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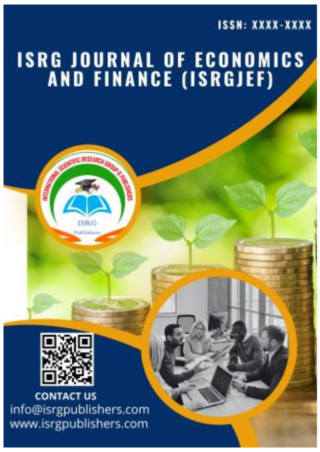

THE IMPACT OF GLOBAL-GAP CERTIFICATION ON WELFARE INDICATORS AMONG SMALLHOLDER FRENCH BEAN FARMERS IN KENYA

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Abstract

Small-scale French bean farmers in Kenya increasingly embrace Global-GAP standards to increase household income, expenditure, and wealth accumulation. To date, limited evidence exists on the role of Global-GAP certification in improving the welfare indicators among smallholder French bean farmers in Kenya. Using the Propensity Score Matching approach on single cross-sectional data from 492 randomly selected French bean farmers; the study determined the effect of Global-GAP certification on household welfare indicators. The results indicate that Global-GAP certification significantly increases net French beans income per acre by KES 17,790.30, daily total household income per adult equivalent by KES 157.991, and daily total household expenditure per adult equivalent by KES 119.74. The results suggest that Global-GAP certification improves farmers' welfare. Farmers should therefore expand the area under Global-GAP-certified French beans to earn more income, spend more, accumulate more assets, and thus improve their household welfare.

Key Words: Global-GAP certification; French beans farmers; Welfare indicators; Propensity Score Matching

1. INTRODUCTION

Agriculture is an important sector globally. Sub-Saharan African Gross Domestic Product (GDP) decreased by 1.9 % in 2020 compared to 3.2 % growth in 2019 due to COVID-19 effects on international trade. In the year 2020, the sector contributed at least 23 percent of the Gross Domestic Product (GDP) (Economic Survey, 2021). According to the Kenya National Bureau of Statistics (2023), the sector contributed approximately 21.2% to the overall GDP in 2022. Agricultural-related activities and services contributed about 17.7% and 61.1% of the total GDP in 2022 respectively.

Most of the French beans produced in Kenya are exported due to low demand locally. It is the main source of income for farmers especially small-scale who are exporting. Kenya is the second-largest exporter of green beans to Europe. The European countries include France, Netherlands, Belgium, and Germany (Masiga et al., 2014, Kok, 2019, Greenlife, 2023). Locally, however, French beans are less consumed (The Standard, 2021 Greenlife, 2023).

Horticultural exports increased by 3.0 percent in 2014 with market value increasing from Kenyan Shillings (KES) 83.4 billion in 2013 to KES 84.1 billion in 2014. At the same time, sales from small farms decreased slightly from KES 244.5 billion in 2013 to KES 243.6 billion in 2014 (Economic Survey, 2015). In 2020 however, the horticulture sub-sector experienced a decline. The volume of horticultural exports decreased by 4.5 percent (Economic Survey, 2020).

Generally, horticultural crops are more profitable relative to cereal crops (Kibet et al., 2011) and hence the ability to reduce poverty even under situations of high risks (Obare et al. 2003). According to FPEAK (2021), horticulture is the third largest foreign exchange earner and employs approximately 350,000 directly and indirectly. An estimated 4% of all the horticultural (Fruits and Vegetables) are exported in Kenya while 96% is being consumed locally. Despite COVID-19, the sub-sector earned Kenya Ksh. 151 billion in 2020. Vegetables alone earned Ksh 24B. Despite the farmers did not realize much profit.

Diao et al. (2007) argued that African farmers need to adopt new agricultural technologies to produce more and earn more income. Kirimi, et al. (2013) noted that an expansion of market participation by smallholder farmers can be critical in helping households transition out of food poverty. McCulloch and Ota (2002) and Muriithi, et al. (2011) further noted that commercial horticultural farming can improve the welfare of both workers and farmers.

