for policy intervention. This paper therefore emperically analyzes smallholder avocado contract farming, determinants and differentials in outcomes between contract and non-contract farmers. The paper seek out to answer the following questions: What factors influence smallholder participation in avocado contract farming? To what extent do quality and quantities of avocados harvested and sold by contract and non-contract smallholder farmers differ?

This paper contributes to contract farming literature in three ways. First, it analyzes factors influencing smallholder participation in avocado contract farming for which there is a dearth of information. Second, we have developed a framework for empirical analysis of the factors that can be used to explain differences in avocado quality and quantities harvested and sold by contract and non-contract farmers taking into account selectivity bias that could result in overestimation of contract effect. To the best of our knowledge, rigorous empirical evidence of gap analysis in contract farming is scarce. Finally, findings from this study could have policy implications on how smallholder avocado farmers can reap maximum benefits from production through contract farming given the current high local demand and export potential of the fruit

The rest of the paper is organized as follows. Section 2 presents an overview of avocado production in Kenya. Section 3 presents the theoretical framework used to analyze the determinants of contract farming and mean differences in sold and harvested fruit quantities between contract and non-contract avocado farmers. Section 4 presents the data used for analysis. Section 5 presents the empirical analysis and is followed by a section on conclusion.

2. Overview of avocado production in Kenya

The agricultural sector is the most prominent economic activity in Kenya. In 2016, the sector accounted for over 26 percent of the total GDP, 75 percent of the labor force, and over 50 percent of the export revenue (KIPPRA, 2017). The horticulture industry, which covers the fruits, vegetables and cut-flower sub-sectors, is the most dynamic and fastest growing component of the agricultural sector. Avocado is one of the major export crops within the horticultural fruits sub-sector. In 2015, avocado exports amounted to 31,227 metric tons compared with other major fruit exports like mango and passion fruit which registered 14,048 and 404 metric tons respectively (Match Maker Associates, 2017). Data from FAOSTAT shows that between 2000 and 2016, the area covered by avocado harvest increased from 4.12 to 10.30 hg, yield increased from 126.29 to 170.83 hg/ha, and production rose from 52.03 to 176.04 tons (FAOSTAT, 2000-2016)

About 70 percent of avocado fruit is grown in Central and Eastern regions, with the former being the leading producer. The main varieties of avocado grown are *Hass* (20%) and *Fuerte* (80%). For export, the *Hass* variety accounts for approximately 20 percent while *Fuerte* accounts for 10 percent (Horticulture Validated Report, 2014). Avocado farmers are now shifting production from

Fuerte to *Hass* in response to change in demand in the western European market where the ready-to-eat Hass avocados are favored.

3. Methodology

3.1 Theoretical foundations of contract farming

The popularity of contract farming schemes in developing countries originates from the private-sector oriented growth strategy of Structural Adjustment Programs (SAPs) introduced in the 1970s. Contract farming was envisioned as an institutional framework for transformation of rural agriculture by linking smallholders to export markets through the private sector. The theoretical basis of contract farming is embedded in the Transaction Cost Theory, which is explained further by the New Institutional Economics (NIE) school of thought. Coase's (1937) seminal paper on contract farming posited that all business transactions involve costs resulting mainly from uncertainty and asymmetric information. The two interrelated factors occur mostly in rural areas where market failure is pervasive. Contract farming, thus, serves as an effective mechanism for reducing the overall cost of farm production as well as lowering risk and market uncertainty (Bijman, 2008). However, contract farming has been criticized for leading to social differences among smallholder farmers through increased concentration of land ownership and loss of independence for the growers (Echanove and Stefen 2005).

On the other hand, the appeal for contract farming as a tool for rural integration through the crop export value chain stems from empirical studies, which show that the practice creates production incentives for smallholders who may differ in economic and social endowment (Prowse, 2012). Empirically, we adopt the non-separable agriculture household model (AHM) by Singh et al. (1986). Using this model, farmers' decision to participate in contract farming can be modeled as a utility maximization problem defined as:

$$U = U(C^m, C^a, l_i Z^h) \quad (1)$$

where U is the utility; C^m, C^a, l_i and Z^h refer to market purchased goods, farm produced goods, leisure, and other household characteristics. The household maximizes utility subject to time constraint on the labor allocation equation such that:

$$L = L_{fc}(\tau) + L_{fnc} + L_{off} \quad (2)$$

In Equation 2, the household labor (L) is used for on-farm activities for contract $L_{fc(\tau)}$ and non-contract crops L_{fnc} as well as off-farm labor L_{off} needs. In addition, the household faces a production function q that is concave and twice differentiable consisting of vector of inputs (X) which is conditional on contract participation (τ), farm labor dedicated to contract farming (L_{fc}), contract participation (τ), and production technology characteristics (E). This relationship is explained in equation 3.

