A Gendered Analysis of the Effect of Peanut Value Addition on Household Income in Rongo and Ndhiwa Districts of Kenya

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ABSTRACT

Agriculture constitutes a significant amount of the Kenya's Gross Domestic Product (GDP). However, a major characteristic of Kenyan agriculture is the predominance of primary production with a high concentration of women in the sector. Peanut production for instance is widespread in western Kenya under rural crop production system; serving as a cover, subsistence and commercial crop. As a commercial crop, peanut has the potential of generating income for rural households and thus help in reducing poverty and improving livelihoods. Moreover, higher incomes can be obtained through value addition activities. Despite the known benefits from value addition, farmers produce and market peanuts with little or no processing. Using survey data from 310 randomly selected peanut producers from two divisions; Ndhiwa and Rongo; a Propensity Score Method (PSM) was used to determine the gendered effect of peanut value addition on household income. From the results, farmers were found to undertake only one form of value addition, shelling. Although they appreciated the higher profitability associated with other forms of value addition like processing, inadequate capital to purchase processing equipment was a major constraint. The PSM results suggest that value addition raises household per capita income by Kshs.88 per day. Male headed households recorded higher levels of income compared to female headed households. This indicates that potential exists in peanut value addition as a possibility to raise farmers' household incomes. However, a diversity of value adding options should be promoted for adoption by farmers to sustainably improve peanut farmers' livelihoods.

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Introduction

Peanut (*Arachis hypogea L.*) also known as groundnut is a species in the legume family (Fabaceae) and among fifteen leading cultivated food crops in the world. It is a high value crop nutritionally and economically and is the sixth most important oil seed crop in the world (FAO, 2005). It contains up to 50% oil, 28% protein, and is a rich source of dietary fibre, minerals and vitamins (Nigam *et al*., 2004). Most of the crop is produced where average rainfall ranges between 600 to 1,200 mm, and mean daily temperatures are more than 20°C. According to FAO (2008) statistics, the world peanut production rose from 14 million tons in 1961 to 47 million tons in 2006, representing a 3.2% annual growth rate. The statistics further indicate that the global peanut harvested area increased at an annual growth rate of 0.7%, from about 17 million hectares in 1961 to about 22 million hectares in 2006. Although peanut is produced worldwide, the largest producers are China and India with a proportion of 41.5% and 18.2% of overall world production respectively, followed by Sub-Saharan African countries and United States of America (6.8%). Despite the fact that China and India produce the highest amount of peanuts, only 4% reaches the international market due to their high domestic demand.

In Africa, peanuts are grown in Western, Eastern and Southern parts of the continent. The major producers include: Nigeria, Senegal, Sudan and Ghana. With Kenya producing lower volumes compared to these countries. In Kenya, peanut growing areas include: Nyanza, Western, Coast, Eastern and Rift valley regions (Andima *et al.,* 2006). However higher outputs are recorded in Coastal and Western Kenya region comprising of Nyanza and Western Provinces with concentration in the Lower midland zones, under small scale (Jaetzold and Schmidt, 1982). The regions have at least two harvest seasons per year. The main systems of production include intercrops with maize, sugar cane, sorghum, finger millet, and small pockets of pure stand.

In many parts of rural Kenya, peanuts are becoming important for subsistence, cash income and as raw materials for agro-based industries. As food, peanut is used for human consumption in the raw, boiled or roasted forms. As edible oil and protein, the nuts are pounded and used as a vegetable oil for cooking, or made into paste and consumed with traditional foods like sweet potatoes, cassava and bananas among others. In addition, peanuts have shown to have specific health benefits including a reduced risk in the development of type 2 diabetes and cardiovascular disease. They can be used to cure stomatitis, prevent diarrhea, and beneficial for growing children, pregnant and nursing mothers. It is also a good source of riboflavin, thiamine, nicotinic acid and iron (Burn and Huffman, 1975). With the increasing cost of animal protein, peanuts have become an important source of protein in Africa (Okello *et al*., 2010). The haulms are either fed to livestock or used in compost or left in the fields as crop residue (Kiriro and Rachier, 1999). Peanuts, being a legume, are also used to improve soil fertility in the farming systems by fixing atmospheric nitrogen (Kiriro, 1993). This is of particular importance when considered in the context of rising prices for chemical fertilizers which makes it difficult for farmers to purchase them.

The crop is among the major agricultural food crops traded in the international market. Studies indicate that marketing of peanuts is done through different channels but without an organised marketing structure. Farmers produce peanuts and after harvesting they dry the peanut pods up to 8-10 % moisture content level or until the kernels brattle in the pods. The pods are packed in gunny bags weighing approximately 45 -50 kg dry weight. The packed peanuts are then sold either to the local market (for seed), or stored for on-farm processing and future sales. They are mainly marketed through farmer to farmer contacts, or through middlemen (Nasambu *et al*., 2010). Peanut farmer groups and farmer cooperatives also carry out marketing for their members. In the market, peanuts are sold as boiled, unshelled and shelled roasted nuts while some is sold in the confectionery trade (Kiriro, 1993). Value addition technologies have not been fully exploited and most of the peanuts are sold as whole kernels (Mutegi, 2010). There are several players in the groundnut market value chain who include; retailers, assemblers, brokers, whole sellers, middlemen, processors and super market chains.

