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# The technology adoption behavior of women farmers: The case of alley farming in Nigeria

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## Abstract

The indigenous system of crop production in Nigeria, the bush fallow farming system, which is known for its stability and biological efficiency, can no longer be operated effectively, due to a shortage of land. In order to increase farm productivity, researchers have devised alley farming, a low-input farming system which sustains crop and livestock production, can reduce competition from weeds, and conserves soil by reducing soil physico-chemical degradation and the decline of soil organic matter. The mobilization of women to adopt agricultural innovations is an important topic in development studies. Due to the important role of Nigerian women farmers in crop and livestock production, they are encouraged to adopt alley farming. Contrary to some of the literature, which claims that women are slow innovation adopters, this study argues that women farmers easily adopt innovations that can enhance their economic status. The paper argues that the characteristics of alley farming influence women farmers' adoption or rejection of the farming system. It was observed that the land tenure system is not an inflexible constraint on alley farming adoption. It is argued that low participation of women in agricultural innovation adoption is caused by lack of information about the advantages of the innovations, because meetings are fixed at times when women are not able to attend. This paper points out that the adoption of alley farming has increased the agricultural production and the quality of life of women farmer adopters.

**Key words:** alley farming, sustainable agricultural techniques, rural development, adoption of agricultural innovations, women farmers, factors affecting adoption

## Introduction

An important challenge facing researchers in developing countries is the urgent need to devise a sustainable farming system able to improve soil fertility, optimize land use and maintain long-term farm productivity at a low cost. Due to urbanization and a high farming population, the bush fallow system can no longer be practiced effectively. Extensive land use has led to reduction in the fallow period and land degradation. Therefore, in order to sustain yield at the present level and possibly to increase it, the use of fertilizers was introduced into farming. To encourage fertilizer usage, the Nigerian government stepped up the importation of chemical fertilizers and also built a chemical plant to meet anticipated demand. The demand for fertilizer increased sharply, resulting in the spending of much hard-earned foreign exchange to import fertilizers. In 1985, 1.1 million tonnes of chemical fertilizers were imported by the Nigerian government[1]. Initially fertilizers were highly subsidized by the government; later the subsidy was reduced. Since the reduction of the subsidy, Nigerian farmers have to spend much money on fertilizers, resulting in the price being beyond the reach of farmers, especially smallholder farmers, who constitute the bulk of the Nigerian farming population. In 1986 a metric tonne of fertilizer cost about N100 (approximately US$200, or N5 per bag; N represents Naira). By the year 2003, a metric tonne cost N40,000 (approximately US$307, or N2000 per bag) (personal communication via emai1 with Dr. Simi Odeyinka, 2003). The increase in price is mainly due to the devaluation of the Naira against the US dollar—a 39,900% increase in price over a period of 15 years. To worsen the

situation, the high prices prevail during the planting season and they are still on the increase. Many writers have pointed out that fertilizer residues are destructive to the environment, in particular to the soil structure[2–4] and the quality of water resources[5,6], leading to increased degradation of the productive capacity of the life-support systems on which farmers depend, i.e., the land. The result is shortage of food[2], which may lead to increased poverty. It is apparent that a sustainable farming system is needed which does not rely on the application of fertilizers, which has a low cost, is consistent with the socio-economic and technological practices of the farmers, and can sustain production and maintain soil fertility.

Researchers at the International Institute of Tropical Agriculture (IITA) and International Livestock Research Institute (ILRI) [formerly known as the International Livestock Centre for Africa (ILCA)] in Ibadan, Nigeria carried out research on alley farming. Alley farming is a farming and agroforestry system in which fast-growing leguminous trees are planted in hedgerows with crops cultivated between them[4,7–9]. Alley farming allows continuous cropping[10], increases agricultural production, helps in poverty alleviation, eliminates the bush fallow system, combats weeds[11] and is considered by some a soil conservation measure, reducing soil degradation and organic matter decline[11,12]. Before alley farming can be effectively adopted, there is a need for long-term investment in land, but the indigenous land tenure system does not recognize the right of many women to own land. Since Yoruba women farmers are cash-crop and food-crop producers and are the main producers of livestock, there is a need to identify the constraints to their adoption of alley farming, which is a profitable and sustainable technology.

