International Journal of Economics, Finance and Management Sciences
2026, Vol. 14, No. 1, pp. 69–78
https://doi.org/10.11648/j.ijefm.20261401.16

Research Article

Are the Farmers Financially Ready to Adopt Hydroponic Farming for Green Bell-pepper Cultivation in Nigeria

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Abstract

This study examined farmers' willingness and financial factors influencing the adoption of the hydroponic system of bell pepper cultivation in Imo State, Nigeria. Using a multi-stage sampling approach, 246 pepper farmers were selected from a population of 667 farmers across the three agricultural zones using the Yamane's formula alongside the probability proportional to size (PPS). The data were collected using a well-structured questionnaire, which was further analyzed using descriptive statistics and the ordered probit model. The results showed that a total of twenty farmers (8.13%) reported that they were not willing at all to adopt the hydroponic system; 11.79% of the farmers indicated that they were only slightly willing to adopt the system; 23.58% of the pepper farmers were neutral, while 50% of the farmers were either willing or eager to adopt hydroponic farming for pepper production in Imo State. The results from the ordered probit regression demonstrated that the age of respondents, annual income, perceived cost of hydroponics, farming experience, perceived costs of inputs, expected return on investment, and savings levels were the variables that significantly influenced the willingness of pepper farmers in Imo State to adopt hydroponics farming for green pepper production. The study recommends the relevant stakeholders should prioritize subsidizing hydroponic inputs and also provide customized funding packages for new and seasoned pepper farmers, given that farmers' revenue, expenditures, and projected returns were among the most significant factors influencing their readiness to embrace the smart farming innovation.

Keywords

Hydroponics, Green Bell Pepper, Farmers, Financial Factors, Willingness to Adopt

1. Introduction

Green bell pepper (Capsicum annum L.) is one of an important group of vegetables grown extensively, widely cultivated, and used as food in almost every country of the world. It is a high-productivity crop, and it has high remunerative and nutritive values. Sweet pepper consumption in Nigeria has been growing recently because of increasing demand by rural and urban consumers. As a result of rapid population growth and water scarcity, there is a call for an alternative means of

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Received: 19 December 2025; **Accepted:** 12 January 2026; **Published:** 2 February 2026

production system for sustenance of the human race [1]. Several factors, such as the vegetable's nutritional benefits, economic significance, and favorable growing conditions within Nigeria, contribute to this surge in demand.

In Imo State, most farmers still rely on open-field cultivation, which exposes the crop to erratic rainfall, pests, soil infertility, and the increasing scarcity of suitable farmland. These challenges often reduce yield and make pepper farming unpredictable, particularly for smallholders who depend on the crop for income.

In recent years, hydroponic farming has been gaining attention as a modern alternative that allows farmers to grow crops without soil, using nutrient-rich water in controlled environments. The controlled environments of hydroponics allow for precise manipulation of factors such as pH, nutrient concentration, and environmental conditions, which can lead to significantly improved yields [20]. However, despite these advantages, adoption among local pepper farmers appears very low. Farmers face limited access to essential resources such as credit facilities, which impedes their ability to invest in the necessary infrastructure and technology for hydroponic systems. In addition, uncertainty still surrounds their willingness to try it [15].

Understanding both their readiness and their financial preparedness is crucial. It helps government agencies and extension officers design interventions that match farmers' real conditions on the ground. This study therefore investigates whether pepper farmers in Imo State are truly positioned, both in mindset and in available resources, so as to transition into hydroponic green pepper cultivation. The specific objectives seek to ascertain the willingness of the farmers to adopt the hydroponic system of farming and also to ascertain the financial factors influencing farmers' willingness to adopt the hydroponic farming system for pepper cultivation.

2. Materials and Methods

2.1. Description of the Study Area

This study was carried out in Imo State, located in southeast Nigeria, within the country's rainforest agro-ecological zone. The state lies between latitudes 5 °45' and 6 °35' north and longitudes 6 °35' and 7 °28' east [4], sharing borders with Abia State to the east, Rivers State to the south, and Anambra State to the west [7]. Imo State covers approximately 5,067 km ²and has a population of about 3.9 million, with a high proportion of subsistence farmers [14]. The region experiences an average temperature of 28 ℃, a mean annual humidity of 80 percent, rainfall ranging from 1,800 to 2,500 mm, and an elevation of around 100 meters above sea level [7]. Administratively, the state is divided into three agricultural zones, Okigwe, Owerri, and Orlu, where the main economic activities include agriculture, trade, education, and public service [21].