In the Central region of Kenya, small-scale vegetable farmers are diversifying towards the production of Global-GAP-certified French beans for export to increase household income, expenditure, and asset base and thus improve welfare. The majority of the producers are small-scale farmers (90%). That is, approximately 2.57 million people are farmers, and out of these 60,000 are farmers producing French beans in Kenya (Ebony Consulting International, 2001; FPEAK, 2021). According to VCA4D (2018), at least 62,000T of French beans were produced in 2017 in an area of 7,500. Production per ha varies from 4,000 to 12,500 kg/ha, depending on farming practices, varieties grown, and general agricultural production conditions. Furthermore, French beans contribute approximately 0.33% to the agricultural GDP in Kenya, €62 million to the balance of trade, and € 3.96 million to public finances.

Private standards are examples of new agricultural technologies that French bean farmers embrace intending to increase household incomes to reduce poverty. In Kenya, many studies on compliance with Global-GAP standards in French bean production have been conducted. However, mixed results have been reported. Muriithi *et al.* (2014) and Achieng (2014) concur that export marketing of French beans increases farmers' income and hence less probability of farmers becoming poor. McCulloch and Ota (2002) determined the effect of horticulture exports on farmer's incomes in Kenya. The study found that rural farming households who exported their horticultural commodities earned more income *vis-a-vis* those who sold through other markets. Using the propensity score matching approach on single cross-sectional data, Chege *et al.* (2015) found a significant and positive relationship between horticultural farming and household food security status. Contrary findings are reported by Weinberger and Lumpkin (2007). The study noted that horticultural farming in developing countries contributes to low yields and income due to high land sub-division.

However, the production of French beans under Global-GAP standards is profitable but a risky venture characterized by high costs and volatile returns due to price fluctuations, pests and diseases, and strict production guidelines among other factors (Asfaw, *et al*, 2010; Muriithi, *et al*., 2011; Economic Survey 2015). This raises the question of whether the continued adoption of the Global-GAP standards will contribute to welfare improvement among farmers or not. The study therefore attempted to answer this question. Welfare is indicated by three elements: household income, expenditure, and value of asset ownership per adult equivalent.

Most of the previous studies (Asfaw, *et al*, 2009, McCulloch and Ota, 2002, Asfaw, *et al*., 2010, Muriithi, *et al*., 2011, Muriithi *et al*., 2014, Achieng, 2014) used income only as a measure of welfare of French beans farmers in the face of Global-GAP certification. To explicitly explain the relationship between the Global-GAP certification and the welfare of vegetable farmers, there is a need to include in the analysis all of the three welfare indicators, not income alone. In doing so, it will help address the problem of mixed findings on the relationship between Global-GAP certification and poverty among farmers. The study also attempted to fill this knowledge gap.

2. MATERIALS AND METHODS

2.1 Study area

The study was conducted in Kirinyaga County because of the growing importance of the production of Global-GAP-certified French beans among farmers in the County. The County is located 120 Km North West of Nairobi and has a total population of 153, 095 (Economic Survey, 2009). The County has five Sub-Counties where French beans are produced. They are namely: Kirinyaga Central, Kirinyaga East, Kirinyaga West, Mwea East and Mwea West. Apart from French beans, rice, maize, and horticulture (Onions, tomato, snow peas, avocado, mango, and pawpaw) are also commonly grown in the County. French beans are mainly produced under irrigation and rain-fed.

2.2 Sample size determination

A sampling frame of 1,943 certified and non-certified farmers was generated first. Then the finite population based sample size determination formula by Krejcie and Morgan (1970) was used to determine the sample size, which is 322. However, to increase the level of accuracy, the sample size was increased to 492. A systematic random sampling procedure was used to draw the sample size of 492 respondents. During sampling, it was ensured that the sample size was proportionate to the population of certified and non-certified farmers from the sampling frame. The sample size was also drawn in such a way that all the Sub-Counties within Kirinyaga County (Kirinyaga Central, Kirinyaga West, Kirinyaga East, Mwea East, and Mwea West) were represented proportionately.