Though peanuts can yield well in poor soils, the production has suffered a number of constraints. Of great significance has been the lack of high yielding varieties, poor agronomic practices and losses due to diseases including rosette and leaf spot diseases (Kiriro, 1993; Rachier, 1994; Mugisha *et al.*, 2004). These diseases can respectively cause up to 60-100% yield losses in groundnuts. To overcome the above challenges, research organizations like Kenya Agricultural Research Institute (KARI) Kakamega, with national mandate for peanut research; has developed strategies to increase productivity, development of better crop management technologies and of improved varieties, tolerant to rosette and leaf spot diseases. With this input, production trend has been on the rise. For instance, from an initial average of 0.5 tonnes per hectare, the production has risen to about 1.3 tonnes per hectare (KARI, 2007). This increase in production presents an opportunity for peanut farmers to increase their incomes through the sale of peanuts. Moreover, higher incomes can be obtained through value addition activities e.g. peanut butter, peanut paste, roasted and shelled nuts. Increased income will help improve reduce poverty and improve the livelihoods of farmers. This study therefore sought to understand the peanut value adding options available and the impact of value addition on household income in Ndhiwa and Rongo Districts of Kenya.

Materials and method

Study area: Rongo and Ndhiwa districts lie within the western region of Kenya. Rongo District lies within Migori County and its located in south western part of Kenya around Lake Victoria with a geographical co-ordinate 34°37′30″E a latitude 0°44′13″S. The district covers an area of 468km^2 with a population of 209,460 persons according to the 2009 population census report. This translates to an average household size of 4.7 persons and an average of 1.08 Ha per household. The area is divided into two Agro-Ecological zones UM1 and LM1 with a bimodal type of rainfall. The long rains occur between February and May (600-1000mm0 with over 60% reliability. The short rains on the other hand occur between September and December (300-700) with over 60% reliability. Most of the location however falls in the lower midland sugar cane zone with altitudes ranging from 1300-1500m above sea

level and annual mean temperatures of 19.3°C-20.8°C. The area is dominated by different soils ranging from black cotton sols, alluvial red, clay soils, nitisols, andosols and gleysols. The dominating food crops in this subzone during the first rainy season are maize, groundnuts, beans, sweet potatoes and indigenous vegetables. This climate highly favors sugarcane cultivation which is the main cash crop with large tracks in Awendo division. Horticulture is drawing much attention as a quick cash crop. This provides a suitable avenue towards agribusiness in the district.

Ndhiwa district on the other hand is found within Homa-bay County, in the south nyanza region, formerly Nyanza province on a geographical co-ordinate of 34° 22′0″E and 0° 44′0 ″S. The area lies in the lower midland (LM3) agro-ecological zone. It covers a total area of 711km^2 (638km^2 as arable land), with a population of 172,212 persons as per the December 2009 population census report. It is situated at an altitude of 1200-1400 meters above sea level, between the lower Lake Victoria basin and western Kenya. It receives on average about 1300mm of rainfall annually distributed in a bimodal pattern. The long rainy season occurs from February to June with peak in March-April, while the short rainy season is from August to November with its peak in October. The area has three types of soils; black soils (vertisols-cotton soils), silt loam and clay loam (luvisols). The vegetation is mainly savanna type with thick bushes and open grass. However, over the past 50 years, there has been a continuous decrease in vegetation cover due to increased agricultural activity. The area is therefore suitable for growing peanuts.

Empirical framework

In estimating the effect of value addition on income, it is not possible to observe the outcome of those farmers who participated in value addition had they not participated or the outcome of those who did not participate had they participated. While it is possible to address this problem in experimental studies by simply assigning households to treatment and control, it is not possible to do so under non-experimental studies. This is because value addition is not randomly distributed between two alternative group of households i.e. participants and non-participants, but rather households decide themselves whether to participate in value addition or not, based on the information they have. In essence, participants and non-participants may be systematically different in each case.

The decision to undertake value addition or not is not voluntary and may be based on individual self-selection. Farmers who decide to value add may have different characteristics from those who do not, and they may have decided to participate based on the expected benefits derived from it. Unobservable characteristics of farmers and their farms may affect both the participation decision and the welfare outcome, resulting to inconsistent estimates of the effect of value addition. For this reason, a propensity score matching (PSM) method was used to address the above challenges. However, a limitation of PSM is that unobservable variables that may affect both the outcome variables and choice of value addition are not accounted for directly; it assumes selection is based on observable variables. However, in

cross-sectional data, the presence of unobserved characteristics in the propensity score estimation can create mismatching and biased estimators.