$$q = q\big(X(\tau), L_{fc}(\tau), \tau, E\big) \text{ where } \tau \geq 0. \quad (3)$$

The utility function is subject to a budget constraint as specified by equation 4, such that by relaxing the assumption of a perfect market, transaction cost is incorporated into the budget constraint through shadow prices.

$$P^s C + (t^c + p^m - p^s)C^m = p^s q - wX(\tau) + w^n L_{off} - (t^q - p^m + p^s)q^m + Y \qquad (4)$$

where p^s and p^m are endogenous shadow price and market price respectively, $C = C^m + C^a$ and represents total consumption of purchases and produced goods, t^c and t^q denote transaction in purchase and sales of commodities respectively, $q = q^a + q^m$ and denotes total crops produced for consumption and marketing, w and w^n are price of inputs and off-farm wage earned, and Y denotes other transfers received by households. Assuming an interior solution, the optimal conditions for contract participation are determined by the Kuhn-Tucker first order conditions as shown in Wooldridge (2002).

Borrowing from literature and theory, the stud hypothesizes that smallholder participation in contract farming is influenced by household characteristics which include: age, education level, gender of farmer, household size, agriculture as main occupation; physical and financial assets such as: number of *Hass* and *Fuerte* trees owned, value of assets, off-farm income and land ownership; social capital includes frequency of attendance in avocado meetings, trust in other people, training in avocado agronomy, hired labor and transaction costs proxied by cost of marketing avocados, information on avocado production and marketing (Coase, 1937; Mwambi et al., 2013). The contract participation model can thus be specified as:

$$P_i = F\left(H, A_{i,} T_i, S_i : \beta\right) + \varepsilon_i \qquad (5)$$

where participation (P) is the dependent variable formulated as one if the farmer participates and zero otherwise, i denotes a farmer, and a nonlinear function *F(.)* include a vector of covariates that include household characteristics(H), physical and financial assets (A), transaction cost (T) and social capital (S). β is a vector of parameters to be estimated and ε is the stochastic error term assumed to be normally distributed. Both logit and probit models are standard binary dependent variable models for estimating probability. The probit model however has the attraction of being motivated by a latent normal random variable that lies between $-\infty$ and βX_i such that the area under the curve represent the probability of participating in avocado contract farming (Cameroon and Trivedi, 2005).

3.2 Oaxaca-Blinder decomposition of differences in mean outcome

Decomposition aimed at identifying and quantifying the contribution of various factors to changes or differences in mean outcome is attributed to the pioneering work of Solow (1957). Since then, labor market and wage discrimination researchers have extensively used the Oaxaca-Blinder (OB) decomposition model to quantify the contribution of labor, capital, and the unexplained portion known as Solow's residual or total factor productivity to changes in economic growth in several countries. This decomposition technique emanates from the seminal works of Oaxaca (1973) and Blinder (1973).

Based on a review of empirical literature, we hypothesize that smallholder contract farmers differ from non-contract farmers in terms of quality and quantities of avocados harvested and sold (Cahyadi and Waibel, 2013; Tatlidil and Akturk, 2004), and that socio-economic factors influencing participation in contract farming may directly or indirectly contribute to these differences. It is also assumed that farmers' adoption of different avocado agronomic management practices such as use of inorganic fertilizer and manure, frequency of pruning, and record keeping in relation to inputs and production contribute positively to these differences.

The empirical OB regression equation models the relationship between quantities of avocado (Q_i) harvested and sold by the farmer i and explanatory variables for both contract and non-contract farmers as follows:

$$lnQ_i = \begin{cases} \beta_1 x_1 + \varepsilon_1 \; if \; c \\ \beta_0 x_0 + \varepsilon_0 \; if \; nc \end{cases} \tag{6}$$

where $\varepsilon's$ are error terms that are assumed to be normally distributed while c and nc denote contract and non-contract farming. Following Jann (2008), the difference or gap in quantity of avocado produced and sold $(Q_n - Q_{nc})$,as per equation 6, can be decomposed into three parts as follows:

$$\bar{Q}_n - \bar{Q}_{nc} = \underbrace{(\bar{X}_c - \bar{X}_{nc})\beta_{nc}}_{\substack{Endowment \\ Effect}} + \underbrace{\bar{X}_{nc}(\beta_c - \beta_{nc})}_{\substack{Coefficient \\ Effect}} + \underbrace{(\bar{X}_c - \bar{X}_{nc})(\beta_c - \beta_{nc})}_{\substack{Interaction \\ Effect}} \tag{7}$$