2.3 Data and data collection

Both structured and unstructured questionnaires were used to solicit the data. Data collected include general household socio-economic and institutional characteristics. Also, information on net

French beans income, daily net per adult equivalent income, daily per adult expenditure, and asset value per annum was captured and used in this study.

3. ANALYTICAL FRAMEWORK

3.1 Welfare indicators

There are three key welfare indicators commonly used in the assessment of household welfare. These include household income, expenditure, and asset ownership. In this study, net French beans income per acre, total daily income per adult equivalent, total daily expenditure on food items per adult equivalent, and total daily expenditure per adult equivalent of both certified and non-certified French beans farmers were determined. The impact of Global-GAP certification on the welfare indicators was then estimated. Total annual household income, total annual household expenditure on food items, and total annual household expenditure were divided by 365 days and then by household size to obtain per-adult equivalent values. Household size was determined using World Health Organization adult equivalent conversion factors found in Muyanga *et al.* (2007). Total French beans income was divided by the number of acres under French beans to obtain per acre income.

3.2 The propensity Score Matching (PSM) approach

The impact of Global-GAP certification on the net French beans income per acre, total daily income per adult equivalent, total daily expenditure on food items per adult equivalent, and total daily expenditure per adult equivalent of both certified and non-certified French beans farmers were estimated using the PSM approach. PSM approach statistically compares participants and non-participants of new technologies to determine the direct causal impact of the new technology. Participants are matched with non-participants based on the probability of participating (propensity score) using observed characteristics (Rosenbaum and Rubin, 1983). In PSM, there are two major versions of aggregated treatment effects: the average treatment effect (ATE), which is the average effect that would be observed if everyone in the treated and the control groups received treatment, compared with if no one in both groups received treatment and the average treatment effect on the treated group (ATT), which is the average difference that would be found if everyone in the treated group received treatment compared with if none of these individuals in the treated group received treatment (Harder, *et al.*, 2010).

Mathematically, the PSM model is derived as follows: Let $G\ I$ denote a dummy variable such that $G_i = 1$ if the French bean farmers are certified and $G_i = 0$ otherwise. Similarly let Y_{1i} and Y_{0i} denote potential observed welfare outcomes for certified and non-certified French beans farmers respectively, such that:

$$\Delta = Y_{1i} - Y_{0i}, \quad (1)$$

where Δ denotes the impact of the Global-GAP certification on the French beans farmer welfare. Given that:

$$Y_i = G_i Y_{1i} + (1 - G) \quad (2)$$

Then Y_{0i} is observable rather than Y_{1i} and Y_{0i} for the same French bean farmer, it is not possible to compute the impact of Global-GAP certification for every French bean farmer. In this study average treatment effect on the treated was estimated. The PSM estimation process involves three steps. In the first step, the study followed the methodology by Rosenbaum and Rubin (1983) whereby the propensity score was determined by using a standard Probit model such that: 0 = Non-certified and 1= Certified. Mathematically, the propensity score is given as follows:

$$P(X) = P(G_i = 1 / X) \quad (3)$$

In equation 3, X denotes the observable covariates (socio-economic, institutional, and psychological factors) used in the determination of the propensity scores. All the other variables are as defined above. Given the assumptions that $Y_{i1}, Y_{i0}\ \pi\ G / X$ (That is, the potential impact of Global-GAP certification on French beans farmers' welfare is independent of Global-GAP certification given X), then it implies that:

$$E(Y_{1i}/G=1, P(X)) = E(Y_{0i}/G=0, P(X)) \text{ and } 0<P(X)<1 \quad (4)$$

That is, for all X there is a positive probability of either adopting ($G=1$) or not adopting ($G=0$), this guarantees every adopter a counterpart in the non-adopter population.