Although other writers[13,14] have studied the factors that influence alley farming adoption, no study has empirically identified the factors that determine women farmers' adoption of alley farming. The objectives of this study were: (1) to examine the effects of the characteristics of alley farming and those of women farmers on the women's adoption of alley farming; and (2) to investigate the effect of customary tenure rules and practices on women farmers' adoption of alley farming in Oyo state, Nigeria. Strategies are suggested for achieving increased adoption of alley farming by women farmers.

## Alley Farming

IITA developed alley cropping. ILCA added livestock production to alley cropping by utilizing part of the foliage as fodder for livestock, calling the system alley farming. When two types of leguminous trees are used in alley farming, they are planted 4 or 5 m apart in alternate rows and 40–50 cm apart within the row. The trees are pruned and used as mulch and livestock feed. Alley trees can grow on degraded land and restore nutrients to the land due to their deep rooting pattern[12]. Alley farming combines many agricultural activities, such as tree planting and management, crop production, livestock husbandry, and land and soil management. IITA and ILRI scientists found that the most suitable hedgerow species in southwestern Nigeria are *Leucaena leucocephala* and *Gliricidia sepium*. These trees perform the same function as observed in the bush fallow system. They yield large quantities of nitrogen when grown in hedgerows in alley farming systems[15,16] and fix 100–300 kg N $ha^{-1}$ $yr^{-1}$ or more[9]. Alley trees yield the largest amount of nutrient (400 kg N $ha^{-1}$ $yr^{-1}$), show higher nutrient recycling capabilities than other woody species and are well suited for alley farming in the humid and subhumid tropics. They are able to pass nutrients slowly to the subsoil because of their deep roots; the nutrients are then absorbed by food crops. *L. leucocephala* is the most efficient of the common alley tree species in maintaining soil organic matter[4,17–21].

Alley farming not only allows higher intensity of land use, but also improves soil fertility at a low cost, thus reducing or eliminating the need for chemical fertilizers. It can therefore be regarded as a bush fallow system that combines cropping and fallow phases. Alley farming has some characteristics that can be found in the indigenous agricultural system. For example, Nigerian farmers are familiar with bush fallow systems and they utilize leaves for mulch. On the other hand, alley farming involves new farming practices. These farming innovations, according to Atta-Krah and Francis (1987)[22], include the planting and establishment of trees within arable farms, their management for mulch and fodder production, cut-and-carry feeding for animals, and the alteration of land-use and rotation patterns.

Alley farming is an innovation that can overcome the problem of land degradation, which is a pressing problem in tropical Africa[23,24]. The functions of alley farming include maintenance of soil fertility through nitrogen fixation and nutrient cycling; maintenance of adequate levels of soil organic matter; supply of mulch for protecting the soil and regulating water infiltration, run off and erosion; supply of fuelwood; supply of stakes and ligneous materials that can be put to industrial use; supply of browse or fodder for animal feed; and limitation of fallows to narrow strips, consequently saving land and making continuous farming possible[9,24–26].

It is sometimes argued that alley farming is not beneficial, due to the fact that alley trees are not planted for direct economic benefit to the farmers in terms of harvested produce; there are no edible fruits from alley trees. Economically, alley farming is profitable to farmers because it enables high crop yields at low cost and allows continuous cropping[27]. Alley farming encourages sustainability of rural development. Its adoption facilitates the sustainability of farmers' environment and income.