Where the endowment effect (or explained effect) represents differences between contract and non-contract farmers in quantities produced and sold due to differences in the level of observable covariates. The coefficient effect, commonly referred to as returns or structural effect, measures the outcome of non-contract farmers if their endowments were rewarded as contract farmers. The interaction effect is due to the simultaneous change of endowment and estimated coefficient. Neuman and Oaxaca (2004) have shown that with adjustment, the decomposition (equation 7) can be amended to incorporate the selectivity term to correct for selection bias as follows:

$$\bar{Q}_n - \bar{Q}_{nc} = \underbrace{\bar{X}'_{nc}(\hat{\beta}_c - \hat{\beta}_{nc})}_{Coefficient} + \underbrace{(\bar{X}_c - \bar{X}_{nc})\hat{\beta}_{nc}}_{Endowment} + \underbrace{(\hat{\theta}_c \hat{\lambda}_c - \hat{\theta}_{nc} \hat{\lambda}_{nc})}_{Selectivity} \tag{8}$$

The selectivity term measures the contribution of selection effects to the observed gap in quantities of avocado harvested and sold.

3.3 Variable Measurement and Summary Statistics

The dependent variable for participation decision is a dummy which equals one if a household participated in avocado contract farming and zero otherwise. Transition and non-contract farmers were classified as non-contract farmers and those with established contracts as contract farmers. This grouping was necessitated by preliminary analysis which indicated that transition and non-contract farmers had more commonalities in various characteristics than contract farmers; and

although transition farmers had formed groups, most of them had not yet signed any contract agreements.

For difference in participation between smallholder contract and non-contract farming, the dependent variables are the mean difference in quality and quantities of avocados harvested and sold. Avocados are sold per piece according to traditional parameters such as size, shape of the variety and quality. Quality considerations include skin color, external skin defects and maturity. Farmers were asked about the quantities of avocados harvested, quality and quantities sold. Avocado quality was coded as a categorical variable with 1 indicating high quality, 2 medium/normal quality and 3 low quality. Since both high and medium/normal are usually the quality grades purchased by exporters or supermarkets, high and medium qualities were combined and recoded as dummy with one representing good quality avocados sold and zero as low quality. Approximately 8,780 avocados were harvested by farmers while 7,777 pieces were sold. Contract farmers however harvested and sold 10,832 and 9,820 pieces while their non-contract counterparts harvested and sold 7,738 and 6,739 pieces. About 63 percent of contract farmers rated their avocados sold as high or normal quality while this was true for 42 percent of non-contract farmers

The explanatory variables used for this analysis are based on empirical literature. Table 1 contains mean comparison tests for contract and non-contract farmers. Contract and non-contract farmers did not differ in educational attainment, household size, and main occupation as farmers. The mean age of non-contract participants was 60 years, but contract participants were two years older. The asset value of contract farmers was twice as much as that of the non-contract farmers.
Contract farmers also owned 21 percent more acres, have thrice as much productive *Hass* trees, received more information on avocado production and marketing and had more household members trained in avocado agronomy than their non-contract counterparts.

Farmers on average spent 65 cents per piece to market their avocados but contract farmers spent 8 times more and hired about 66 percent of labor for production while non-contract participants hired only 43 percent of labor. Contract farmers were more frequent at avocado group meetings than non-contract participants. Questions of farmer's trust in other people were aggregated as an index. The reasoning behind a possible association of trust and contract farming is that people, who in general trust that others will look after their interests, have fewer concerns about the risk and uncertainty of entering contract agreement. The trust index however revealed no significant difference in their trust and perception of other people. Contract farmers applied on average 5.75 kg of fertilizer and pesticide, while only 4.16 kg was applied by non-contract farmers. Eighty eight percent of contract farmers grafted their avocado trees while this was true for only 75 percent of non-contract farmers. The two groups also differed in the frequency of tree pruning and record keeping on inputs used and production.

