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DETERMINING RICE PRODUCTIVITY LEVEL FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT IN PATIGI LOCAL GOVERNMENT AREA (LGA) OF KWARA STATE, NIGERIA

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ABSTRACT

The study investigates rice productivity level for sustainable agricultural development within Patigi Local Government Area of Kwara State, Nigeria. The study further identifies; rice yield level based on the agro-ecological impact. Data used were collected through questionnaire and oral interview with a reconnaissance visit to the sample groups. However, secondary data were collected from the existing books, journals, maps and internet. Random Sampling technique was used to draw a population of 224 from a population of 45,712 which was used for 200 people as sampling frame of the entire population. Above all, a number of 224 questionnaires were administered and used in the course of the study. Tables and figures were used for presentations and discussions of results. Finally, it was observed that an appreciable level of rice yield was a function of various technological improvements. It was, therefore, recommended that yield improvement can come in either of two ways: (a) by shifting the yield frontier, i.e., breeding varieties that have significant higher yield potential than the current varieties, e.g., New Plant Type; and (b) by developing and promoting technologically enhanced yield, through the use of high quality seeds, efficient fertilizers application and gravity irrigation system.

Keywords: Sustainability, Rice, Productivity, Agriculture, yield

INTRODUCTION

Background of the Study

The rapid increases of population on both global and national scales have necessitated high demand of food production. Rice is a major commodity in the world trade. It has become the second most important cereal in the world after wheat in terms of production, due to a recent decline in maize production (Jones, 1995). In Nigeria, rice (grown on 1.77 million ha) ranks sixth after sorghum (4.0 million ha), millet (3.5 million ha), cowpea (2.0 million ha), cassava (2.0 million ha) and yam (2.0 million ha), but if placed on a social scale, it can as well be ranked first because it is no longer just a mere festival meal, but the staple of most homes in urban and rural areas. It is therefore mandatory to have adequate knowledge on meaningful production areas that can allow the decision-makers to identify population that are most liable to food insecurity and poverty.

Rice is important in Nigeria because of its major contribution to internal and sub-regional trade. Farmers find rice more adaptable than a high input staple like maize when there is declining soil fertility because of the huge array of varieties they can switch over to every few years. Since it is becoming a staple crop, farmers seem to be willing to grow it all the time no matter the constraints they are facing.

As farmers strive for profitable, efficient and sustainable production from renewable resources (crops in particular but also livestock, timber and forage), so also the decision makers and planners have to address and respond to issues of over and/or under production, imports, exports, and quotas, conservation and protection, food security, subsidy allocation and administration. Explicit within this mandate is state production levels, in particular.

In relation to agriculture, sustainability means changing agricultural system so that farmers are able to produce indefinitely (Rodale, 1988). The importance of sustainable agricultural production system is becoming a major concern of agricultural researchers for both sustainable development and environmental management.

Sustainability represents the last step in a long evolution that economic development must consider for both the protection of national resources and the maintenance of environmental quality (Batie, 1989). Hence, sustainable agriculture should be based on approaches that reduce environmental degradation, conserve resources, and provide an adequate and dependable farm income through reducing poverty and associated problems.

In order to achieve a sustainable agriculture, national/state planners and decision-makers require timely, accurate and detailed information on land resources. According to Selbut (2003), the economy of Nigeria has long been dominated by trade in crude oil and agriculture has been neglected by successive governments since 1966. Production had largely stagnant despite the huge injection of capital through World Bank loans and myriad of programmes now largely defunct. These include Operation Feed the Nation (OFN, 1976), National Accelerated Food Production Project (NAFPP, 1975), Green Revolution (1979), Back to Land (1984), Directorates for Food Roads and Rural Infrastructures (DFRRI, 1985), Better Life for Rural Women (1986), National Agricultural Land Development Authority (NALDA, 1992), Family Economic Advancement Programme (FEAP, 1994) and National Agricultural Research Project (NARP, 1995). The Special Rice Project (SRP, 1998) and National Fadama Development Project (NFDP, 1999) are still existing due to a huge injection of funds from the World Bank. The question is, how can the challenges facing agricultural development be sustained in this period of different environmental issues?

