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Rural Food Production Systems and Effects on Sustainable Agriculture and Environmental Quality in Cross River State, Nigeria

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Abstract. Agricultural resources are not inexhaustible, and their sustained availability and use depend on the sustainability of the system or practices involved in their exploitation. Most systems and practices adopted by farmers in food production most often are not constantly assessed for their impacts on the soil and its related resources as well as the quality of the environment; thus threatening the sustainability of the agricultural system. This study was therefore designed to carry out a survey of the rural food production systems and practices adopted by farmers with a view to determining the effects of these systems on sustainable agriculture and environmental quality. Two research questions and two related null hypotheses were formulated to guide the study. A sample of 256 respondents made up of registered farmers, and extension workers were used for the study; a structured questionnaire was used for data collection while the data generated were analyzed using the mean, standard deviation, and t – test statistics. The findings of the study revealed that rural food production system adopted revolved around shifting cultivation and related fallow systems, which have negative effects on sustainable food production and environmental quality. Based on the findings, some recommendations were made.

Keywords: Food production, sustainable Agriculture and environmental quality

Introduction

Agricultural food production involves a modification of the environment to provide a micro- climate conducive for the growth and production of plants and animals using production systems. Several authors have identified some of these

systems to include shifting cultivation, bush fallowing, nomadic herding or pastoralism, mixed farming/mixed agriculture, semi-permanent or permanent cultivation, terrace cultivation, flood land cultivation and market gardening (Holder, 1975; Agbooba, 1979; Ruthenberg, 1980; Udo, 1982; Okigbo and Green land in FAO 1984; Biserup in Bisong, 2001and Osinem 2005). The predominant rural food production and farming systems are based on shifting cultivation practices and related bush fallows, with about 84% of rural farmers adopting shifting cultivation and related bush fallowing with varying length of fallow periods.

The key feature of most rural food production systems and practices is the destruction of soil vegetative cover through clearing and subsequent burning exposing the soil to the impact of wind and water as well as destroying useful micro flora, and fostering loss of useful nutrients. This impedes the soils ability to replenish lost nutrients through the natural process of nutrient cycling. This situation was aptly captured by Anijah – Obi (2001) who observed that food production involve practices by which the natural vegetation is cleared and ploughed, thus destroying several species of plants as weeds; animals, birds, and insects are seen as pasts and destroyed, causing a threat to biodiversity.

Naturally, rural food production allow the soil to regain lost nutrients during fallow periods, but with increasing population pressure, the length of fallow periods have been drastically reduced to near zero in areas where population pressure have become intensive. This does not allow a long enough fallow to enable the soil regain lost nutrients through nutrient cycling forcing farmers to resort to alternative means of raising crop yield. Such alternatives include the use of chemical fertilizers and herbicides which have varying effects on the soil and its environment. These effects as summarized by Miller (1975); Olembo (1991); Adinna (2001)' and Agbi (2003) include reduced organic matter, euthrophication of surface water, toxicity potentials of high nitrate levels in ground and surface water, crop damage (scorching, decaying, excessive production of leaves), damage to soils by damaging the Nitrogen cycle, and destruction of micro and macro-organisms.

The destruction of organic matter and soil micro and macro-organisms leads to continual reduction in soil nutrient level thus posing a threat to sustained nutrient availability and by extension, sustained agricultural production. Further, destruction of vegetation increases the level of CO_2 and other green house gases in the atmosphere and increasing the threat of global warming. This problem is further expressed in the scarcity of fire – wood which is becoming acute in most parts of the State due frequent felling of forest trees resulting in the use of crop residue and animal dung as fuel rather than been added to the soil to improve its fertility (Bisong, 1999 and Osinem & Mama 2008) which impacts negatively on environmental quality.

Environmental quality define the strength and/or weaknesses of the resource components of the environment. Osinem (2005) observed that it defines the state of the environment and help determine whether the environment is healthy or sick (degraded). Environmental quality can be described as the relative capacity of an environment to satisfy the needs and wants of an individual or society. It is a balance of nature, being composed of animals, plants, mineral resources and man-made objects which is for the benefit and subsistence of human being and nature.

A healthy environment according to the Swedish environmental protection Agency (2006) is characterized by a reduced climate variation, clean air, natural acidification only, a non toxic environment, a protective ozone layer, zero euthrophication, flourishing lakes and streams, and a good quality water. Others include a balanced marine environment, flourishing coastal areas and archipelagos, thriving wetland, sustainable forest, a varied agricultural landscape, a magnificent mountain landscape, a good build environment, and a rich diversity of plant and animal life.