Propensity Score Matching Technique

The technique is a two-step procedure. First, a probability model of participation in peanut value addition is estimated to calculate the probability (or propensity scores) of participation of each household. In the second step, each value adder is matched with a non-value adder with similar propensity score values, in order to estimate the average treatment effect for the treated (ATT). Several matching methods have been developed to match participants and non-participants of similar propensity scores. Asymptotically, all matching methods should yield the same results. However, in practice, there are trade-offs in terms of bias and efficiency with each method (Caliendo and Kopeing, 2008). In this study, Kernel-based matching (KBM) method was used. The basic approach here is to numerically search for "neighbors" of non-participants that have a propensity score that is very close to the propensity score of participants.

The main purpose of propensity score estimation is to balance the observed distribution of covariates across the groups of participants and non-participants (Lee, 2008). The balancing test is normally required after matching to ascertain whether the differences in the covariates in the two groups in the matched sample have been eliminated, in which case, the matched comparison group can be considered a plausible counterfactual (Ali and Abdulahi, 2010). Although several versions of balancing tests exist in the literature, the most widely used is the mean absolute standardized bias (MASB) between participants and non-participants suggested by Rosenbaum and Rubin (1983). Additionally, Sianesi (2004) proposed a comparison of the pseudo R^2 and p-values of the likelihood ratio test of the joint insignificance of all the regressors obtained from the logit analysis before and after matching the samples. After matching, there should be no systematic differences in the distribution of covariates between the two groups. As a result, the pseudo-R^2 should be lower and the joint significance of covariates should be rejected (or the p-values of the likelihood ratio should be insignificant). If there are unobserved variables that simultaneously affect the participation decision and the outcome variables, a selection or hidden bias problem might arise; to which matching estimators are not robust (Rosenbaum, 2002).

Assume D_i is a dummy variable equal to one if the individual i is a treated individual (i.e. a household participating in value addition) and zero if not. Assume also that Y_{i1} and Y_{i0} are the outcome variables describing household income patterns for unit i conditional on the presence and absence of treatment respectively. The treatment effect for the individual i measures the difference between the relevant outcome indicator with the treatment and the relevant outcome indicator without treatment. This is given by:

$$\Delta Y_i = E(Y_{i1}/D_i = 1) - E(Y_{i0}/D_i = 1) \qquad (1)$$

While the post treatment outcome can be observed, its value in the absence of a treatment (i.e. the counterfactual) is not. This is because, in household surveys, it is impossible to simultaneously observe someone in two different states. Consequently, the

components $(Y_{i1}/D_i = 1)$ and $(Y_{i0}/D_i = 0)$ are observable outcomes, whereas $(Y_{i1}/D_i = 0)$ and $(Y_{i0}/D_i = 1)$ are non-observable outcomes. By filling in the missing data on the counterfactual, propensity score matching provides a potential solution to the evaluation problem

More specifically, PSM methods are based on the Conditional Independence Assumption (CIA), which states that the outcome of the untreated state is independent of the treatment participation conditional on a particular set of observable characteristics, denoted by X (Rosenbaun and Rubin, 1983). This assumption is equivalent to the absence of selection bias based on the unobservable heterogeneity and is therefore expressed as;

$$(Y_{i0}, Y_{i1}) \perp D_i/X_i \tag{2}$$

This means that, given X_i, the outcomes of the non-treated units can be used to approximate the counterfactual outcome of treated units in the absence of treatment.

$$E(Y_{i0}/D_i = 1, X_i) = E(Y_{i0}/D_i = 0, X_i) \tag{3}$$

It is possible to condition participation on the propensity score denoted by p(x) rather than on observable characteristics x as indicated by Rosenbaum and Rubin (1983). The propensity score represents the probability of treatment conditional on the vector of observable characteristics and may be interpreted as the one-dimensional summary of the set of observable variables. This is expressed as follows;

$$P(X_i) = \Pr(D_i = 1/X_i) \tag{4}$$

It follows that the estimation of the counterfactual is:

$$E(Y_{i0}/D_i = 1, P(X_i)) = E(Y_{i0}/D_i = 0, P(X_i)) \tag{5}$$

Finally, the average treatment effect (ATE) for the individual i is measured by:

$$\Delta Y_i = E(Y_{i1}/D_i = 1, P(X_i)) - E(Y_{i0}/D_i = 0, P(X_i)) \tag{6}$$

Where Y_{i1} denotes the income when ith participates in value addition, Y_{i0} is the income of ith farmer who does not participate in value addition, and P denotes the value addition participation, 1=participate, 0=otherwise. The mean difference between observable and control is written as:

$$D = E(Y_1/P_i = 1) - E(Y_0/P_i = 0) = ATT + \varepsilon \tag{7}$$

Where ε is the bias also given by

$$\varepsilon = E(Y_0/P_i = 1) - E(Y_0/P_i = 0) \tag{8}$$

The true parameter of ATT is only identified if the outcome of treatment and control under the absence of value addition are the same. This is written as:

$$E(Y_0 / P_i = 1) = E(Y_0/P_i = 0) \tag{9}$$

In a regression framework, the treatment effects model is given by

$$R = a + bP_i + cX_i + e_i \tag{10}$$

Where P_i is a dummy variable that takes the value 1 if farmer i adding value and takes the value 0 otherwise, X_i is a vector of control variables such as farmer characteristics; *b* measures the impact of value addition on mean returns. Under the assumption of homogenous treatment effects, *b* identifies the average treatment effect as well as the treatment effect on the treated.

RESULTS AND DISCUSSION

The descriptive results shown Table 1 are disaggregated by value addition status. About 52% of the sampled households practiced value addition. Out of the total households, 66.5% were male headed households while 33.5% were female headed households. The proportion of male headed households engaged in value addition was slightly more than half that of female headed households (69% and 31% respectively). Regarding the level of education, 11.3% of the total sample had never accessed any formal education. A slightly more than half the population (55.2%) had accessed primary education while 24.2% secondary education. Only 9.4% had managed to access tertiary education, which included college and university. There is however no significant difference in the level of education between value adders and non-value adders.

There is a significant difference between those who accessed credit and those who did not; with 39.4% having accessed credit while 60.6% not having accessed credit (formal or informal). This resulted due to the risky nature of loans that hinder farmers from accessing credit, while some did not just want to access loans. Approximately 56% of the total value adders had access to credit. This indicates a possible correlation between value addition and access to credit. Apart from accessing information from agricultural extension agents, farmer groups also serve the same purpose and 80.3% of the sampled household heads belonged to some agricultural group. A significant proportion of value adders (86%) were members of such groups compared to (14%) who did not belong to any group. Slightly more than half of the sampled households (58.1%) had access to agricultural information while 41.9% did not.

Table 1: Descriptive summary of dummy variables (N=310)

Characteristic	Type	Value adders	Non-value adders	Total	t-statistic
Gender	Male	68.8	36.0	66.5	33.561***
	Female	31.2	64.0	33.5	
Education level	None	11.9	10.7	11.3	185.806***
	Primary	51.9	58.7	55.2	
	Secondary	25.6	22.7	24.2	
	College	10.6	8.0	9.4	
Credit access					
	Yes	55.6	22.0	39.4	14.052***
	No	44.4	78.0	60.6	
Group membership	Yes	85.6	74.7	80.3	114.013***
	No	14.4	25.3	19.7	
Extension agent access	Yes	67.5	48.0	58.1	8.065***
	No	32.5	52.0	41.9	
Training	Yes	53.1	37.3	45.5	2.529
	No	46.9	62.7	54.5	

Significance level: ***significant at 1%, **significant at 5%, *significant at 10%
Source: Survey data, 2012

From the results in Table 2, the average age of household heads involved in peanut production is 46 years and there is no significant difference in age between value adders and non-value adders (47 and 44 years respectively). This ranged from a minimum of 19 years to a maximum of 89 years indicating that those involved in peanut production are the active and energetic members of the society. The average land holding size is 1.40ha and value adders have a significantly larger proportion (1.52ha) than non-value adders (1.22ha). Approximately 0.4ha is allocated for peanut production with value adders allocating larger proportion of land for peanut production (0.55ha) than non-value adders (0.34ha). Many farmers (84.5%) however do intercrop their peanuts with maize, sugarcane, cassava among other crops.

When education level is expressed as years of schooling, the results indicate that the average years of schooling are 7 years. There is however no significant difference in the years of schooling between value adders (7.11 years) and (6.87years). This suggests a lack of significant effect between value addition and years of formal education. The mean number of contacts with extension agents is 4 years. However, peanut value adders had significantly higher number of contacts (5 times) than non-value adders (4 times) indicating a positive correlation between value addition and contact with extension agents (access to information). The mean value of assets is Kshs.125,240. There is however a significant difference in the value of assets owned by value adders (Kshs.152,880) and non-value adders (Kshs.95,752) indicating that households with higher value of assets have a higher propensity to participate in value addition. There is also a significant difference between value adders and non-value adders in the years of experience in growing peanuts, distance from households to the neatest

extension office, average income and the quantity of peanuts harvested per season. The average quantity of peanuts produced by value adders is approximately three times more than the average quantity produced by non-value adders (153kgs and 54kgs respectively).