In step 2, a number of matching algorithms were estimated. They include Nearest Neighbor Matching (whereby observations are randomly ordered, and the first treatment observation is matched with the first control group observation having the nearest propensity score), Caliber/Radius Matching Method (whereby a predefined propensity score radius identifies all possible matches), Stratification Matching Method and Kernel Matching which utilizes nearly all of the control group participants in creating a counterfactual. These methods numerically search for "neighbors" that have a propensity score for non-treated individuals that is very close to the propensity score of treated individuals. All methods should give similar results, otherwise, tradeoffs in terms of bias and efficiency are more likely with each algorithm (Mendola, 2007; Becerril and Abdulai, 2010; Kassie, *et al*., 2010). The four matching algorithms were estimated and compared to determine the robustness of the results. French bean farmers' welfare was estimated using income and consumption expenditure such that, an increase in income and household expenditure indicates increased welfare and vice versa (Chaudhuri, 2000 and Chaudhuri, 2003).

In the third step, ATT was determined as the average impact of Global-GAP certification on Certified French bean farmers' income, household expenditure, and asset value. Mathematically this is given as:

$$ATT = E(Y_{1i} - Y_{0i} / G_i = 1) \quad (5)$$

$$ATT = E[E(Y_{1i} - Y_{0i} / G_i = 1, P(X))] \quad (6)$$

$$ATT = E[E(Y_{1i} / G_i = 1, P(X)) - E(Y_{0i} / G_i = 0, P(X))] \quad (7)$$

The soundness of the PSM approach depends on two assumptions: First is the conditional independence (CIA) which states that, given a set of observable covariates (X), the respective treatment outcomes Y_{1i}, Y_{2i} are independent of the actual participation status G. The assumption permits the use of matched non-participants to measure how the participants would have performed had they not participated (Pan, 2014). Mathematically CIA is given as follows:

$$P(X) = Pr(G=1 \mid X) = E(G \mid X);\ P(X) = F\{h(X_i)\} \quad (8)$$

The second assumption is common support which ensures that every individual has a positive probability of either being a participant or a non-participant (Pan, 2014). According to Dillon (2008), when there is no random participation of individuals in a given technology, a balancing score, which is a function of the observed characteristics (X) of the individuals, is needed. According to (Pan, 2014) this is given as:

$$0 < Pr(G=1 \mid X) < 1 \quad (9)$$

The balancing property ensures that the treatment and control observations are equal concerning the observable covariate set.

Therefore any chosen specification should satisfy the balancing property. Existing literature presents several ways to test the balancing property. According to Rosenbaum and Rubin (1983), one can check the differences in covariates between adopters and non-adopters before and after the procedure. Secondly, the propensity score can be re-estimated on the matched sample to verify if the pseudo-R-Square after the matching is fairly low. Thirdly, a likelihood ratio test can be done on the joint significance of all repressors, as suggested by Sianesi (2004).

The *score* in PSM estimates the propensity score, based on a model specification, and tests the balancing properties of the sample, whereby, the sample is split into equally spaced intervals of the propensity score. Propensity scores are then compared between treated and control observations within each interval to ensure that propensity scores do not differ. Additionally, t-tests are performed within each interval to ensure that the means of the covariate set do not differ between treatment and control observations. Blocks (*my block*) identify propensity scores while the common support option (*comp*) is a dummy variable that ensures matching is done only on controls that are similar to the treated group (Vigani and Magrini, 2014).

The issue of selection bias may occur because of the: failure of the common support condition, selection of unobservable, selection of a comprehensive set of covariates not related to treatment or outcome, and geographic mismatch among other factors (Heckman and Navarro-Lozano, 2004). To overcome the problem, the study ensured that the independent variables used were not affected by the adoption of Global-GAP standards as suggested in Caliendo and Kopeinig (2008). The study further ensured that the samples of certified and non-certified French bean farmers were drawn from the same region, which is Kirinyaga County and the same questionnaire was used in all the respondents.