Information about cropping system such as; crop types, crop location, crop management, and the favorable condition under which crop grows facilitates modern approach to crop research based in general. This often lead to a sustainable utilization of the available resources through which, appropriate high level decisions regarding food movements, pricing and imports/exports could be taken.

On a general note, adequate information about these component parts of agriculture is a pathway to the scientific research based for sustainable agricultural development. This certainly improves agricultural productivity and general environmental management.

This study therefore seeks to determine rice productivity level for sustainable agricultural development within Patigi Local Government Area of Kwara State, Nigeria; by identifying rice development methods, examining rice management measures and finally identifying rice yield level based on the agro-ecological impact.

Study Area

The study was carried out in Patigi Local Government Area (consisting of three districts including Pategi, Lade and Kpada), which was created from Edu Local Government Area of Kwara State, Nigeria. This area is geographically located within $8^0 50^1$ N and $5^0 25^1$E of the equator. The location shares common boundaries with Niger State, Kogi State as well as Edu and Irepodun Local Government Areas (Figure 1 & 2). It has a total land area of about 2924.62sq.km, which is about 5% of the total land area of the state – Kwara State (www.kwarastate.com). According to Kwara State Agricultural Development Project, (KWADP, 2007), approximately 25% of the land area of the Local Government is used for farming activities.

The information from the Meteorological Office (2007) Ilorin shows that the study area falls within humid climate with two distinct seasons (the wet and dry seasons). The wet season lasts between April and October during which there is rain and dry season is between November and March. The rainfall ranges between 50.8mm during the driest months to 2413.3mm in the wettest months. The minimum average temperature throughout the state ranges between 21.1^0c and 25.0^0c while, maximum average temperature ranges from 30^0c to 35^0c.

The soil is red laterite of tropical area formed under seasonal rainfall climatic region. Soil aggregation is poor, with tendency to compact under wet condition. Surface texture is sandy loam. Clay is predominantly kaolite. Soil is about 30-40% clay especially with depth. The climax vegetation was tropical deciduous forest but the influence of man, especially farming activities has turned it into dry woodland savanna, which is characterized with scattered trees and tall grasses. As a result of topographic changes, rainfall differences and edaphic factors, some pockets of other distinct vegetation types are supported within the study area. Various vegetation species contained here are; Raphia Palm (Raphia Sardomical), eiba Pentandra, and Lannea Acida among others. Of grasses, Andopogen Tenctorum is evident where the soil is deep and Morrocymbium Ceresiiforme is frequent in poorer soils (KWADP, 2007).

The study area was chosen because agriculture is the bedrock of its economy and also characterized with various forms of ecological zones that give rise to different types of crop. The typical cropping systems in the study area are, Rice – based system, Sugar Cane-based system, Ground Nut -based systems, Millet-based system and Melon cultivation in areas located along river Niger, the major river in the study area. The major crops cultivated in the location include Rice, Sugar Cane, Ground Nut, Millet, and Melon and some leafy vegetables. Majority of the food produced are for personal consumption, while some households sell small amount of the food in the market to earn additional income for household upkeep (KWADP, 1996).

The total estimated population of Patigi Local Government Area according to National Population Commission (1991) is about 45,494 (22,712 males, 22,782 females) of which farmers account for about 70% (www. Kwarastate.com). Agricultural production is largely peasant and small-scale relying heavily on the use of manual labour equipped with crude implements, while fertilizers, mechanical implement, improved seeds and agrochemicals are also used to some extent (KWADP, 2007).

