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Farmers' use of sustainable production practices for yellow pepper crop in the Nsukka agricultural zone, Enugu State, Nigeria

Paschal Chidi NWONU,[1] Cynthia Ebere NWOBODO,[2] Elizabeth Amechi ONWUBUYA,[3] Sunday Alagba OBAZI*[4]

[1] Department of Agricultural Extension, University of Nigeria, Nsukka, Nigeria
e-mail: chidi.nwonu.pg01239@unn.edu.ng
ORCID: https://orcid.org/0000-0002-2672-2787

[2] Department of Agricultural Extension, University of Nigeria, Nsukka, Nigeria
e-mail: cynthia.nwobodo@unn.edu.ng
ORCID: https://orcid.org/0000-0002-5664-6498

[3] Department of Agricultural Extension, University of Nigeria, Nsukka, Nigeria
e-mail: elizabeth.onwubuya@unn.edu.ng
ORCID: https://orcid.org/0000-0002-9832-9431

[4] Department of Agricultural Extension, University of Nigeria, Nsukka, Nigeria
e-mail: sunday.obazi@unn.edu.ng
ORCID: https://orcid.org/0000-0003-4597-3255

*Corresponding author

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Abstract: This study investigated farmers' use of sustainable production practices for yellow pepper crop in the Nsukka agricultural zone, Enugu State, Nigeria. Multi-stage sampling procedure was used in selecting 135 farmers and interview schedule using structured questionnaires was employed for data collection. Data generated were analysed with SPSS software using frequency and percentage, mean scores, standard deviation, factor analysis, and logistic regression. Findings revealed that the majority (91.1%) of the yellow pepper farmers had moderate knowledge on sustainable production practices and that some of the practices used were mass selection (97.0%), use of poultry manure (95.60%), use of improved varieties of yellow pepper (94.0%), crop rotation practices (91.10%), and minimum use of agrochemicals (78.50). Among the factors considered to be potential determinants of farmers' use of sustainable production practices, only sex was statistically significant, at 5% level. Also, findings indicated that technical, institutional, and economic constraints affected farmers' use of sustainable production practices. Furthermore, results indicated that sustainable production practices could be enhanced through the use of improved seeds (85.5%), access to credit facilities (77.8%), access to extension services (71.8%), and training of farmers (68.9%). The

study therefore recommends that government and private sectors should provide services that will facilitate the development of sustainable production practices of Nsukka yellow pepper crop, as this will have a long-term effect on productivity and the production environment.

Keywords: pepper, sustainable, manure, crop, Nigeria

Introduction

Pepper is a major spicy crop grown in Nigeria. The bulk production of the crop occurs in the dryer Savannah areas of Nigeria where irrigation is often practised. In the south-east zone, pepper is widely cultivated, but the production is mostly carried out in rain-fed systems. This crop used to be termed "women's crop" because it was mostly grown by women [21, 20], but today most men are into the production of pepper due to its lucrative nature. Pepper crop offers income security to many farmers and provides employment to about 70% of the population (including local farm labourers) in the region [21].

Pepper is an important food crop with essential nutrients. It provides minerals, pro-vitamin A, vitamins C and E, carotenoids, phenolic compounds, and metabolites [15, 19]. Also, it provides flavour, colour, and pungency to human food. Apart from using pepper for (domestic) culinary purposes [4], it is also used for the seasoning of some processed foods, in hot sauces and in pickling [22]. Additionally, pepper is used in medicine as anti-oxidant in reducing degenerative diseases, asthma, cough, sore, and toothache [26]. It is also used in plant-based insecticides and in the cosmetics industry for fragrance ingredients, as well as for hair and skin conditioning [11].

There are different varieties of pepper in Nigeria. However, the common species that has offered an important source of livelihood to many farmer families in the Nsukka agricultural zone, owing to its acceptability and potential, is the Nsukka yellow pepper. The Nsukka yellow pepper is indigenous to Nsukka, widely grown in Enugu State, and rarely grown elsewhere in the country, probably because of its propensity to lose pungency, aroma, and colour [28]. This species of pepper has a unique aroma, and the fruits are considerably large, green at the early stage and yellowish at maturity stage [10]. The distinctive aroma of the pepper enhances its acceptability in the market by attracting more customers than other pepper types in the rural and urban markets within the zone. Similarly, [17] asserted that the distinctive aroma of the crop makes it very much cherished by women and hotel managers for cooking and other uses. The yellow pepper fruit also exhibits traits such as pendant, conical, pointed end, and slight fruit corrugation at the immature and mature stages [8]. It bears an adequate number of fruits at a given time [2], with about 1-3 fruits occurring in the axils of one leaf [9]. These desirable characteristics of the Nsukka yellow pepper have drawn the attention of researchers to take measures to preserve them, and one of the ways is the adoption of sustainable production practices.