About 81% of the sampled households are farmers, deriving their income from the sale of farm output. The average annual income per household is kshs.106, 000 which translates to Kshs. 26,500 per person per year. This in turn gives an approximate of kshs.72 per individual per day for an average of 4 adults, which is an equivalent of USD 0.85($1=Kshs.85). This amount is way below the world poverty line of $1.25 per person per day but slightly above the rural poverty line in Kenya of $0.6. However the large standard deviation shows that income is highly variable among the sampled households. This therefore shows that some households have very large incomes while others have very low income levels. This income variation is as a result of many factors and of most importance being the value assets in the household; this included the value of land, livestock mobile phones, vehicles, machinery, bicycles among others.

For the value adders, the average income per household per year was Kshs.144, 000. This in turn gives Kshs.98 per day per adult in a household of 4 adults which is equivalent to $1.16. This is very close to the world poverty line of $1.25 and way above the poverty line in Kenya of $0.6. The average income for non-value adders was Kshs. 64,500 translating to Kshs.44 per day per adult, which is equivalent to $0.52. This value is very low in relation to the world poverty line and still lower than the poverty line in Kenya.

Table 2: Descriptive summary of continuous variables (N=310)

Variable	Value adders	Non value adders	Total	Std. deviation	t-test
Age (years)	47.03	44.42	45.77	13.965	1.650
Education (years)	7.11	6.87	7.00	4.278	0.775
Household size	5.43	4.95	5.20	2.275	1.855*
Adult equivalent	3.64	3.43	3.54	1.685	1.099
Value of assets (Kshs)	152880	95752.0	125240.0	109705	4.738***
Experience (years)	12.19	9.24	11.10	10.638	1.872*
Distance to the main market (km)	3.78	4.11	3.94	3.499	-0.850
Contacts with extension agent(days/year)	4.69	3.64	4.18	3.173	-1.496
Distance to extension office (km)	4.42	5.56	4.9	3.936	-2.574**
Total land (Ha)	1.52	1.22	1.37	1.067	2.506**
Land allocated to peanuts (ha)	0.55	0.327	0.44	0.295	7.326***
Average income per year (Kshs)	144000	64500	106000	93395.7	6.540***

Quantity of peanuts harvested per season(kgs)	152.67	54.45	105.15	98.585	10.097***

Significance level: ***significant at 1%, **significant at 5%, *significant at 10%
Source: Survey data, 2012

The effect of peanut value addition on household income

The logit estimates of the participation propensity equation are presented in Table 3. The model has a Pseudo R2 value of 0.46 and a log likelihood value of 197.6. The model further provides information about some of the driving forces behind farmers' decision to participate in in value addition. The dependent variable takes the value of one if the farmer undertakes value addition and 0 otherwise. The result show that the coefficient of most of the variables hypothesized to influence participation have the expected signs and these include; gender of the household head, age of the household head, the household size, distance to the nearest market, the value of assets, number of contacts with the extension agents, the education level of the household head, the total size of the household land, the quantity of peanut produced, access to credit, the experience in growing peanuts in years, group membership and the total size of land allocated for peanut production.

The coefficient for distance to the market is negative and significant at 10% suggesting that the probability of participation in value addition diminishes as the distance to the market increases. One possible explanation for this scenario is the fact that household located far from the market are uncertain about market availability. Proximity to regular markets is important since it helps farmers meet clients at the shortest time possible.

Wealth related factors like the value of assets and size of land allocated to peanut production have a positive and significant at 10%. This implies that as the value of assets and land allocated to peanut production increases, it increases the probability of farmers' participation in value addition. Allocation of more land to peanut production enhances a quantity produced which in turn influences the decision of farmers to participate in value addition.

In addition, the coefficient of number of contact with extension agent is positive and significant at 10%. This implies that the probability of participation in value addition increases contact with extension officers increase. Similar studies by Doss and Morris (2001) found out that the number of contact with extension agent had a positive effect on adoption of agricultural innovations in Ghana. Moreover, farmers with higher levels of education had a high probability of participating in value addition. The coefficient of education level is positive and significant at 10%, which shows the importance of increased knowledge in influencing the decision to participate in value addition.

The quantity of peanut harvested has a positive and significant effect on the ability of households to participate in value addition activities. Larger quantities produced are able to cater for both consumption and marketing. This is because while some members of the household may need to market for income to be used for other activities in the house, the

food aspect of it is also very important. This case is supported by Berem *et al.* (2010) who established that the quantity of honey harvested had a positive and significant effect on the decision of households to participate in value addition. This is why those households producing fewer amounts of peanuts are likely to use it as food for the family as opposed to selling.

The results further indicate that access to credit has a negative and significant effect; at 1% on participation. This case is contrary to most economic constraint paradigm of adoption models which have found credit to be positive and significant impact on facilitating adoption of most agricultural innovations. This finding is inconsistent with the finding reported by Ngore *et al.* (2011) who highlighted access to credit as a key determinant to value addition by meat agribusiness operators in Kenya. A possible explanation to this could be because farmers allocated larger proportion of their loans to payment of school fees and production of major crops like sugar cane and maize.