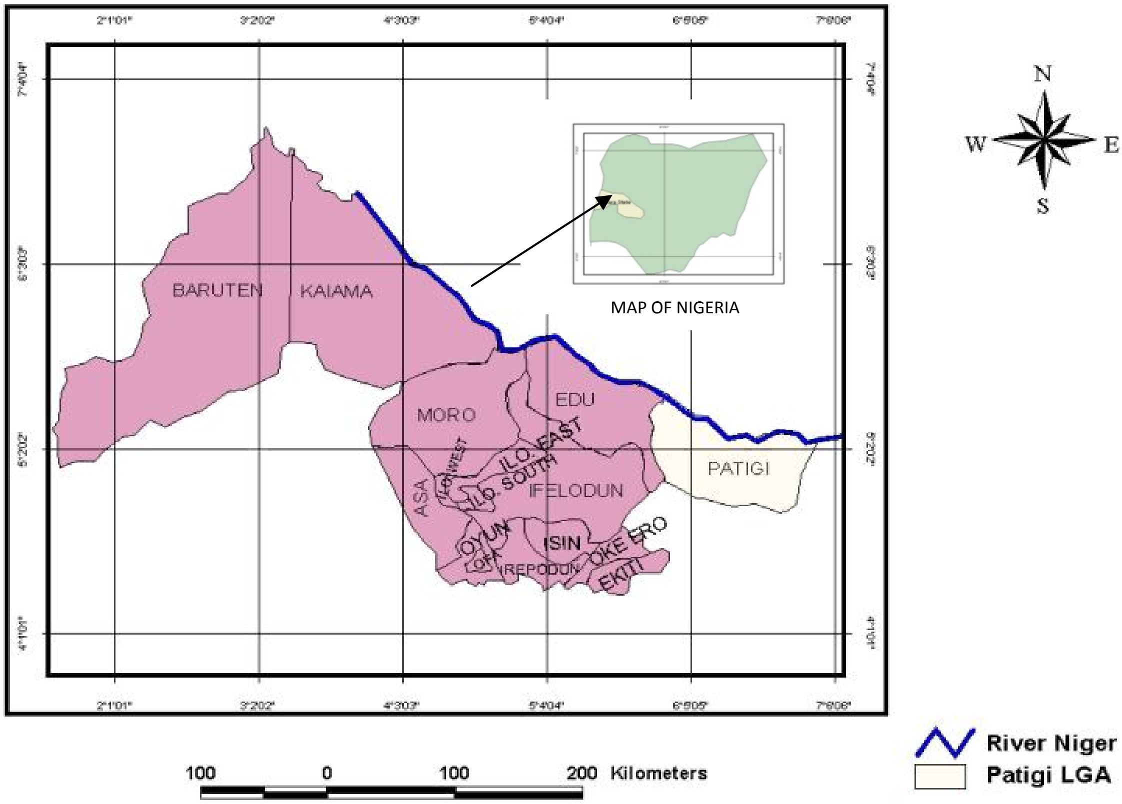

Figure 1: Map of Kwara State showing Patigi LGA
Source: Kwara State Ministry of Land and Housing, 1999.