Sustainable agricultural production practices are management procedures that work with natural processes to conserve all resources, minimize waste and environmental impact, prevent problems, and promote agro-ecosystem resilience, self-regulation, evolution, and sustained production for the nourishment and satisfaction of everyone [16]. It is the production practices and farming systems that maintain the ability of agriculture to produce agricultural commodities and products, maintain a decent standard of living for the farmers yet jeopardize neither the ability of future generations of farmers to produce and maintain a decent standard of living nor the quality of the environment for both present and future generations [12]. By implication, agricultural practices that diminish long-term prospects for food production, regardless of their short-term benefits, are not considered sustainable [3]. A holistic discussion on sustainability is often done under the three dimensions of social, environmental, and economic sustainability [25]. The three pillars of sustainability are intertwined and sometimes inseparable. For instance, when environmental sustainability is compromised, other aspects will be affected. According to [24], changes in land and overuse of land as a result of increased cropping cause loss of biodiversity (environmental problem) and, by extension, reduce food production as well as affect income generation from the farm. On the contrary, the use of crop rotation, increased crop diversity, use of cover crops, no-till and reduced-till systems, integrated pest management (IPM), sustainable agro-forestry practices, and precision farming, among others, facilitate ecosystem protection, increase farm productivity, reduce poverty, and advance food security [23]. Based on these premises, this study sought to gain an insight into farmers' use of sustainable production practices on yellow pepper crop in the Nsukka agricultural zone, Enugu State, Nigeria.

So far, many researchers ([21], [28], [17], [10], [6], [29], [5], [22], [2], [8], and [9], among others) have conducted studies on the Nsukka yellow pepper but none have focused on sustainability. This study was carried out to fill this gap by providing information on sustainability practices for the crop. Specifically, it looked into farmers' knowledge on sustainable production practices, the sustainable production practices used, factors that influence farmers' use of sustainable production practices, constraints to the use of sustainable production practices, and it determined the measures to be taken to enhance the use of sustainable production practices for the Nsukka yellow pepper.

Methodology

Study area

The study was conducted in the Nsukka agricultural zone, Enugu State, Nigeria. The zone comprises three areas as follows: Nsukka, Igbo-Etiti, and Uzo-Uwani, is situated on a gentle slope with hills and valleys, and is located between longitude

$7^{0}20^{1}$E and $7^{0}29^{1}$E and latitude $6^{0}54^{1}$N and $7^{0}00^{1}$N. The predominant crops produced in the area include yellow pepper, cassava, maize, cocoyam, yam, rice, cucumber, oil palm, and vegetables. The area has been recognized for growing an indigenous pepper popularly known as the Nsukka yellow pepper.

Population and sampling procedure

The population for the study comprised all yellow pepper farmers in Nsukka. Multi-stage sampling production was used to select respondents for the study. At the first stage, all blocks (Nsukka, Uzo-Uwani, and Igbo Etiti) in the Nsukka agricultural zone were used for the study. At the second stage, 3 cells were randomly selected from each of the blocks in the zone, giving a total of 9 cells. At the third stage, 15 yellow pepper farmers were randomly selected from each of the 9 cells based on their involvement in the Nsukka yellow pepper production, giving a total of 135 respondents that were used for the study.

