



Institutional and Technical Factors Influencing Sustainable Agricultural Practices in Nigeria

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ABSTRACT

Sustainable agriculture is the management and conservation of natural resources base and the orientation of technological and institutional change to ensure the attainment and continued satisfaction of human needs for the present and future generation. In Nigeria, heterogeneity in the agro climate implies that no single approach can be applied in a uniform manner, the traits and diverse nature of Nigeria farming system characterized by mixed cropping, mixed farming and small farm sizes also challenges technologies available. It is therefore imperative to develop sustainable practice to tackle the various factors and ensure sustainable agricultural practices are on par with more conventional technologies.

Keywords: *Sustainable Institutional, Technological, Heterogeneity develop, Conventional,*

1. INTRODUCTION

Agriculture plays a vital role in sustainable development and in hunger, poverty eradication. 70 per cent of poor and hungry people in developing countries live in rural areas and depend directly or indirectly on agriculture for their livelihoods.

Future global food and fiber demand is expected to increase substantially as population grow and average income rises but limited land and water resources can be brought into production to satisfy this demand.

Agricultural system must therefore intensify the use of land and water resources through sustainable methods and changing current production system and diversifying into new productive and conservative methods. According to (Dixon et al 2001), Agricultural intensification is an increase in productivity of existing land and water resources in the production of food and cash crops, livestock, forestry and aquaculture, generally associated with an increase in use of external inputs. Intensification is now defined as more efficient use of production inputs; increased productivity comes from the use of improved varieties and breeds, more efficient use of labor and better management.

Sustainable agriculture is defined as the management and conservation of natural resources base and the orientation of technological and institutional change to ensure the attainment and continued satisfaction of human needs for present and future generation (FAO 1995). According to World Development Report (2002), institutions are rules, enforcement, mechanism and organization put in place in an economy. Institutions are defined by North, (1990) as rules of the game that facilitate coordination or govern

relationships between individuals or groups and can be divided into formal and informal institutions. Sustainable agriculture is a set of complementary approaches that seek to minimize negative environmental impacts from agriculture, by increasing efficiency of input use and by making greater use of biological and ecological factors in production processes, (FAO 2003). In his opinion, (Crisson 1992) deduced that sustainable agriculture emerged as an alternative agricultural system that addresses the many constraints faced by resource poor farmers and at the same time ensures environmental sustainability. It refers to the capacity of agriculture overtime to contribute to overall welfare by providing sufficient food and other goods and services in ways that are economically efficient and profitable, socially responsible while also improving environmental quality. According to Pretty *et. al* (2003), this system involves a combination of inter related soil, crop and livestock production practices in conjunction with discontinuation or reduced use of external inputs, it emphasizes the use of techniques that integrate and are adapted to local natural processes such as nutrient cycling, biological nitrogen fixing, soil regeneration and natural enemies of pests, into food production processes. Countries have different ways of defining "sustainable agriculture". In Denmark, farmer organizations have developed guidelines on how to achieve environmental sustainability at the farm level while maintaining economic sustainability. Codes of good agricultural practice provide practical guidelines to farmers. The main objectives for codes of good agricultural practice are:

- to produce high quality food and fiber,
- to use sustainable and profitable production methods,
- to reduce adverse effects on the environment, and
- to use ethically justifiable production methods.

These objectives can be achieved through:

- focusing on the quality of agricultural products,
- optimizing the nutrient balance,
- judicious use of pesticides,
- improving animal welfare and health,
- improving feed quality,
- maintaining cultural landscape values,
- improving energy efficiency,
- adequate work safety measures, and
- Appropriate farm management practices.

The purpose of the guidelines, disseminated through extension services, is to help set standards for individual farmer's management practices. In addition to the codes of good agricultural practice, these practices are also influenced by various government regulations on sustainable farm management. Adopting sustainable farm management practices often requires farmers to make investments. In some cases, these investment costs can be covered through higher prices for their products at the market, but this can occur only if the consumer is aware of the shift to a more sustainable production method and is willing to pay a premium for such products. Farmers, however, are still not successful at getting this information across to consumers. When farmers do a good job in improving their farm management practices, they should inform the public about it. So it is important to improve communication.

2. NEW TECHNOLOGIES AVAILABLE TO FARMERS

Farming methods are undergoing significant technological changes. New government regulations and the demand for more advanced and labor-saving technological solutions are among the driving forces behind the change. To give a practical example, some of the important changes on various farms in the past ten years include:

- animal waste storage capacity increased to one year,
- manure spread while crops growing and better spreading equipment used,
- total plant nutrient balance calculated,
- nitrogen and phosphorous content in animal feed minimized,
- pesticide use optimized with help of a computer programmer,
- pesticides sprayed at the optimal time (very early in the morning), and
- better spraying equipment used and spraying equipment cleaned in a safe place.

3. ELEMENTS OF SUSTAINABLE AGRICULTURE

Sustainable Agriculture intensification are relevant to the developing countries, where poverty,

The choice of farming technologies will continue to increase in the future. One problem, however, is the price of new technology, which is often high. Adopting new technologies can thus require making significant investments and farmers are only willing to invest money when it is profitable for them to do so. This can require expanding the scale of the farm operation through buying more farmland or livestock. Thus new technologies are a major driving force behind structural change resulting in fewer and larger farms, more machinery used on farms, and less manpower needed to run the farm.

Examples of technologies that can enhance the environmental performance of agriculture and contribute to sustainable farming are:

- reduction in the reliance on pesticides through
 - increasing mechanical weed control;
 - wider application of biological pest control methods; and
 - increasing precision in calculating thresholds and improving warning systems.
- reduction in the loss of plant nutrients through:
 - improving the quality of feed without using excessive amounts of nitrogen and phosphorous fertilizers; and
 - “precision farming” based on the global positioning system and advanced tool control technologies that enable farmers to optimize with accuracy nutrient use and crop treatment at the field level.
- application of modern biotechnology

The most far-reaching changes can be expected from the application of modern biotechnology and genetic engineering of crops. These are controversial issues at the moment. However, in order to meet the increasing global demand for food in a sustainable way, it is necessary to explore the possibilities of modern bio-technology. Agricultural productivity and resource degradation are closely inter-related and negatively affected by increasing population pressure on the natural resource base. Sustainable agricultural practices are not new but draw on traditional knowledge and practices, some of which have now been positively evaluated by scientific methods.