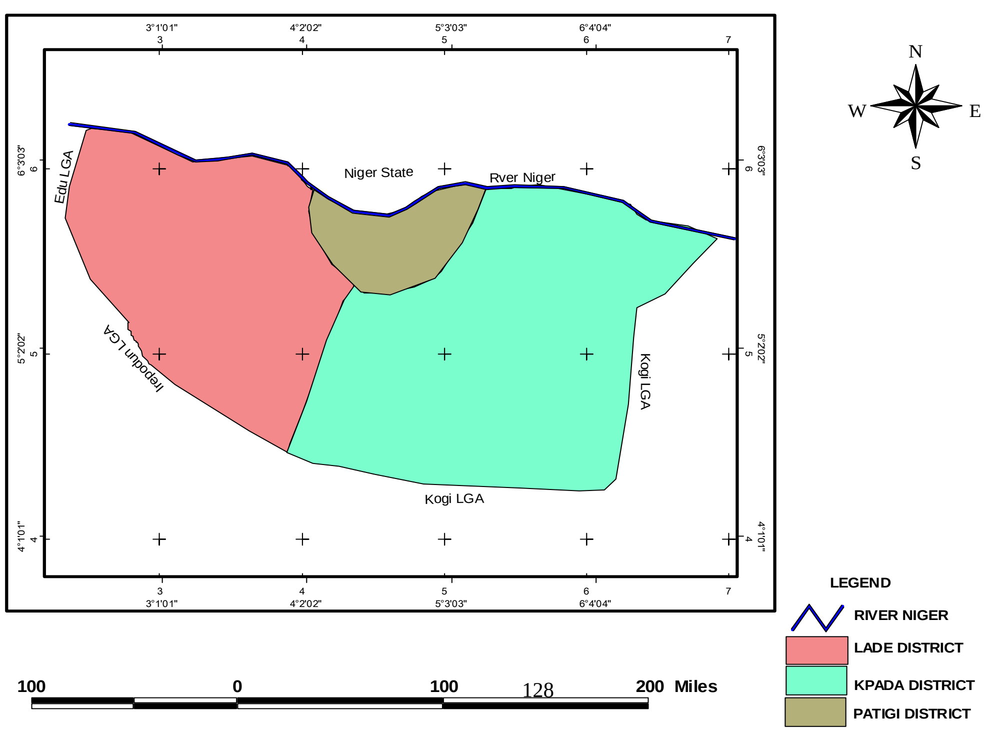

Figure 2: Locational Map of Patigi LGA
Source: Extracted from Kwara State Map, 2009

CONCEPTUAL CLARIFICATION

Ecological Crop Geography

According to Klages (1928), Ecological Crop Geography deals with the broad distribution of crop plants and the underlying reasons for such distributions. An Ecological Crop Geographer is concerned with more than the direct relationships of crop plants to their physiological environment but also with the study of crop plants in relation to their social environment. It is therefore sufficient to state that the main ecological factors such as water relationships, temperature relationships, light relationships and the availability of plant nutrients determine the physiological environment that influences crop production.

Agro-ecology: the ecology of food systems

Agro-ecology has been variously defined as the ecology of agriculture, the study of ecological functions in farming, and the marriage of agriculture and ecology. Specifically, Agro-ecology, according to Gliessman (1978), is defined as the application of ecological concepts and principles to the design and management of sustainable agro-ecosystems. This concept has captured the imaginations of farmers and academics that are searching for innovative ways to increase productivity and sustainability of agriculture while maintaining a lasting and productive environment.

In what ways can we recapture the knowledge developed over centuries of traditional agricultural production experience, and link these with the efficiencies of natural systems with new technologies? To this, Gliessman (1990) submitted that, "The greater the structural and functional similarity of an agro-ecosystem to the natural ecosystems in its bio-geographic region, the greater the likelihood that the agro-ecosystem will be sustainable."

Sustainable agriculture and integrated farming systems

In Sustainable Agriculture and Integrated Farming Systems by Edens, et. al., (1985), there is sections devoted to economics of systems, ecological impacts, and ethics and values in agriculture. Altieri (1985) discussed pest management in the context of a changing structure of agriculture, including consolidation of farms, planting of monocultures, and how these impact pest populations. Gliessman (2001) added that "Socio-economic, technological, and ecological components constantly interact, creating a complex feedback mechanism that through time has selected for the types of food production systems that we observe today." These agro-ecologists laid the foundation for what has become in some programs a comprehensive study of the food system. Parallel to this development was the emerging literature on agricultural systems (Spedding, 1976).

Integrated Pest Management (IPM)

The concept of Pest Management Practices (PMP) is essential in describing the role and rationale for responsibly managing pests and pointing scientists and practitioners alike to identify future needs in biological information, and placing pest control in perspective with production goals. To this end, the concept of pest Economic-injury Levels has been central to dismiss the notion that pests must be controlled at all cost in favor of break-even analysis i.e., Gain Threshold; (Stone and Pedigo, 1972).

Materials and Methods

In this study, (n) stands for 200 people as the sample size where (N) is 45,712 people (as the entire population of the study area) of which sampling frame is 228.56. From the above mentioned sampling frame, a further division of the entire sample size on the basis of the random selection of 32 Rural Village Areas (RVA) within the 3 districts in Patigi Local Government Areas was done through which, 228.56 was divided by 32 (the number of the selected Rural Village Areas in Patigi L.G.As) equal to 7which determined the number of questionnaires that were administered in each RVA. This means, a total number of two hundred and twenty-four questionnaires were administered for this research.

