Journal of International Agricultural and Extension Education

Volume 27 | Issue 1 Article 5

4-15-2020

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Recommended Citation

Gikunda, R. M., & Lawver, D. E. (2020). Effect of Certification on Adoption and Sustainability of Organic Agricultural Practices. *Journal of International Agricultural and Extension Education, 27*(1), 64-78. DOI: https://doi.org/10.5191/jiaee.2020.27105

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Keywords

adoption;certification;organic agriculture; diffusion of innovations; sustainability *doi: 10.5191/jiaee.2020.27105*

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This study highlights the importance of certification on the adoption and sustainability of organic agriculture (OA). The research took place in four counties of Central Kenya; Nyeri, Muranga, Kirinyaga, and Kiambu. Data were gathered from 329 farmers selected through stratified random sampling. A valid and a reliable (sustainability, $\alpha = .96$; adoption, $\alpha = .84$) semi-structured questionnaire was used for data collection. MANOVA followed with discriminant analysis was used to establish the differences between certified and non-certified farmers. The adoption levels of pest and disease control, weed, soil, and water management practices were higher among the certified farmers compared to non-certified farmers. Certified farmers also reported higher scores in the three dimensions of sustainability; ecological, social, and economic sustainability. Certification accounted for 15% of the variance in the adoption and sustainability of OA, $\Lambda = .85$, $F(7, 313) = 7.87$, $p < .05$, $\eta p^2 = .15$. Certification had a large effect on the adoption and sustainability of OA. This can be attributed to need to meet certification and market requirements, better access to extension information, and premium prices attracted by certified produce. Therefore, non-certified farmers should be encouraged to certify their production systems. Increased contacts between farmers and extension agents is also a basic necessity.

Keywords: adoption; certification; organic agriculture; diffusion of innovations; sustainability

Introduction

Organic agriculture (OA) is one of the fastest growing agricultural sectors in the world today. However, the success of OA relies significantly on local conditions and entails use of natural resources such as land, vegetation, animal manure, legumes, cover crops, compost, mulch, and minerals (Brzezina, Kopainsky, & Mathijs, 2016). This makes OA system compatible with the existing values and needs of the potential adopters (Rogers, 2003). According to the Organic Farming Research Foundation (OFRF) (2011), OA makes an important contribution to the economy and wellbeing of farmers. The demand for organic produce has expanded worldwide. The United States, which reported the highest annual sales in organic production of $97 billion in 2017 and $106 billion in 2018, is ranked at the top globally. Other large consumers of organic products include Germany ($11.3 billion), France ($8.9 billion), and China ($8.6 billion). Switzerland was the country with the highest per capita organic expenditure at about 6% of total food in dollars (Willer & Lernoud, 2017). OA certification is undertaken to ensure that organic regulations are being followed with verification, inspection, and record keeping (IFOAM, 2005).

Willer and Kilcher (2010) reported that by the 1970s organic food was becoming popular, resulting in the formulation of organic standards in Europe and the United States that could guide certification. Certification does not only open doors for new markets and valuable economic opportunities, but also helps improve product differentiation, ensures product value, and boosts consumer confidence. According to Reganold and Wachter (2015) farmers are increasingly converting to certified OA systems in order to capture high-value markets and premium prices for the produce, and thus boost farm income. The premium prices of organic produce raises the relative advantage of OA over conventional systems making organic production attractive for adoption (Rogers, 2003). Willer and Lernoud (2015) reported that as of 2015, there were 283 organizations in 170 countries. Internationally, many organizations are using IFOAM's set of organic standards as a basis of formulating their local standards (IFOAM, 2005).

Despite the proliferation of certifiers in both developed and developing countries, there are many farmers who are applying organic practices but are not certified organic (Reganold & Wachter, 2015). Caceres (2005) confirmed that shifting from conventional to non-certified OA has proved to be a very successful strategy for subsistence farmers. The conversion to OA allows the subsistence farmers to grow, consume, and sell the surplus as well as to improve their food safety and conserve the environment. Certified farmers obtain better prices for their produce than non-certified as noted by Constance, Choi, and Lyke-Ho-Gland (2008). OA practices are easier to adopt as they do not require a lot of technical knowledge. Most practices rely on tacit and traditional knowledge that is possessed by many farmers, thus making adoption much easier even to the uneducated (Rogers, 2003).