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## Methodology

### *Data collection*

The study was conducted in southwestern Nigeria in November 1990. Primary data were collected through the field survey of Yoruba women farmers in seven villages: Iwo-Ate, Owu-Ile, Alfa, Oke, Iyana Ofa, Ofa-Igbo and Arikuyeri. In Owu-Ile and Iwo-ate, there are about 172 households, with an average of 3.6 adults per household. The population density of the other villages is between 138 and 404 people per square kilometer. Many farmers cultivated small farms in the study area. Twenty-five percent cultivated 0.5 acres of land, 60.7% had between 1 and 3.5 acres of land, 13.8% had 4–7 acres and 0.6% had 8 acres. The average farm size is 1.92 acres. The villages have a bimodal rainfall regime. The average annual rainfall in Owu-Ile and Iwo-Ate is 1700 mm while the average annual rainfall in the other villages is over 1800 mm. The bimodal pattern of rainfall in the villages allows two cropping seasons in a year. The first season is between April and June and the second is between July and October.

The villages were selected intentionally so as to incorporate those villages where alley farming has been introduced. The women farmers were interviewed by trained research assistants using modified structured and unstructured interview schedules. The sample size was 168. The sample includes both women adopters and non-adopters of alley farming. As few understood English, questions were asked in the local language but responses were recorded in English. In order to achieve accuracy in the data collection, secondary information was gathered through official statistical reports and personal observations. The author visited some of the alley farms of adopters, who told her their views about alley farming. Information was also gathered from persons known for their expertise on the customary land tenure system and alley farming.

The main occupation in all the villages is agriculture. Men and women cultivate the land. Some women worked on their husband's farm and harvested the crops, while many women had their own land, were independent farmers, cash-crop producers and main producers of livestock. They were farm managers, decision-makers and owners in their own right[28]. Of the women farmers surveyed, 86.9% were managers of their livestock in their own right and 86.3% made decisions on their own regarding the management and disposition of their crops. Women also engage in other economic activities, such as food processing, trading, sewing, selling clothes and poultry farming. Moreover, women own most of the small ruminants such as sheep and goats. Women also practice caretaking of small ruminants. Livestock are allowed to roam unrestricted in these villages. Small ruminants, especially sheep and goats, are owned by most households. Farmers in the villages engage in the bush fallow rotation system, with 3–4 years cropping and only 3–4 years fallow. Land shortage is a problem in the study area. The major crops include cassava, yam and maize, which are interplanted with many minor crops, i.e., peppers, tomatoes, okra, cowpeas, cocoyams, banana and other vegetables. These crops are grown for marketing. Some farmers grow peppers, cocoyams, tomatoes and vegetables for consumption.

There are differences between men and women in terms of their access to land through the land tenure system. Men acquire land through inheritance, but not all women have the right to land through inheritance. Women's access to land differs across families. Whereas some Yoruba families do not allow women to inherit land, others grant equal rights to both male and female children. If all the children are female, they have the right to inherit land from their fathers. In some families, wives have the right to allocation of land through their husbands, and they can plant any type of crop on such land. The main qualification for land ownership is lineage membership. Two categories of qualified women were identified. The first include those women who have the right to land in their lineage and those who can inherit land from their parents in the absence of any male offspring of their parents. The second category are those who have access to land through their husbands. Usually the husbands inform their family members of their wives' intention to use part of the family land.

One of the problems facing agriculture in the villages is the migration of some able-bodied men to cities in search of waged work. This has resulted in a reduction of food production.

The Pearson correlation coefficient was used to determine the strength and direction of the linear relationship between the dependent and the independent variables. The Pearson's level of significance used was one-tailed and the significance level less than 0.01. The dependent variable was women farmers' level of adoption. This was operationalized by using three levels of adoption, namely awareness, trial and adoption. Farmers were asked to indicate the stage at which they were. Farmers in the awareness stage were those who had heard about alley farming but had neither tried nor adopted it. Those in the trial stage were those who had heard and were trying it on a small scale but had not adopted it; and those in the adoption stage had adopted it. These levels were arranged in an increasing order, and numerical values were assigned to each. Those farmers in the awareness stage were assigned 1 point; trial, 2 points; and adoption, 3 points. The independent variables were factors affecting adoption of alley farming, which were effect of customary land tenure system on women's access to land, socio-economic characteristics of the farmers, and the characteristics of alley farming. Membership in an organization was one of the farmers' characteristics that was tested. They were asked: 'Do you belong to any organization?' They were asked to mark Yes or No. The farmers who answered Yes were assigned 2 points while those who said No were assigned 1 point.