Method of data collection and measurement of variables

Data for the study were collected using structured interview schedule administered by the researcher and the assistants. The knowledge levels of farmers on sustainable production practices was elicited by providing 18 positive and negative statements/ items on sustainable production practices and having the farmers respond to each of the questions by ticking either Yes or No. One mark was assigned to each correct answer and zero to a wrong answer. Each respondent had a composite score. The negative questions were reversed, and respondents were categorized into four groups based on their knowledge level, namely: No knowledge (for respondents with 0 scores); Low knowledge (for respondents with 1–6 scores); Moderate knowledge (for respondents with 7–12 scores), and High knowledge (for respondents with 13–18 scores). To ascertain the sustainable production practices that farmers are using, a list of sustainable production practices (such as use of conservative tillage, use of mass selection, minimal use of agrochemicals, use of crop rotation to control built-up of pests and diseases, use of cover crops, and integrated pest management among others) was provided, and respondents indicated either "used" (1) or "not used" (0). A composite score for the use of sustainable practices was obtained for each respondent. The scores were categorized into three levels (low use, moderate use, and high use) and subjected to further analysis. Also, to ascertain the constraints to the use of sustainable production practices by Nsukka yellow pepper farmers, a list of constraints was provided and farmers rated them on a four-point Likert-type scale as follows: to a great extent (3), to some extent (2), to a small extent (1), and to no extent (0). The values were added and divided by 4 to give a mean score of 1.5. Any variable with a mean value equal to or greater than 1.5 was regarded as a constraint

to the use of sustainable production practices in yellow pepper production, while variables with mean scores lower than 1.5 were considered otherwise. The obtained data were subjected to further analysis, and variables with a value of 0.4 or higher were regarded as constraints (technical, institutional, or economic). Furthermore, information on measures to enhance the use of sustainable production practices was gathered. To achieve this, respondents were asked to suggest measures that could be used to enhance the sustainability of yellow pepper production, and their responses were collated. To determine the factors that influence farmers' use of sustainable production practices for yellow pepper crop, the model is represented as thus:

$$Logit\ (P\ (Y \leq j)) = \beta_{j0} + \beta_{j1}X_1 + \beta_{j2}X_2 + \cdots + \beta_{jn}X_n \text{ for } j=1,\ldots,\ j-1 \quad (1)$$

$$Logit\ (P\ (Y \leq j)) = \beta_{j0} + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_nX_n \quad (2)$$

where: Y = ordinal outcome variable (level of use of the sustainable production practices)
P = predictors
J = ordered categories for the dependent variable (low, moderate, and high)
β_0 = intercept
$\beta_{1-}\ \beta_n$ = parameter estimates
X_1-X_n = independent variables
X_1 = age (years)
X_2 = sex (male = 1; female = 0)
X_3 = marital status (married =1; not married = 0)
X_4 = household size (continuous)
X_5 = member of organization (member = 1, not member = 0)
X_6 = year of farming experience (continuous)
X_7 = farm size (continuous)
X_8 = education status (formal education = 1; no formal education = 0)

Data analysis

Data generated were analysed with SPSS software using frequency and percentage, mean scores, standard deviation, ordinal logistic regression, and factor analysis.

Results and discussion

Yellow pepper farmers' knowledge level of sustainable production practices

Figure 1 revealed that the majority (91.1%) of the yellow pepper farmers had a moderate level, 8.2% had a high level, and 0.7% had a low level of knowledge on

sustainability production practices. This implies that respondents lack adequate access to timely information on innovations and sustainability practices involved in yellow pepper production. It could also mean that there is a lack of training on sustainable farming. The poor information dissemination and trainings on sustainable practices might be due to inadequate extension service delivery to farmers. Extension service is entrusted with supplying reliable and sustainable agricultural information to farmers in order to improve their production practices and productivity. A few farmers that have a high level of knowledge about sustainable production practices may be cosmopolitans who sought information about pepper production and its sustainable practices elsewhere. This finding agrees with [27], who found that pepper farmers in Malaysia were knowledgeable about sustainable agricultural practices.

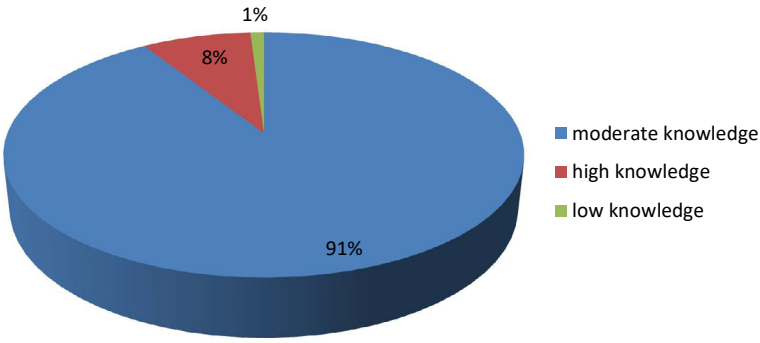

Figure 1. Yellow pepper farmers' knowledge level of sustainable production practices