4. Data

The data for the empirical analysis was collected as part of a research project on 'Productive Employment in the Segmented Markets (PRESM) for Fresh Produce' funded by the Dutch Science Foundation (NWO) and implemented by the Partnership for Economic Policy (PEP), in collaboration with the VU-University of Amsterdam and Amsterdam Institute for International Development (AIID), University of Nairobi, Fresh Produce and Exporters Association of Kenya (FPEAK), and PRIME-ITC (coordinated by LEI Wageningen UR) in November–December 2015.

A multistage sampling approach was used to select the county, sub-county, villages and households. In the first stage Murang'a County in Central region of Kenya was purposefully selected because it is the main avocado producing counties in Kenya. Kandara sub-county was then selected in the second stage from seven sub-counties of Murang'a County. This sub-county was selected because it is one of the main avocado producing sub-counties in Muranga and the County government has thrown its weight behind avocado production. Besides, the County has experienced substantial expansion in avocado production over the previous ten years in both volume and exports and therefore was found to provide an interesting case study to analyze the implications for rural development.

Three main household groups based on their participation status regarding the avocado marketing contracts were selected in the third stage. The first group covered farmers involved in contract farming; the second group comprised of farmers who had new contractual arrangements with Small and Medium Enterprises from the 2016 avocado season; the third group contained farmers without contracts who sold their avocado to middle men or brokers. A sampling frame of all avocado farmers in the area was provided by the Kandara sub-county agricultural office. From the sampling frame 266 contract farmers were sampled. Those who had just signed contracts consisted of four farmer groups, each consisting of 50-60 farmers. From this group, 30-40 farmers were randomly sampled from each farmer group totaling up to 144 farmers. A total of 380 farmers without contracts were also randomly sampled from the list.

The survey instruments consisted of two questionnaires. A household questionnaire was administered to all households in the sample while a Farmers' Organization (FO) instrument was administered to all households engaged in avocado framers group. The household questionnaire collected information on the number of mature avocado trees owned, household demographic composition and resources, various income sources and a variety of household contextual characteristics. Information was also collected on avocado production and marketing, knowledge of avocado farmers' agronomy, harvesting, marketing, access to credit and banking. The respondents were also asked to rate their trust in other people with regards to reliability, meeting their interest and fairness on a scale of 1 to 5.

Table 1: Comparison of Mean Values for Avocado Contract and Non-Contract Farmers

	Non-contract N=524		Contract N= 266		All farmers N=790		
Independent variables	Mean	SD	Mean	SD	Mean	SD	T- stat
Age of farmer (years)	60.55	13.95	62.44	13.39	61.19	13.78	-1.82*
Gender dummy (Male=1)	0.77	0.42	0.82	0.38	0.79	0.41	-1.61
Household size (no of persons)	3.59	1.84	3.67	1.77	3.62	1.82	-0.57
Education of household head (years)	7.85	3.94	8.22	3.50	7.97	3.80	-1.30
Main occupation of household head (farming=1; 0 otherwise)	0.87	0.34	0.88	0.33	0.87	0.33	-0.46
Value of assets (Ksh)	29,431.7	73105.0	60,655.3	165330.0	39,944.9	113759.5	-3.67***
Non-farm income(Ksh)	108,513.6	240115.3	111,685.8	158,795.8	109,581.7	216,076.9	-0.19
Total land owned (acre)	1.96	1.82	2.37	2.11	2.10	1.93	-2.86***
Number of productive *Hass* tress	5.61	12.13	14.49	19.66	8.60	15.65	-7.82***
Number of productive *Fuerte* trees	4.71	9.07	5.83	8.46	5.09	8.88	-1.69*
Received information on prod. & marketing (yes=1)	0.20	0.40	0.35	0.48	0.25	0.43	-4.48***
Household member rec. training in avocado prod. year (yes=1)	0.23	0.42	0.74	0.44	0.40	0.49	- 15.98***
Cost of marketing avocados (Ksh/piece)	0.02	0.08	0.16	17.98	0.65	12.09	-9.98***
Hired labor (yes=1)	0.43	0.50	0.66	0.47	0.51	0.50	-6.14***
Frequency of avocado meeting attendance (no. in a year)	8.06	4.12	12.85	12.15	10.01	7.96	-4.71***
Trust in other people (index)	0.57	0.13	0.58	0.13	0.58	0.13	
Household member rec. training in avocado prod. year (yes=1)	0.20	0.40	0.35	0.48	0.25	0.43	-4.48***