Results and Discussions

Crop Development Methods for Rice Production System

In this study, four major crop development methods were observed. These include; fertilizer application, regular weeding, irrigation system and availability of good drainage (Table 1).

According to the Lade rice farmers, irrigation system has the largest percentage of (50%) contribution towards effective rice production. Fertilizer application is 30% while regular weeding and good drainage are 20% respectively. Fertilizer application and good drainage support 40% of production system in Patigi while in Kpada, 50% of fertilizer application and 40% of good drainage system has been the sustainable measure of rice production. The findings here agreed with the work of David and Balisacan (1995) Titled; “Predicting Rice View”. In their work in Philippine Palay, the irrigated areas produce the highest average yield with 3.4 mt/ha, followed by the rainfed ecosystem at 2.0mt/ha, and the upland areas at 1.5mts/ha.

Irrigation System

Dukun-Lade Irrigation Scheme (DIS) is the major irrigation system enhances effective rice production system in one of the rice fields visited. The type of irrigation here is Gravity Irrigation (GI) by which water could flow through a drainage channel along and in-between the farm land as it was observed by Chambers (1988), “that a major and perhaps the main beneficial effect of canal irrigation are to distribute water through the command area, allowing it to seep and to provide water for irrigation through wells”. This irrigation system is said to be the best type for rice production, because other types of irrigation such as; Sprinkling Irrigation in the form of down-pour (i.e, direct water contact) is not most appropriate for the growing stage of rice seed especially at the flowering stage. Gravity Irrigation has necessitated high yield condition for rice production with a minimum yield of 2,442 tones on about 800 hectares of land in a specific production period.

Chemical Application

This crop development method for rice production is prominent in all the locations visited. It was examined that different types of chemicals are applied at each stage of rice development. As a result of this, certain chemical like herbicide is needed to be applied on any proposed rice field in order to neutralize the effect of weed and pests earlier before planting. Fertilizer like NPK, haste soil nutrient replenishment for optimum output as observed by Hutchins and Gehring (1993) that, technology, in the classical sense, includes the development and use of nutrients, pest control products, crop cultivars and farm equipments for maximum output. Ricardo (1817) also argued that as soft fertility changed, productivity levels would also change, thus ensuring that land of the highest fertility or quality would provide more output per unit area than land of inferior quality.

Regular Weeding

The timely removal of any unwanted plants enhances rice development. Weeding could be done manually or by using chemicals. This method disallows competition between the crop and various other grasses on the available nutrients.

Good Drainage Method

This crop development method was observed to be prominent in the Low Land Rice field (LLRF). It was noticed that the early growing stage of rice need much protection from being effected by surface-flow activities. The drainage system is patterned in such a way that excess water that could damage the crop is diverted and drained away. To this, Adas (1974) submitted that canalling also served the crucial purpose of communication (and provided places for homesteads), flood regulation allowed to better control flood-based agriculture, while river diversions of both small (Philippines, Java) and large scale (India) accounted for classical gravity irrigation.

Table 1: Crop Development Method

Location	Rice Area(In Hectare)	Yield Type	Fertilizer Application	Irrigation	Regular Weeding	Good Drainage Pattern
Patigi	184	Rainfed	40	0	20	40
Kpada	160	Irrigation	50	0	10	40
Lade	818	Irrigation	30	50	10	10

Source: Author's Field Survey, 2010.

Crop Management Measures for Rice Plantation

Crop management measures employed by the rice farmers include; mono-cropping, mixed-cropping, and shifting cultivation (see Table 2).

Mono-cropping and Mixed-Cropping

100% mono-cropping was recorded for all the farmers in the location visited (Table 2). That is, mixed cropping is of little or no effect on the farmers' cropping system, only that the response given reflects the interchange of crops on the same land parcel in different time frame. For instance, some of the rice farmers in Patigi district use a piece of land for growing melon for the period of 3 months in a year; after which the same land is prepared for rice farming.