Sustainable production practices for the Nsukka yellow pepper crop

The results in *Table 1* indicate that 99.3% of the respondents harvest their pepper at optimum time, 98.5% use mass selection (selecting and preserving seeds of the best yellow pepper plants for the next planting season), 97.8% use poultry manure, 95.6% use improved varieties of yellow pepper, 94.8% use appropriate plant spacing, 92.6% use crop rotation practices, and 80% make minimum use of agrochemicals, among others. Results imply that farmers use one or more sustainable production practices for the Nsukka yellow pepper crop. Mass selection may have been used by the majority of the yellow pepper farmers because it has the best seed properties for planting. It could be that the use of the mass selection method is easier for them than the use of the pedigree selection method and pure-line method, which few people practise. [1] noted that mass selection is very important in the domestication of major crop species. The practice of mass

selection will provide farmers the opportunity to select the Nsukka yellow pepper with differing phenotypes and to develop a new cultivar by improving the average performance of the crop species. Similarly, the practice of optimum harvesting time in yellow pepper crops could be a strategy to get seed traits or fruit quality and reduce postharvest losses or pest infestation. Also, the high usage of poultry manure and other organic manures in yellow pepper production could be because of the awareness that organic manure improves plants' biodiversity and environment. This may be the case because of poultry dung and other organic manures are available and relatively cheaper than inorganic fertilizers. [10] noted that yellow pepper fruits grown with 10 t/ha poultry manure had the highest percentage of fat, crude fibre, moisture content, alkaloid, flavonoid, tannin, and volatile oil. Also, [18] reiterated that organic fertilizers are vital for the healthy development of pepper and vegetable blooms and fruits because they provide rapid growth with superior quality to all species. Furthermore, the minimum use of agrochemicals and crop rotation are good sustainability practices. While crop rotation aims to reduce the amount of the pest population present on the production site and allows the land to regain fertility, the minimum use of agrochemicals, such as fertilizers, herbicides, and pesticides, among others, is good for maintaining soil structure and reducing harm to crops and animals. This finding is consistent with [30], who found that crop rotation, compost manure, the planting of tolerant crop varieties, and cover cropping were some of the sustainable agricultural practices adopted by farmers in the Ohaukwu Local Government Area of Ebonyi State.

Table 1. Use of sustainable production practices by Nsukka yellow pepper farmers

Variables	**Frequency**	**Percentage**
Optimum harvest time	134	99.30
Use of mass selection of seeds	133	98.50
Use of poultry manure	132	97.80
Use of improved varieties of yellow pepper	129	95.60
Appropriate plant spacing	128	94.80
Crop rotation practices	125	92.60
Seed and seedling selection practices	114	84.40
Minimum use of agrochemicals	108	80.00
Minimized bush burning practice	100	74.10
Pure-line selection	83	61.50
Use of recommended doses of fertilizers	63	46.70
Use of compost manure	48	35.60
Use of lime/ash in pH control	47	34.80
Inter-plant with cover crops	39	28.90

Variables	Frequency	Percentage
Treatment of organic manure before use	32	23.70
Use of mulching	23	17.00
Treatment of yellow pepper seeds before nursery	23	17.00
Integrated pest management	17	12.60
Pedigree selection of seeds	6	4.40
Biological weed control practices	5	3.70
Conservative tillage practices	4	3.00

Source: field survey, 2020

Factors that influence the level of use of sustainable practice for yellow pepper crop

Table 2 shows the ordinal logistic regression analysis carried out to identify the main factors influencing farmers' use of sustainable practices for yellow pepper crop. Several factors were considered as potential determinants in this regard. However, results revealed that only sex was statistically significant (coefficient = -1.632; $p < 0.05$) at 5% significance level. The value is negative, and it implies that a unit increase in the number of male or female farmers will decrease the level of use of sustainable practice for yellow pepper crop, given that all other variables in the model are held constant. The result is unusual because, ideally, a unit increase in the number of farmers should lead to increase in the use of sustainable practices on a specific farm. Nevertheless, the reason might not be far from the fact that the use of any agricultural practice is dependent on an individual's willingness in addition to the wherewithal to use it. This finding corroborates the result from [30], who revealed that sex was significantly correlated with farmers' adoption of sustainable agricultural practices in Ebonyi State. On the other hand, [7] found that farmers' age, farming experience, and education status were factors that affected citrus farmers' adoption of sustainable agriculture practices in the Northern Ghor of Jordan valley. Similarly, [17] found that education level, income from agriculture, farmer cooperative and credit were determinant factors in the adoption of most of the agricultural practices that were considered.