The dissemination of OA practices relies majorly on diffusion of innovation theory principles (Rogers, 2003) where most farmers decide to adopt the practices on the basis of social values and norms disseminated through interpersonal networks. This mainly involves change agents with connections both within and outside of local communities (Atwell, Schulte, & Westphal, 2009; Rogers, 2003). Certified farmers are more economically motivated through incentives such as advance payments, provision of inputs, and credit facilities (Constance, et al., 2008), and this speed up the rates at which they adopt the practices (Rogers, 2003). Taylor (2006) asserts that certified OA has existed in Kenya for many years. Three bodies are involved in ensuring organic standards and thus certifying OA; EnCert, Nesvax, and Kenya Organic Agricultural Network (KOAN). KOAN is a national coordinating body for OA activities in Kenya. With global population increases being witnessed, the demand for organic products is going to double, if not triple, resulting in an increase of certification levels due to growing food security concerns. Few studies have been undertaken to connect a certification of OA to the adoption of the practices and subsequent sustainability of those practices. This study was therefore designed to address that paucity.

Theoretical Framework

This research is based on the assertions of Rogers' diffusion of innovation theory (Rogers, 2003) to investigate the adoptive behavior of certified and non-certified farmers with regard to OA practices. As illustrated in Figure 2, Rogers (2003) proposed four main elements that determines the rate of adoption of innovations; innovation itself, communication channels, time, and a social system. According to Rogers (2003), an innovation must be widely adopted in order to be self-sustainable. As such, OA practices must be widely disseminated and adopted to self-sustain. The dissemination of these practices take place through varied sources and channels, although, much of the information flows through social networks. The nature of network and change agents determines the possibility of the new practices to be adopted (Atwell, et al., 2009).

Diffusion research had shown that capital and proximity to the source of innovation (Tarde, 1969: Goss, 1979), plays a substantial role in the adoption and distribution of innovations. Rogers (2003) cites the attributes of innovations; relative advantage, compatibility, complexity, trialability, and observability as the predictors of adoption rates. Among the characteristics, relative advantage has been found by diffusion researchers to be one major predictors of rate of adoption. According to Rogers (2003) relative advantage as the ratio of expected benefits and costs of adoption of an innovation. Farmers are likely to convert to OA if they are convinced of its benefits over and above those of conventional farming systems. OA has unique characteristics that make it advantageous to smallholder farmers in line with Rogers (2003) relative advantage, complexity, and compatibility attributes.

OA has been found to be suitable for many cadres of farmers as it involves predominantly low production costs (Brzezina, Kopainsky, & Mathijs, 2016). Organic farms have proven to be profitable even though there is a decrease in yields as farmers convert to OA (Nemes, 2009). The farming system involves the use of indigenous knowledge of the natural environment and of the unique relationships between biotic and abiotic components of the environment. These benefits coupled with its profitability makes it attractive for smallholder farmers especially those in developing countries (Rogers, 2003). However, the full benefits of OA cannot be achieved until the production process is certified. This study hypothesized that certification may be associated with higher adoption of OA practices and it's sustained utilization.