Shifting Cultivation

The percentage of farmer practicing shifting cultivation is low in Lade with 10% while 90% response was given to non-shifting as indicated in Table 2. This could mean that farmers are able to have maximum output on a unit of land through the use of fertilizer and other crop development aids. That is why Hutchins and Gehring (1993) said, that the rate of technological development and the degree of innovation in future technologies will greatly influence the stability, and certainly the productivity of agriculture.

Table 2: Rice Management Measure Employed (%)

Location	Land Area(in hectare)	Mono-Cropping	Mixed-Cropping	Shifting	Non-Shifting
Patigi	184	100	-	70	30
Kpada	160	100	-	65	35
Lade	818	100	-	10	90

Source: Author's Field Survey, 2010.

Rice Yield Level

Crop Yield Level Based on the Agro-Ecological Impact

General overview of the quantity of rice production in relationship with the land area under production is shown in Table 3. Out of all the 3 districts visited (Lade, Patigi & Kpada) ; Lade has the highest rice production level of 2,442 tons on 818 hectares of land, followed by Patigi with 360 tons while Kpada has 320 tons of rice yield. It was further observed that, the irrigation system in Lade boosts crop production especially during the dry season when the natural moisture for crop growth is seized for a specific production period in a year.

Table 3: Rice Yield Level/Land Area

Location	Land area(in hectare)	Yield type	Yield Level (tons/production period)
Patigi	184	Rainfed	360
Kpada	160	Rainfed	320
Lade	818	Irrigation	2442

Source: Author's Field Survey, 2010.

Rice Yield Level and Seasonal Variability

The effect of seasonal variation was obvious on the production level of rice yield as shown in Table 4. For instance, report shown that 70% of Lade rice farmers are interested in growing rice in dry season, while the rest 30% prefer raining season. It was further gathered that dry season is suitable for rice production because of;

- the available irrigation scheme.
- the increase in temperature, which negates the reproduction system of pests and thereby increases rice yield.
- the photosynthesis that permits food production for plant growth.
- an improved rice seed like "faro 52 and 44" where farmer realizes a minimum of 3 tons/ha at a production period.

These findings agreed with Whelan and Mc Bratney (2000) that yield variability is often defined in terms of summary statistics such as temporal variance and spatial variance by comparing the variances among seasons (temporal) with those within a season (spatial).

Table 4: Rice Growth and Seasonal variability

Location	No of RVA	Dry Season(%)(DS)	Raining Season (%)(RS)
Lade	7	70	30
Patigi	13	30	70
Kpada	12	30	70

Source: Author's Field Survey, 2010.

Problems Limiting Rice Yield

Series of problems impeding rice yield level in the study location are identified in Table 5. These problems include the effect of pests, animals (especially birds) and weather system. Though, the activities of some of these could be restrained to certain level, yet their impacts are still obvious in many cases. For instance, 70% of the farmers in Lade district responded positively to the effect of animals (birds) that feed on the rice seeds mostly when the farmers are not available in the farm, while 30 percent response was on pests effects on crop yield.

Patigi and Kpada districts are adversely affected with all the stated problems, especially, the problem related to weather system in terms of flood. 40% response in Patigi and 50% in Kpada were given in order to establish the impact of flood on their farming system. This is as a result of excessive rainfall, which in many cases destroys rice fields; especially those at the bank of River Niger. This findings were also identified by Hochman, Z, et; al., (1994) that there are large number of external, non-controllable factors, which influence the technical and economic performance of the farm system, such as prevailing weather conditions or the incidence of pests and diseases.

Table 5: Problem Identification in Rice Fields

Location	No of RVA	Animal (bird)	Pests	Weather System
Lade	7	70	30	-
Patigi	13	30	30	40
Kpada	12	30	20	50

Source: Author's Field Survey, 2010.

Conclusions and Recommendations

This study revealed that the most productive land units must be cultivated with technological inputs such as fertilizer application, applicable irrigation method, chemical spraying, and good drainage system for an appreciable output. Thus, technology is now the most effective means to get the best out of cropping system as supported by Scott (2009), that:

- Technology has/will increase agricultural productivity
- Technology development has been /will be sustained
- Technology is therefore, the basis for sustainable agriculture

It is therefore recommended that Lade Rice Field could be a model for the rest of the rice growers within the Local Government Areas if not for the whole State and entire nation. The rice production system in this location is related to the discovery of Richards (1990), where sustainability in agriculture relates to the capacity of an agro-ecosystem to predictably maintain steady production overtime. A key concept of sustainability therefore, is stability under a given set of environmental and economic circumstances.