Table 2. Factors that influence the level of use of sustainable practice for yellow pepper crop

Variables	Coefficient	Std. error	Wald	P-value
Age	0.052	0.031	2.749	0.097
Sex	**-1.632****	0.775	4.430	**0.035**
Marital status	-0.472	1.028	0.210	0.646
Household size	0.023	0.127	0.033	0.856

Variables	Coefficient	Std. error	Wald	P-value
Member of organization	-1.066	0.967	1.215	0.270
Year of farming experience	0.064	0.058	1.224	0.269
Farm size	0.021	0.025	0.689	0.407
Education status	1.759	1.215	2.095	0.148

Notes: test of parallel lines: 0.064; goodness-of-fit test of overall model: Pearson (0.069), deviance (1.00); model fitting information: chi-square = 8.860; Nagelkerke's R = 0.115.

Constraints to the use of sustainable production practices on the Nsukka yellow pepper crop

Table 3 revealed the major constraints to farmers' use of sustainable production practices on the Nsukka yellow pepper crop. The Varimax Rotation results on constraints were classified into three factors based on the variable loading. Technical constraint (Factor 1) is made up of variables relating to insufficient knowledge in production, processing, and sustainable practices of the Nsukka yellow pepper crop. These variables include among others: lack of technical know-how on yellow pepper production (M = 0.817), lack of capability in soil fertility management (M = 0.811), lack of access to training on sustainable practices (M = 0.735). The training of farmers in sustainable practices is sacrosanct because these farmers depend on the indigenous knowledge and information from fellow farmers to grow yellow pepper. The training will build their capacity on both sustainable production and processing of the yellow pepper crop. Adequate training of the rural farmers is the sure way to achieving sustainable agriculture and increasing productivity, while poor access to training limits productivity. This is in agreement with the findings by [30], who revealed that poor knowledge of sustainable practices and low literacy limit farmers' use of sustainable agricultural practices. [14] also found that the major constraint to sustainable high-yielding wheat production in Tajikistan was lack of knowledge among farmers (lack of knowledge about the variety grown, lack of crop rotation, and poor crop performance).

In a similar way, the institutional constraint (Factor 2) comprises inadequate extension services (M = 0.879), lack of access to information on yellow pepper innovations (M = 0.819), and poor access to finance/credit facilities (M = 0.489), among others. Lack of extension services has been a reoccurring problem for the development of agriculture in developing countries. Extension workers are meant to disseminate and/or train farmers on agricultural innovations, practices, or techniques. However, due to poor extension service delivery in most farming communities, farmers depend on their own knowledge and the information they receive from neighbours. This has not only hindered the acceptance of innovation or practices (such as sustainability), but it has also deprived farmers of important information and skills in agriculture. This is in agreement with [30], who found that inadequate

extension contact, climate factors, and poor extension in promoting sustainable agriculture reduce farmers' opportunities to use sustainable agricultural practices. Similarly, lack of access to credit facilities also constitutes a huge hindrance to the development of agriculture. Farmers who have access to credit facilities can procure farm production inputs, adopt innovations or practices, and pay for labour. On the other hand, farmers without enough capital and opportunities for credit facility will find it difficult to accept new practices. This finding is consistent with [31], who found that the major constraints faced by farmers in sustainable agricultural production were financial problems, labour scarcity, and irrigation water shortage.

Furthermore, economic constraints include high perishability of yellow pepper (M = 0.753), low return on investment in yellow pepper (M = 0.706), cross-pollination with other cultivars (M = 0.633), and unavailability of improved varieties of yellow pepper (M = 0.532). Most farmers lost their produce during and after harvest because of the perishable nature of the yellow pepper crop. This reduces farmers' income generation from the produce. Similarly, the low return on the sales of yellow pepper crop, especially during glut, discourages farmers from expanding production and embarking on sustainable practices. Again, the absence of improved varieties of yellow pepper leads to farmers growing the same species that does not give the best yield and are not resistant to pests, diseases, and harsh environmental conditions. This finding is consistent with [30], who found that unavailability of inputs and poor incentives were some of the constraints to the adoption of sustainable agricultural practices. Similarly, [14] found that not using certified seed and resistant varieties in production and the lack of suitable management systems, in particular for weeds (co-production of wheat and weeds and no weed management), hinders sustainable high-yielding wheat production.