Considering the impact of rural food production on environmental resources, it has become necessary to conduct a survey of the rural food production systems and practices adopted by farmers with a view to determining the likely effects of these systems on sustainable agriculture and environmental quality. Knowledge of

these will be useful to farmers, extension workers, researchers, and the ministry of environment and will go a long way to enhance sustainability in food production.

Purpose of the Study

The purpose of this study was to:

1) identify rural food production systems adopted by farmers in food production
2) determine the effects of rural food production systems on sustainable agriculture and environmental quality

Research Questions

The study was guided by the following questions:

1) What are the rural food production systems adopted in food production?
2) What are the effects of rural food production systems on sustainable agriculture and environmental quality?

Research Hypothesis:

The following null hypothesis were formulated to guide the study:

(1) farmers and extension workers did not vary significantly in their mean ratings of the rural food production systems adopted in the area.
(2) There is no significant difference in the mean rating of farmers and extension agents on the effects of rural food production systems on sustainable agriculture and environmental quality.

Methodology

The study was carried out in the five local government areas within the Northern senatorial district of Cross River State of Nigeria using descriptive survey research design. The population for the study was 2272 made up of all the 2240 registered farmers and 32 extension workers in the study area. A stratified random sample of 10% of all registered farmers in each local government area was used for the study while the entire number of extension workers sub-population group was

used because of the relative small size of the respondents population giving a total sample size of 256 respondents (224 registered farmers and 32 extension workers).

A 32-item structured questionnaire was used for the collection of data. This was divided into two parts. Part A containing fifteen (15) questionnaire items sought information on the rural food production systems and practices adopted by farmers, while part B containing seventeen (17) items sought information on the effects of rural food production systems on sustainable agriculture and environmental quality. A four point rating scale was used with four response options as Strongly agree (SA), Agree (A), Disagree (D), and Strongly disagree (SD) which were coded 4, 3, 2, and 1 respectively.

The instrument was face validated by three experts in Agricultural Education, while the reliability of the instruments was determined by administering copies of the questionnaire to 11 registered farmers and 4 extension workers, bringing the total to 15. The data obtained was analyzed using the Cronbach alpha reliability coefficient, the result of which was 0.85 indicating high reliability index. The instrument was administered through direct contact with the aid of four research assistants, while the data generated were analyzed using the mean, standard deviation, and t – test statistics.

Results and Discussion

Rural food production systems and practices;

The results of the study presented in Table 1 showed food production systems and practices farmers employ in food production.

Table 1: t test analysis of mean ratings of rural farmers and extension agents on rural food production systems and practices adopted by farmers.

		1	2		3		4	5
S/no	Food production systems and practices	$\overline{X}a$	Farmers		Extension workers		T – cal	Remark
			$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2		
1	Leave a plot of land fallow for 10	2.88*	2.29	1.11	2.47	1.22	0.466	Ns

	years and above before recultivation							
2	Leave a plot of land fallow for only 1 – 5 years before recultivation	3.05*	3.00	0.85	3.06	0.56	0.521	Ns
3	Cultivate the land every year without rest	1.72**	1.71	0.90	2.00	1.05	1.482	Ns
4	Same piece of land is cultivated each year with different type of crops	2.63*	2.60	1.07	3.03	0.78	0.869	Ns
5	Clear virgin forest every farming season	2.65*	2.60	1.08	2.81	1.15	0.970	Ns
6	Burning of cleared grasses and refuse before planting	2.71*	2.64	1.00	2.84	0.88	1.175	Ns
7	Rotate crops from one plot to another without any logical sequence	2.44**	2.38	1.00	2.44	1.05	0.303	Ns
8	Follow logical sequence in rotating crops from one plot to another.	2.88*	2.96	0.96	2.97	1.00	0.052	Ns
9	Both tree crops and food crops are combined in the farm	2.41**	2.81	0.94	2.78	1.04	0.154	Ns
10	Cut down all trees in the farm before cultivation	2.81*	2.81	0.94	2.78	1.04	0.154	Ns
11	Animals are moved from one place to another in search of food and water	3.29*	3.28	0.83	3.44	0.67	0.238	Ns
12	Feed all animals in confinement	2.70*	2.75	1.00	2.56	1.19	0.856	Ns
13	Rear animals and crops separately on different piece of land	2.98*	2.94	0.93	3.31	0.69	2.010	S
14	Combine livestock with crops on the same farm land	2.04**	2.02	1.05	1.94	1.05	0.403	Ns
15	Plant different types of crops on the same piece of land at the same time	2.94*	2.88	0.91	3.00	0.88	0.525	Ns
16	Plant only food crops in my farm land	2.81*	2.81	0.95	3.00	0.84	1.171	NS
17	Do not plant tree crops on farm land	2.53*	2.50	0.94	2.66	0.97	0.873	Ns