The principles of sustainable agriculture are environmental sustainability, economic sustainability and social sustainability.

3.1 Environmental Sustainability

Sustainable agriculture is frequently described as ecological sound practices that have little to zero adverse on natural ecosystems or even enhance environmental

quality and natural resource base upon which the agriculture economy depends. This is achieved typically through protecting, recycling, replacing and maintaining the natural resource base such as land (soil), water and wild life that contribute towards conservation of natural capital, while synthetic fertilizers can be used to supplement natural inputs which are applied on need basis. Under sustainable agriculture, synthetic fertilizers are known to harm soil organism, soil structure and biodiversity are avoided or reduced to minimum use.

3.2 Economic Sustainability

In order to be truly sustainable a farm must be economically profitable, farms that are not economically viable are replaced by alternative uses of land that are more profitable. Sustainable agriculture can improve the economic viability of a farm in a number of ways in the short term, improving soil management and crop rotation can increase yields while in both the medium and long term, improve soil quality and water availability as well as other environmental benefits from sustainable practices may rise the value of the farm and provide for payments for environmental services. Economic viability can also be achieved through for example, reducing on-specific characteristic of the production system. Economic sustainability is also conditioned by many factors aside from crop production methods, e.g household characteristics such as managerial ability, institutions, infrastructures and market access among others.

3.3 Social Sustainability

This relates to the quality of life of those who work and live on the farm as well as those in the surrounding communities. It includes ensuring equitable revenue returns to different stakeholders of the agricultural production chain. In context of high unemployment, sustainable agriculture can promote sharing of agricultural value added by more members of the community through more extensive use of available labor, at least for some techniques, thus contributing to social justice and cultural cohesion. Fair treatment of workers and choosing to purchase locally rather than from more distant markets are also elements of social sustainability.

4. THE AIMS OF SUSTAINABLE AGRICULTURE

Increasing agricultural productivity remains one of the most effective ways to combat hunger and poverty. Sustainable production practices can improve agricultural productivity while conserving bio-diversity, soil fertility and efficiency of water use while reducing the pressure to clear forest and over fish the seas. In some cases the technologies need do not exist and needed to be developed, farmers lack the capital to acquire technologies or the human capital to use them effectively.

Policies, institutions, infrastructure and market access influence production practices that are applied and determine whether their impact on the environment and the people is indeed sustain. According to the FAO's most recent estimate 848 million people suffered from chronic hunger worldwide between 2003 and 2005, 98% of which lived in developing countries (FAO, 2008). Decreasing hunger requires increased food production which in turn requires farmer's access to productivity enhancing inputs, knowledge and skills. However the majority of the chronically hungry are small holder farms in developing countries that practice subsistence agriculture on marginal soils, lack access to inputs and product market as well as financial resources to procure costly chemical fertilizers and other agrochemical that might enhance the productivity of their land. Renkov, 2000 opined that sustainable agriculture is a way of farming that can be carried out for generations to come, this long term approach to agriculture combines efficient productions with the use of wise stewardship of the earth resources. Rewald 2001, in his own opinion hopes that sustainable agriculture overtime will accomplish the following; meets human needs with safe, high quality and affordable supply of food and fiber, protects the natural resource base and prevent degradation of air, soil and water quality, usage of non-renewable resource efficiently, usage of natural biological cycle and control, assuring the economic survival of farming and wellbeing of farmers, their families and communities and creating institutional incentives and funding the focus public and private research, education and technology development on integrating agricultural productivity and profitability with environmental stewardship.

5. Key Issues for Investment

Future investments are likely to support more diverse products and production systems and to include less favorable production regions. Investments will need to apply modern science and new marketing systems to help both women and men farmers move into more productive and sustainable production systems. Investments in sustainable agricultural intensification must be economically, environmentally, and socially sound, efficient, and based on sustainable institutions. Common characteristics of these investments are described below.

- *Based on holistic systems approaches.* Farming systems are defined by the economic, social, and environmental conditions within which they operate. Interventions must be based on an understanding of the interrelationships between these factors, and they will therefore frequently require a holistic, multidisciplinary approach. For example, introduction of a new production system or an innovation in an established system will often require attention to the policy environment, agro ecology, market systems, social system (including how gender and social group influence the division of labor and