Table 3. Constraints to the use of sustainable production practices for the Nsukka yellow pepper crop

Constraints	**Technical constraints (Factor 1)**	**Institutional constraints (Factor 2)**	**Economic constraints (Factor 3)**
Lack of technical know-how on yellow pepper production	**0.817**	0.076	0.198
Lack of capability regarding soil fertility management	**0.811**	0.224	0.098
Lack of access to training on sustainable practices	**0.735**	0.183	0.173
Lack of processing capabilities	**0.684**	0.326	-0.039
Herdsmen attacking the farm	**0.571**	-0.038	-0.291
Inadequate extension services	0.014	**0.879**	-0.071

Constraints	Technical constraints (Factor 1)	Institutional constraints (Factor 2)	Economic constraints (Factor 3)
Lack of access to information on yellow pepper innovations	0.039	**0.819**	-0.035
Pest and disease insurgence	0.162	**0.567**	0.206
Poor access to finance/credit facilities	0.323	**0.489**	0.016
High cost of adopting sustainable practices	0.170	**0.409**	0.235
High perishability of yellow pepper	-0.297	0.119	**0.753**
Low return on investment in yellow pepper	-0.062	0.111	**0.706**
Cross-pollination with other cultivars	0.210	-0.010	**0.633**
Unavailability of an improved variety of yellow pepper	0.313	0.000	0.532

Source: field survey, 2020

Notes: extraction method: Principal Component Analysis; rotation method: Varimax with Kaiser Normalization.

Measures to enhance the use of sustainable production practices by the Nsukka yellow pepper farmers

Results in *Table 4* indicated measures to enhance the sustainable production of the Nsukka yellow pepper, and these include: provision of improved seeds (85.2%), access to credit (77.8%), security against herdsmen (77.0%), pest-/disease-resistant variety (76.3%), access to extension services (71.8%), training on the use of sustainable practices (68.9%), etc. Provision of an improved cultivar of the Nsukka yellow pepper is necessary to ensure the increased productivity and sustainability of the crop. The use of mass selection, pedigree selection, pure-line selection methods, or other crop breeding techniques may improve yellow pepper production cultivars. Similarly, access to credit facilities is essential for the expansion of farms, the procurement of farm inputs, and the adoption of new and better farming practices. Farmers who have access to credit facilities are more likely to engage in sustainable farming practices in yellow pepper crop. Again, the provision of extension services to yellow pepper farmers is imperative. Extension workers will not only create awareness but also enlighten yellow pepper farmers on the need to embark on sustainable production practices. Furthermore, extension workers will also improve farmers' knowledge through provision of trainings on sustainable production practices. This finding supports [14], who revealed that education, use of certified seeds of suitable wheat varieties, and appropriate crop management practices were important measures for increasing wheat yield and improving sustainability.

Table 4. Measures to enhance the use of sustainable production practices by Nsukka yellow pepper farmers

Measures	Frequency	Percentage
Provision of improved seeds	115	85.2
Access to credit facilities	105	77.8
Security against herdsmen	104	77.0
Pest-/disease-resistant variety	103	76.3
Access to extension services	97	71.8
Training on the use of sustainable practices	93	68.9
Access to export markets	84	62.2
Access to bio-fertilizers	73	54.1
Construction of irrigation dams	64	47.4
Access to tractors	53	39.3
Access to organic manure	17	12.6
Cheap labour	9	6.7

Source: field survey, 2020

Conclusions and recommendations

Based on this study, Nsukka yellow pepper farmers have a moderate knowledge on sustainable production practices, especially on the use of crop rotation, poultry manure, selection of good seeds, optimum harvesting time, minimal use of agrochemicals, and reduced bush burning. This level of knowledge on sustainable production practices is good for their production activities but needs improvement. Again, famers' sex influences the use of sustainable production practices on yellow pepper crop. Furthermore, farmers' use of sustainable production practices was affected by technical, institutional, and economic constraints. Thus, the government, non-governmental organizations, and private sectors should provide yellow pepper farmers with adequate trainings on sustainable production practices, as this would improve their indigenous knowledge about such practices. Also, the government, donor agencies, and private sectors should assist the Nsukka yellow pepper farmers with incentives and credit facilities to boast their adoption and use of sustainable production practices. Furthermore, the government should also enact policies regarding the adoption and use of sustainable production practices in crop production to boost agricultural productivity and conserve the environment.

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Conflict of interest

Authors have no conflict of interest.

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