$\bar{X}a$ = grand mean, * = Agree, ** = Disagree

N_1 = 210, Ns = 32, $\bar{X}_1$ = mean 1, $\bar{X}_2$ = mean 2

SD_1 = Standard Deviation 1

SD_2 = Standard Deviation 2

t – cal = t – calculated,

t – tab = 1.960, Pα = .05, df = 240, Ns = Not significant

S = significant

Column 1 of Table 1 shows the mean ratings of the opinion of respondents on the rural food production systems and practices adopted by farmers in food production. Thirteen out of seventeen items recorded mean ratings ranging from 2.53 – 3.29 which are above the 2.50 cult – off point indicating agreement, which four items received mean ratings ranging between 1.72 and 2.44 while were below the 2.50 cut - off point, indicating disagreement.

The data on the table showed that food production systems adopted included shifting cultivation and bush fallowing with short fallow periods ranging from 1 – 5 years, rotational cropping without any logical sequence, and nomadic pastoralism. Mixed cropping and mixed farming were also identified as most of the respondents rear some animals, mostly sheep, goat and chicken in their backyards.

Further, the data on the table revealed that practice such as clearing of virgin forest and bush burning which are key features of bush fallowing were practised among farmers in the area. However, respondents generally disagree that land is not cultivated every year without rest although fallow periods have reduced, they rotation of crops from one plot to another does not follow any logical sequence, while tree crops are not integrated with arable food crops.

The data in columns 2 – 5 of table 1 present the results of the t - test analysis of the mean responses of farmers and extension workers on the rural food production systems adopted in food production. The data reveal a non- significant difference in the response of farmers and extension worker on 16 out of 17 items expressed in the questionnaire. These recorded t – calculated values ranging from 0.052 – 1.482 which were less than the t – tabulated value of 1.960 at 0.05 level of significance and 240 degrees of freedom. The null hypothesis were therefore upheld. However, item number 13 recovered t – calculated value of 2.010 which was above the t – tabulated value thus the related null hypothesis was rejected.

Effects of Rural food Production on Sustainable Agriculture and Environmental Quality

Table 2;

t – tests analysis of mean ratings of rural farmers and extension agents on the effects of food production systems on sustainable agriculture and environmental quality.

		1	2		3		4	5
S/no	Effects of rural food production system	$\overline{X}a$	Farmers		Extension workers		T – cal	Remark
			$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2		
1	Burning destroy organic matter in the soil	3.43*	3.41	0.83	3.56	0.80	0.983	Ns
2	Gasses burnt help in build up of organic matter	2.42**	2.42	1.05	2.31	0.93	0.612	Ns
3	Washing away of soil by water and wind leads to rapid nutrient loss	3.44*	3.41	0.79	3.66	0.55	2.263	Ns
4	Removal of forest cover reduces microbial activities	3.07*	3.06	0.78	3.28	0.68	1.779	Ns
5	Burning add ashes to the soil which is rich in plant nutrients	2.95*	2.90	0.86	3.00	0.88	0.601	Ns
6	Continuous cultivation leads to increased use of chemical fertilizers	3.32*	3.21	0.93	3.28	0.85	0.428	Ns
7	Majority of farmers are poor because of poor crop yield.	3.37*	3.31	0.86	3.59	0.67	2.114	s
8	Clearing of forest for farming exposes the soil surface to erosion	3.26*	3.26	0.84	3.34	0.83	0.507	Ns
9	Animals trample and compact soil surface as they move from place to place in	3.30*	3.28	0.80	3.56	0.56	2.470	Ns

	search of food and water							
10	Useful plant and animal species are destroyed	3.28*	3.21	0.93	3.28	0.85	0.425	Ns
11	Trees around stress are destroyed exposing water to direct sunlight	3.09*	3.06	0.92	3.19	0.93	0.738	Ns
12	There are more species of plants and animals in the forest than there was twenty years ago	2.18**	2.21	1.09	2.16	1.25	0.214	Ns
13	Streams that were ** twenty years ago have become seasonal	2.98*	2.92	0.92	3.25	0.76	2.221	S
14	Grasses grow inside ponds and other water bodies	2.91*	2.96	0.89	2.94	0.72	0.142	Ns
15	Fertilizers and other agro-chemicals are washed into ponds and other water bodies.	3.25*	3.27	0.70	3.38	0.71	0.818	Ns

*1 = 210, *2 = 32, $\bar{X}_a$ = Grand mean, $\bar{X}_1$ = mean

$\bar{X}_2$ = mean 2, * = Agree, ** = Disagree,

SD_1 = Standard deviation 1, SD_2 = Standard deviation 2,

T-cal =t-calculated, t-tab = 1.960, pα =0.05

df = 240, Ns = ot significant, S = significant.