Table 3: Determinants of participation in value addition-Estimated coefficients

Variables	Estimates		
	Coeff.	**SE**	**P>|z|**
Gender of the household head(1=male,0=otherwise	-0.1351	0.3934	0.731
Age of the household head (yrs)	0.0103	0.0176	0.556
Household size	0.0133	0.0938	0.887
Distance to the nearest market (Km)	-0.1910	0.0725	0.008***
Total value of assets (KES)	2.94E-06	1.60E-06	0.066*
Number of contact with the extension agent	0.0486	0.0280	0.083*
Education level of the HHH (yrs)	0.3826	0.2255	0.09*
Total land owned (Ha)	0.0381	0.1613	0.813
Quantity of peanuts produced (Kgs)	0.0336	0.0052	0.000***
Access to credit (1=yes,0=otherwise)	-1.2543	0.3573	0.000***
Experience in growing peanuts (yrs)	0.0132	0.0174	0.448
Group membership(1=yes,0=otherwise)	0.0392	0.4311	0.927
Size of land allocated to peanut production (Ha)	1.4693	0.8676	0.090*
Constant	-2.4738	1.1434	0.031
Number of observations	310		
LRchi2(13)	197.6		
Prob>chi^2	0.0000		
Pseudo R^2	0.4602		

Significance level: ***significant at 1%, **significant at 5%, *significant at 10%

After estimation of the propensity scores, the sum of the propensity score was estimated to establish the probability of participation. Since the propensity score is a probability, the mean should range between an interval (0 and 1). So the average probability of participating in the treatment for all individuals was 51.5% as shown in Table 4.

Table 4: Sum of propensity scores

Variable	Observation	Mean	Std. Dev.	Min	Max
ps	310	0.516129	0.3611317	0.0014636	1

Matching

Estimation of the propensity scores was then followed by matching. This means that a suitable matching algorithm has to be selected. As discussed in chapter three, there are several matching algorithms. These include: nearest neighbor (NN) with or without replacement, caliper and radius, stratification and interval, and kernel and local linear. Unlike all other matching algorithms that use only a few observations from the comparison group to construct the counterfactual outcome of the treated individuals, kernel matching (KM) and local linear (LL) are different. KM and LL are non-parametric matching estimators that use weighted averages of all individuals in the control group to construct the counterfactual outcome. Therefore one major advantage of these approaches is the lower variance which is achieved because more information is used.

Kernel matching was therefore used in this study to obtain the average treatment effect of the treated (ATT). Estimation of the standard errors was obtained by bootstrapping as in Lechner (2002). This option was used because the analytical estimates were unavailable. In this case bootstrapping was done 500 times (N). Each bootstrap draw includes the re-estimation of results, including the first steps of estimation. Although Imbens (2004) notes that there is little evidence to justify bootstrapping, it is widely used in other studies (Black and Smith, 2003; Sianesi, 2004). The results in Table 5 show that 106 individual were used as the counterfactual. It also further indicates that the daily per capita income of individuals who participated in value addition increased by about Kshs 88. This amount is adequate to raise an individual above the poverty line. The finding is consisted with Ramirez (2001) who reported that the adoption of various value addition technologies in Mexico increased income by up to 350%.

Table 5: Kernel matching

Treated	Controls	ATT	Std. Err.	T
160	106	88.508	16.58	6.07

Average Treatment Effects (ATE)

As indicated in Table 6 the average treatment effect of an individual randomly drawn from the population, whether male or female is about Kshs. 61. This implies that the daily per capita income of this individual increased by about Kshs.61 as a result of participation in value addition suggesting that at value addition can potentially increase household income. Similar results were observed by previous studies which show a positive impact of adoption of agricultural technologies (Winters *et al*., 1998; de Janvry and Sadoulet, 2002; Mendola,

2007 and Diagne *et al.,* 2009). The effect is however higher in male headed households than female headed households.

Table 6: Average Treatment Effect of the whole sample on per capita income

Variable	Sample	Treated	Controls	Difference
Daycapita	**Unmatched**	126.2083	66.7276	59.48068***
	ATT	126.2083	38.56667	87.64162***
	ATU	66.7276	99.82023	33.09263
	ATE			61.24694

Average Treatment Effect by Gender

When separated by gender the results are as indicated in Tables 7 and 8. Table 7 shows that the average treatment effect (ATT) of a male individual is Kshs.86.63. This means that a male individual who participated in value addition had their daily per capita income increase by Kshs.86.63. A randomly drawn male from the population would have his income increase by Kshs.68.56 (ATE).

Table 7: Average Treatment Effects for Males on per capita income

Variable	Sample	Treated	Controls	Difference
Daycapita	**Unmatched**	127.07	56.22178	70.84828
	ATT	127.07	40.44076	86.6293
	ATU	56.22	104.0927	47.87087
	ATE			68.56712

The results in Table 8 on the other hand show that a female individual who participated in value addition would have her income increase by Kshs. 73.08 (ATT) while a randomly drawn female would have an increased income by Kshs.29.04 (ATE).