Fertilizer & pesticide application rate (kg/tree)	4.16	2.54	5.72	1.92	4.68	2.46	-8.787***
Grafting of trees (yes=1)	0.74	0.44	0.88	0.33	0.79	0.41	-4.52***
Pruning at least once a year (yes=1)	0.56	0.50	0.70	0.46	0.61	0.49	-3.737***
Record keeping on input used & prod (yes=1)	0.07	0.25	0.16	0.37	0.10	0.30	-4.007***

Asterisks ***, **, * denotes significant at 1%, 5% and 10%, respectively

5. Empirical results and discussion

The average marginal effects from the probit model are presented in Table 2. Preliminary diagnostic tests for multicollinearity ruled out the existence of collinearity amongst the variables. The probit model correctly predicted 87 percent of the observed outcome with most variables showing high significance levels. A Wald Chi-square value of 126.55, significant at 1 percent, was an indication that our model fit the data well. The Pearson or Hosmer-Lemeshow's goodness of fit test returned a probability greater than the Chi square value of 0.8757. Classification test of model sensitivity and specificity with a cut-off of 0.5 percent also showed a high model fit.

The result revealed that the age of the house head was positive and significant, showing that as farmers grew older and gained more experience in avocado farming, they become more confident to participate in contract farming. Household assets were significant and positive, implying that assets aid and increase the chances of farmer's participating in contract farming. This finding corroborates the study of Warning and Key (2002) who found a significant and positive effect of assets on peanut contract farming in Senegal. Mwambi et al. (2013) however found no significant relationship for poultry farming in Kenya.

Furthermore, an increase in the number of productive *Hass* trees increased the chance of participating in contract farming by 0.5 percentage points. This result can be explained by the fact that *Hass* is the most preferred avocado variety for export. Reason being that *Hass* is less prone to pests and disease attacks and has a longer shelf-life compared to *Fuerte.* As such, farmers with more *Hass* trees belong to a contract scheme as this increases their chances of participating in the export market. The result for the number of *Fuerte* trees was positive, but insignificant. This is probably due to the low export demand for *Fuerte* avocados which may not provide adequate incentives for farmers to participate in contract farming.

Hiring labor for avocado production and marketing was positively correlated with avocado contract farming, suggesting that as more farmers join contracts, there is a higher likelihood of hiring more workers. This is an indication that the sector could generate employment by using family labor as well as hired labor. A one percent increase in the cost of marketing avocados increased the probability of participating in contract farming by 63 percentage points. The perishability of avocados coupled with the cost of transporting the fruit probably explains why

most non-contract farmers sell their avocados at the farm gate at relatively lower prices. Hence, farmers who live in remote areas may find additional security in contract farming. This finding is in line with (Wang et al. 2014; Leung et al. (2008). Wainaina et al. (2012) however found that the distance to market reduced the likelihood of contract participation for poultry farmers in Kenya.

The frequency of meeting attendance in avocado group meetings significantly influenced contract participation and received marketing and production information increased the likelihood of smallholder participation in contract farming by 1.1 percentage points. This suggests that although being a group member is a necessary step to contract participation, active participation in the group through meeting attendance leads to more social interactions and group commitment to participate and upholding contract agreements. The acquisition of specialized information is vital for enhancing avocado quality and better prices for farmers. Man and Nawi (2010) made similar conclusion on access to information on production and marketing of vegetable contract farming in Malaysia.

Table 2: Probit regression of Factors influencing Participation in Avocado Contract Farming

	Maximum Likelihood Estimates			Average Marginal Effects	
	Coeff	SE	P-value	Coeff	SE
Age of household head (years)	0.010	0.005	0.026	0.002**	0.001
Gender dummy (Male=1)	-0.112	0.134	0.403	-0.027	0.032
Household size (no. of	0.043	0.034	0.200	0.011	0.008
Education of household head					
(years	-0.001	0.017	0.962	0.000	0.004
Main occupation of household					
(Farming=1)	-0.146	0.177	0.409	-0.035	0.043
No of productive *Hass* trees	0.022	0.006	0.000	0.005***	0.001
No of productive *Fuerte* trees	-0.002	0.007	0.817	0.000	0.002
Land owned (acre)	0.011	0.030	0.720	0.003	0.007
ln total assets (Ksh)	0.028	0.056	0.621	0.007**	0.014
Non-farm income (Ksh)	-0.005	0.019	0.812	-0.001	0.005
Credit constrained (yes=1)	0.003	0.153	0.984	0.001	0.037