access to resources), and the farm/household economy

- ***Sensitive to social change.*** The transition from one farming system to another is often as much an issue of behavioral change as of economic change. Production systems are rooted in cultures and traditions. Major changes may require two or more generations of farmers to make the transition from, for example, subsistence farming to commercial farming, nomadic pastoralism to settled agriculture, or traditional to nontraditional crops. Since social resistance to change may be strong, a sound social analysis should be part of the plan for new investments in agricultural intensification. Extension services must help farmers address and adapt to social change, but these services are frequently very weak in their ability to deal with social issues.
- ***Targeted to specific production environments.*** There are 72 major categories of farming systems –each with numerous variations –found in the various agro-ecological regions of the developing world (Dixon et al. 2001). Investments in sustainable intensification must be designed within the context of established agricultural systems and the level of technology, resource availability, and market opportunities in the area. In areas where high input use already threatens environmental resources, for example, the challenge will be to use fewer purchased inputs more efficiently. In other areas, as in most of Africa, the use of production inputs must increase to provide sustainable livelihood options to growing populations.
- ***Supported by a sound policy framework.*** As the private sector is largely involved in agricultural production and marketing systems, governments have a key role in establishing a facilitating policy and regulatory environment for sustainable agriculture. To maximize agriculture’s efficiency and sustainability, public policy should seek to internalize all costs and benefits in the prices of production inputs, such as improving pricing mechanisms for irrigation water, facilitating land market development, and eliminating distorting taxes and subsidies on chemical inputs, including fertilizers. Government investment programs must also provide for critical infrastructure (roads, electricity) and other public goods, such as regulatory frameworks, administration of property rights, research, and information services, especially for small-scale farmers.
- **Built on knowledge-intensive innovations.** Sustainable intensification must build on a strong understanding of the system and its components. Research and extension will need to provide the technical and management recommendations suited to specific farms and fields rather than broad general areas. “Precision farming” systems will help apply the knowledge to field-level production. Investments in biotechnology, ICTs, processing, and marketing technologies are also needed.
- ***Focused*** on poor and marginal farmers. If countries are to achieve social objectives and improve political stability, investment in sustainable agricultural production should be directed at poor people. Sustainable livelihoods within agriculture will not be possible for everyone, however, and some marginal farmers with little potential to improve incomes in agriculture must seek off-farm employment. Practitioners must consider the wider social impacts of investments and the need for alternative employment.
- ***Equitably shared by all gender and minority groups.*** Agricultural production system innovations are socially sustainable only when all members of society share in the benefits. Because almost half of all farmers in the world are women, and because in most rural areas women carry out many specialized production activities (planting, weeding, vegetable gardening, managing small animals, postharvest handling), investments must ensure their participation in programs and avoid negative impacts. Men may displace women farmers, as has occurred in some parts of Africa, when export horticultural market opportunities have encouraged men to take over women’s traditional plots of land. The same is true for many minority ethnic and cultural groups, who have more limited access to education, loans, property rights, and technical information. Social analysis is needed to guide project design and investment, draw on traditional knowledge, and identify and mitigate negative environmental impacts on different groups. Gender analysis is a particularly important tool for predicting gender-specific impacts of agricultural intensification investments and mitigating adverse impacts, such as increases in women’s workload or reduced access to land.
- ***Participatory processes.*** All relevant stakeholders should be included in the design and implementation of sustainable intensification activities, as this inclusiveness will empower farmers to plan and execute these activities and to obtain information and develop options needed in the decision-making process. With these skills, farmers have a better ability to link to markets and to negotiate their interests with agribusinesses and governments. Strengthening representative rural producer organizations (RPOs) and other advocacy groups for the agricultural sector can facilitate this empowerment.
- ***Environmentally sound.*** Sustainable agricultural production systems must be environmentally sound

neither depleting the natural resource base on which they depend nor contributing significantly to the depletion of downstream resources. Agricultural intensification investments should seek to reduce soil erosion and land degradation, avoid loss of biodiversity, and improve the efficiency of land and water resource use. In general, more efficient use of existing resources avoids pressure on more marginal production areas, thus preventing more widespread environmental degradation.

- **Nonpolluting.** As agricultural production systems use inputs more intensively, avoiding pollution of environmental resources (water, land, air) and food products through minimizing downstream pollution from agrochemicals, livestock manures, and soil erosion is critical to the sustainability of downstream production systems. Government regulation relating to pollution, both mitigation measures and charges, is relevant to environmental assessments of new production systems.
- **Market and private sector based.** Small-scale farmers seeking to intensify and diversify their production systems are especially affected by poor access to knowledge and the lack of input and output markets. Investment is needed to develop these markets and infrastructure, which will expand producers' production options and facilitate production changes to satisfy consumers' demand for better quality production, safer products, and information on methods of production. In these circumstances, an effective response requires that agribusinesses and government and commodity organizations develop standards, grades, and certification of processes (certification of processes may relate to farm practices, including environmental and social conduct—that is, encouraging environmentally sustainable or “good” farming practices). Farmer organizations have a central role in scaling up production to develop new markets and meet market demands.
- **Low risk.** Agricultural production nearly always involves substantial risk because of weather, pests and diseases, and market prices. Farmers, particularly resource-poor farmers, are risk adverse, and they may maintain traditional production systems and practices even when market, environmental, and technological changes make them unsustainable. Innovations for sustainable intensification are most acceptable to farmers when they involve minimal risk or reduce risks. Where this is not the case, investments may be needed to help deal with risk by providing financial, information, and risk management services, as well as improved infrastructure. In addition, financial incentives such as matching grants may be needed to encourage resource-poor farmers to try out more sustainable methods of production.

Trade-offs. Options for intensification will not necessarily involve win-win scenarios. In practice there are trade-offs between productivity (and income), environmental sustainability, and various social objectives. Common trade-offs include efficiency/ equity, specialization/ flexibility, profits/ environmental benefits, and long-term/ short-term paybacks. These trade-offs present difficult choices for policy makers, and sound cost/benefit analysis accounting for economic variables, and their social and environmental implications, must be employed. This will involve building the capacity of both public and private sector decision makers to make effective decisions within complex decision environments. It will also require compensatory mechanisms to mitigate adverse effects on groups that are negatively affected by initiatives that provide positive overall net benefits to the target population.

6. Future Directions for Lending

Public investments to intensify sustainable production systems are generally best focused on (1) facilitating the capacity of farmers, government, and the private sector to make decisions about the appropriate technological and resource allocation and (2) providing the necessary social/organizational and physical infrastructure. It is critical that agricultural production systems be sufficiently flexible to adapt to changing environmental and economic conditions.

