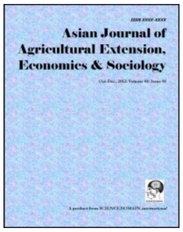

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Socio-economic Factors Influencing Adoption of Dual-purpose Cowpea Production Technologies in Bichi Local Government Area of Kano State, Nigeria

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Authors' contributions

The study was designed analyzed and discussed by author AS of blessed memory assisted by authors BZA, TKA and LA. Author DHY assisted in data collation, proof read the work and the gallery proof. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the socio-economic factors influencing adoption of dual-purpose cowpea production (DPC) technologies among farmers in Bichi Local Government Area of Kano State, Nigeria. Data were collected with the use of questionnaire administered to 200 farmers selected randomly. Descriptive statistics, correlation analysis, and step-wise multiple regression were used to analyze the data. Findings indicated that 35.7% of the farmers were within 41-50 years. The largest percentage (24.5%) had a family size within the range of 11-15, with a mean of 8. Majority of the farmers had formal education, ranging from primary to post-secondary. They had more than 1ha of land, with a mean of 2.2ha. They all participated in one form of farmers' organization or the other. The mean adoption rate was 77.5%. The use of improved seeds and insecticides had the highest adoption score (100%). Result of the correlation analysis indicated that level of education, household size, farming experience; number of ruminants owned, social participation and

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contact with extension agents were significantly related to technology adoption and hence, influenced adoption of DPC production technologies. Moreover, level of education, social participation and extension contact made the highest contribution in explaining variations in the differential adoption of the DPC production technologies among the farmers. It was concluded that educational level, social participation and extension contacts were the major socio-economic factors influencing adoption of the DPC production technologies. The need for improvements in promoting these factors, were therefore recommended.

Keywords: Technology adoption; dual-purpose cowpea; socio-economic characteristics.

1. INTRODUCTION

Cowpea (*Vigna unguiculata (L.)* Walp) is a leguminous crop grown mainly in the savanna regions of the tropics and subtropics of Africa, Asia and South America [1]. Being a drought tolerant and warm weather crop, cowpea is well adapted to the drier regions of the tropics where other food legumes do not perform well. It is of major importance to the livelihoods of millions of people in less developed countries of the tropics, particularly in Asia and Africa. From its production, rural families derive food, animal feed and income [2].

Cowpea is one of the most economically and nutritionally important indigenous African grain legumes and an inexpensive source of protein for both rural poor and urban consumers [3]. Cowpea grain contains about 25% protein and 64% carbohydrate and therefore has a tremendous potential to contribute to the alleviation of malnutrition among resource-poor farmers [4].

According to [2] about 7.56 million tonnes of cowpea are produced worldwide annually on about 12.76 million hectares with sub-saharan Africa accounting for about 75% of the total production. West Africa is the key cowpea producing zone, mainly in the dry savannah and semi-arid agro-ecological zones. The principal cowpea producing areas are Nigeria, Niger, Senegal, Ghana, Mali and Burkina Faso. According to [5], Nigeria was the world largest cowpea producer with the production of about 3.15 million tonnes in 2007, accounting for 41.67% of world total production. However, the domestic supply of cowpea did not meet with Nigeria's demand leading to a deficit of 518, 400 tonnes per year.

By 2050, West Africa's population was projected to increase to about 574 million [6,7]. It is anticipated that livestock numbers will also increase dramatically [8]. With the popular view that crop-livestock integration provides some of the best options for sustainable productivity, the trends in human and livestock population and the imperative agricultural intensification point to the fact that cowpea is likely to become more popular and to play an important role in agricultural production systems in the near future. This vision supports the need for research to develop and disseminate cowpea varieties that continue to respond to the food-feed as well as the soil fertility needs of the region.