Reference:

Adas, M. (1974). The Burma Delta: Economic Development and Social Change on an Asian Rice Frontier, 1852-1941, the University of Wisconsin Press.

Altieri, M.A. (1985). Diversification of Agricultural Landscapes—a Vital Element for Pest Control in Sustainable Agriculture, In: T.C. Edens, C. Fridgen, and S.L. Battenfield, (eds). Sustainable Agriculture & Integrated Farming Systems, (166-184), Michigan State University Press, East Lansing, Michigan.

Batie, Sandra S. (1989). Sustainable Development: Challenges to the Profession of Agricultural Economics, AJAE 70(5).

Chambers, R. (1988). Managing Canal Irrigation, Practical analysis from South Asia, New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd.

David, Cristina C. and Balisacan, Arsenio (1995). Philippine Rice Supply Demand: Prospects and Policy Implication, Makati City : Philippine Institute of Development Studies.

Edens, T.C., C. Fridgen, and S.L. Battenfield, (eds) (1985). Sustainable Agriculture & Integrated Farming Systems, East Lansing :Michigan State University Press.

Gliessman, S.R., (ed) (2001). Agroecosystem Sustainability: Developing Practical Strategies. Boca Raton, Florida: CRC Press.

Gliessman, S.R., (ed.) (1990). Agroecology: Researching the Ecological Basis for Sustainable Agriculture. Springer-Verlag : New York.

Gliessman, S.R., (eds), (1978). Agroecosistemas Con enfasis en el Estudio de Tecnologia Agricola Tradicional, Colegio Superior de Agricultural Tropical, Cardenas, Mexico.

Hochman, Z, Pearson, C.J. & Litchfield, R.W.,(1994). USERS' Attitudes and Roles in the Development and Evaluation of Knowledge Based Systems for Agricultural Advisers, Agricultural Systems, 44(2), 217-235. NSW Agriculture, Australia : Wollongbar Agricultural Institute.

Hutchins, S.H. and P.J. Gehring (1993). Perspective on the Value, Regulation, and Objective Utilization of Pest Control Technology. Amer. Entomol. 39:12-15.

Jones, M.P. (1995). The Rice Plant and its Environment. West African Rice Development Association, Cote d'Ivoire.

Klages, K.H.W. (1928). Crop Ecology and Ecological Crop Geography in the Agronomic Curriculum, J. Amer. Soc. Agron. 20:336-353.

Kwara State Agricultural Development Project (KWADP)(1996). Ilorin, Nigeria.

Kwara State Agricultural Development Project (KWADP)(2007). Ilorin, Nigeria.

NPC (1991). National Population Commission Office, Ilorin, Nigeria.

Ricardo, D.(1817). The Principles of Political Economy and Taxation of Ricardo, New York Macmillan and co.

Richards, J.F. (1990). The Earth as Transformed by Human Action, Cambridge University Press.

Rodale, R. (1988). Agricultural Systems: The Importance of Sustainability in Agricultural Development, Emmaus, PA: Rodale Press.

Scott Cato, M. (2009). Green Economics, London: Earthscan, 142–150.

Selbut R. L. (2003). Eco-systems Development Organisation, WIS Partners Building, 5 Lugard, Jos, Plateau State – NIGERIA.

Spedding, C.R.W. (1979). An introduction to Agricultural Systems, First (eds), London : U.K. Elsevier Publication.

Stone J.D. and Pedigo L. P. (1972). Development and economic injury level of the green clover worm on soybean in Iowa. Journal of Economic Entomology, 65: 197-201.

The Meteorological Department (2010). Climatological Data for Agricultural Land Classification, Ilorin, Nigeria.

Whelan, B.M., and A.B. McBratney (2000). The "null hypothesis" of Precision Agriculture Management, Precis. Agric. 2:265–279.

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