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The characteristics of an innovation include its relative advantage, compatibility, complexity, triability and observability. Respondents were given some statements that measure the characteristics of the innovation. For example, for relative advantage they were asked: 'Do you agree that alley farming is better than the farming system you were practicing before?' They were asked to select, for each statement, one of five response categories which were scored according to the intensity of agreement with statements that are favorable to innovation characteristics. The response categories were scored as follows: Strongly Agree, 5 points; Agree, 4 points; Neutral, 3 points; Disagree, 2 points; and Strongly Disagree, 1 point.

Data were analyzed using the Statistical Package for the Social Sciences for Personal Computer SPSSPC, version 4.10, developed by SPSS Inc., USA. Percentages, frequency counts, chi-square test and bar charts were used in this study.

## Results and Discussion

### *Levels of adoption*

Six (3.6%) of the women farmers had not heard about alley farming before, while 96.4% had heard about it. Grouping the women cultivators into three levels of adoption, namely awareness, trial and adoption; 55.6% were in the awareness stage and 0.6 % in the trial stage, while 43.8% were in the adoption stage. Only one respondent was in the trial stage of alley farming, and it was not certain whether she would adopt alley farming or not. This respondent was excluded from the rest of the analyses, due to small sample size. It is observed that many of the women farmers did not adopt alley farming. When asked to give the reasons why, lack of information about the benefits of alley farming (21.0 %) and lack of money (19.8 %) were the two major reasons given. Information about alley farming was not communicated effectively to women. Meetings were fixed at times when it was not convenient for women to attend. The main village contacts, the researchers and the extension workers were men[29].

### *Factors affecting the adoption of alley farming*

**Characteristics of alley farming.** The characteristics of an innovation affect its adoption. Kinnucan et al. (1990)[30] point out that the characteristics of agricultural innovations influence farmers' decisions regarding adoption. It does not matter whether or not the inherent characteristics of an innovation are better than those of the idea it is replacing; what matters is whether the farmer sees the advantage of the innovation to be superior to current practices. An innovation can be characterized in several dimensions, namely its relative advantage, compatibility, complexity, triability and its observability[31].

*Relative advantage.* Relative advantage is the degree to which a new idea or practice is superior to the idea or practice it is intended to replace. The relative advantage is expressed in terms of cost, social prestige, convenience and satisfaction. Sheth et al. (1999)[32] asserted that the relative advantage of an innovation determines its adoption. The price of an innovation affects its rate of adoption and use; the higher the price, the lower the rate of adoption[30]. The relative advantage of alley farming in a society or community depends on land availability, and fertilizer and feed prices. The benefits of the farming system are likely to be realized sooner by a farmer using chemical fertilizer than one who is not using it. Alley farming has been found to be more profitable than indigenous bush fallow systems[4,33]. According to Kang and Shannon (2001)[4], alley farming is more advantageous than the bush fallow system because of its continuous cropping, thus eradicating a fallow phase and land clearing. Alley farming has a labor-saving potential, and this may make it an attractive farming system in Africa where the land/labor ratio is high[33].