New technologies will be developed, and variations on established production systems are likely to continue. At present, options that may warrant public sector support include:

- Variety improvement will remain crucial as it becomes increasingly difficult to “adjust the environment to the plant.” Plant varieties adapted to specific production environments and sustainable agricultural practices, and to resisting specific pests and diseases, will become increasingly important. Livestock improvement will increase productivity and make more efficient use of scarce land and water. Biotechnology's potential as a tool for sustainable production systems should be evaluated and supported on a case-by-case basis.
- Conservation farming practices can reduce unnecessary input use. Minimum tillage or no-till crop production reduces labor and equipment costs, enhances soil fertility, reduces erosion, and improves water infiltration, thereby reducing unit costs and conserving land resources. Improved crop residue management, including mulching, is often a necessary component of these systems. No-till systems of conservation farming have proven a major success in Latin America and are being used in South Asia and Africa.³

- Organic farming eliminates use of chemical inputs and can be sustainable as long as practices maintain productivity at a reasonable level, consistent with price incentives provided by growing market opportunities for organic produce. Organic farming depends mainly on the development of niche markets with reliable standards and certification systems for production.

Along with policy-level support.

- *Precision agriculture* improves productivity by better matching management practices to localized crop and soil conditions. Relatively sophisticated technologies are used to vary input applications and production practices, according to seasonal conditions, soil and land characteristics, and production potential. However, with help from extension and other services, resource-poor farmers can also apply principles of precision agriculture for differential input application and management on dispersed small plots. Appropriate technologies suitable for use by small-scale farmers include simple color charts to guide decisions on fertilizer application, and laser leveling of fields for irrigation.
- *Fertilizer use in Africa is low* and soil fertility is declining, which explains much of the lagging agricultural productivity growth in Africa relative to other regions. Fertilizer use is resurfacing on the African development agenda, and policy makers face a major challenge in deciding how to promote increased use of mineral fertilizers. There are several obstacles to overcome to avoid fertilizer-market failure, however. They include strong seasonality in demand for fertilizer, the riskiness of using fertilizer (stemming from weather-related production variability and uncertain crop prices), highly dispersed demand for fertilizer, a lack of purchasing power on the part of many potential users, the bulkiness and perishability of most fertilizer products, and the need to achieve large volumes of throughput in fertilizer procurement and distribution to capture economies of scale.

7. PROMOTING SUSTAINABLE USE OF NATURAL RESOURCES

If rural poverty and hunger are to be reduced and if global food demand is to be met, increased outputs will have to come mainly from intensified and more efficient use of the limited means of production. At the same time, action must be taken to arrest the destruction and degradation of the natural resource base, because this is increasingly becoming the barrier to increasing productivity. Achieving these tasks requires investments to develop and deploy practices that improve technical production

efficiency and develop practices and foster sustainable and intensified food production. The needs are institutional as much as technical. To promote the maintenance and restoration of natural assets in rural areas, countries should develop strategies that give overall guidance for approaching rural natural resource management issues and that set the framework for linking rural, and especially agricultural, development with natural resource management

7.1 Agriculture and Energy

From an energy perspective, agriculture has a double role: energy consumer and energy producer. All stages of the food chain—from land preparation to irrigation, fertilization, mechanization, processing, conservation, transport and consumption—require one form of energy or another. A combination of fossil fuels and, increasingly, renewable energies such as biomass, solar and wind need to contribute to agriculture's sustainability and productivity. The key is not eliminating energy use from agriculture but increasing the efficiency of its use and minimizing its negative impacts on the natural resource base on which sustainable agriculture depends. Achieving gains in efficiency also addresses the concerns about climate change and its potentially negative effects. This—plus land use practices aimed at lowering greenhouse gas emissions and carbon sequestration—give agriculture important linkages to the energy sector. This does not mean that the energy needs of agriculture need to be curtailed. In many developing countries, human force, agricultural residues and animal power are still overwhelmingly the only energy sources available, with obvious implications regarding human drudgery and health. Compare with other sectors, agriculture in developing countries requires relatively small amounts of energy. Meeting agriculture's energy requirements contributes greatly to sustainable development. Agriculture could become a major energy producer. The conversion of large amounts of biomass and agricultural residues into energy, taking into account nutrient recycling, can contribute considerably to national energy balances. Biomass grown on purpose for conversion to solid, liquid and gaseous fuels contributes also to the rehabilitation of degraded and marginal lands—fulfilling important environmental services linked to soil fertility, offsets for greenhouse gas emissions and rural sustainable development. It is important, however, to prevent this form of energy production from entering into competition with land for food production, which must take precedence.

7.2 Agriculture and Health

Increased food availability accounted for 25 per cent of the reduction in child malnutrition in 1970–95, so productivity increases in agriculture are important for gains in child survival. In addition, nutritional quality of foods is a critical element. Food-based approaches to

micronutrient malnutrition should be integrated into agricultural development efforts. In fact, agriculture is central to reducing child mortality because malnutrition is a factor in more than half the deaths of children under five in developing countries. In addition, agriculture plays an important role in improving maternal health because unhealthy, malnourished mothers and women farmers are more likely to have low-birth-weight babies, who in turn are susceptible to malnutrition and disease. About 25 per cent of newborns in developing countries are considered to have low birth weights. By improving incomes and nutrition, gains in agricultural productivity can help break this cycle of passing malnutrition from one generation to the next. Agriculture and health are linked in another way: combating HIV/AIDS, malaria and other diseases is good for agriculture. Poor people and farming communities in rural areas have been hit hardest by HIV/AIDS, with more than 7 million farm workers dying of the disease in 25 countries over the last 15 years. This has affected productivity at the farm level and led to depletion of assets, skills, knowledge, social bonds and economic opportunities. Those left behind are forced to turn to less nutritious and economically valuable crops that are easier to produce. Furthermore, malaria often strikes during harvest time, threatening agriculture. Pesticides and fertilizers used in agriculture can contaminate water. Misuse of pesticides can have immediate and chronic health effects on farmers and consumers. Persistent organic pollutants can cause harm to ecosystems both locally and, because of their chemical properties, at great distances from where they are applied. In addition, globalization of animal diseases—such as the outbreak of foot-and-mouth disease—has caused billions of dollars in losses and required the culling of 4 million head of cattle in the United Kingdom. With demand for meat and milk products expected to more than double by 2020, links between livestock diseases and human health will be increasingly important. About half of the 1,700 organisms causing diseases in humans are naturally transmitted from animals.