2.2. Sampling Procedures and Sample Size Determination

A multi-stage sampling procedure was adopted for the selection of respondents. In the first stage, the three agricultural zones of Imo State, namely, Okigwe, Orlu, and Owerri zones were purposively selected to ensure that all zones were equitably represented in the study. In the second stage, one Local Government Area (LGA) was purposively selected from each agricultural zone based on the high concentration of pepper farmers.

In the third stage, a total population of 667 registered pepper farmers was obtained from the various farm cooperative groups in the three zones. The overall sample size was determined using Yamane's (1967) formula, which provides a simplified method for calculating sample size when the population is known. A five-percent margin of error was applied, resulting in a sample size of 250 respondents, as represented below:

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

Where:
$n =$ Sample size
$N =$ Population size
$e =$ Margin of error (5%)

Taking into account the time limitations and budgetary constraints of the study, a margin of error of (5%) was considered adequate for the study's level of precision and available resources.

However, in order to prevent the underrepresentation of any zone, the number of sample sizes from each representative agricultural zones (Okigwe, Orlu and Owerri agricultural zones) was calculated using probability proportional to size (PPS), as represented below:

According to Ref. [22], the sample size for each LGA (n_i) is calculated as:

$$n_i = \frac{N_i}{N_t} \times n_t \quad (2)$$

Where:
(n_i) = sample size allocated to each LGA
(N_i) = population size of each LGA
(N_t) = total population (across all LGAs (667)
(n_t) = total sample size (250)

Table 1: pepper farmers available per selected LGAs and number of sample size determined by PPS.

Table 1. Shows the number of sample size per selected LGA calculated by PPS.

S/N	Selected LGAs	Population Size (N_i)	Sample Size (n_i)
1	Okigwe	267	100
2	Orlu	233	87
3	Owerri	167	63
4	Total	667	250

Source: Authors Computation 2025

This method allowed the distribution of the 250 respondents among the three agricultural zones in proportion to the number of registered agribusiness operators in each zone. Thereafter, respondents were randomly selected from each zone according to their allocated sample sizes.

A total of 250 questionnaires were administered, out of which 246 responses were usable for analysis representing a response rate of 98.4 percent. Considering the study's time frame and financial limitations, the adopted margin of error (5%) was deemed sufficient for achieving reliable and generalizable findings.

2.3. Method of Data Collection

This study relied on primary data obtained from structured questionnaires administered to respondents in the study area. Data collection involved the use of structured questionnaires complemented by interview schedules to capture both quantitative and qualitative information. The questionnaires were designed to obtain responses on respondents' socio-economic characteristics, farmers willingness, and financial factors influencing the adoption of hydroponic farming for bell-pepper cultivation.

Method of Data Analysis: Ordered Probit Model

To assess the willingness of pepper farmers in Imo State to adopt hydroponic farming for green pepper cultivation, an ordered probit model was employed. This model is suitable for situations where the dependent variable is ordinal; in this case, farmers' willingness is measured on a 5-point scale: 1 = Not willing at all, 2 = Slightly willing, 3 = Neutral, 4 = Willing, 5 = Very willing.

Model Specification

The ordered probit model assumes the existence of a latent variable (Y_i*) representing the underlying willingness of a farmer to adopt hydroponic farming:

$$Y_I^* = X_I\beta + \varepsilon_I \quad (3)$$

The latent variable is modeled as:

$$Y_I^* = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \cdots + \cdots \beta_{10} x_{10} + \varepsilon_i \quad (4)$$

Where:

Y_I^* = latent variable of willingness to adopt hydroponic farming

β_0 = intercept

$\beta_1 \ldots\ldots\ldots\ldots \beta_{10}$ = coefficients of explanatory variables

X_I =vector of explanatory variables including age, access to credit, annual income, perceived cost of hydroponic setup, farming experience, perceived cost of inputs, farm size, expected ROI, extension contact, and savings levels

$\varepsilon_i \sim N(0,1)$ = standard normal error term

The observed ordinal outcome Yi is defined as:

$$Y_I = j \text{ if } \mu_{(j-i)} < Y_I^* \leq \mu_{(j)}, j = 1,2,3,4,5., \quad (5)$$

Where μ_j are threshold parameters to be estimated, with $\mu_0 = -\infty$ and $\mu_5 = +\infty$.