In view of cowpea's multiple roles and contributions to both human and livestock production, one of the opportunities recognized during the mid 1990s was to develop dual-purpose cowpea varieties that would yield both grain and fodder. This is in contrast to most local varieties usually grown in roughly equal proportions of grain and fodder types, intercropped with cereals [9]. It was on this basis that scientists at International Institute of Tropical

Agriculture (IITA) and International Livestock Research Institute (ILRI) began working together to include fodder quantity and quality, along with grain parameters among the selection criteria in the cowpea-breeding programme [10]. Recognition of the potential of the dual-purpose cowpea stimulated this study to investigate some of the likely factors affecting its adoption.

The test of a successful technology is its adoption by the target group. DPC production and the associated management strategies were fully disseminated particularly in parts of northern Nigeria where extensive on-farm trials on cowpea are going on due to the presence of IITA and ILRI Kano research stations. However, data on dual-purpose cowpea cultivation and adoption are scarce. Thus, it is difficult to know the extent to which farmers are adopting the new production technologies, how, and why. Such critical baseline information is required for the prediction, monitoring and evaluation of the impacts on farming systems and farming households [11] suggested that although scientific research into new varieties, fertility factors, improved farming system and new technology has continued, impact of these research results on production is still minimal despite huge funds committed to those researches. This is because the technology were either inappropriate to farmer's needs and perception, not properly disseminated or farmers are not using the technology following researchers' recommendation.

Technologies are viable only when farmers use them. No matter how well new technologies work on research stations, if farmers will not have them for use, their development would have been in vain [12]. Technologies often meet with resistance among certain kinds of farmer families. In particular, rates of technology adoption by small-scale farmers, in Africa, were not as encouraging as expected. Despite the potential benefits in increased agricultural production, farmers often reject technologies with proven positive impact on farm yields discovered through agronomic experimentation and testing. This mystery motivated efforts to identify and analyze the various determinants and obstacles to adopting new technologies by farmers. These efforts picked up steam as it became clear that the simple existence of improved technologies and high yielding varieties was sufficient to ensure their adoption by small farmers.

Socioeconomic factors (age, marital status, education, household size, farm size, social participation and so on) are important factors affecting productivity level in Nigeria. Therefore the knowledge of their effect on DPC technology adoption will help policy makers in the country to make more informed decisions in improving production and livelihood of the farmers.

The major objective of this study was to examine the socio-economic factors influencing adoption of improved dual-purpose cowpea production technologies. Specifically, it determined the rate of adoption of dual-purpose cowpea production technologies, analyzed the farmers' socio-economic factors influencing adoption of dual purpose cowpea production technologies and identified the problems encountered by farmers in using the recommended production technologies.

2. MATERIALS AND METHODS

Bichi Local Government is located in the northern part of Kano state, Nigeria. The state fall within the dry sub-humid agro-ecological zone, lying between latitudes $10^{0}33'$N to $12^{0}03'$ and longitude 7º34'E to 8º32'E [13]. It shares common boundaries with Katsina state to the north-west, Jigawa state to the north-east and Bauchi and Kaduna states to the south. Kano is the largest populated state in Nigeria, having 9,383,682 people [14]. It has a land area of 20,760 km^2.

The climate of the state is mainly the sudan savannah type of the tropical wet-dry season, characterized by 5-6 months of rainfall (May to October) and 6-7 months of dry season, with the mean annual rainfall of 792 mm [15]. Temperature is warm all over the region, with an average of 26ºC in the south and 28ºC in the north.

Kano state, with *Hausa* and *Fulani* as the major ethnic groups has been a commercial and agriculture state. The major rainfed crops produced include rice, millet, cowpea sorghum, groundnut and maize. The dry season crops include tomato, pepper, cabbage, lettuce, okra, spinach and onion. Cattle, sheep, goat and poultry are the major animals domesticated in the area.