7.3 Agriculture and Biodiversity

Sustainable agriculture depends on effective management of natural resources and preservation of the biodiversity base. The earth contains some 14 million species, and the majority of them are in tropical forests and marine systems. Yet biodiversity is being lost at unprecedented rates. Twenty-five locations around the world, occupying only 1.4 per cent of the earth, contain more than 60 per cent of the planet's plant and animal species. Agriculture now extends to cover about one-third of the land surface and is the largest user of biodiversity and its components.

Projections suggest that global food production will need to double over the next half-century, either by intensification or expansion. Both scenarios will have important impacts on biodiversity. Management of biodiversity in agricultural ecosystems is thus a necessary

component of any overall approach to its conservation. Furthermore, the productive management of agricultural biodiversity will be key to meeting future food needs while also maintaining and enhancing the other goods and services provided by agricultural ecosystems.

Farmers for centuries have created an impressive storehouse of knowledge through the selection, storage and propagation of landraces as well as through livestock breeding. They constitute the largest group of ecosystem managers among humans. As such, there is an opportunity to engage them to improve the management of biodiversity in ecosystems by integrating ecosystem approaches into everyday agricultural management. At the same time, attention will need to be given to reducing the negative externalities of agriculture on biodiversity at all levels (ranging, for example, from within field destruction of beneficial predators and pollinators up through the increasing load of fixed nitrogen in global ecosystems). Activities should draw on the political will and technical expertise embodied in the programs of work established under the Convention on Biological Diversity, and with targets exemplified by those set in the Convention's Global Strategy for Plant Conservation.

7.4 Agriculture and the Millennium Development Goals

The Millennium Development Goals (MDGs, see inside front cover) adopted in September 2000 provide key targets to address the most pressing development needs. The central role of agriculture within the context of the MDGs is well understood: agriculture is important in stimulating sustainable economic growth and rural employment, and it is the cornerstone for food security and poverty reduction. Most poor people live in rural areas, for example, so productive on-farm and off-farm activities are critical to reducing poverty in rural communities. Similarly, women are the engine of agricultural growth in developing countries, so promoting gender equality and empowering women is important for achieving sustainable agricultural development. At the same time, a vibrant agricultural sector helps to promote economic opportunities for women, allowing them to build assets, increase incomes and improve family welfare— all essential steps to empowerment. If we are to ensure environmental sustainability, reducing agriculture's large and growing ecological footprint is critical.

Agricultural activities—land cultivation, freshwater use, depletion of strategic aquifers for irrigation, habitat encroachment through agricultural expansion and misuse of pesticides—have transformed between one-third and one-half of the earth's land surface, and current practices are threatening long-term sustainability. The development of high-yielding crop varieties in the late 1960s is estimated to have preserved over 300 million hectares of forests and grasslands, including considerable wildlife

habitat. This both conserved biodiversity and reduced the amount of carbon released into the atmosphere. Improved farming practices and the use of agro-ecosystem approaches will help ensure the viability of agriculture in the future and will enable farmers to become better stewards of the global environment.

Increasing agricultural productivity remains one of the most effective ways to combat hunger and poverty in the first decades of the twenty-first century. Sustainable production practices can improve agricultural productivity while conserving biodiversity, soil fertility and efficiency of water use and while reducing the pressure to clear forests and overfish the seas. In some cases, the technologies needed do not exist and need to be developed. In other cases, farmers lack the capital to acquire technologies or the human capital to use them effectively. Policies, institutions, infrastructure and market access influence the production practices that are applied and determine whether their impact on the environment and on people is indeed sustainable.

Addressing the interlinked challenges in agriculture requires co-ordinated responses that draw on the strength of all stakeholders. They must be addressed within coherent national strategies for agriculture and rural development, in partnership with the international community, the private sector and civil society. This requires putting in place appropriate policies and institutions and mobilizing resources at the national, regional and global levels. Furthermore, if we are to address all the challenges facing the world today in agriculture, we must refocus our attention on improving the wellbeing of rural people and reducing rural poverty in the widest possible sense. Average incomes in rural areas need to be increased. At the same time, efforts must be made to improve the quality of rural life, which is currently too often at unacceptably low levels.

8. SUSTAINABLE AGRICULTURE IN NIGERIA

In Nigeria, agriculture needs sustainability so that Nigerians can rely on a safe domestic supply of food rather than relying on foreign imports that could affect security if cut off and not be able to guarantee its safety. Also considering the recent economic situation of galloping inflation, starvation and food scarcity, there has been consistent rapid increase in the prices of many agricultural inputs and thus this has made farming practices to change continually, farmers building their own experiences and managing their crops. Considering the interlinked challenge in agriculture, it requires coordinated strategies, appropriate policies, institutions and mobilizing resources both at household, sectorial, national, regional and global level. Increasing agricultural productivity remains one of the most effective ways to combat hunger and poverty in the first decades of the twenty-first century. Sustainable production practices can

improve agricultural productivity while conserving biodiversity, soil fertility and efficiency of water use and while reducing the pressure to clear forests and overfish the seas. In some cases, the technologies needed do not exist and need to be developed. In other cases, farmers lack the capital to acquire technologies or the human capital to use them effectively. Policies, institutions, infrastructure and market access influence the production practices that are applied and determine whether their impact on the environment and on people is indeed sustainable. Addressing the interlinked challenges in agriculture requires co-ordinated responses that draw on the strength of all stakeholders. They must be addressed within coherent national strategies for agriculture and rural development, in partnership with the international community, the private sector and civil society. This requires putting in place appropriate policies and institutions and mobilizing resources at the national, regional and global levels. Furthermore, if we are to address all the challenges facing the world today in agriculture, we must refocus our attention on improving the wellbeing of rural people and reducing rural poverty in the widest possible sense. Average incomes in rural areas need to be increased. At the same time, efforts must be made to improve the quality of rural life, which is currently too often at unacceptably low levels.