The probability that the pepper farmer i falls into category j is given by:

$$P\ (Y_i = j) = \Phi\ (\mu_j - X_i\ \beta) - \Phi(\mu_{(j-1)} - X_i\ \beta) \quad (6)$$

where $\Phi\ (\cdot)$ is the cumulative distribution function of the standard normal distribution.

Table 2. Variable Measurement.

Variable	Measurement
Y (Willingness to adopt)	1–5 ordinal (Not willing → Very willing)
X_I =Age	Years
X_2 = Access to credit	0 = No, 1 = Yes
X_3 =Annual Income	Naira (continuous)
X_4 = Perceived cost of hydroponic setup	1 = High, 2 = Moderate, 3 = Low

Variable	Measurement
X_5 = Farming experience	Years
X_6 = Perceived cost of inputs	1 = High, 2 = Moderate, 3 = Low
X_7 = Farm size (F/SIZE)	Ha
X_8 = Expected ROI	1 = Low, 2 = Moderate, 3 = High
X_9 = Extension contacts (E/CONTACT)	Number of visits
X_{10} = Savings levels	Amount in Naira

3. Results and Discussions

3.1. Pepper Farmers Willingness to Adopt Hydroponic Farming System for Green Pepper Cultivation in Imo State

The distribution of pepper farmers by willingness to adopt hydroponic farming system for green pepper cultivation in Imo State is presented in Table 3.

Table 3. Distribution of pepper farmers by willingness to adopt hydroponic farming system for green pepper cultivation in Imo State.

Category of willingness to adopt	Frequency	Percentage
Not willing at all	20	8.13
Slightly willing	29	11.79
Neutral	58	23.58
Willing	80	32.52
Very willing	59	23.98
Total	246	100.00

Source: Field Survey data, 2025

The distribution of pepper farmers by their willingness to adopt the hydroponic farming system for green pepper cultivation was examined to provide a clear understanding of their readiness to embrace this technology. The results presented in Table 3 show noticeable differences in the levels of willingness among the respondents. A total of twenty farmers, representing 8.13%, reported that they were not willing at all to adopt the hydroponic system. This indicates that a small portion of the farmers have no interest in this method of cultivation. A slightly larger group of twenty-nine farmers, which accounts for 11.79%, indicated that they were only slightly willing to adopt the system. These two groups thus represent farmers who have a very low interest in or willingness to consider hydroponic farming. The neutral category includes fifty-eight farmers, representing 23.58%. This group is important because it shows that almost one quarter of the respondents have not reached a clear decision about adopting the system. Their neutral stand could be as a result of a lack of knowledge, uncertainty, or cautiousness as they await to be in a position to see the merit and demerit of hydroponic farming better. The results also show that many farmers have already developed a positive attitude towards the technology. Eighty farmers, representing 32.52%, reported that they were willing to adopt the hydroponic system. This suggests that a good number of farmers are open to modern pepper production techniques. In addition, 59 farmers, representing 23.98%, indicated that they were very willing to adopt this pepper farming system. This finding is of great interest, as it shows that nearly one quarter of the respondents have a high level of interest and readiness to take up hydroponic farming for pepper production. Therefore, the distribution has indicated that over 50% of the farmers are either willing or very willing to adopt hydroponic farming for pepper production in Imo State. This is a pointer to the high and increasing interest in new farming practices by pepper farmers in Imo State. The fact that the number of neutral farmers is relatively high also promotes the necessity of efficient extension support, awareness programs, and practical demonstrations, which can allow them to get confidence in the technology. Such results provide a valuable basis to continue the research on what influences the willingness of farmers to implement hydroponic farming, as well as include valuable insights into the policy and intervention development that could lead to more extensive adoption of this farming system.

3.2. Financial Factors Influencing the Adoption of Hydroponic Farming System for Green Pepper Cultivation

To estimate the factors influencing the adoption of hydroponic farming system for green pepper cultivation among farmers in Imo State, an ordered probit regression was employed and the result is presented in Table 4.