4. RESULTS AND DISCUSSIONS

4.1 Descriptive statistics

Socioeconomic, institutional, and psychological characteristics of French bean farmers were compared based on Global-GAP certification status. A t-test and Pearson Chi-square test were carried out to determine whether the certified and non-certified French bean farmers were statistically and significantly different or similar based on their characteristics. Results indicate that both certified and non-certified French bean farmers did not statistically and significantly differ in terms of household size, years of experience in French beans farming, number of times household head was sick, total land size owned, acreage under French beans, total asset value per adult equivalent, net crop income, net livestock income, total off-farm income per adult equivalent, total net income per adult equivalent, total consumption expenditure per adult equivalent and total distance to the French beans market (Table 1).

Table 1: Summary of respondents' socio-economic characteristics by Global-GAP certification category

Variable	Certified (N = 294)			Non-Certified (N = 198)			
	Mean	S.E	S.D	Mean	S.E	S.D	M.D
Household size	3.68	0.09	1.46	3.80	0.10	1.46	0.12
Age of household head	45.79	0.74	12.71	43.49	0.95	13.30	-2.29*
Total household adult equivalent	3.14	0.08	1.41	3.56	0.42	5.89	0.42
Years of experience in farming	15.62	0.67	11.42	14.71	0.81	11.38	-0.90
Number of times household head sick	0.59	0.11	1.88	0.55	0.11	1.48	-0.04
Total Land size owned	2.39	0.28	4.73	1.93	0.10	1.43	-0.46
Acreage under French beans	0.51	0.03	0.43	0.54	0.03	0.41	0.04
Net French beans income	35421.45	2980.42	51103.54	26204.59	2282.67	32119.97	-9216.86**
Net crop income	83787.17	8792.93	150767.39	76570.34	10093.30	142025.31	-7216.84
Net livestock income	12145.13	2867.58	49168.76	6897.58	2955.59	41588.83	-5247.55349
Total off-farm income per adult equivalent	80987.76	9001.26	154339.53	96307.07	16804.26	236456.89	15319.32
Total net income per adult equivalent	67535.01	6005.44	102971.84	68230.96	9565.00	134591.52	695.95
Total asset value per adult equivalent	746110.81	80305.97	1376960.60	649166.93	106570.04	1499573.34	-96943.89
Expenditure on food items per adult equivalent	44066.70	6447.48	110551.34	42979.11	6738.33	94816.75	-1087.60

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Expenditure on non-food items per adult equivalent	44303.34	13960.69	239375.99	43237.37	12600.92	177310.67	-1065.98
Total expenditure per adult equivalent	88370.04	19947.12	342021.94	86216.47	17799.94	250467.33	-2153.57
Total distance to the market	5.68	0.27	4.68	5.62	0.39	5.44	-0.06

S.D-Standard Deviation, S.E-Standard Error, N-Number of Observations, M.D-Mean Difference. *, **, and *** mean significance at 10, 5, and 1 percent levels of significance respectively.

Certified farmers were however older (45.8 years) than non-certified (43.5 years) by 2.3 years. Certified farmers earned more income per acre of French beans (KES 35,421.5) than the non-certified (KES 26,204.6) by KES 9,216.9. This is because Global-GAP-certified French beans have higher market value relative to those marketed in the local markets. The results suggest that Global-GAP compliance and certification positively influence French bean's income and thus total household income. The findings concur with those of Imran, *et al.* (2021) who found that the production of vegetables for export enables farmers to receive higher prices, yields, and lower costs, which in turn increase household income. McCulloch and Ota (2002), Muriithi and Matz (2014), and Hichaambwa *et al.* (2015) also found a positive relationship between the commercialization of vegetables through the export market channel and household income.

Variable indicating marital status is statistically significant (p=0.074) with a negative effect (B=-0.293) on Global-GAP compliance and certification decisions in French beans production (Table 2). That is, at *ceteris paribus*, French bean farmers' decisions to marry reduce their probability of Global-GAP compliance and certification by 29.3 percent. The results suggest that married farmers have more household members who depend on the household head's income which eventually outlays his/her income more on consumption expenditure rather than investing in the Global-GAP standards. The results concur with those of Challa and Tilahun (2014) while contrary findings are reported in Nyota (2011) and Idrisa, *et al*. (2012).