Column 1 of Table 2 shows the mean ratings of opinion of respondents on the effects of rural food production systems on sustainable agriculture and environmental quality. Thirteen out of fifteen items recorded mean ratings ranging from 2.91 – 3.44 which were above the 2.50 cut – off point indicating agreement, while two items received mean ratings of 2.18 and 2.42 which were below the 2.50 cut – off point, indicating disagreement.

The data on the table shows that the effects of rural food production systems include the destruction of soil organic matter, destruction of vegetation which expose the soil surface to wind and water as well as increase the concentration of carbon (iv) oxide in the atmosphere, thus increasing the threat of global warming. It encourage soil compaction, reduce soil microbial activities, and add ashes to the soil as a result of burning which is highly unstable and easily blown or washed away, and the destruction of useful plant and animal species. Further, the table reveal that food production practices bring about the destruction of trees and vegetation around streams leading to the transformation of erstwhile perennial streams to seasonal ones. Also identified included the euthrophication of surface water due to increased nutrient loading in water bodies from offsite water wash of agro-chemicals increasingly being used due to reduced organic matter content of the soil. However, respondents disagree that there are more species of plants and animals in the forest than there were twenty years ago, and that bush burning increases the building up of organic matter.

Columns 2-5 of table 2 shows the results of the t-test analysis of the mean response of farmers and extension workers on the effects of rural food production on sustainable agriculture and environmental quality. The results reveal a non-significant difference in the opinion of farmers and extension workers on 12 out of the 15 items identified in the questionnaire. These had t-calculated values ranging from 0.983 – 0.142 which were below the t-tabulated value of 1.960 at 0.05 level of significance and 240 degrees of freedom. The related null hypothesis were therefore upheld. However, three items recorded t-calculated values of 2.470, 2.221, and 2.114 which were above the t-tabulated value of 1.960. The related null hypothesis were therefore rejected. Farmers and extension workers were therefore unanimous in their opinion on the effects of food production systems on sustainable agriculture and environmental quality. The differences observed in three items might be attributed to differences in their educational levels.

Discussion:

Rural Food Production Systems:

The study found that the food production systems and practices adopted by farmers included: bush fallowing with short fallow periods ranging from 1 – 5 years, continuous cropping, crop/land rotation, pastoral nomadism, and mixed cropping / farming. Also identified are practices such as clearing of virgin forests, bush burning and clear felling of trees before planting as well as the practice of crop rotation without any logical sequence.

Shifting cultivation and related bush fallowing as identified in the findings formed a major agricultural system adopted by farmers when population pressure was still low, and land then was not a problem. This finding corroborates those of Okigbo (1981) who reported that shifting cultivation and related fallow cultivation formed a major farming system under conditions of low population density. However, progressive decrease in fallow period which is approximately near zero in some areas where population pressure have become intensive, has rendered these systems unsuitable as they no longer allow a long enough fallow period for the soil to regain its lost nutrients through the natural process of nutrient cycling.

Further, the systems and practices identified in the findings are in agreement with several other authors including Holder (1975); Agboola (1979); Ruthernburg (1980);Udo (1982); Okigbo and Greenland in FAO (1984); and Biserup in Bisong (2001) who identified the predominant farming systems to include shifting cultivation, bush fallowing, nomadic herding or pastoralism, mixed farming/ mixed cropping, permanent or semi-permanent cultivation, flood land cultivation among others. Further, Okafor (1989) buttressed this point when he reported that about 84% of rural farmers adopt shifting cultivation and related bush fallowing with varying length of fallow periods.

Continuous cultivation as identified in the findings was as a result of the pressure put on land by increasing population which left individual farmers with plots of land too small for any reasonable fallow period. This gave rise to mixed cropping, aside from the fact that it had been an integral part of rural agriculture.

Supporting the above, Omara – Ojungu (1992) remarked that the influence of population growth and increased consumption have forced farmers to resort to more intensive cultivation systems such as continuous cultivation/ cropping and mixed-cropping or mixed agriculture. Crop rotation identified in the findings did not follow any logical sequence characteristic of modern day rotational cropping, but based on the traditional principles of land rotation.