Table 4. *Ordered probit regression result of the factors influencing the adoption of hydroponic farming system for green pepper cultivation among farmers in Imo State.*

Variables	Coefficient (β)	Standard Error	t-value	p-value	Sig
Age of respondents	-0.264	0.045	-5.84	0.000	***
Level of Education	0.024	0.072	0.33	0.741	
Access to Credit	-0.091	0.158	-0.58	0.562	
Annual Income	4.84e-07	2.05e-07	2.36	0.018	**
Perceived Cost of Hydroponics	0.216	0.122	1.78	0.076	*
Farming Experience	0.203	0.089	2.29	0.022	**
Perceived Costs of Inputs	1.062	0.332	3.19	0.001	***
Farm Size	-0.003	0.056	-0.06	0.950	
Expected Return on Investment	0.960	0.364	2.64	0.008	***
Extension Contact	0.257	0.215	1.19	0.232	
Savings Levels	5.65e-06	1.60e-06	3.52	0.000	***
cut1	-11.198	2.967			
cut2	-10.604	2.967			
cut3	-9.497	2.957			
cut4	-7.825	2.936			
Pseudo r-squared	0.483				
Chi-square	209.239				
Prob > chi2	0.000				
Log likelihood	-265.483				
Akaike crit. (AIC)	560.967				
Bayesian crit. (BIC)	613.547				
Number of obs	246				
Note: *** p <.01, ** p <.05, * p <.1					

Source: Field Survey data, 2025

The diagnostic statistics from the ordered probit regression model show that the model fits the data very well. The chi-square value of 209.239 is significant at the 1% level, which indicates that the explanatory variables jointly influence farmers' willingness to adopt the hydroponic farming system. The pseudo-R squared of 0.483 suggests that the model explains a substantial proportion of the variation in the dependent variable. The log likelihood value and the information criteria values also confirm that the model is appropriately specified. With these diagnostics, the interpretation of the significant variables becomes meaningful and reliable.

The findings indicate that a number of factors have a strong influence on the willingness of farmers to use hydroponic farming to produce green peppers. Age of respondents, annual income, perceived cost of hydroponics, farming experience, perceived costs of inputs, expected return on investment, and savings levels were the variables that significantly influenced the willingness of pepper farmers in Imo State to adopt hydroponics farming for green pepper production.

Age of respondents was negative and significant at the 1% level. This indicates that as farmers grow older, their willingness to adopt hydroponic farming decreases. The elderly farmers might not want to try out new forms of production due to the fact that they are more used to the traditional methods and might view the new technologies as a risky or stressful approach. This finding supports the rationale that younger farmers tend to be more receptive to innovation, as well as faster to adopt new production systems. A study on the willingness

of farmers to adopt hydroponics in tomato farming reported a similar relationship between farmers' age and willingness to adopt hydroponic farming, with older farmers reported to feel reluctant to adopt this new farming innovation due to diminished involvement in agricultural activities, while younger farmers show a high propensity to adopt new innovations compared to older counterparts [2, 17].

Annual income was positive and significant at the 5% level. This suggests that farmers with higher income are more willing to adopt hydroponic farming. Higher-income farmers are better equipped to handle the initial investment costs that come with hydroponic systems and are also more confident in trying modern technologies. This result shows that financial strength plays an important role in determining whether farmers are ready to adopt improved production methods. This finding was in line with the results of [8], who stated that more affluent farmers are able to afford the high initial investments required to install hydroponic systems, which may comprise equipment and infrastructure installation, and [3], who described higher-income farmers as being more willing to take risks in adopting new technology, resulting in higher adoption rates of hydroponic systems.

The perceived cost of hydroponics was positive and significant at the 10% level. This result suggests that as farmers develop a favourable perception of the cost involved, they become more willing to adopt the hydroponic system. The farmers who see the cost as fair compared to the inherent benefits could be willing to adopt the technology. This suggests that the adoption decisions are heavily influenced by farmers' perceptions relating to the affordability of a technology or new innovations. A study reported that the perceptions of cost relative to benefits by farmers influence their willingness to embrace innovative agricultural methodology like hydroponic farming [19]. Another study noted the crucial role of positive perception of cost in technology adoption but cautions that some farmers may still hesitate to adopt new innovations due to such barriers as high initial setup costs and the need for specialized knowledge [10].