The variable indicating the education level of the household head is statistically significant (p=0.036) with a negative effect (B=-0.229) on Global-GAP compliance and certification decisions in French beans production (Table 2). That is, at *ceteris paribus*, an increase in the household head's education by one level reduces his/her probability of Global-GAP compliance and certification in French bean production by 22.9 percent. The results indicate that, as French bean farmers get more formal education, the likelihood of being certified under Global-GAP standards decreases. The reason is that, as one advances his/her formal education, there is a high probability of an individual engaging in formal/off-farm activities and thus concentrating less on farming. Furthermore, as farmers seek higher levels of education more is spent, and given the high cost of Global-GAP compliance and certification processes, it may be difficult for them to comply with the standards. The study findings contradict those of Kersting and Wollni (2012) and Kangai and Mburu (2012) who found that higher education level positively influences French bean farmer's decisions to comply with Global-GAP standards in Kenya. Other studies include Salasya, *et al*. (2007) and Alene and Manyong (2007) who found a significant and positive influence of education on the technology adoption decisions of farm households.

Table 2: Propensity SM Probit Regression Results

	Dependent variable: Certified=1, Not certified=0				
Variable	**Coefficient (B)**	**Z**	**P>|z|**	**95 percent C.I**	
Household size	0.010(0.048)	0.21	0.837	-0.08482	0.10469
Gender	-0.149(0.222)	-0.67	0.504	-0.58424	0.28718
Age	0.004(0.006)	0.76	0.446	-0.00694	0.01575
Marital status	-0.293 (0.164) *	-1.79	0.074	-0.61462	0.02800
Education level	-0.229 (0.109) **	-2.10	0.036	-0.44191	-0.01524
Total land size owned	0.011(0.026)	0.42	0.675	-0.03963	0.06117
Donor support	1.876 (0.14) ***	12.99	0.000	1.59308	2.15941
Risk preferences	0.234 (0.065) ***	3.58	0.000	0.10595	0.36220
Membership in a group	0.362 (0.166) **	2.18	0.029	0.03619	0.68759
Distance to the nearest market	0.028 (0.016) *	1.75	0.079	-0.00331	0.05991
Access to credit	0.069(0.182)	0.38	0.704	-0.28809	0.42693
Number of farmer trainings	0.087 (0.050) *	1.74	0.081	-0.01076	0.18477

Access to irrigation services	0.004(0.009)	0.44	0.659	-0.01363	0.02155
Constant	-1.477 (0.492) ***	-3.00	0.003	-2.44180	-0.51304
Prob > chi2 = 0.0000					
Pseudo R2 = 0.3803					
Log likelihood = -205.49193					
The region of common support is (0.08927914, 0.9987548)					
The balancing property in all the outcome variables was satisfied					

*, **, and *** mean significance at 10, 5, and 1 percent respectively. Figures in parentheses are standard errors and stand for Confidence Intervals. Coefficients and standard error values were rounded off to three decimal points. C. I values were rounded to five decimal points.

Distance to the nearest French bean markets is statistically significant (p=0.079) with a positive effect (B=0.028) on Global-GAP compliance decisions (Table 2). That is, at *ceteris paribus*, a 1km increase in the distance to the nearest French bean market increases the probability of Global-GAP compliance and certification among French bean farmers by 2.8 percent. This indicates that French bean farmers who were far from the nearest French bean market were more likely to comply and get certified under Global-GAP standards. The reason is that long distances to the market induce farmers to act collectively to reduce costs of production and marketing through collective purchase of inputs and sale of products (Muriithi, *et al.*, 2008). The results however contradict those of Nyota (2011) who found that long distances to the market negatively correlate with farmers' Global-GAP compliance decisions among French bean farmers in Kenya. That is, an increase in the distance to the market by one kilometer reduces the chances of individual compliance by 18 percent and increases the chances of group compliance by the same value.