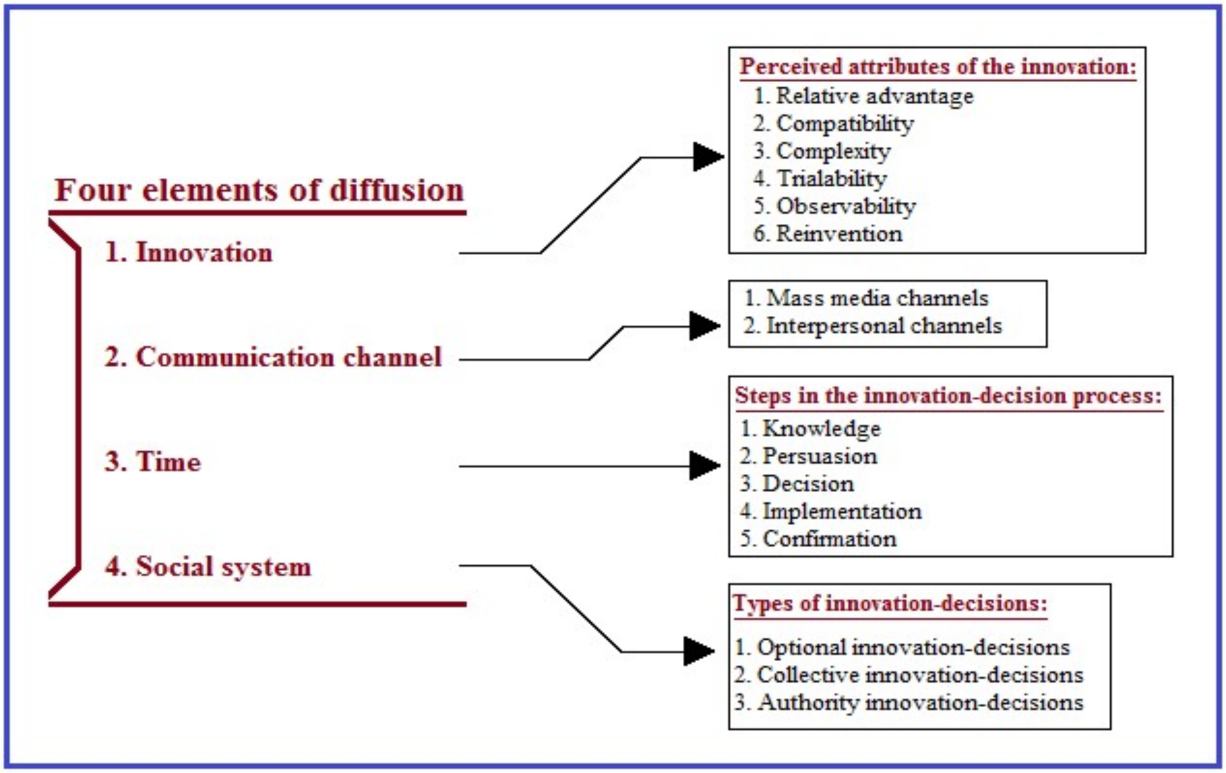

Figure 1. A model illustrating the four main elements in the Diffusion of Innovations (Rogers, 2003).

Purpose & Objectives

This research sought to generate information that would deepen the understanding of the importance of certification of OA with regard to adoption and subsequent sustainability of OA practices. The specific objectives that guided the study were to;

1. Describe the levels of adoption and sustainability of organic practices in Central Kenya, and;
2. Examine the perceived effect of certification on adoption and sustainability of organic practices.

Statistical Hypothesis

The omnibus hypothesis tested was:

H_O: there are no significant differences in the adoption and sustainability of OA practices between certified and non-certified organic farmers (HO: $\mu_1 = \mu_2$)

Methodology

Study Population & Sample

The population for this study consisted of 26,954 certified and non-certified organic farmers from Nyeri, Kiambu, Kirinyaga, and Murang'a counties of Central Kenya. A descriptive survey was adopted to gather farmers' perceptions (Fraenkel, Wallen, & Hyun, 2015) on the adoption and sustainability of OA so as to address the purpose of the study. The population of the study was organized in counties (strata), thus stratified random sampling was applied to select the study sample. The choice of the sampling method was not only meant to achieve population generalizability but also ecological generalizability in which results can be generalized in areas with similar conditions as those of the study area. The study was scheduled to cover a sample of 377 farmers (Krejcie & Morgan, 1970) however, only 329 farmers and farms were accessible due to financial and time constraints. This translated to 87.3% of the target sample. Given

Data Collection

Data were gathered by the use of a peer and expert reviewed semi-structured questionnaire. The questionnaires were administered with the assistance of enumerators who had been trained in order to empower them to collect reliable and valid data (Author, 2017). A pilot involving a random sample of 33 farmers was conducted in Nyandarua County. Pilot study data were used to analyze the internal consistencies of the study variables. The reliability analysis results indicated that the instrument was reliable as the Cronbach alpha values were above the acceptable alpha of .70 (Nunnally, 1978); sustainability $\alpha = .96$, and adoption $\alpha = .84$.

Data Analysis

The independent variables were the adoption and sustainability of OA practices. Application of organic practices, was assessed through the summated score of 27 Likert-type items involving four groups of practices. The groups included pest control, disease control, weed control, water, and soil conservation practices. The items evaluated the frequency of application of the practices and were scaled from 1 to 5, where 1 meant never and 5 implied always. Sustainability of OA had three dimensions namely ecological, economic, and social sustainability. The variable elements were measured using a Likert-type scale of 1 = strongly disagree, 2 = disagree, 3 = somewhat agree, 4 = agree and 5 = strongly agree and consisted of 16 items. The dependent variable was certification, a categorical variable measured in nominal scale (0 = non-certified, 1 = certified). Figure 2 illustrates the hypothesized linkages between the adoption and sustainability of OA, and certification of organic farms.