Farming experience was positive and significant at the 5% level. This indicates that farmers with more years of experience are more willing to adopt hydroponic farming. Experienced farmers often have better knowledge of farming challenges and may be more capable of appreciating the advantages that hydroponics offers, such as efficiency and improved yield. Their long involvement in agriculture may help them judge the value of new technologies more accurately. This result is consistent with Adepoju and Adekunle (2023), who found that farmers with tertiary education and prior farming experience were more willing to start using hydroponics, which indicates that knowledge of agriculture practices helps to consider what new technologies offer.

The perceived cost of inputs was positive and significant at the 1% level. This suggests that when farmers believe that the cost of inputs required for hydroponic farming is manageable, their willingness to adopt the system increases. A positive view toward the affordability of inputs for this technology can diminish the fear of a possible financial loss and promote willingness to adopt it. This finding is consistent with the findings of [16], who reported that farmers are less likely to adopt irrigation technology due to its perceived affordability, and [2], who noted that perceived cost influenced the decision to adopt a hydroponic farming system by tomato farmers in Oyo State, Nigeria.

Expected return on investment was positive and significant at the 1% level. This means that farmers who expect high returns from hydroponic farming are more willing to adopt it. When farmers believe that the system will produce good profits, they are more motivated to try it. This is in line with the concept that perceived economic benefits play a critical role in adoption decisions. This finding aligns with the findings of [6], who reported that farmers are willing to adopt hydroponic farming systems due to their potential high return from all-season farming despite the challenges of their initial setup costs.

Savings levels were positive and significant at the 1% level. This result suggests that farmers with higher savings are more willing to adopt hydroponic farming. The financial security offered by savings is beneficial as it allows farmers to cope with the risks of new technologies. Farmers with a sufficient amount of money will be more assured that they can invest in hydroponic structures and inputs. This finding aligns with [12], who reported that personal savings of farmers give them financial security for investment and to adopt new innovations more than relying on debt financing, whose access and timely disbursement are uncertain. Therefore, farmers' economic capacity, experience, perception, and expectations play key roles in shaping their willingness to adopt hydroponic farming systems for green pepper production in Imo State.

While the ordered probit regression coefficients show the direction of influence for each variable, they are presented in log odds form and are not immediately meaningful for policy interpretation. To make the results clearer and more practical, marginal effects and quasi-elasticities were computed and presented in Table 4. Marginal effects show how a one-unit change in a variable shifts the likelihood of falling into any willingness category. Quasi-elasticities express how a 1% change in a continuous variable alters the probability of each willingness category. These measures make it much easier to understand how farmers respond to changes in both demographic and economic conditions. When examined together, they reveal very convincing patterns about what drives or discourages the adoption of hydroponic farming among green pepper farmers in Imo State.

Age of respondents was one of the strongest and most consistent influences across the willingness categories. The elasticities show that a 1% increase in age raises the probability of being not willing at all by about 23% and raises the probability of being slightly willing by about 16%. Age also raises the probability of remaining neutral by about 8%. At the same time, a 1% increase in age reduces the probability of being

willing by about 3% and reduces the probability of being very willing by about 15%. These results clearly indicate that older farmers are pulled toward the lower willingness categories, while younger farmers move more easily into the higher willingness categories. This reflects a generational pattern where younger farmers are more open to experimenting with new technologies, and older farmers tend to hold on to traditional methods. This result shows that targeted sensitization and practical demonstrations may be necessary to help older farmers build confidence in modern systems such as hydroponics.

Marginal Effects and Quasi-elasticity Estimates of the Factors Influencing the Adoption of Hydroponic Farming System for Green Pepper Cultivation

The marginal effects and quasi-elasticity estimates of the factors influencing the adoption of hydroponic farming system for green pepper cultivation among farmers in Imo State are presented in Table 5.