Hired labor (yes=1)	0.003	0.001	0.000	0.001***	0.000
Cost of transporting avocado to market (Ksh)	2.609	0.896	0.004	0.631***	0.211
Trust in other people (index)	0.176	0.402	0.661	0.043	0.097
Frequency of avocado meeting attendance (no. in a year)	0.015	0.007	0.030	0.004**	0.002
Rec. information on avocado production & marketing (yes=1)	0.044	0.158	0.050	0.011**	0.038
House member rec. training on avocado prod. year (yes=1)	1.118	0.136	0.000	0.270***	0.030
Constant	-2.458	0.716	0.001		
Number of observations				777	
Wald chi2(18)				237.45	
Prob > chi2				0.0000	
Pseudo R^2				0.3270	
Pearson or Hosmer–Lemeshow ‘s test (Prob > chi2)				0.8647	
Correct classification				82.03%	

Asterisks ***, **, * denotes significant at 1%, 5% and 10%, respectively

Preliminary analysis showed that contract farmers were different from their non-contract counterparts in quantities of avocado harvested and quality sold. To delineate these gaps and explore the extent to which individual covariates contribute to these differences, Oaxaca-Blinder (OB) decomposition technique was used as outlined in the methodology section. The OB decomposition is based on regression analysis that proceeds in two stages. In the first stage, group-specific regressions models were estimated for avocado quality, quantities harvested and sold. In the second stage, mean values, and estimated parameters from the first stage regression were used for decomposition. Non-contract farmers were defined as the counterfactual group of interest from whose perspective the results are reported.

Two equations were estimated for checking robustness. In the first estimation, the inverse Mills ratio was calculated from the probit model of participation and included in the Oaxaca-Blinder decomposition as an additional variable in the production outcomes equations. The coefficients of the inverse Mills ratio were however insignificant in the quality and quantities of avocados sold estimates. In the quantities harvested equation, the inverse Mills ratio equations showed a marginal significance for only the endowment component of the individual variable contribution whiles the coefficient and interaction effects were insignificant. Even with the marginal significance in the endowment variable, the signs of the coefficients were not intuitive. The analysis therefore

proceeded with the OLS estimator for the OB decomposition. The first stage results were not presented because the interest was on the second stage. They can however be available upon request.

The OB decomposition results presented in Table 3 gives the mean predictions for contract and non-contract farmers, gap and its components (the endowment, coefficient and interaction effects) for quantities of avocados harvested, quality and quantities sold. The mean predictions and gaps for the three outcome variables were statistically significant at 0.01% level. In quantities harvested, both the endowment effect, i.e the proportion of gap due to differences in observable characteristics between contract and non-contract farmers, and the coefficient or structural effect, i.e. the portion of the gap attributed to the returns of the same observable and unobservable characteristics were both positive and statistically significant at one percent and ten percent respectively. The endowment effect contributed about 93.1 percent [(0.463/0.497)*100] to the overall gap while 58.4 percent. [(0.290/0.497)*100] was attributed to the coefficient effect. The gap was however lowered by the interaction effect by 51.5% [(-0.256/0.497)*100]. The interpretation of the interaction effect is however ambiguous since it captures both observable and unobservable effects. For quantities sold, the endowment effect accounted for 102 percent of the overall gap. The decomposition result for avocado quality sold contrasted with those in quantities harvested and sold. Only the coefficient effect was statistically significant and accounted for 70.6 percent of the overall gap. The endowment gap is consistent with most treatment effect literature on contract farming (Wainaina et al. 2012; Cahyadi and Waibel 2013; Warning and Key 2002) and study by Tatlidi and Akturk (2004).

The positive and significant endowment effects noted for both quantities of avocados harvested and sold and the marginal significant coefficient effects are indications that avocado contract farmers enjoy both endowment and structural advantage over their non-contract counterparts. The positive and larger endowment contribution may probably be because contract farmer asset levels are twice larger than non-contract farmers as indicated in the descriptive statistics. The positive and significant large coefficient effect suggests that difference in avocado quality was mainly due to the structural disadvantages of non-contract farmers in returns to observable and unobservable characteristics. The results suggests that even though equalizing resources between the two groups is a necessary condition for reducing the gap in quantities harvested and sold, it is not a sufficient condition for reducing the gap in avocado quality. Thus understanding the sources of these gaps is important for policies that would ensure avocado farmers receive adequate benefits from both endowment and the returns to their endowments. Detailed contribution of individual covariates presented in Table 4 sheds more light on the various effects.