One-way Multiple Analysis of Variance (MANOVA) was used to establish whether there was a difference in the adoption and sustainability of OA among certified and uncertified organic farmers. MANOVA is used to test the differences between groups across several dependent variables simultaneously (Field, 2017). It is an appropriate statistical analysis when the purpose of the research is to assess if mean differences exist on more than one continuous dependent variable by one or more discrete independent variables (Dattalo, 2008). MANOVA uses the F test to test the null hypothesis. If the obtained *F-value* is larger than the critical F, the null hypothesis is rejected (Dattalo, 2008). The null hypothesis was tested at .05 alpha level set *a priori.*

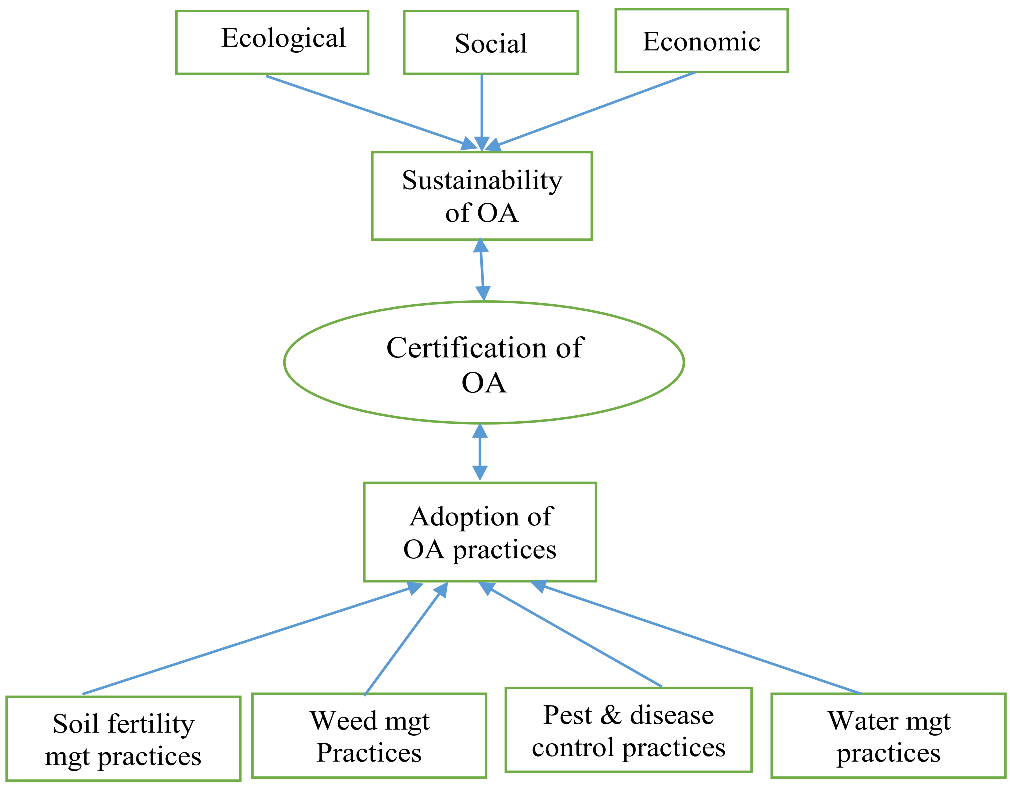

Figure 2. A model linking certification of OA to adoption and sustainability of organic practices.

Discriminant analysis was conducted as a follow-up analysis since the MANOVA *F* test was significant ($p < .05$). MANOVA indicates whether groups means are significantly different, while discriminant function analysis indicates how groups differ; that is, which variables best differentiate the groups (Field, 2017). Prior to analysis, the assumptions of normality and homogeneity of variance/covariance matrices were assessed. The data were found to be normally distributed as reported by the values of skewness and kurtosis. Stevens (2009) posited that MANOVA is robust toward the violation of normality with respect to Type I error. Homogeneity of covariance matrices is the multivariate equivalent to the homogeneity of variance and was tested using Box's M test (Leech, Barrett, & Morgan, 2015).

The Box's *M* test, ($p < .05$) was significant implying that the assumption of homogeneity of covariance matrices was not met. Tabachnick and Fidell (2013) reported that in instances where group sizes are unequal and the bigger group produces a greater variance and covariance, then the probability values are conservative and significant findings can be trusted. The centroids for each group were computed and Wilk's lambda was used to test for significant differences between certified and non-certified groups. The standardized canonical discriminant coefficients were interpreted using the general rule that the coefficients whose absolute value is not less than one half of the largest value are considered in the discriminant function (Hair, Anderson, Tatham & Black, 1995). The hypothesis was tested at .05 level of significance set *a priori.*

Results

The first objective sought to describe the levels of adoption and sustainability organic practices in Central Kenya. The results are presented in Table 1 (adoption levels) and Table 2 (sustainability of organic practices).