Table 5. *Marginal effects and quasi-elasticity estimate for the factors influencing the adoption of hydroponic farming system for green pepper cultivation among farmers in Imo State.*

Variables	Not willing at all	Slightly willing	Neutral	Willing	Very willing
Age of respondents	0.011 (22.829)	0.022 (16.324)	0.064 (8.126)	-0.048 (-2.973)	-0.049 (-15.843)
Level of Education	-0.001	-0.002	-0.006	0.004	0.004
Access to Credit	-0.004	-0.007	-0.022	0.016	0.017
Annual Income	-2.01E-08 (-1.292)	-3.95E-08 (-0.924)	-1.17E-07 (-0.460)	8.75E-08 (0.168)	8.88E-08 (-0.896)
Perceived Cost of Hydroponics	-0.009	-0.018	-0.052	0.039	0.040
Farming Experience	-0.008 (-3.547)	-0.017 (-2.536)	-0.049 (-1.263)	0.037 (0.462)	0.037 (-2.462)
Perceived Costs of Inputs	-0.044	-0.087	-0.256	0.192	0.195
Farm Size	-1.45E-04 (-0.023)	-2.85E-04 (-0.017)	-0.001 (-0.008)	0.001 (0.003)	0.001 (0.016)
Expected Return on Investment	-0.040	-0.078	-0.231	0.174	0.176
Extension Contact	-0.011	-0.021	-0.062	0.046	0.047
Savings Levels	-2.34E-07 (-14.200)	-4.61E-07 (-10.154)	-1.36E-06 (-5.055)	1.02E-06 (1.849)	1.04E-06 (9.855)

*Marginal effects are above while partial elasticities are in brackets.

Source: Field survey, 2025

Annual income also showed important marginal effects. The elasticities indicate that a 1% increase in annual income of the farmers reduces the probability of not being willing at all by about 1%, being slightly willing by about 1%, and the likelihood of being neutral by about 0.5%. In contrast, income increases the probability of being willing by about 0.2% and of being very willing by nearly 1%. This indicates that farmers with higher income tend to move into the higher willingness categories because they have more financial freedom to invest in new systems. This suggests that hydroponic adoption for green pepper production by farmers in Imo State is still strongly tied to affordability. Therefore, policy supports that want to improve the adoption of hydroponic farming in pepper production should target enhancing the income level of the farmers.

The marginal effect of farming experience shows that a 1% rise in farming experience increases the probability of not being willing at all by about 4% and of being slightly willing by about 3%. It also reduces the likelihood of being very willing by about 2%. This shows that long years of practicing traditional farming create hesitation toward adopting an unfamiliar system. Farmers who have been in the field for many years may find hydroponics too different from the methods they have used for most of their lives. Their caution is understandable because the shift from soil-based production to nutrient-controlled water systems can feel very stressful. This finding therefore highlights the importance of targeted training programs that can help experienced farmers gradually understand and accept hydroponics by showing its long-term advantages.

The marginal effect of the level of savings of the respondents shows that a 1% increase in savings reduces the probability of being not willing at all by about 14%, of being slightly willing by about 10%, and of being neutral by about 5%. At the same time, a 1% increase in savings increases the probability of being willing by nearly 2% and of being very willing by about 10%. These results demonstrate that financial readiness or security is a major factor influencing farmers' willingness to adopt hydroponics. Farmers with higher savings are able to make decisions with greater confidence, knowing that they can fund the initial cost of starting a hydroponic pepper production system.

Expected return on investment yielded varying marginal effects across the willingness to adopt categories. An increase in the expected return on investment decreases the probability of being not willing at all, slightly willing, and neutral by 4%, 8%, and 23.1%, respectively. It, however, raises the probability of being willing and very willing by 17.4% and 17.6%, respectively. This indicates that farmers respond strongly to perceived profitability, and its expectation influences their decisions to adopt or not to adopt a hydroponic farming system for pepper production in the study area. Farmers believe that hydroponic farming systems improve yields, which translates to higher income, which will propel them towards their adoption. Therefore, financial expectations guide the behavioural change of pepper farmers towards adopting new technologies.

The marginal effects of extension contacts indicate that more visits of farmers by extension agents reduce the probability of not being willing at all, slightly willing, and neutral by 1.1%, 2.1%, and 6.2%, respectively. However, it increases the probability of being willing and of being very willing by 4.6% and 4.7%, respectively. This demonstrates the crucial role of extension workers as trusted sources of information. The continuous advice, training, and field demonstrations by extension workers help farmers to understand the various prerequisite steps in setting up hydroponic systems and to develop confidence in their usage.