Data were collected through the use of structured questionnaire administered to the farmers. The sampling frame consisted of contact farmers growing the DPC in the region. Multistage sampling technique was use to select the representative farmers. Ten of the 15 villages covered by the programme were randomly selected to give two-third of the villages covered. The villages are Badume, Yakasai, Tsaure, Bakin Shara, Yan tasha, Santar rago, Kargon Bichi, Santar sabo, Muntsira, Rimayen rake and Ciromawa. Two farmer groups out of the 3 that participated were randomly selected from each village. Ten of 25 farmers in each group were chosen at random, giving a total of 200 farmers. The list of the farmer groups from each of the villages was obtained from the village extension agents.

2.1 Data Analysis

Data collected were analyzed using descriptive and inferential statistics. The descriptive statistics used were mainly frequencies and percentages while the inferential statistics used were Pearson-product moment correlation and linear multiple regression analysis to analyze the farmers' socio-economic factors influencing adoption of DPC production technologies.

2.2 Measurement of Variables

The dependent variable is adoption of 13 cowpea production technologies referred to as recommended farm practices. These are: use of improved DPC seed, cropping system (cowpea and cereal at 4:2 ratio), planting date (late June/early July), seed rate (2 seeds per hole), spacing (20cm intra row and 75cm inter row), basal application of fertilizer at ridging, type of fertilizer (Single Super Phosphate), quantity of fertilizer (40kg/ha), method of fertilizer application (side placement), time of fertilizer application (2 weeks after planting), pesticides spray (3 times), harvesting (75 days after planting) and storage method (triple bagging)

Each farmer was scored by the number of technologies (practices) he reported using. Therefore a farmer had a minimum score of 0 and a maximum of 13.

The predictor or explanatory variables for the regressions were identified and the choice of these variables is explained in more detail below.

2.2.1 Age (X_1)

The age of household head is incorporated as it is believed that with age, farmers accumulate more personal capital and, thus, show a greater likelihood of investing in innovations. However, it may also be that younger household heads are more flexible and hence likely to adopt new technologies. The expected sign of the coefficient on age is indeterminate.

2.2.2 Educational level (X_2)

More educated farmers are typically assumed to be able to process information and search for appropriate technologies to alleviate their production constraints. The belief is that education gives farmers the ability to perceive interpret and respond to new information much faster than their counterparts without education. The expected sign on the coefficient on education is positive.

2.2.3 Household size (X_3)

The number of individual members in the household determines labour availability and likely influence of innovation acceptance. The expected sign is positive.

2.2.4 Farm size (X_4)

The size of the family farm is a factor that is often argued as important in affecting adoption decisions. It is frequently argued that farmers with larger farms are more likely to adopt an improved technology compared to those with small farms, as they can devote part of their fields (sometimes the less productive parts) to try out the improved technology. There is often a minimum threshold farm size acting as a constant to agricultural technology adoption.

2.2.5 Farming experience (X_5)

Those that adopted technology first are expected to have the highest adoption score more than new adopters.

2.2.6 Number of livestock owned (X_6)

Farmers with high number of livestock (cattle sheep and goats) are expected to adopt DPC variety which produces high yield in both grain and fodder for livestock feeding. The expected sign is positive.

2.2.7 Membership in social organization (X_7)

Membership to social organization is included because it has been shown that farmers within a group learn from each other how to grow and market new crop varieties. Evidence suggests that network effects are important for individual decisions, and that in the particular context of agricultural innovation, farmers share information and learn from each other [16]. The expected sign on the coefficient on membership in social organization is positive.

2.2.8 Contact with extension agents (X_8)

Farmers' contact with extension agents was measured as the number of visits by the extension agent in a year. Contact with extension agents is expected to have a positive effect on adoption based on innovation-diffusion theory. Such contacts, by exposing farmers to availability of information can be expected to stimulate adoption [17]. A positive relationship is hypothesized between extension visits and the probability of adoption of a new technology.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of the Farmers

Some demographic attributes of the rural farmers such as age, educational level, household size, farm size, occupation, farming experience, etc constituted some of the variables in this study. The variables, in one way or the other may have influenced or were influenced by technological change in the traditional farming.