The variable denoting donor support is statistically significant (p=0.000) with a positive influence (B=1.876) on Global-GAP compliance and certification decisions in French bean production. That is, at *ceteris paribus*, access to donor support increases the probability of Global-GAP compliance and certification among French bean farmers by 187.6 percent. This means that French bean farmers who got support (financial or in-kind) related to the production of French beans were more likely to comply with Global-GAP standards than non-certified farmers (Table 2). Donor support is critical in determining the success of Global-GAP compliance and compliance in French bean production because it is a costly process, especially among small-scale farmers. The findings concur with those of Kersting and Wollni (2012) who determined factors influencing the uptake of Global-GAP standards among fruit and vegetable farmers in Thailand and found that support from donors and exporters positively influences farmers' certification decisions.

Variable indicating the number of times of access to agricultural training is statistically significant (p=0.081) and positively influencing (B=0.087) Global-GAP compliance and certification decisions (Table 2). That is, at *ceteris paribus*, a 1 percent increase in the number of times of access to agricultural training increases the probability of Global-GAP compliance and certification among French bean farmers by 8.7 percent. That is, French bean farmers who accessed more agricultural extension training and services were more likely to comply and get certified under Global-GAP standards. Access to adequate agricultural training and information equips farmers with the knowledge and skills necessary to take risks associated with compliance and certification. Similar results are reported by Kleinwechter and Grethe (2006), Muriithi, *et al.* (2011), and Kangai and Mburu (2012) who found that lack of access to information negatively influenced the uptake of the Global-GAP standards in Kenya.

Table 2 further shows that the variable denoting membership to a farmer group is statistically significant (p=0.029) with a positive effect (0.362) on Global-GAP certification decisions. That is, at *ceteris paribus*, membership of a French bean farmer in a group increases his/her probability of Global-GAP compliance and certification by 36.2 percent. Previous studies show that collective action helps farmers reduce costs and mitigate risks in doing business through the sharing of information and cost-sharing among members. For instance, Nthambi *et al*. (2013) argue that Global-GAP compliance and certification processes are characterized by high costs that include: putting up grading sheds, purchase of fertilizer and pesticide, putting up stores, and purchase of protective clothing and maintenance costs which eventually encourage farmers to participate in group compliance and certification to achieve economies of scale. The findings also concur with those of Muriithi, *et al.* (2008) who found that high social capital encourages farmers to comply with the Global-GAP standards. That is the more the number of groups, the higher the chance of complying with the Global-GAP standards due to homogeneity of interests and norms as well as higher levels of trust among members. When a household is in more groups, there is reduced fear of the probability of forfeiture by the other members as they already know them and their interests are similar (Nyota, 2011).

Attitudes toward risks are critical in determining the adoption of new agricultural technologies (Feder, 1980; Cavane, 2011; Bradford *et al.*, 2013). The results in Table 2 show that, the variable denoting farmers' preferences toward risks is statistically significant (p=0.000) and positively related (B=0.234) with Global-GAP compliance and certification decisions. That is, at *ceteris paribus*, a risk-loving attitude increases the probability of French bean farmers complying and getting certified under Global-GAP standards by 187.6 percent. That is, risk-taking French bean farmers were more likely to comply and get certified under Global-GAP standards and vice versa. The findings concur with those of Chinwendu, *et al*. (2012) and Bradford, *et al*. (2013) who found a negative relationship between aversion to risk and adoption of new agricultural technologies. However, Ross, *et al*. (2012) found no significant relationship between risk attitudes and uptake of new agricultural technologies.

4.2 Impact of Global-GAP Certification on net French beans income, total household income, and total household expenditure

Table 3 summarizes the income and expenditure outcome variables of the PSM model. The minimum critical value of "t" that is significant at 10, 5, and 1 percent is 1.645, 1.960, and 2.000 respectively. Based on these critical values, results show that Global-GAP compliance and certification significantly and positively influenced the income and expenditure of certified French bean farmers.