Table 3: OLS Oaxaca-Blinder Aggregate Decomposition of Total Harvest, Sales and Quality

	Quantity harvested	Quantity sold	High quality grade
	Coeff	Coeff	Coeff
Mean prediction Contract farmer	8.745***	8.535***	0.627***
	(0.065)	(0.084)	(0.031)
Mean prediction Non-contract farmer	8.248***	7.957***	0.426***
	(0.052)	(0.074)	(0.023)
Difference	0.497***	0.578***	0.201***
	(0.083)	(0.112)	(0.038)
Endowment effects	0.463***	0.590***	-0.009
	(0.085)	(0.113)	(0.042)
Share of total gap	(93.2%)	(102.1%)	(4.5%)
Coefficient effects	0.290*	0.398	0.142**
	(0.168)	(0.253)	(0.075)
Share of total gap	(58.4%)	(68.8%)	(70.6%)
Interaction effects	-0.256	0.410	-0.050
	(0.256)	(0.254)	(0.077)
Share of total gap	(51.5%)	(-70.9%)	(24.9%)

Asterisks ***, **, * denotes significant at 1%, 5% and 10%, respectively. Robust standard errors in parenthesis

A detailed decomposition of variables contributing to the gap in production outcomes between contract and non-contract farmers presented in Table 4 shows a clear contribution of the number of productive *Hass* trees owned, total land owned, household member received training in avocado agronomy, fertilizer and pesticide application rate as well as grafting of avocado trees, hired labor and pruning of trees at least once a year to the endowment gap. The descriptive statistics lends support to the contribution of these variables in widening the gap between avocado contract farmers and their independent counterparts. The positive and significant coefficient of *Hass* trees owned and household members received training in avocado agronomy showed that contract farmers are reaping higher returns from these endowments. On the other hand, the negative and significant effect of land owned, cost of transporting avocados to market and frequency of avocado group meeting attendance in the coefficient effect reduced the gap in quantities harvested. This suggests that non-contract farmers may have some structural advantage in quantities of avocados harvested.

Notably, these variables also contributed to the gap in quantities harvested. This is an indication that there is a close linkage between the production and marketing processes. Low yields result in lower quantities sold and income. The positive sign of information received on production in the endowment effect and the negative sign in coefficient effect could mean that, although non-contract farmers maybe disadvantaged in terms of endowment to production and marketing information, they may have possibly benefited from spill-over effect of information flow which reduced the gap in quantities sold.

In the coefficient effect, years of educational, the number of productive *Fuerte* trees owned, and cost of transporting avocados to market were also favorable to non-contract farmers in reducing the gap. The significant effect of *Fuerte* in reducing the gap could be due to the current expansion of fruit outlets where the local *Fuerte* variety is mostly sold. The contribution of transport cost in lowering the gap could probably be because non-contract farmers mostly sell their produce at the farm gate thus accruing some advantage in terms of transport cost. Also in the case of land, non-contract farmers could have scale requirement where they could split their land for commercial avocado production and also produce other crops for sale or consumption. Hence, policy for enhancing avocado sales should focus on strengthening areas where non-contract farmers have relative advantage and thus closing the endowment gap.

The age of the household, education, farming as main occupation, training received by household members and recording keeping on inputs and production were positive and significant in the coefficient or returns effect. The descriptive analysis in Table 2 showed that at 10 percent significant level, contract farmers were on average older than noncontract farmers. The difference in age endowment could perhaps reflect the returns to experience in avocado farming and quality produced by contract farmers. Although the descriptive statistics showed no significant difference between contract and non-contract farmers in terms of education and main occupation, contract farmers had more years of education and more of them had farming as their main occupation. This perhaps also explains the difference in returns of these variables in contributing to the gap in avocado quality sold. Avocado agronomy training received by household member and keeping records on input used and production also positively contributed to the gap in avocado quality.

This shows that enhancing human capital through training and extension services is essential for the quality of avocados produced and sold.