*Compatibility.* Compatibility means the extent to which an innovation is consistent with the farmer's existing community values, traditional management objectives and existing levels of the farming system[31]. Farmers may reject the capital-intensive technology of advanced economies due to its incompatibility with the existing level of farm technology. On the other hand, they may easily adopt appropriate technology because of its compatibility with their values. Due to some similarities between alley farming and bush fallow systems, farmers in Nigeria may not find it difficult to adopt alley farming. For instance, indigenous Nigerian farmers planted crops and woody species on the same piece of land. Moreover, traditional farmers in the lesser Sudan Islands of southeastern Indonesia and southern Philippines have practiced alley farming for a long time[9]. Farmers in these area are likely to adopt alley farming. Farmers in developing countries whose farmlands have deteriorated due to use of foreign technologies are adopting technologies that are consistent with their indigenous practices, as a means of restoring their farmland.

*Complexity.* Complexity is the relative ease or difficulty with which the farmer can understand and use the innovation. Alley farming is easy to learn[34]. Foreign mechanical devices may be difficult for farmers to operate and may not be easily adopted.

*Triability.* Triability is the extent to which an adopter can test the innovation on a limited scale. Rogers (1995)[35] points out that some innovations are more difficult to divide for trial than others. Kang and Shannon (2001)[4] assert that alley farming can be cultivated on a small area and produce an annual crop.

*Observability.* Observability concerns the degree to which the results of an innovation are visible to farmers. An innovation is more likely to be adopted if its advantage can

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easily be seen. Farmers need to conserve the fertility of their land, but the initial time lag in deriving benefits, that is the time taken for the leguminous trees to grow, may be a constraint for them in adopting alley farming[33,36,37].

The data reveal that there was a positive and significant relationship between the characteristics of alley farming and the farmers' level of adoption of alley farming (Table 1). The coefficients for level of adoption and the relative advantage of alley farming in terms of its cost (–0.8291), social prestige (0.8182), convenience (0.8431) and satisfaction (0.8493) were slightly higher than those of its compatibility with existing community values (0.7680), traditional management objectives (0.7596) and existing level of farming system (0.7607). Moreover, there was a high positive and significant correlation between women farmers' level of adoption and the complexity of alley farming (0.8458), its triability (0.8637) and its observability (0.8671). The largest percentage of adopters, 73.2%, agreed that alley farming is consistent with their existing level of farming system, compared with only 2.2% of the non-adopters who agreed that it is. Moreover, 14.1% of the adopters strongly agreed, while none of the non-adopters strongly agreed. These findings support IITA (1989/90)[38], which states that farmers readily adopt innovations that they consider are compatible with their existing level of farming system.

Women farmers who said that alley farming is cheaper than their former farming system are more likely to adopt it than those who did not. This benefit may be seen easily by farmers who have formerly used chemical fertilizers, which are very expensive in Nigeria. In contrast to fertilizer, alley trees can gradually increase production with minimal investment. This is because, ideally, farmers purchase their initial seed stocks at a cheap rate, or they may be given free. Farmers can get their seed supplies from each successive harvest. As a result, they only need to make the planting investment and to multiply the seeds. Whereas, in the case of fertilizer, farmers require more capital to acquire fertilizer due to its high cost and scarcity in Nigeria. Moreover, fertilizer is a non-seed innovation, and its adoption involves recurring costs which result from input consumption and replacement requirements. Furthermore, chemical fertilizer increases yield in the short term whereas alley farming increases production for the long term, although alley farming requires a longer time to start yielding[39]. In addition, the cost of labor for clearing new land in the case of farmers who practice the bush fallow system is very high. Such farmers may find that alley farming is cheaper and may result in saving part of their labor costs. Although some women are assisted by their children in clearing the land, this may be restricted by school attendance.

**Characteristics of women farmers.** The study of adopters often includes the effect of their personal and socio-economic characteristics, such as age, level of formal education, level of income, marital status, size of farm, extension contacts and membership in an organization, on their adoption of innovations.