Agriculture production certainly occupies a prominent position in every economy that is aimed at alleviating poverty. However maximum agricultural productivity can only be achieved when the productive forces are adequately equipped with modern techniques and skills. The Nigerian Agricultural sector is predominantly dominated by resource poor farmers who still practice the traditional or subsistence agriculture in which simplest traditional tools are being used, output and productivity are low, capital investment are minimal while land and labor constitute principal factors, thus cumulating in the law of diminishing returns, high labor and inputs but low returns.

A range of new technologies, management strategies and analytical tools relevant to sustainable agricultural intensification has emerged in recent years, and these production practices include integrated pest management (IPM), conservative farming (CF), diversification, organic agriculture, low external inputs and sustainable agriculture, precision agriculture.

8.1 Integrated Pest Management (IPM)

Integrated Pest Management is an eco-system based strategy that seeks to control pest or their damage through a combination of techniques (biological control, pest monitoring against economic threshold, habitat manipulation, modification of cultural practices, use of resistant varieties), using less toxic chemicals and pesticides only after pest monitoring indicate the need.

8.2 Conservative Farming

Conservative farming encompasses four broad intertwined management practices; minimal soil disturbance, sound crop rotation, direct sowing and maintenance of a permanent vegetative soil cover.

8.3 Diversification

Diversification is an adjustment of the farm enterprise pattern in order to increase farm income or reduce variability by reducing risk, by exploiting new market opportunities and existing market niches and diversifying not only in production but also on-farm processing and other farm based income generating activities.

8.4 Organic Agriculture

Organic agriculture employs agronomic, biological and mechanical methods to control pest and maintain soil fertility with virtual elimination of synthetic chemicals for crop and livestock production.

8.5 Low External Input and Sustainable Agriculture

This management technique uses farmer's knowledge and a range of management practices (agroforestry, IPM, inter-cropping, crop-livestock integration), to minimize the need for purchased inputs.

9. FACTORS HINDERING AGRICULTURAL AND RURAL SECTORS FROM ACHIEVING SUSTAINABLE NATIONAL DEVELOPMENT

9.1 Agricultural Sector

The Nigerian agricultural industry is generally subsistence and underdeveloped, thus the country's food supply relies heavily on imports. Nigeria imports approximately US\$2.5 billion food products and exports only US\$400 million (Agri-Food Trade Services, 2008). Processed foods and live animals are two of Nigeria's largest agricultural imports. Basic bulk food products and ingredients are also imported to supply domestic manufacturers and processors. It is estimated that 60% of inputs used in the food processing sector are imported. Some of the factors that have hindered the agricultural sector from contributing meaningfully to sustainable national development are:

- **Neglect of the sector by Government:** Nigeria's dependence on oil export caused the agricultural industry to be neglected for many years. Once a net exporter of food, Nigeria now has a substantial trade deficit. This deficit is largely due to the industry's

inability to expand as quickly as population growth. Lack of attention to the agricultural sector led to the disappearance of prime components of the agricultural sector, including the groundnut pyramid and oil palm plantations, along with the general regression of the industry.

- **Farm size and Resources Available to Farmers:** The Nigerian farmers are predominantly rural peasant farmers with very meager resources. The farm size in the country is small with over 90% of the agricultural output accounted for small-scale farmers with less than two (2) hectares under cropping (FMCOR, 2008). In the country, where the rural population (constituting over 80% of the total population) is engaged in agriculture, 42% of the farms are less than 2.0 hectares in size while about 70% operate on less than 4.0 hectares of farm land. The relatively small size of most farm holdings in the country provides a resource base far too small for use of most technologies in the more advanced countries of the world (Idike, 2008). The Nigerian farmer has insignificant power resources. The only and sure power source is the farmer himself and his family members (i.e. Human power). His major tillage implement is the hoe and matched. These meager resources (Financial and power) definitely limit the types of technologies the farmer can afford and the risks he will take when adopting such new technologies. Small farm size and the farmers' very meager resources dictate that new agricultural technologies, whether imported or locally developed, must be affordable and acceptable to the farmer as well as practicable within the local environment and condition. quality control and to sell high quality seeds and seedlings of selected arable tree crops namely oil palm, rubber, cotton, groundnut, soybeans, gum Arabic etc.
- **Low crop Yields:** Crops yields in the country, like in many developing countries of the world, are generally much lower than those in the developed countries. Although arable lands in the country are suitable for cultivating most crops, the crop yields are presently far below the potential yield. In fact Nigerian agriculture records an overall average of about 4 tons of agricultural product per hectare compared to about 13-14 tons per hectare in some other countries (FMA&COR, 2008).
- **Low level of adoption of Agricultural Technology:** In the present day, low crop yield signifies lack of adoption of modern agricultural technologies that have actually revolutionized crop production. Among the reasons often given for low crop yield and lack of adoption of agricultural technologies in Nigeria include:
 - Nigerian farmers are backward and resist change

- Extension services are ineffective
- Inputs are not available or are unreliable
- Ratio of inputs to crop prices discourage adoption.
- Low-cost credit is lacking
- Technology is not applicable to actual farmers' condition.