Adoption of OA Practices in Central Kenya

As reported in Table 1, the study identified four groups of OA practices; weed, soil, water, pest, and disease management practices. Practices meant to manage pest and disease were the most frequently applied by both certified (*n* = 222, *M* = 28.52, *SD* = 6.11) and non-certified (*n* = 107, *M* = 23.91, *SD* = 6.83). This can be attributed to the prevailing environmental conditions that favors increased incidences of pest and diseases. Most of the pest and disease control cultural practices are simple to execute hence experience high adoption rates (Rogers, 2003). Water management techniques were the least applied by both certified (*M* = 18.09, *SD* = 3.07) and non-certified (*M* = 16.30, *SD* = 4.83). The poor adoption of water management techniques may have resulted from the lack of permanent sources of water and rainwater harvesting skills (Author, 2019). Very few farmers practiced irrigated farming (certified, *M* = 2.35, *SD* = 1.29, non-certified, *M* = 2.17, *SD* = 1.30) and thus, agriculture in the region is heavily dependent on bimodal rainfall patterns characterized by two rainy seasons; long rains (March to July) and short rains (October to December) (Franzel, Wambugu, & Tuwei, 2003).

Among the certified farmers, composting which involves decomposition of plant wastes to make manure (*M* = 4.42, *SD* = .78), use of organic matter (*M* = 4.30, *SD* = .86), and mulching (*M* = 4.16, *SD* = .98), to enrich, control weeds, and improve the water holding capacity of the soil, were the most frequently applied practices. Hand weeding to kill weeds (*M* = 4.09, *SD* = 1.15), mulching (*M* = 3.93, *SD* = 1.94), and application of organic matter (*M* = 3.87, *SD* = 1.33), to enrich, control weeds, and improve the water holding capacity of the soil, were the most commonly applied practices by non-certified farmers. The adoption levels of these practices were higher compared to other practices as they were compatible with the setting, simple to use and involved use of indigenous knowledge (Rogers, 2003).

Based on the reported mean scores, the adoption levels of pest and diseases control (*M* = 28.56, *SD* = 6.11), weed (*M* = 23.54, *SD* = 4.92), soil (*M* = 21.42, *SD* = 3.77), and water management practices (*M* = 18.09, *SD* = 3.07) were higher among the certified farmers compared to non-certified farmers (*M* = 23.91, *SD* = 6.83; *M* = 22.50, *SD* = 5.52 ; *M* = 19.50, *SD* = 4.47 ; *M* = 16.30, *SD* = 4.83 respectively). The higher application of organic practices by certified farmers may have resulted from a higher number of contacts with private extension agents, regular inspections and audits, assurance of lucrative markets, and higher prices for their products (Muller, 2009). However, most of the practices had a mean score of 3 (Table 1) implying that farmers applied the practices occasionally rather than all the times. Most farmers cited lack of knowledge as the main reason why they were not utilizing the practices as frequently as they should be applied. As noted by Rogers (2003), knowledge is paramount to adoption of innovations. Non-certified farmers had less contact with private extension agents, thus they had little or no knowledge of some of the organic practices. These farmers must first learn about the organic practices before they can begin adopting them.

Table 1

Descriptive Statistics on Application of Organic Crop Production Practices (N = 329)