*Age.* Two contrasting views have been expressed by researchers on the relationship between the age of the farmer and adoption behavior. Some researchers claimed that age affects adoption, while others have said that there is no relationship between age and adoption. Kinnucan *et al.* (1990)[30] observed that there is a relationship between age and farmers' adoption behavior. Some studies have emphasized highest adoption at middle age. Younger farmers are said to be more interested in making changes in farming, so they are more likely to adopt new ideas than older farmers. As shown in Figure 1, the age group 31–39 years had the highest percentage of adopters (46.48%).

*Formal education.* The level of formal education of women may be a predictor of their adoption of innovations. Some studies have emphasized a positive association between formal education and adoption[30,40]. The assumption is that schooling facilitates learning which, in turn, is presumed to instill a favorable attitude towards the use of improved farm practices[41]. On the other hand, Cramb and Nelson (1998)[34] believed that education is not important in explaining adoption. In most cases, whether an individual has a formal education or not has no relationship with his or her adoption behavior.

**Table 1.** Correlation between farmers' level of adoption and the characteristics of alley farming.

| Characteristics of alley farming | Correlation coefficient (*r*) |
|---|---|
| Its cost | –0.8291 |
| Social prestige derived from adopting it | 0.8182 |
| Its convenience | 0.8431 |
| The satisfaction derived from adopting it | 0.8493 |
| Conformity with existing community values | 0.7680 |
| Conformity with traditional management objectives | 0.7596 |
| Conformity with existing level of farming system | 0.7607 |
| Its relative ease or difficulty | 0.8458 |
| Possibility for its trial on a limited scale | 0.8637 |
| Extent to which its advantages can easily be seen | 0.8671 |

The values of 'r' are significant, with one-tailed significance levels less than 0.01.

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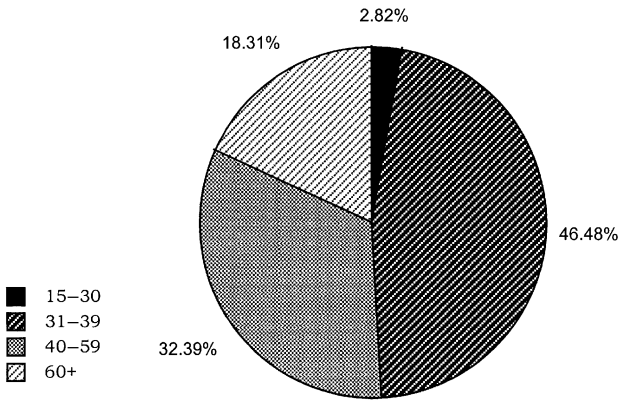


**Figure 1.** Adopters according to age group.

*Level of income.* Many research findings have shown an important relationship between level of income and adoption of innovation. Kinucan *et al.* (1990)[30] claimed that farmers possessing a high level of income make better use of innovative farming techniques. The higher the level of income of a farmer, the more he or she can afford to take financial risks, because he or she can offset losses from some of the less successful experiments.

*Marital status.* In their study on the adoption of alley farming by women farmers, Francis and Atta-Krah (1988)[42] discovered that there is a relationship between marital status and adoption of alley farming by women. Married women are said to participate more actively than single women in projects that can increase their income. Women whose children go to school are assumed to readily adopt new agricultural practices so that they can better finance the post-primary education of their children.

*Size of farm.* There is positive relationship between farm size and adoption[34,40,43]. Some researchers found no association between size of farm and farm practice adoption[44]. Discussing the Green Revolution in Asia, Jabbar (1990)[33] stated that although the technology was originally characterized as scale neutral, larger farms became early and major adopters.

*Extension contact.* Agricultural extension services help in disseminating information about agricultural innovations to potential adopters, thus enhancing innovation adoption. In their study, Adesina et al. (1999)[14] found out that the rate of adoption is higher among farmers who had contact with extension agencies.

*Organization membership.* Membership in organizations, for example farmer cooperatives and village societies, is an important farmer's characteristic that promotes adoption of new agricultural practices[45].