Other factors that have hindered the agricultural sector from contributing to sustainable National development are:

- Insufficient funding of research and development and extension of new – Inadequate improved cultivars and poor pest control management
- Poor soil, water and crop management
- High cost of small scale farm machines and equipment

9.2 Rural Sector

There continues to be the general acceptance that agro industrial development, even at the micro, small and medium levels, is critically significant to sustainable national development through the diversification of the agricultural sector (which is of rural based) of the Nigerian economy. In Nigeria, agro-industrial development could make a very important contribution to the transformation of rural and national development. Vibrant agro-industrial activities can expand the markets for primary agricultural products, add value by vertically integrating primary production and food processing systems and minimize post-harvest loses. In addition, such activities would reduce seasonality of consumption of large range of processed foods, increase the viability, profitability and sustainability of production systems through their impact on increasing farm incomes, rural employment and foreign exchange earnings. However, with few exceptions, the rural agro-industrial sector remains underdeveloped and largely without institutional, technical and financial support, thus hindering this sector from contributing meaningfully to sustainable national development. Some of the factors responsible for hindering this sector from playing its expected role include:

- Out-dated agricultural mechanization and rural development policies and policy summersaults.
- An inconsistent and insufficient supply of high quality raw materials for rural agro-industries.
- Lack of appropriate storage facilities.
- Seasonality of crops.
- Poor quality of raw materials supply and high losses during transportation of farm produce from farms to factory due to poor road condition.
- Lack of basic infrastructure.
- Poor environment and environmental regulations – lack of proper hygiene and sanitation practices.
- Insufficient and unreliable access to power and energy.

- Inadequate access to credit by rural agro-industrialists.
- Lack of technical support for the rural agro-industrial sector.
- Poor marketing and commercialization strategies.
- Absence of good management and non- existence of market development strategy.
- Inappropriate or obsolete processing and ancillary equipment and lack of maintenance culture.
- Poor government policy for the protection of home-based rural agro industries

9.3 Programs Aimed at Sustainable Agriculture in Nigeria

In the past, the Nigerian government in order to create enabling environment for food sufficiency embarked upon number of developmental programs which include, Operation Feed the Nation (OFN), the Green Revolution, Directorate For Food, Road and Rural Infrastructure (DIFRRI), Agricultural Development Projects (ADP), National Directorate for Employment (NDE), and the National Agricultural Land Development Authority (NALDA).

Successive administration in Nigeria has made concerted effort aimed at improving the agricultural sector with bid to achieving self- food sufficiency in food and fiber production. Through the ministry of Agriculture and Natural Resources, the government has embarked on a number programs aimed at promoting sustainable agriculture and rural development. The programs and their associated activities are;

• National Seed Service (NSS)

This aim at producing high quality seeds for Nigerian farmers within a commercial environment of sound certification.

• Agricultural Finance Program

This aim at providing loans and credit to small scale farmers which is done through agricultural oriented financial institutions, such as Agricultural cooperative banks (NACB), The Agricultural Credit and Guarantee Scheme (ACGS) and Farmers Credit Scheme.

• Agricultural Land and Resource Program

The objective of this program is to select suitable lands for production of suitable crops through soil survey and land evaluation, monitor and improve their quality soil fertility management and ensure the conservation of agricultural land through rehabilitation of degraded lands.

- **Establishment of Federal Agricultural Coordinating Units (FACU)**

This is primarily responsible for the provision of planning and implementing support to the activities of the Agricultural Development Projects in the country.

- **The Strategic Reserve Scheme**

Its objective is to undertake the shortage of excess grains during harvest for release when price are high in the market, thus stabilizes the price and make grain available all year round.

9.4 Institutional and Technical Factors Affecting Sustainable Agricultural Practices

The adoption of any technology by farmers depends on its economic benefits. Sustainable Agriculture can create multiple benefits and at the same time increase food production. In ensuring an effective sustainable practice, heterogeneity and economic incentives should be bore in mind.

Heterogeneity in an agro-climatic environment implies that no single approach can be applied all over the world in a uniform manner. Different technologies and methods are applied and adapted in different agro ecological zones with different results. Thus heterogeneity of the environment will condition the need to adapt and the type of sustainable agricultural practices adopted. Economic incentives is also important in determining the economic viability of sustainable agricultural viability, Its profitability (short or long term) will affect broader diffusion.

Technology challenges which hinges on the traits and diverse nature of African agriculture characterized by mixed cropping, mixed farming and small farm sizes .In ensuring effective sustainable practices it is imperative to tackle various technical factors which include, poor infrastructure, adoption of improved technologies, storage infrastructure, communication links. Institutional factors include, land systems, extension services and monitoring, funding of research institutions, social and political factors, market systems and information.

- **Land Systems**

Insecurity of land tenure has proven to be a constraint to any investment whose return is weighed towards the future while requiring immediate cash outlays. Impacts of tenure insecurity on investment in Sustainable agriculture has been found to be country and site specific, fragmentation of land can also affect the adoption of sustainable agricultural practices since it implies that farmers has to transport inputs to several isolated plots in different location, fragmentation of land may also results

in decreasing plot size which make certain practices impracticable.

- **Extension Services and Supervision**

Lack of proper extension services has been identified as constraining adoption of productivity enhancing technologies. Lack of skills of extension workers particularly on sustainable agricultural practices has been recognized as a key shortcoming of many extension delivery systems. There is a need for a system of training and organizational development that constantly upgrades the capacity of extension workers to ensure their technical competence, particularly in ‘unconventional’ farming practices such as sustainable agricultural practices.

- **Social/Political Constraints**

The policy environment may be more or less conducive to the wide spread adoption of sustainable agricultural practice. One factor affecting the design of agricultural policy is the degree awareness of policy makers on the benefit of sustainable agricultural practice some of which represent departure from previously accepted paradigms sustainable agricultural discourage the use of external input such as chemical fertilizer and chemical weed management and pest control might face resistance from agrochemical induction and other traditional actors in intensive agricultural supply chain.

- **Research Institutions**

The role of institutions (both formal and informal) in facilitating the promotion and adoption of sustainable agricultural practices cannot be overemphasized. Research technologies and production methods that yield few private benefits to research, but can provide sustainable increase in agricultural production and improved management of rural resources among the poor is seriously underfunded. This includes most form of pro-poor technology development and most approachable to farm development that depends on the increased use of purchased inputs.

- **Market Access**

Markets are important drivers for agricultural growth, making cash crops attractive and allowing specialization and diversification into new products. However in many developing countries market access faces constraints such as inadequate physical infrastructure, sanitary barriers. Unstable market opportunities related to production variability’s, relatively small markets, lack of current market information, and trading skills uncertain policy environment and rapidly changing trade regulations. slicer – used in slicing tomatoes, okra and carrot, and other vegetable crops.