3.2 Age of the Farmers

Age of farmer is said to influence farmer's maturity and decision making ability [18]. Result of the study Table 1 indicates 46 years as the mean age of the farmers. Large proportion (37.5%) of the farmers was within 41-50 years, closely followed by 30-40 and 51-60 years that constituted 29.0% and 17.5%, respectively. The least proportion (6.0%) is within the age range of <30. There was therefore a relatively widespread of DPC production among the age groups in the study area. This implies that DPC farming is embraced by all the age groups in the area which is an advantage for increased investment and improved technology utilization and hence, innovativeness. This finding is similar to that of [19] who observed the widespread of adoption of cocoa production technologies among several age groups.

3.3 Educational Level of the Farmers

It is a well known fact that the literacy level in rural Nigeria is generally low. The result obtained from this analysis, therefore, is not much different from what is expected. Table 1 shows that the literacy level in the study area was relatively fair, with 39.5% admitting to have no formal education. Larger proportion of the categories (49.0%) had primary education while 7.0% and 4.5% had secondary and post-secondary education, respectively. This finding is in consistence with that of [20].

3.4 Household Size of the Farmers

Most rural households in Nigeria are large because of the kinship structure and the extended family system [21]. It is not surprising therefore that more than half (51.0%) of the farmers had between 6 and 10 members in their households. Furthermore, another 24.5% had 11-15 members, 22.0% had 1-5 while 2.5% had 16 and above members in their households, with an average of 8 members Table 1. This is in agreement with the findings of [22] who reported 8 persons as average household size of integrated pest management adopters. [23] Also reported that the average household size in Africa was 8-9 persons per household. This is highly indicative of the extended family system in the study area where parents and other relations dwell together as a household. Implication of this finding is that large family size of the farmers probably necessitated them to learn new agricultural technologies for augmenting production and increasing returns. More family labour would also be readily available since relatively large household size is an obvious advantage in terms of labour supply.

3.5 Farm Size

The results show that the highest proportion of the farmers (46.0%) had 2.1-3 hectares of land while only 10.5% had more than 3 hectares of land. The mean farm size was 2.2 hectares. This implies that the study area comprises of small-scale farmers. This finding agrees with [24] that Nigerian farmers are small-scale farmers that cultivate small area of land. Similarly, [20,19] in their study found the average farm size of their respondents to be 2 and 2.5 hectares, respectively. This relatively small farm size will inevitably lead to subsistence farming which do not encourage commercial farming. It could also constitute a major constraint to full technology adoption.

3.6 Occupation

The distribution of the farmers among the various occupation groups in the communities studied shows that majority (89.5%) were engaged in farming as their major occupation while few were into civil service (2.5%), trading (3.0%), artisan (3.0%) and driving (2.0%) Table 1. This finding agrees with [25,26] who found that the occupational status of their respondents showed that they were primarily engaged in farming.

3.7 Farming Experience

Majority (90.5%) of the farmers had 5-10 years of farming experience. The mean farming experience was 8 years. This indicates that the farmers were experienced enough to be able to understand the technology and adopt it. The length of experience in farming is probably an indicator of a farmer's commitment to agriculture. It may not necessarily pre-dispose him to adoption of new practices; it is more logical to expect veteran farmers to be less receptive to innovation. Long farming experience is an advantage for increase in farm productivity since it encourages rapid adoption of farm innovation. Long farming experience according to [27], is an advantage for increase in farm productivity since it encourages rapid adoption of farm innovation.

3.8 Sources of Labour

Table 2 shows that majority of the farmers used both family and hired labour in their farm operations while the others used either family (22.0%) or hired labour (29.0%). This suggests a relatively high demand for labour by the technology. [28] observed that in Nigeria, labour is a major constraint in peasant production. [29] also reported that availability of labour has been found to have impact on planting precision, better weed control, timely harvesting and crop processing.

3.9 Social Participation

Farmers belong to social organizations which serve as fora through which they exchange ideas about new farm practices. Table 2 indicates that the farmers participated in social groups, with the majority belonging to more than one group. In their study, [20] similarly observed high social participation among farmers. This indicates that the farmers were very likely to access information on the DPC production technologies.