Effects of Rural food Production Systems on Sustainable Agriculture and Environmental Quality

From the findings, major effects of rural food production identified included destruction of organic matter in the soil, bush burning, and addition of ashes to the soil. Bush burning had been used as a fast means of land clearing, but it destroys most organic matter and plant debris accumulated in the soil over the years as well as destroy useful micro-organisms in the soil. That bush burning enriches the soil with addition of ashes rich in nutrients contradicts those of Bisong (1999) Anijah-Obi (2001) and Allan in Bisong (2001), who noted that nitrogen flush, reduction in microbial activity, and a delay in the oxidation of ammonia may all influence the availability of nutrients and render the ashes less useful. The addition of ashes to the soil however, does not in any way replace lost organic matter as it is highly unstable in the soil and can easily be blown or washed out of the soil.

Also identified from the findings were the increased use of agro-chemicals, euthrophication of surface water, the pollution of ground and surface water, and destruction of useful plant and animal species. The use of agro-chemicals led to the destruction of several species of plants which are seen as weeds; while most animals, birds, and insects are seen as pest and destroyed thus resulting in biodiversity loss. When washed into streams, there are capable of destroying water ecosystem and man. The increased use of fertilizers have resulted in ecological and environmental problems including soil erosion, pollution of ground and surface water, destruction and disturbance of wild life habitat, and adverse effects on rural landscape. Olembo (1991), Adinna (2001), Bisong (2001) and Agbi (2003) lend credence to these when

they reported variously that the increased use of fertilizer was responsible for the euthrophication of surface water, toxicity potential of high nitrate levels in ground and surface waters, crop damage (scorching, decaying, excessive production of leaves), damage to soil by damaging the nitrogen cycle and destruction of micro and macro organisms. Food poisoning of human consumers of chemically destroyed animals and chemically over-charged foods have become common place.

As farmers continue to search for more farmlands, more plant and animal species would become extinct. As forest continue to be destroyed, the soil surface will continue to be exposed to erosion by wind and water, compaction of soil surface and rapid nutrient loss. Also, carbon stored in vegetation and soils is released as carbon (iv) oxide through burning and decomposition of biomass and the oxidation of soil organic matter. The increase in carbon (iv) oxide is responsible for about half of the total global worming potential of the environment in line with Haughton (1990) who observed that the expansion of crop and pasture land on forest land accounts for about 20-25% of carbon (iv) oxide emissions and 25% of the total radiative effect of green house gas emission.

Conclusion and Recommendation

Based on the findings of this study, it was concluded that majority of farmers adopted rural food production systems based on shifting cultivation practices with very short or no fallowing periods which rapidly degrade the production base; and contribute negatively to the enhancement of sustainable agriculture and environmental quality.

This has obvious implications for the sustainability of farming systems in particular, and agricultural production in general. The continual adoption of inappropriate farming systems and practices will lead to rapid depletion of the basic agricultural resources of soil, water and air as they do not allow a long enough fallow period for the land to recover. The depletion of soil will lead to decreased soil organic matter, and by extension soil nutrient which culminates in poor yield and reduced productivity. In a bid to raise productivity through the use

of chemical / artificial fertilizers, herbicides and other agro-chemicals, the environment is negatively affected due to the residual effects of these agro-chemicals. Thus, problems such as eutrophication of surface water, toxicity potential of high nitrate levels in grounds and surface water, damage to nitrogen cycle, loss of biodiversity, increase carbon (iv) oxide in the atmosphere, soil erosion, pollution of ground and surface water among others become obvious.

On the basis of the above, it was recommended that,

(1) The rural food production systems which were based on shifting cultivation/ bush fallowing should be replaced by more sustainable farming technologies in the light of increasing population pressure,

(2) Farmers and the general public should be educated on the environmental implications of unsustainable agricultural practices such as bush burning, clear felling, and destruction of vegetative cover. This can be done through a combined effort of extension workers and officials of the ministry of agriculture as well as farmers' clubs, and organisations.

(3) The inappropriate use of chemical / artificial fertilizers and other agro-chemicals should be replaced by more sustainable organic agricultural practices that will impact positively on the soil physical and chemical properties and thus increase the rate of nutrient cycling. The promotion of organic agriculture through the use of organic manure and biological methods of weed and pest control would go a long way to mitigate the effect of agro-chemicals on water and air as these substances are bio- degradable, and will enhance nutrient cycling as well as increase the rate of soil microbial activities.

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