Practices[a]	Certified (*n* =107)		Non-certified (*n* =217)	
	M	*SD*	*M*	*SD*
Soils fertility management practices	**21.42**	**3.77**	**19.50**	**4.47**
Composting	4.42	.78	3.81	1.25
Mulching	3.92	1.02	3.51	1.22
Minimum tillage	3.57	1.01	3.03	1.08
Use of leguminous plants	3.32	1.21	3.20	1.12
Crop rotation	3.18	1.20	3.18	1.23
Use of Green manures	2.99	1.28	2.66	1.23
Weed Control practices	**23.54**	**4.92**	**22.50**	**5.52**
Hand-weeding to remove weeds	4.12	.94	4.09	1.15
Mulching to stop weed seeds from germinating	3.65	1.19	3.43	1.20
Soil cultivation carried out at repeated intervals and appropriate time	3.70	1.05	3.24	1.35
Crop rotation to break the weed plant cycles	3.15	1.19	3.30	1.31
Green manures or cover crops to outcompete weeds	3.14	1.20	3.18	1.37
Planting crops close together within each bed, to prevent space for weeds to emerge	3.03	1.16	3.07	1.28
Use of mechanical weeders to kill weeds	2.72	1.43	2.07	1.32
Pest and disease control practices	**28.56**	**6.11**	**23.91**	**6.83**
Growing crops that suffer less damage from diseases	3.58	.87	2.99	1.09
Growing crops that suffer less damage from pests	3.54	.91	2.65	1.17
Crops with a natural resistance to specific pests	3.36	.99	2.64	1.16
Crops with a natural resistance to specific diseases	3.34	1.06	2.71	1.21
Timely planting of crops to avoid the period when a pest does the most damage	3.15	1.15	2.88	1.33
Providing natural habitats to encourage natural predators that control pests	3.06	1.43	2.66	1.21
Using crop rotations to help break pest cycles	3.03	1.26	2.61	1.28
Trapping or picking pests from the crop	2.98	1.32	2.61	1.33
Companion planting with other crops that pests will avoid, such as onion or garlic.	2.47	1.26	2.08	1.19
Water management practices	**18.09**	**3.07**	**16.30**	**4.83**
Organic matter to the soil to improve its ability to hold water	4.30	.86	3.87	1.33
Mulches to hold water in the soil	4.16	.98	3.93	1.94
Rainwater basins or catchments	3.86	1.36	3.18	1.54
Use of terracing	3.35	1.36	3.04	1.39
Appropriate irrigation methods	2.35	1.29	2.17	1.30

Note: [a] 1= never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always

Perceived Sustainability of OA Practices

Table 2 presents the farmers' ecological, social, and economic sustainability of OA mean scores comparing certified and non-certified farmers. The majority of the farmers, both certified (*n* = 221, *M* = 23.37, *SD* = 3.19) and non-certified (*n* = 103, *M* = 22.19, *SD* = 3.85), indicated that use of organic practices enhanced economic sustainability the most as compared to social and ecological aspects. Overall, certified farmers indicated that the adoption of organic practices had ecological (*M* = 19.47), social (*M* = 20.80), and economic sustainability (*M* = 23.17) more than non-certified. This suggests that certified farmers are more likely to sustain their production than non-certified. Many of the certified farmers perceived that OA was sustainable as it resulted in increased yields in the long run (*M* = 4.33, *SD* = .79), improved health status of the members of the family (*M* = 4.30, *SD* = .76), food safety (*M* = 4.29, *SD* = .79), and reduced financial risks (*M* = 4.14, *SD* = .92).

According to non-certified farmers, safety of food was greater with OA (*M* = 4.40, *SD* = .92), yields gradually increased (*M* = 4.26, *SD* = .87), production costs were lower (*M* = 4.12, *SD* = .93), and the health status of the family members also improved (*M* = 4.11, *SD* = .92). Both certified and non-certified were in agreement that with time the yield increased to cover up the 19% gap that exists between OA and conventional systems (Schrama, Haan, de Kroonen, Verstegen, & Van der Putten, 2018). This, according to the farmers, was brought about by the gradual enrichment of the soil and improvement of its structure arising from continuous application of organic matter, composted manure, and other organic inputs.

Table 2

Comparison between Certified and Non-Certified Organic Farmers Based Upon Sustainability of OA (N = 324)

Sustainability	Certified (*n* =221)		Non-Certified (*n* = 103)	
	M	*SD*	*M*	*SD*
Ecological sustainability	**19.47**	**.16**	**19.07**	**.33**
Maintaining healthy soil free of chemical contamination	4.10	.77	4.07	1.12
Supports water conservation and water health	4.00	.80	3.85	1.07
Help conserve biodiversity as it encourages a natural balance within the ecosystem	3.91	.60	3.57	1.23
Increased usage of animal or green manure	3.81	1.10	4.00	1.18
Reduces erosion through cover crops	3.65	.85	3.60	1.01
Social sustainability	**20.80**	**2.48**	**19.75**	**2.45**
Improved health status of family members	4.30	.76	4.11	.92
Safety of food is greater with organic farming	4.29	.79	4.40	.92
Provides access to attractive markets through certified products	4.00	.84	3.45	1.15
Improved quality of rural life	3.97	.97	3.75	.99
Improves access to credit facilities	3.32	1.24	2.80	1.22
Economic sustainability	**23.37**	**3.19**	**22.19**	**3.85**

Increasing yields in the long run	4.33	.79	4.26	.87
Reduces the financial risks involved in farming	4.14	.92	3.98	1.05
Reduced costs of production	4.05	.89	4.12	.93
Allows farmers access to new market opportunities; local and international markets.	3.88	.77	3.64	.92
Job creation; labor use is higher on organic farms than on their equivalent conventional farms	3.65	.97	3.46	1.11