Table 1. Demographic characteristics of the farmers

Variables	Frequency	Percentage
Age (years)		
<30	12	6.0
30-40	58	29.0
41-50	75	37.5
51-60	35	17.5
>60	20	10.0
Mean age = 46 years		
Educational Level		
No Formal Education	79	39.5
Primary Education	98	49.0
Secondary Education	14	7.0
Post-secondary Education	9	4.5
Household Size		
1-5	44	22.0
6-10	102	51.0
11-15	49	24.5
16 and above	5	2.5
Mean household size = 8		
Farm Size (ha)		
<1	10	5.0
1-2	77	38.5
2.1-3	92	46.0
>3	21	10.5
Mean farm size = 2.2ha		
Major Occupation		
Farming	179	89.5
Civil Service	5	2.5
Trading	6	3.0
Artisan	6	3.0
Driving	4	2.0
Farming Experience (years)		
<5	6	3.0
5-10	181	90.5
>10	13	6.5
Mean years of farming experience = 8 years		

Source: Field survey, 2010

3.10 Extension Contact

Contact with extension agent is a major factor determining the level of adoption of agricultural innovation. Such contact is more effective in facilitating adoption if it relates to the technology in question. Consequently, farmers' contact with extension agents that disseminate information relevant to cowpea production was examined. The result shows that 46.0% of the farmers had 3-4 contacts with the change agents per year; 27.0% had 5-6 and only 1.5% had 7-8 contacts. The average number of extension contacts was 4 per year. This indicates that the farmers were relatively, fairly receiving extension support which may auger well for innovation adoption and transfer. It also indicates that the extension agents are playing their roles in promoting agriculture in the area. Extension workers and co-farmers were therefore the major sources of information on the DPC production technology.

Table 2. Distribution of farmers based on labour source, social group participation and extension contact

Variables	Frequency	Percentage
Source of Labour		
Family	44	22.0
Hired	40	20.0
Both	116	58.0
Social Participation		
1	61	30.5
2	82	41.0
3	53	26.5
4	4	2.0
Extension Contact per Annum		
1-2	51	25.5
3-4	92	46.0
5-6	54	27.0
7-8	3	1.5

Source: Field survey, 2010

3.11 Sources of Technology Information

The primary goal of the information sources is to create awareness by diffusing among potential adopters, useful and practical information on the innovation and encourage its application. Agricultural extension workers constituted the most important source of information to the farmers (51.0%). Findings of the study also reveal that 33.0% of the farmers got their information on the DPC production technology package from co-farmers, 15.0% from IITA officials and 1.0% through radio. The result also shows that extension workers and fellow farmers were the effective sources of information. This finding is consistent with that of [30] who also reported that extension workers and fellow farmers/neighbours were the most effective source of information on new technology in six LGAs of Benue state. Result of an investigation by [31] shows how the information behaviour of traditional people was unwittingly applied to encourage a group of traditional farmers to produce food for their consumption. The incoming information was understood by the group because the messages were communicated in a way which they could identify. Therefore, [31] noted that rural people used to oral tradition, have their own peculiar way of handling information that is closely related to their social and cultural background. This makes choice of appropriate medium very crucial in agricultural information delivery. [32] noted that no one medium is the best. The selected medium, they argue, must be adapted to the message, target audience and the socio-economic environment of the farmers. The tremendous role of agricultural extension agents as information sources in the area is attributable to the effort of the programme initiators that may have influenced both literate and non-literate people accepting the technology. Similarly, contact farmers and/or contact groups receive the technologies' first hand information from extension agents and other farmers copy from project farmer [33].

3.12 Source of Inputs Production Purpose

The major source of inputs as indicated by majority of the farmers (80.5%) is the open market. However, 11.5% got theirs from IITA office, 3.5% from ministry of agriculture, 2.5% from extension agents and 2.0% from the LGA agriculture department.