Table 4: Variables Contributing to Net Gap in Avocado Quality, Harvested and Sold Quantities

	Endowment Effect	**Coefficient Effect**	**Interaction Effect**
Quantities Harvested	Coeff	Coef.	Coef.
Variables			
No of productive *Hass* trees	0.150***	0.165**	0.104**
	(0.034)	(0.076)	(0.049)
No of productive *Fuerte trees*	-0.055	-0.119**	0.022
	(0.034)	(0.049)	(0.016)
Land owned (acre)	0.014**	-0.294***	-0.053
	(0.013)	(0.095)	(0.025)
Hired labor (yes=1)	0.036*	-0.230	-0.047
	(0.021)	(0.119)	(0.058)
Cost of transporting avocado to market (Ksh)	0.011	-0.230**	0.210*
	(0.010)	(0.119)	(0.112)
HH member rec, training in avocado prod. year(yes=1)	0.171***	0.489**	0.139**
	(0.056)	(0.207)	(0.061)
Group meeting attendance (no. in a year)	-0.013	-0.517***	0.133***
	(0.013)	(0.130)	(0.049)
Fertilizer and pesticide application rate (kg/tree)	0.033**	-0.058	-0.011

Grafted avocado tree(yes=1)	0.018**	0.204	-0.032
	(0.023)	(0.171)	(0.028)
Pruning of avocado trees (at least once a year (yes=1)	0.009*	0.020	-0.005
	(0.017)	(0.087)	(0.022)
Quantities Sold			
Education of household head (years)	-0.024	-0.494**	0.023
	(0.019)	(0.249)	(0.020)
No of productive *Hass* trees	0.173***	0.110	-0.070
	(0.043)	(0.112)	(0.071)
No of productive *Fuerte* trees	-0.065	-0.139**	0.026
	(0.040)	(0.069)	(0.020)
Land owned (acre)	0.014	0.241*	-0.044
	(0.018)	(0.135)	(0.029)
Hired labor (yes=1)	0.057**	0.002	-0.001
	(0.029)	(0.115)	(0.088)
Cost of transporting avocados to market (Ksh)	0.015	-0.388**	0.354**
	(0.014)	(0.190)	(0.181)
Rec. information on avocado production & marketing (yes=1)	0.303***	-0.758***	0.215**
	(0.079)	(0.287)	(0.085)

Grafted avocado trees (yes=1)	0.006	0.510**	-0.080**
	(0.030)	(0.241)	(0.041)
Quality Sold			
Age of household head (years)	0.016	0.591***	-0.017
	(0.011)	(0.211)	(0.011)
Education of household head (years)	0.009	0.265***	-0.014
	(0.007)	(0.098)	(0.010)
Main occupation of household head (farming=1)	0.001	0.182*	-0.003
	(0.003)	(0.107)	(0.005)
Land owned (acre)	-0.017*	-0.031	0.006
	(0.010)	(0.052)	(0.010)
Hired labor (yes=1)	0.022*	-0.020	0.015
	(0.012)	(0.039)	(0.030)
House member rec. training in avocado prod. year (yes=1)	0.042	0.175**	0.121*
	(0.047)	(0.082)	(0.057)
Keeping records of input & production (yes=1)	-0.009	0.041**	0.025
	(0.008)	(0.021)	(0.014)

Asterisks ***, **, * denotes significant at 1%, 5% and 10%, respectively. Robust standard errors in parenthesis

6. Conclusions

This paper has empirically analyzed determinants of participation in smallholder avocado contract farming and differentials in production outcomes between contract farming and non-contract farmers using data from 266 contract farmers and 524 non-contract farmers from Murang'a County of Kenya. The results of our investigation showed that the number of *Hass* avocado trees owned, household assets, hired labor, training in avocado agronomy, information received on avocado production and marketing, cost of transporting avocados and frequency of avocado meeting attendance were important determinant of contract participation.

Gap analysis from the Oaxaca-Blinder decomposition for avocado quality and quantities of avocados harvested and sold by contract and non-contract farmers, revealed that a large portion of the gap in quantities of avocados harvested and sold were mostly explained by the endowment effect while the gap in avocado quality was due to the coefficient effect or returns to endowments. This suggests that interventions aimed at enhancing smallholder avocado commercialization should go beyond resource equalization to encompass programs that would enable non-contract farmers get returns from endowments as their contract counterparts.

The implication of this finding is that Kenya's competitiveness in the global avocado market is dependent on the alignment of production to the increasing demand for *Hass* variety fruit quality assurance which could be achieved through contract farming. Thus policy makers should ensure a wider scope of smallholder participation in avocado contract farming by encouraging farmers to take advantage of this growth opportunity to invest in *Hass* avocado farming. Other support services like training in avocado agronomy, innovative system of information dissimilation on new production techniques, marketing channels and prices and creating cheaper means of transportation for farmers to transport avocados to market would not only encourage participation in contract farming but also help preserve the quality considering the perishability of the fruit.

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