10. IMPLEMENTABLE AGRICULTURAL MECHANIZATION STRATEGIES FOR SUSTAINABLE NATIONAL DEVELOPMENT

The fundamental problems facing agricultural mechanization in Nigeria include adoption of mechanization strategies which are often proffered by government and international agencies who do not pay sufficient attention to the interests of the local farmers and to the processes of technological change. Oni (1996) asserted that the major inadequacy in agricultural mechanization in Africa is the tendency to supply machinery and equipment without due consideration to equipment appropriateness, local maintenance and support capabilities. Other problems include prevalence of small, fragmented farm holdings which hinder efficient use of implements and machinery, lack of classified data and information on the suitability, adaptability and performance of commercially available agricultural equipment as related to types and conditions of soil and crops, inadequate repair and maintenance facilities, severe difficulties in obtaining spare parts, lack of well-trained machinery operators, poor credit facilities, inadequate research programme, absence of incentives for indigenous design and manufacture of implements and equipment and inadequate infrastructural facilities (road, water and electricity).

11. THE WAY FORWARD

Sustainable national development through agricultural and rural development are generally concerned with the need for agricultural and rural development practices to be economically viable, their adaptability and flexibility over time to respond to the demands for food and fibre (both high and low). This goal requires an efficient use of technology in a manner conducive to sustainability, its demand on natural resources for production, and its abilities to protect the soil and the resources. Because agriculture is affected by changes in market and resource decision in other sectors and regions, it is important that these changes do not provide a rationale for depleting the agricultural and rural resource base locally. Industrial processing of agricultural produce plays a key role in rural development; providing food, shelter and clothing, generating employment and income and contributing to overall economic growth and national development. But access to appropriate technical processes, machinery and equipment, technical inputs and markets must be carefully developed and maintained. Furthermore, this production chain must stretch continuously from the raw material producer (farmer) to the processor, distributor and buyer, with each link strengthened and improved in the process. Importantly, just as the production chain must be continuous, so must the chain of governance and assistance. All too often administrative barriers and

competition between public and private sector interests hamper efforts to optimize these chains. Cooperation is a key component in the development of rural agro-industrial processing of agricultural crops. It should be noted that government alone cannot be left to carry the task of promoting agriculture and agro-industrial development in the rural areas. The rural people should be deeply involved. To this end, the following steps would help to further enhance the usefulness of the agriculture and rural development sectors to sustainable national development.

- The rural people should be encouraged to come together to form cooperatives for the purpose of sourcing loans for establishing small scale farms and industries.
- There is the need for further research to cover different areas of small scale rural agro-industrial innovations.
- There is the need for training and retraining of the rural people to enhance the dissemination of new skills; ideas and technologies for agricultural mechanization and rural development.
- Young school leavers should be mobilized, trained and funded for the purpose of establishing small scale farms and agro-processing industries.
- Proprietors of small scale agro-industries should be encouraged to come together as partners in promoting small scale agro-industrial development.

12. CONCLUSIONS

Sustainable Agricultural has received a growing attention from farmers, research communities and development organization given the high cost associated with traditional intensive models of agriculture, malnutrition and persistent hunger. Thus an agricultural system that can both ensure sustainable food production while at the same time increase farmer's income and minimizing damage to the environment and the health of farmers and consumers. In order to ensure sustainable agricultural practices on a par with more conventional technologies, need for social capital base connection, and rural institutions that would ease market imperfection, research institutions must develop appropriate technologies and improvement upon dissemination of such technologies, knowledge and in various government must accord high priority to agriculture its research and development

Revitalizing the agricultural sector for sustainable national development involves making agricultural and rural development practices to be economically viable to meet human needs for food, be environmentally friendly and to be concerned with enhanced quality of life. Under this strategy, the vision of the government should be to transform Nigeria's agriculture and rural sectors into a profitable, commercially oriented and internationally competitive economic activity. The mission of the agricultural and rural development sectors should be to promote and guide sustainable development of

agriculture, livestock, fisheries and agro-based production systems and strengthen related institutions now and in the future. The overall objectives of the strategy should be to raise household incomes, create employment and ensure food security. To achieve these objectives, the government of Nigeria will take positive actions aimed at: Improved funding of the Agricultural and rural sector: Funding was, and remains a major problem for both the government and farmer investors. Government budget for agriculture has been on decline rather than increasing. Development assistance from external agencies should be sourced to compliment limited local funding. Efforts should be made to achieve reasonable draw down of external development funds by playing to rule. Raising the productivity of the sector through efficient research and extension service support, adequate allocation of budgetary resources and adequate provision of support services such as rural infrastructure. Commercializing activities in the sectors by encouraging private sector participation at the Federal, State and Local Government levels. Making the agricultural and rural agro-industrial sectors attractive for private sector participation by providing a conducive environment for investment including rationalizing taxation applied to agriculture and rural agro-industries. Undertaking a comprehensive review of the current legal framework and adopting a framework that is facilitative to the development of the sectors. Stabilizing the growth of the sector by encouraging farmers to diversify farming into non-traditional commodities. Improving governance in key agricultural and rural development institutions, particularly in the cooperative and farmers organizations. Also, other private sector stakeholders should be encouraged to play the following roles for the agricultural and rural sectors of the economy to be truly revitalized.

Farmers Organization will be expected to empower farmers by pooling them together so that they are able to benefit from economies of scale. Agri-business institutions should promote value addition through processing of agricultural products and providing employment opportunities. Financial institutions will be expected to expand and deepen their outreach to provide farmers and other rural people with financial services at reasonably low interest rates. Civil society will enhance farmers' capacity to organize, generate and utilize resources more effectively. Other roles for civil society groups include providing education, health, and extension services in areas they are best placed; advocacy for improved governance, human rights and environmental.

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