Table 3 shows that the farmers' main purpose of production is to obtain the cowpea grain (77.5%). Others (21.5%) produce for both grain and fodder. Only 0.5% produces the DPC for fodder only. This may be connected to the farmers' profit-oriented production and accessibility to market place which lead to preference of grain over fodder.

Table 3. Distribution of farmers based on sources of technology information, inputs and production purpose

Variables	Frequency	Percentage
Source of Technology Information		
Radio	2	1.0
Extension Agents	102	51.0
IITA Officials (Farmers Forum)	30	15.0
Co-farmers	66	33.0
Source of Inputs		
Local Government Agriculture Department	4	2.0
Extension Agents	5	2.5
IITA Office	23	11.5
Market	161	80.5
State Ministry of Agriculture	7	3.5
Production Purpose		
Grain Only	155	77.5
Fodder Only	1	0.5
Grain and Fodder	43	21.5
Soil Improvement	1	0.5

Source: Field survey, 2010

3.13 Rate of Technology Adoption

The rate of adoption, defined as the number of technologies used by a farmer varies among farmers [34]. Result of compliance index of DPC production technologies presented in Table 4 indicated that out of the 13 technologies disseminated to the farmers, planting improved seeds and pesticide spray recorded the highest adoption score of 100.0%. This is not surprising as it is well known that the yields of cowpea varieties are generally near zero without the use of insecticides. Hence, the high level of adoption associated with the use of this technology implies that farmers in the area were aware of the fact that spraying their cowpea farms with insecticides provides an attractive opportunity for them to make better economic gains. Basal application of FYM, seed rate, planting date, cropping system and spacing have adoption scores of 97.5%, 91.5%, 88.5% and 81.0% respectively. Also, type of fertilizer, quantity required, method of application and time of application have 72.5%, 71.5%, 71.0% and 69.5% adoption score, respectively. 56.0% adopted harvesting technique while only 24.5% adopted the triple bagging storage method. The mean adoption rate was found to be 77.5%. This high level of adoption of the DPC production technologies may be connected with simplicity of coping with the technology transfer among farmers if the technologies are well presented, appropriate or relevant as well as profitable in the view of farmers. It therefore appears from the study results that the farmers were very much convinced about the merits of some of the technologies or even aware of some of them being promoted. According to [35], innovations which have immediate demonstrable results are more readily adopted compared to those that are capital intensive, preventive and requires a long gestation period before observable changes. However, non adaptation of the storage method (triple bagging) technology was attributed to high prices, relative scarcity and lack of awareness.

Table 4. Distribution of farmers by the rate of technology adoption

Technology	Frequency	Percentage
DPC Seed	200	100.0
Cropping System(4:2)	162	81.0
Planting Date (Late June/Early July)	177	88.5
Seed Rate (2 seeds/hole)	183	91.5
Spacing (20cm x 75cm)	162	81.0
Basal Application of FYM	195	97.5
Type of Fertilizer (SSP)	145	72.5
Quantity of Fertilizer (40kg/ha)	143	71.5
Side placement	148	71.0
Time of Application (2 weeks after sowing)	139	69.5
Pesticide spray (3 times)	200	100.0
Harvesting (75 days after planting)	112	56.0
Storage Method (Triple Bagging)	49	24.5
Mean Adoption Rate = 77.5%		

Source: Field survey, 2010

3.14 Correlation Analysis of the Farmers Socio-economic Characteristics and Technology Adoption

In order to examine the direction and strength of relationship between adoption of DPC production technologies and selected predictor variables, a correlation analysis was ran with the adoption score as criterion variable and selected socio-economic factors as predictor variables (age, educational level, household size, farming experience, number of ruminant animals owned, social participation and contact with extension agent). The result in Table 5 depicts that there was positive relationship between adoption and all the selected variables. However, six out of the seven variables were found to be significantly related to adoption of the DPC production technology.