Note: [a] 1= strongly disagree, 2 = disagree, 3 = somewhat agree, 4 = agree, 5 = strongly agree

Effect of Certification on Adoption and Sustainability of OA Practices

Objective two sought to examine the perceived effect of certification on adoption and sustainability of organic practices. MANOVA was used to compare the means of certified and non-certified organic groups of farmers for the three dimensions of sustainability of OA namely: ecological, social, and economic and four aspects of application of OA practices (soil fertility, weed, water, pest and disease management practices). The independent variables were the application and sustainability of OA while the dependent variable was certification.

As reported in Table 3, a statistically significant MANOVA effect was obtained, Wilks' Lambda $(\Lambda) = .85$, $F\ (7, 313) = 7.87$, $p < .05$, multivariate $\eta p^2 = .15$. The multivariate effect size was estimated at .15, a large effect (Cohen, 1992). This implies that 15% of the variance in the adoption and sustainability of OA was accounted for by certification. The findings suggest that certified organic farmers reported a greater application of soil, water, pest and disease control organic practices as a result of certifying their production. Petrokofsky and Jennings (2018) found a clear confirmation that certification contributes to the adoption of improved practices. OA certification demands adherence to certain practices and standards. To meet these standards, farmers have to apply pre-determined practices. Regular external and internal audits, coupled with continued provision of agricultural advice from the extension agents, all of which were geared towards ensuring that organic produce meets the certification standards, resulted in a sustained production. The differences witnessed in the adoption of practices is a clear confirmation that adoption does not happen simultaneously in a social system. Farmers adopted OA practices at different times, some reported a quicker uptake than others based on the degree of innovativeness of each individual farmer (Rogers, 2003).

Table 3

Multivariate Tests for Application[a] and Sustainability OA[b] among Certified and Non-Certified Organic Farmers (N = 329)

Test	*V*	*F*	*Hypothesis df*	*Error df*	*p*	ηp^2
Pillai's Trace	.15	7.87	7	313	< .05	.15
Wilks' Lambda	.85	7.87	7	313	< .05	.15
Hotelling's Trace	.18	7.87	7	313	< .05	.15
Roy's Largest Root	.18	7.87	7	313	< .05	.15

Note: [a,b] 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always; [b] 1 = strongly disagree, 2 = disagree, 3 = somewhat agree, 4 = agree, 5 = strongly agree

The MANOVA test was followed up with discriminant analysis (Field, 2017). Discriminant analysis was used to determine which weightings of the ecological, social, and economic sustainability, soil fertility, weed, water, pest and disease control organic management variables best discriminated between non-certified and certified OA groups of farmers. As shown in Table 4, discriminant function analysis revealed a significant Wilks' lambda λ = .84, χ^2 (7) = 51.17, p = < .05, R^2 = .15.

Table 4

Adoption and Sustainability of OA in Discriminant Function Analysis (N =321)

Variables						*Structure Matrix*	*Standardized Canonical Coefficients*
						Function 1	
Pest & disease management						**.82**	**.79**
Water management						**.54**	.22
Soil management						**.53**	**.39**
Social						**.41**	.24
Economic						**.39**	.12
Weed management						.23	**.58**
Ecological						.14	.06
Wilks' lambda							
Function	*λ*	*χ2*	*df*	*p*	Eigenvalue	% variance	Canonical Correlation
1	.85	51.17	7	< .05	.18	100	.39
Group centroids						Certified	Non-certified
						.29	-.60

Note: 62.6% of original grouped cases correctly classified.

This is the proportion (λ = .85) of the total variance in the discriminant scores not explained by differences among groups. This also implied that the group (certified and non-certified) means differed significantly and the model was a good fit for the data. The eigenvalue was .18 (Table 4) indicating that the discriminant function explained 18% of the variance in group membership. Since there is only one function, 100% of the variance is accounted for by this function. The squared canonical correlation was .15 indicating that 15% of the variance in group membership was explained by adoption and sustainability variables. The standardized discriminant function coefficients presented in Table 4 indicate the relative importance of the independent variable in predicting the dependent variable. Hair, et al., (2005) assert that coefficients with large absolute values correspond to variables with greater discriminating ability. On the basis of the rule that those coefficients whose absolute value is not less than one-half of the largest value are considered in the discriminant function (.79/2 = .39). It was found that three out of the seven variables met the criteria and thus were considered in the discriminant function. Among the three categories of organic practices, pest and disease control measures had the highest discriminating ability (.79), followed by weed control (.58), and lastly soil fertility management practices (.39).