Table 3: Impact of Global-GAP certification on French beans income per acre, pa capita household income, and pa capita household expenditure

Net French beans income per acre				
NNM	294	70	15293.45 (5963.714) ***	2.564
SMM	294	188	17790.28 (4358.488) ***	4.082
RMM	56	51	11479.98 (5847.866) **	1.963
KMM	294	188	17052.6 (4867.711) ***	3.503
Total daily income per adult equivalent				
NNM	294	70	40.24 (102.383)	0.393
SMM	294	188	51.079 (24.524) **	2.083
RMM	56	51	157.991 (52.772) ***	2.994
KMM	294	188	46.916 (19.507) **	2.405
Daily expenditure per adult equivalent on food items				
NNM	294	70	42.485 (27.303)	1.556
SMM	294	188	39.893 (21.284) *	1.874
RMM	56	51	51.398 (28.875) *	1.780
KMM	294	188	35.865 (17.647) **	2.032
Total daily expenditure per adult equivalent				
NNM	294	70	108.275 (66.86)	1.619
SMM	294	188	80.507 (61.051)	1.319
RMM	56	51	119.744 (56.041) **	2.137
KMM	294	188	73.006 (54.499)	1.34

*, **, and *** mean significant at 10, 5, and 1 percent respectively. ATT – Average impact of Treatment on Treated. Figures in parentheses are standard errors. NNM Nearest Neighbor Matching, SMM = Stratification Matching Method, KMM = Kernel Matching Method, and RMM= Radius Matching Methods.

On average, net French beans income per acre increased by KES 11,480.00 for RMM (t=1.963), KES 17,790.30 for SMM (t=4.082), KES 15,293.45 for NNM (t=2.564) and KES 17,052.60 for KMM (t=3.503). Daily expenditure on food items per adult equivalent increased by KES 51.40 for RMM (t=1.780), KES 39.90 for SMM (t=1.874), and KES 35.87 for KMM (t=2.032). Total daily expenditure per adult equivalent increased by KES 119.74 for RMM (t=2.137) and KES 108.28 for NNM (t=1.619). Total daily household income per adult equivalent increased by KES 157.99 for RMM (t=2.994), KES 46.92 for KMM (t=2.405), and KES 51.08 for SMM (t=2.083).

The results confirm that Global-GAP compliance and certification positively influence French bean income, total household income, and expenditure on both food and non-food items. The findings concur with those of McCulloch and Ota (2002), Humphrey (2008), Asfaw, *et al*. (2009 and 2010), Rao and Qaim (2010), Muriithi and Matz (2014), Achieng (2014), Muriithi *et al.* (2014) and Mukaila (2022) who found that vegetable commercialization positively and significantly increases farmers' income. also noted that adoption of the Global-GAP standards improves smallholder farm financial performance. That is, sustaining Global-GAP compliance in French bean production in Kenya enables farmers to reach a pay-off period whereby compliance begins to increase farmers' income. Contrary findings are reported by Weinberger and Lumpkin (2007). The study noted that horticultural farming in developing countries contributes to low yields and income due to high land sub-division. The findings suggest that farmers should continue the production and expansion of French beans in the face of Global-GAP standards to improve their household welfare.

5. CONCLUSIONS

The study assessed the impact of Global-GAP certification on French bean farmer's welfare indicators. Descriptive statistics show that Global-GAP certification significantly and positively influenced French bean's income but no significant effect on total annual household expenditure per adult equivalent, total annual asset value per adult equivalent, and total annual household net income per adult equivalent. Certified farmers earned more income per acre of French beans than non-certified ones. The propensity Score Matching approach shows that Global-GAP certification significantly and positively influences annual household income and expenditure per adult equivalent. The study has shown that compliance with the Global-GAP standards is likely to improve

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farmers' welfare. French bean farmers should therefore expand acreage under French beans and embrace Global-GAP standards to improve further their household welfare.

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