**Table 8: Average Treatment Effects for Females on per capita income**

Variable	Sample	Treated	Controls	Difference
Daycapita	**Unmatched**	124.3124	85.40462	38.90776
	ATT	124.3124	51.23151	73.08087
	ATU	85.40462	73.6796	-11.725
	ATE			29.04705

Verification of the common support condition

Verification of the common support or overlap condition is an important step in investigating the validity of the results. It is assumed that the probability of participation in an intervention, conditional on observed characteristics lies between 0 and 1. This assumption ensures that units with the same x-values have a positive probability of being both participants and non-

participants. One obvious approach is through visual inspection of the propensity score distributions for both the treatment and control groups. Simple histograms or density distribution plots can be used. If the common support condition holds, there must be an overlap of the propensity scores of both participants and non-participants as shown below

Figure 1: Propensity Score Histogram
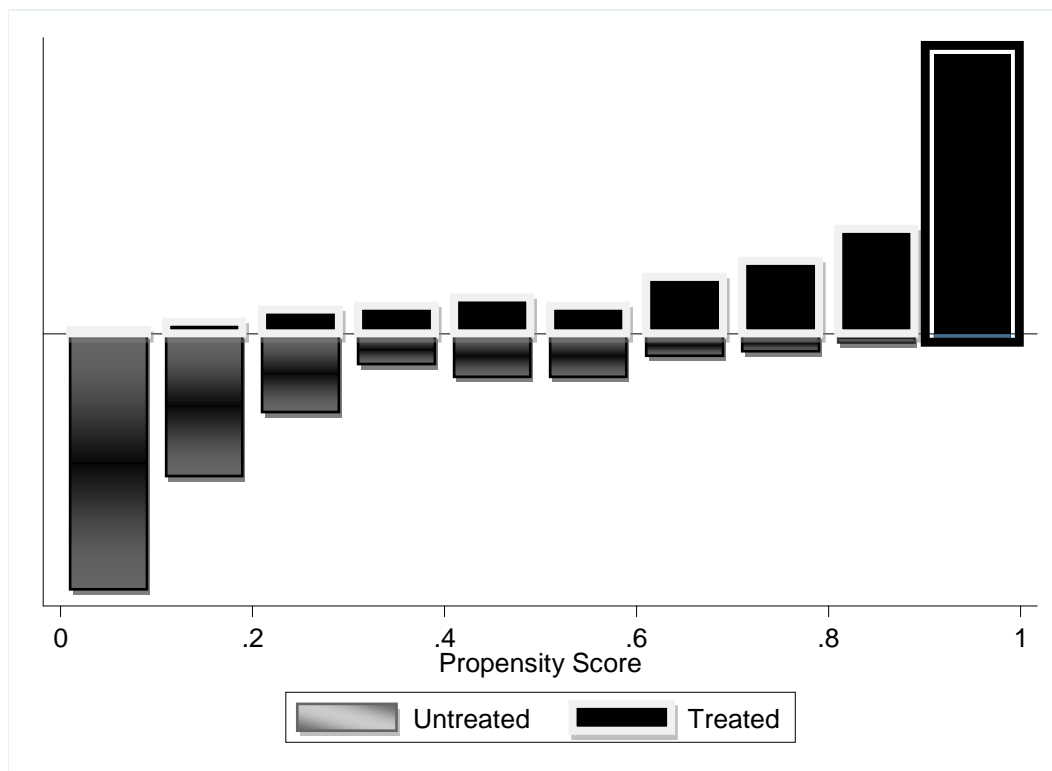
CONCLUSION

The effect of value addition on household income is positive but significantly different between male and female headed households. Whereas gender as a variable does not significantly influence the decision for one to participate in value addition the effect of participation is different. The effect of value addition on male headed households is higher

compared to female headed households. A randomly drawn male participant would has his daily income increasing by about Kshs.69 as opposed to Kshs.29 for a female participant. This difference cannot be explained by gender *per se* but in terms of factors that are correlated to gender. These include number of contacts with extension agents, distance to the market and the size of land allocated to peanut production; factors which significantly influence the decision to participate in value addition. The difference may have been as a result of more participation by male headed households (69%) as opposed to (31%) of female headed households.

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REFERENCES

Ali, A. and Adbulai, A. (2010). The Adoption of Genetically Modified Cotton and Poverty Reduction in Pakistan. *Journal of Agricultural Economics*, 61 (1), 175-192.

Andima, D., Kidula, N. and Makini, F. (2006). Research Priorities for KARI Kisii Mandate Area..