Correlation coefficients ($r$) were computed for the women farmers' level of adoption and their characteristics, namely level of formal education, size of farm, age, extension contact and membership in an organization, in order to discover the relationship between the variables. Among the correlation coefficients, only the coefficient between farmers' level of adoption and level of formal education was negative and non-significant (–0.0905). This indicates that the level of formal education of the women farmers was not related to their adoption behavior. Size of farm and level of adoption were positively and significantly correlated (0.5717). Moreover, with increased farm size, there was an increased propensity for women farmers to adopt alley farming. There was a positive and significant correlation between farmers' level of adoption and farmers' extension contact (0.5393) and membership in organizations such as farmer cooperatives and village societies (0.3483). Women farmers who adopt alley farming were more likely to belong to an organization than non-alley farmers, although the relationship between membership in an organization and level of adoption was weak. Also, there was a low positive and significant correlation between farmers' level of adoption and age (0.1891). From Table 2, age group 60 and above were more likely, as a percentage of their total (54.2%), to adopt alley farming. This age group was followed by age group 40–59 (53.5%).

**Table 2.** Respondents' age group by their level of adoption.

| | Level of adoption | | | |
|---|---|---|---|---|
| **Age group** | **Awareness** | **Trial** | **Adoption** | **Total** |
| 15–30 | 5 (71.4%) | | 2 (28.6%) | 7 (100.0%) |
| 31–39 | 55 (62.5%) | | 33 (37.5%) | 88 (100.0%) |
| 40–59 | 20 (46.5%) | | 23 (53.5%) | 43 (100.0%) |
| 60 and above | 10 (41.6%) | 1 (4.2%) | 13 (54.2%) | 24 (100.0%) |

The marital status of the farmers, as a factor affecting alley farming adoption, was examined (Table 3). The majority (74.7%) of alley farming adopters were married, 1.4% were single, 2.8% were divorced, 21.1% were widowed and none were separated. The only single woman adopted alley farming. One of the respondents was separated but she did not adopt alley farming. Fifty percent of those who were divorced adopted alley farming, 41.1% of the married women adopted the technology and 57.7% of the women who were widows adopted the technology.

**Customary land tenure system.** The customary land tenure system is the right of individuals and of groups in a social system that regulates their use and control of the system's land resources.

The majority of the women farmers surveyed (57.2%) did not have access to land through the customary land tenure system. As shown on Table 4, the largest percentage of the adopters (47.9%) in the sample disagreed that the tenure system allows them to have access to land, and 45.1% of them agreed. These findings show that those who do not have access to land, through the land tenure system, can adopt. The

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**Table 3.** Distribution of respondents by marital status and level of adoption.

| | Single | | Married | | Separated | | Divorced | | Widowed | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Level of adoption** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** |
| Awareness | – | – | 76 | 84.5 | 1 | 1.1 | 2 | 2.2 | 11 | 12.2 | 90 | 100.0 |
| Adoption | 1 | 1.4 | 53 | 74.7 | – | – | 2 | 2.8 | 15 | 21.1 | 71 | 100.0 |
| Total | 1 | 0.6 | 129 | 80.1 | 1 | 0.6 | 4 | 2.5 | 26 | 16.2 | 161[1] | 100.0 |

[1] 161 = number of women adopters and non-adopters of alley farming.

**Table 4.** Respondents' level of adoption by their opinion on the effect of customary land tenure system on their access to land: Do you agree that the customary land tenure system allows you to have access to land?

| | Effect of custumary land tenure on access to land | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Strongly agree | | Agree | | Neutral | | Disagree | | Strongly disagree | | Total | |
| **Level of adoption** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** | ***N*** | ***%*** |
| Awareness | 1 | 1.1 | 29 | 32.2 | 3 | 3.3 | 53 | 59.0 | 4 | 4.4 | 90 | 100 |
| Adoption | 2 | 2.8 | 32 | 45.1 | 2 | 2.8 | 34 | 47.9 | 1 | 1.4 | 71 | 100 |
| Total | 3 | 1.9 | 61 | 37.9 | 5 | 3.1 | 87 | 54.0 | 5 | 3.1 | 161[1] | 100 |