The positive but non-significant relationship between age and adoption, implying that age is not a barrier to adoption of the technology. This was attributed to the widespread of the technology adoption by all age categories in the area. Similarly, [36,37,26] observed that age was not significantly related to the adoption of new recommended farm practices. However, the finding disagrees with [20,38,25] who found age to be significantly related to new technology adoption.

Farm size was not significantly related to the rate of technology adoption either. This implies that farmers with different farm sizes adopted the DPC production technologies. This might likely be due to two reasons. First, it makes sense that it is still profitable to cultivate DPC even on a small land area. Secondly, small scale farmers live at subsistence level that attracts them to adopt improved varieties which give better yields, earn more income and thereby help in raising their standard of living. The finding contradicts [19] who reported farm size to significantly affect the rate of technology adoption.

Table 5. Correlation Analysis of the Relationship between Adoption Level and Socio-economic Variables

Variable	Correlation Co-efficient (r-value)
Farmer's age	.09
Level of Education	.20**
Household Size	.66**
Farm size	.11
Farming Experience	.21**
Livestock owned	.15*
Social Participation	.80*
Extension Contact	.83**

** = Significant at 1% level, ** = Significant at 5% level, Source: Field survey, 2010*

The result further shows a positive correlation between educational level and rate of adoption. It implies that the educated farmers adopted more than the less or non-educated ones. This agrees with *apriori* expectation. The finding is consistent with results of previous studies such as those of [39,40,41]. However, it is inconsistent with the finding of [42]. The result is not unexpected considering the fact that exposure to education permits an individual to control the rate of message input and develop the ability to store and retrieve information for later use [43]. For certain technical information such as that dealing with agricultural innovations, this retrieval ability may be quite important [44]. Education enables the individual farmers to know how to seek for and apply information on improved farm practices. An illiterate farmer is generally apathetic and lacks choice and according [45,46] lack of choice is due largely to lack of knowledge which can be epistemological, technical or prudential. Prudential knowledge is knowledge of what to do under different circumstances and involves the understanding of the social, economic, political and cultural context in which one lives. [47] is of the view that a general lack of awareness among traditional farmers in Nigeria can be attributed to the high level of illiteracy, which in turn contributes to the low level of adoption of agricultural production technology. It is widely acknowledge that farmers with basic education are more likely to adopt new technology and become more productive.

There was a positive and significant relationship between household size and rate of technology adoption. This implies that adoption level is higher among large and medium-size households, similarly, [22] observed a significant positive relationship between household size and adoption level. Households with larger size tend to attach greater importance to food security than those with smaller size. This is because as a man's household size increases he is faced with added responsibility of feeding the members. Food is usually the most basic need in every household and use of improved technology for higher output is usually opted for. Also, with increasing household size, there is corresponding increase in number of individuals assisting in labour demanding activities. However, the result is not consistent with that of [48] who reported negative significant relationship between household size and rate of adoption.

Farming experience has positive significant relationship with adoption of technology. This positive relation between farming experience and technology adoption implies that those that adopted first had more adoption score than the new adoptors. This result agrees with the *apriori* expectation that the more experienced the farmer was the more he would be willing to face the risks associated with a new farming method. [49,50] had indicated that farming experience of farmers to a large extent affects their managerial know-how and decision making. Besides, it influences the farmer's understanding of climatic and weather conditions as well as socio-economic policies and factors affecting farming. This finding indicates that the length of farming experience among the farmers is an important determinant of technology adoption.

Number of ruminant animals owned by the farmer had significant positive effect on the adoption of the technologies. It implies that the numerical increase in the ruminant animal holding of the farmers may increase the adoption rate. This may not be unconnected with high fodder quantity of DPC that provides feed for animals. This result is similar to that of [6] who found that the number of ruminant animals influences the rate of adoption of improved cowpea production technologies.

Social participation of the farmers had positive significant relationship with adoption. This implies that the higher the number of social/farmers organizations a farmer belonged to, the more improved agricultural technologies the farmer would adopt. This could be attributed to the fact that constant interaction and contact with fellow members help farmers to become aware of new technologies. Social group participation enhances access to information on improved technologies, material inputs of the technologies such as fertilizers, chemicals, credit for purchase of inputs and payment of hired labour [30]. They also found membership of social group to positively influence technology adoption.