The marginal effect of perceived cost of inputs shows that increases in perceived input costs reduce the probability of being willing at all, slightly willing, and neutral by 4.4%, 8.7%, and 25.6%, respectively. However, it increases the probability of being willing and of being very willing by 19.2% and 19.5%, respectively. This contrasting finding shows that farmers are already burdened by the rising costs of such farm inputs as fertilizer, pesticides, and other farm inputs and are willing to adopt any alternative that offers them better output and enhances their income level, not minding how expensive its start-up cost may be. Such farmers may see adopting hydroponic farming of pepper as a more efficient method that saves inputs in the long run and hence be eager to adopt it as a cost reduction strategy.

Willingness is also influenced by the perceived cost of hydroponics. Increasing the perceived cost reduces the likelihood of falling in the lower willingness categories and increases the likelihood of falling in the higher willingness categories. This implies that with a better understanding of the cost structure, farmers can also view hydroponics as an investment as opposed to an expenditure. This shows the significance of detailed information about the future profit associated with the adoption of the technology in the long term with little regard to its setup cost.

The level of education and access to credit had marginal effects but were not very significant in all categories. The overall trend that can be identified in their relationship with willingness to adopt hydroponics is that access to credit increases the willingness of farmers to adopt hydroponics, and being educated helps farmers get more familiar with the system.

These findings show consistency with other studies on technology adoption. Studies have shown that technology adoption remains influenced by several factors, including personal and financial factors [5, 13, 18]. A study by [9] shows that a rise in economic benefits increases technology adoption, while [11] found that farmers with higher education and better access to training are more likely to adopt innovative farming methods, as training enhances both understanding and practical competence. Thus, financial readiness, technical knowledge, and capacity building remain indispensable for encouraging hydroponic adoption among green pepper farmers in Imo State.

4. Conclusion and Recommendations

Findings revealed that a total of twenty farmers, representing 8.13%, reported that they were not willing at all to adopt the hydroponic system; 11.79% indicated that they were only slightly willing to adopt the system; 23.58% were neutral, while 50% of the farmers were either willing or very willing to adopt hydroponic farming for pepper production in Imo State. Results from the ordered probit regression revealed that age of respondents, annual income, perceived cost of hydroponics, farming experience, perceived costs of inputs, expected return on investment, and savings levels were the variables that significantly influenced the willingness of pepper farmers in Imo State to adopt hydroponics farming for green pepper production.

This study revealed that the majority of the farmers examined were willing to adopt hydroponic farming for pepper production in the study area. However, certain financial and socioeconomic factors influenced their willingness to adopt hydroponic techniques for bell pepper farming. Some of these factors include the age of respondents, farmers' annual income, the farmers' perceived cost of the hydroponic setup, the farmers' farming experience, farmers' perceived costs of inputs needed for hydroponic setup, expected return on investment, and savings levels of the farmers. In practical terms, in a situation whereby farmers perceive costs of inputs needed for hydroponic setup, farmers' savings, and their annual income are strong determinants of their willingness to adopt hydroponic

techniques for farming; this implies that agricultural and financial policies should prioritize better-tailored funding packages for pepper farmers. In the case of perceived costs of inputs, stakeholders should address creating awareness on low-cost alternative inputs and accessories for hydroponic farming systems. In addition, the issue of expected return of investment for farmers should be addressed by formulating policies that emphasize easy market accessibilities and a stable pricing system for hydroponically grown pepper in Nigeria. Furthermore, we recommend that stakeholders should organize training sessions for farmers to overcome hesitations and understand the benefits of hydroponic farming production systems, financial record management, and finally Encourage farmers to pool savings so as to improve their financial capacity to adopt hydroponic systems of pepper farming in Nigeria, as this action can help Nigerian pepper farmers align with the United Nations' 2030 Sustainable Development Goals (SDGs), alongside the National Agricultural Technology and Innovation Plan (NATIP) and the African Union's Agenda 2063.

Abbreviations

PPS	Probability Proportional to Size
LGA	Local Government Area
SDGS	Sustainable Development Goals
NATIP	National Agricultural Technology and Innovation Plan
NPC	National Population Commission

Conflicts of Interest

The authors declare no conflicts of interest.

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