Berem, R. M., Obare, G. and Owuor, G. (2010). Is Value Addition in Honey a Panacea for Poverty Reduction in the Asal of Africa? Empirical Evidence from Baringo District in Kenya. Contributed Paper Presented at the Joint 3rd Africa Association of Agricultural Economics (AAAE) and the 48th Agricultural Economics Association of South Africa (AEASA) Conference, Cape town, South Africa, Sep 19-23.

Caliendo, M. and Kopeing, S. (2008). Some Practical Guidance for the Implimemtation of Propensity Score Matching. *Journal of Economic Surveys*, 22(1), 31-72.

De Janvry, A. and Sadoulet, E. (2002). World poverty and the role of Agricultural Technology: Direct and Indirect effects. *Journal of Development Studies* 38 (4), 1–26.

Diagne, A., Adekambi, S. A., Simtowe, F. P. and Biaou, G. (2009). The Impact of Agricultural Technology Adoption on Poverty: The Case of Nerica Rice Varieties in Benin. A shorter version of the paper is being presented as contributed paper at the 27th Conference of the International Association of Agricultural Economists. August 16-22, 2009. Beijing, China.

Doss, C. R. and Morris, M. L. (2001). How does Gender Affect Adoption of Agricultural Innovations? A Case of Improved Maize Technology in Ghana. *Journal of agricultural Economics* 25(2001) 27-39.

FAOSTAT. (2008).Online agricultural statistics. http://www.faostat.org. Accessed on 20/01/2012.

Imbens, G.W., Angrist, J.D(1994). Identication and Estimation of Local Average Treatment Effects. Econometrica 62, 467-476.

Jaetzold, R. and Schmidst, H. (1982).*Farm management handbook of Kenya* .Vol. II part A (West Kenya).Ministry of Agriculture Livestock Development and Marketing.

Kiriro, F. H. (1993). Groundnuts in Western Kenya Region – A Status Report.

Kiriro, F. H. and Rachier, G. O. (1989).Groundnut (*ArachishypogaeaL*) Production in Western Kenya.Astatus Report Presented to ICRISAT Regional Office. Nairobi

Lee, W.S. (2006). Propensity Score Matching and Variations on the Balancing Test Manuscript,UniversityofMelbourne.Availableat:http://works.bepress.com/laure_dutoit/3 (Accessed on 3/02/2012)

McFadden, D. (1974). Conditional Logit Analysis of Qualitative Choice Behaviour.In P. Zarembka, editor, Frontiers in Econometrics.Academic Press, New York, 1974 p. 105–142.

Mugisha, J., Ogwal, O.R., Ekere, W. and Ekiyar, V. (2004). Adoption of IPM Groundnuts Production Technologies in Eastern Uganda. *African Crop Science Journal*.12 (4),383-391

Mutegi, C. K. (2010). The Extent of Aflatoxin and *aspergillus* section *flavi*, *penicillium*spp. and *rhizopus*spp. Contamination of Peanuts from Households in Western Kenya and the Causative Factors of Contamination. PhD Thesis, Faculty of Science and Agriculture,

Muzari, W., Gatsi, W. and Muvhunzi, S. (2012). The Impact of Technology Adoption on Smallholder Agricultural Productivity in Sub-Saharan Africa. *Journal of Sustainable Development*, Vol 5, No.8.

Ngore, P. M., Mshenga, P. M., Owuor, G. and Mutai, B. K. (2011). Socio-economic Factors Influencing Meat Value Addition by Agribusiness in Kenya. Current Research Journal of Social Sciences 3(6); 453-464

Nigam, S. N., Giri, D.Y. and Reddy, A. G. S. (2004). Groundnut Seed Production Manual.Patancheru 502324, Andhra Pradesh, India: International Crop Research Institute for the Semi-Arid Tropics. 32 pp.

Okello, D. K., Biruma, M. and Deom, C. M. (2010). Overview of Groundnuts Research in Uganda: Past, Present and Future. *African Journal of Biotechnology*.Vol 9 (39), 6448–6459.

Okoko, E. N. K., Kidula, N. L., Wasilwa, L. and Rachier, G. (2008). Participatory evaluation of groundnut seed varieties in southwest Kenya Paper presented in 11th. Biennial KARI Conference, 2008.

Ramírez, L. (2001). Globalization and Livelihood Diversification through Non-traditional Crops.The Mexico case.Overseas Development Institute, London, United Kingdom.4p.

Rosenbaum, P. R. and Rubin, D. B. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. Biometrika, 70(1), 41-55.

Rosenbaum, P.R. (2002). Observational Studies, Springer, New York.

Sianesi, B. (2004). An Evaluation of the Swedish System of Active Labor Market Programs in the 1990s. Review of Economics and Statistics, 86 (1), 133–155.

Winters, P., de Janvry, A., Saudolet, E. and Stamoulis, K. (1998). The Role of Agriculture in Economic Development: Visible and Invisible Surplus Transfers. *Journal of Development Studies* 345, 71–97.