The structure coefficients signify correlations of each variable with each discriminant function and are interpreted the same way as factor loadings in factor analysis, by identifying the largest absolute correlations associated with the discriminant function. Hair, et al., (2005) recommends that coefficients greater than .3 be considered meaningful. Among the organic management practices several were found meaningful: pest and disease control (.82), water (.54), soil fertility (.53), social (.41), and economic sustainability (.39). The group centroids are the mean discriminant score for each variable in the two groups (Field, 2017). The centroid for non-certified was -.60 and .29 for the certified group. It also emerged from the findings that 69.1% of original grouped cases were correctly classified.

Conclusions & Implications

This study utilized four groups of OA practices; a) pest and disease control, b) weed control, c) soil fertility, and, d) water conservation practices. Most of the practices were being used on certain occasions although, pest and disease control practices were the most frequently applied by both certified and non-certified. An integrated approach involving biological, ecological, and physical measures were adopted to deal with pests and diseases. It also emerged that pest and disease management in OA is heavily reliant on precautionary measures rather than curative practices which are based on ecologically safer management techniques (Haldhar, Jat, Deshwal, Gora, & Singh, 2017).

The pest and disease management practices included growing healthy crops that are resistant and suffered less damage from pest and diseases, timely planting of crops to avoid the period when the pest causes most damage, companion planting with other crops that would repel pests, trapping or picking pests from the crop, rotating crops to help break pest and disease cycles and prevent carryover of pests to the next season, and providing natural habitats to encourage natural predators that control pests. Most non-certified farmers cited lack of knowledge as an impediment to the adoption of the practices (Rogers, 2003) and therefore, improved access to extension services could possibly help address the problem. Proper management of pests in OA is intensively cultural and therefore, requires keen monitoring and correct identification of insects and knowledge of their lifecycles (Stoleru & Sellitto, 2016).

Certification was associated with higher levels of adoption and perceived sustainability of OA. Certified organic farmers applied pest and disease, water, weed, and soil fertility management practices more than non-certified farmers as reported by the application scores. The high levels of application of OA practices among the certified farmers were as a result of the requirement and standards that go together with certification (Petrokofsky & Jennings, 2018) and frequent contacts with extension agents; in line with Rogers, (2003) assertion that ideas are first adopted by those closest to the sources. The contractual agreements signed between the certified farmers and the exporter companies purchasing organic produce from the farmers created an assurance of market and higher prices for their products (Muller, 2009) also contributed to increased application. This also corroborates Rogers (2003) claim that farmers are more likely to adopt innovations whose relative advantage is certain. The regular and continuous follow-ups conducted by the companies' extension agents and farm inspections carried out on certified farms may also have propelled the high levels of application of OA practices witnessed.

As reported by Rogers (2003), diffusion of innovations occurs within a social context. Extension agents assigned to advise certified farmers' not only provided OA information but also linked the farmers to other actors (research institutions, buyers, organic input dealers) in the organic industry. This created social networks that served as avenues of information and knowledge sharing. The application of organic water management practices was not as frequent as the other categories. The minimal application of irrigation techniques may have been brought by lack of permanent sources of water (e.g. rivers, wells, springs) and lack of knowledge of rainwater harvesting. This a confirmation of the findings of Author (2017), whose study recommended deliberate efforts to educate farmers on the resource needs of rainwater harvesting. However, many organic farmers practiced terracing and mulching to control soil erosion as well as to conserve soil water.

The findings also suggest that continued application of soil fertility, weed, water, and pest and disease management organic practices enhanced environmental, social, and economic sustainability. The finding that social sustainability was higher than economic and ecological dimensions explains the importance of social system in diffusion of innovations and their continued use (Rogers, 2003). The ecological sustainability entailed building and maintaining healthy soil that is free of chemical contamination, support water conservation, and water health, help conserve biodiversity as it encourages a natural balance within the ecosystem, reduction of soil erosion through cover crops, and increased usage of animal or green manure. Social sustainability entailed safety of food, improved yields, improved health status, access to attractive markets, improved quality of life, and improved access to credit facilities. Higher levels of economic, social, and ecological sustainability were associated with certified OA as reported by the sustainability scores. This implied that certified farmers were more likely to sustain their OA production more than non-certified. Therefore, non-certified farmers should be encouraged to certify their production process to boost adoption and sustain the practices.

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