[1] 161 = number of women adopters and non-adopters of alley farming.

findings contradict the literature on women's access to land through the land tenure system and their adoption behavior, which states that women who do not have access to land through the land tenure system may not adopt agricultural innovations. The disadvantaged status of women in having access to land, through land tenure systems, does not hinder them from adopting alley farming. A similar result was obtained by Adesina et al. (1999)[14] in their survey conducted in Cameroon, Nigeria and Benin. Women who do not have access to land through land tenure can lease or purchase land.

### *Impact of alley farming on women adopters*

When asked about the benefits they derived from alley farming, many women adopters in the sampled villages claimed that alley farming has improved their crops and livestock production. A similar result was obtained by Isaac et al. (2003)[11] in their study conducted in Haiti. In the study area, the Nigerian women adopters indicated that they derived higher income from the sale of their crops and livestock, and this has improved their quality of life. They declared that alley trees maintained the soil fertility at low cost, thus minimizing the cost of their farm maintenance. Their livestock were healthier when fed with alley trees. These were consistent with the results reported by Kang et al.(1999)[9], Kang and Akinnifesi (2000)[46] and Isaac et al. (2003)[24]. None of the adopters had stopped alley farming. They claimed that alley farming is a profitable technology.

## Conclusions

Many Nigerian farmers are facing serious problems of land shortage which is caused by urbanization and the extensive use of land. This has led to rapid deterioration of the soil structure. The application of large amount of fertilizers to farmland has led to land degradation. Farmers need sustainable and more productive farming systems. Sustainable land use is that which achieves production combined with conservation of the resources on which production depends, thereby permitting the maintenance of productivity[47].

Alley farming can lead to sustainability of rural development. It can maintain soil fertility through nitrogen fixation and nutrient cycling. Isaac et al. (2003)[11] claimed that alley farming is a soil conservation measure. Alley farming can counteract many adverse conditions, such as weed growth[12]. It is capable of protecting the soil from erosion. Alley farming is acceptable to small farmers because it is not an expensive farming system. It is a sustainable alternative to the bush fallow system. Unlike imported complex technology, alley farming is 'appropriate' and is 'within the ability' of small farm holders to manage; it is also 'compatible with their financial capabilities'. Its ability to increase crops and livestock production and to produce usable materials in years of severe drought enhance its adoption by women farmers who are producers of cash crops and livestock.

The characteristics of alley farming influence the decision of the women farmers to adopt it. There is a

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positive and significant relationship between the relative advantage, compatibility, complexity, triability and observability of alley farming and its adoption by women farmers. The personal characteristics of women farmers, such as size of farm, extension contact and membership in organizations, are positively and significantly correlated with farmers' level of adoption, while their level of formal education is not related to their adoption behavior. Women's lack of access to land through the customary land tenure system does not hinder their adoption of alley farming.

## Recommendations

Researchers should focus on what may be termed 'needs identification', which means they try to recognize exactly the farmers' felt needs and design technologies that can meet their needs. This can enhance farmers' willingness to adopt agricultural technologies. Many women farmers were not aware of the benefits of alley farming and were, therefore, not motivated to adopt it. In order to increase women's rate of adoption of alley farming, four things must be done. First, innovation messages must be effectively extended to women; secondly, meetings must be fixed at times when women will be able to attend, and women should be involved in the decision-making process; thirdly, the research and extension teams should include women, simply because many women farmers prefer to communicate with female researchers and extension workers; and finally, female research associates should be posted to the villages in order to inform the women about the benefits of alley farming and to find out those cultural factors that can enhance women's adoption of alley farming.

Land is an essential element in agricultural production. Many women did not have access to land through the land tenure system. The government should create an avenue whereby women can borrow money to purchase land.

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