Extension contact as source of information had a significant and positive relationship with technology adoption. It implies that the higher the frequency of extension contacts the higher the rate of adoption. This result is in line with the findings of [51] which revealed that frequent contact with extension contact with extension agent is likely to minimize doubts among farmers and ensure timely purchase of inputs. Similarly, [52,49] revealed that the level of technology adoption was consistently and significantly affected by the level of extension input.

3.15 Regression Analysis of the Farmers Socio-economic Characteristics and Technology Adoption

In order to determine the socio-economic factors that best predicted a farmer's rate of technology adoption, a multiple regression analysis with stepwise method was carried out. The regression model incorporated all of the predictor variables which had significant correlations with the technology adoption. The dependent variable was the farmers' adoption scores, which was defined as the scores obtained from their compliance with the thirteen recommended farm practices. The result indicates that only three variables, namely level of formal education, social participation and extension contact positively and significantly influenced the adoption of the DPC production technologies, hence, were important in predicting adoption behaviour of the farmers.

Finding reveals that the three predictor variables, when taken together, are effective in predicting the farmers' adoption behaviour. The observed F-ratio of 262.27 is significant (P<0.01) indicating that the effectiveness of a combination of the predictor variables in predicting farmers' adoption of the technology and could not therefore have occurred by chance. The magnitude of the relationship between farmers' use of the technology and a combination of the predictor variables is reflected in the value of the co-efficient of multiple correlations R^2 (0.801) as shown in Table 6. It may therefore be said that about 80.1% of the total variability in farmers' adoption score of the technology is accounted for by a linear combination of the three predictor variables and by implication, increase in level of formal education, social participation and contact with extension agent would increase the rate of adoption of the DPC production technologies.

Table 6. Linear Regression Results Predicting Changes in Level of Technology Adoption

Variable	R^2 Change	Regression Co-efficient	Standard Error	t-value	*P*- value
Constant		2.583	0.246	10.494	0.00*
Educational Level	0.695	0.905	0.083	10.837	0.00*
Social Participation	0.100	1.229	0.145	8.451	0.00*
Extension Contact	0.006	0.079	0.033	2.433	0.02**
F-ratio				262.27	0.00*
R^2				0.801	

** = Significant at 1% level, ** = Significant at 5% level. Source: Field survey, 2010*

From the regression analysis, educational level had the strongest power in predicting the farmers' technology adoption as it accounted for about 69.5% of the variation the adoption score. Social participation accounted for 10.0% of the variation while extension contact accounted for about 0.6%. In a study on adoption of Sawah rice production technology, [53] found that membership of association and level of education were important contributors to adoption decision of farmers. Similarly, studies by [39,54] show that organizational participation, significantly influences adoption behaviour.

4. CONCLUSION

The major socio-economic factors influencing the adoption of DPC production technologies among farmers in Bichi Local Government Area of Kano State, Nigeria include educational level of the farmers, their social participation, and extension contact. However, the rate of DPC production technology adoption by the farmers is high, with the cowpea grain as the main target of production. Extension agents and co-farmers are the pre-dominant sources of information to the farmers, having played a key role in making them aware of and adopting the DPC production technologies.

5. RECOMMENDATIONS

It is essential to improve the educational standard of the potential adopters of the DPC production technologies from informal and primary to secondary and post-secondary. This should be a responsibility of all stakeholders including the governments (local, state and federal), IITA, and other organizations.

Social group participation should be maintained and possibly improved by the farmers through public enlightenment on its relevance particularly on technology adoption.

The extension agencies should improve the number of extension contacts as the existing contacts per annum may not be adequate in creating the desired awareness and interest of the potential adopters of the innovation.

COMPETING INTEREST

Authors have declared that no competing interests exist.

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