CLIMATE CHANGE AND SUSTAINABLE RENEWABLE NATURAL RESOURCES MANAGEMENT

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SUSTAINABLE FOOD PRODUCTION IN A CLIMATE CONSTRAINED ENVIRONMENT IN NIGERIA - THE ACTION LEARNING APPROACH

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Abstract
The nexus of food security with sustainable forest management and rural development is a topical issue. Food availability is related to production, which is a land use activity. In Nigeria where population density is high coupled with the global climate constrain, the blending and spatial planning of different and changing land uses, including legislation thereof are crucial policy issues, which involve various stakeholders. Thus, a synergy of different interests and hence system thinking approach is imperative. Systems' thinking is in particular suitable for studying complex dynamic issues that have to do with human behaviour for example. Traditional analysis focuses on the separating the individual pieces of what is being studied. Systems thinking, in contrast, focus on how the thing being studied interacts with the other constituents of the system of which it is a part. This paper examines the impact of global climate change on sustainable food production with a view to evolving mitigation to the anthropogenic impacts.

Key words: Climate change, system thinking, food security, land uses, action learning.

Introduction
The availability of food has always been a central preoccupation of mankind. Despite a doubling of the global population during the past four decades, farmers have produced sufficient food to allow average per capita food intake to grow gradually. Yet hunger persists and food reserves have fluctuated markedly during this period, sometimes falling to critically low levels. In Nigeria, around 70 percent of her 80 to 100 million people still live on land (Arokoyo, 2005), but the country cannot feed itself and thus spends $2.4 billion a year importing food (Akuh, 2000; Arokoyo, 2005). The source of food, which is land, is not only an economic factor, it is an ecological and socio-cultural resource as well. Apart from agriculture, forestry, fisheries and the supply of natural products and minerals, other multiple-functions of land include the provision of urban, industrial and infrastructural space, as well as space for recreational purposes and cultural heritages. In addition, land performs inherent ecological functions including the storage and transfer of water and solids, it acts as a sink for carbon and provides foothold for vegetation. However, the ecological functions of land will not be accomplished in the tropics without adequate forest cover. Also topical is the food security nexus with sustainable forest management and rural development, which have increasingly become matters of concern for developing countries (Africa inclusive) and for the international community (FAO, 2001, 2000). But while many complex factors have been identified as influencing sustainable development and food security, it is clear that education on the interdependency of renewable natural resources (RNR) is imperative. Such education was

posited as playing an important role in preparing farmers, researchers, educators, extension staff, members of RNR-businesses and others to making productive contributions to sustainable RNR management (Van Crowder *et. al.*, 1999). Thus, FAO identified the changes and adaptations expected from knowledge imparted through RNR education as critical to improving food security, sustainable agricultural production and rural development in the 21st century.

Knowledge could also bring negative consequence if the environment is not conducive for its application. This is why in Nigeria where population density is high coupled with the global climate constrain, the blending and spatial planning of different and changing land uses, including legislation thereof are crucial policy issues involving stakeholders as varied as land and house owners associations, farmers organizations, civil society representatives the private sector and local-level, regional and national planning institutions. Creating a learning environment is equally imperative among these stakeholders if food security is desired within the set ecologic, climatic and population linitations. This paper aims at analyzing different learning approach to various stakeholders understanding and embracing of sustainable mass food production in a climate constrained environment.

Mass Food Production

In microeconomics, production is the act of making things, in particular the act of making products that will be traded or sold commercially. Production decisions concentrate on what goods to produce, how to produce them, the costs of producing them, and optimizing the mix of resource inputs used in their production. This production information can then be combined with market information (like demand and marginal revenue) to determine the quantity of products to produce and the optimum 'pricing' Mass food production is the churning out of large amounts of standardized food products from production lines the agricultural field for example. It engender high production rate per worker through simple repetitive tasks leading to high-volume cropping of in-expensive agricultural products. According to Wikipedia (2008) mass production is capital intensive, as it uses a high proportion of machinery in relation to workers. With fewer labour costs and a faster rate of production, capital is increased while expenditure is decreased. However the machinery that is needed to set up a mass production line is so expensive that there must be some assurance that the product is to be successful so the company can get a return on its investment. Thus, mass food production is ideally suited to serve large, relatively homogeneous populations of consumers, whose demand would satisfy the long production runs required by this method of manufacturing.

However, apart from human diversity, which demands heterogeneous wants, sustaining mass food production demands high external inputs, which are mostly not environmentally friendly. Thus, Röling (2002) was of the opinion that focusing on speciality products, diversification, niche markets and multi-functional agriculture is becoming the norm rather than the exception.

Advantages and disadvantages of Mass Production

The economies of mass production come from several sources. The primary source is a reduction of nonproductive effort of all types. In food production, the farmer must make maximum use of land probably all year round to justify the high external input to agricultural production. In mass

production, each worker repeats one or a few related tasks that use the same tool to perform identical or near-identical operations on a stream of products. The worker spends little or no time retrieving and/or preparing materials and tools, and so the time taken to manufacture a product using mass production is shorter than when using traditional methods. The probability of human error and variation is also reduced, as tasks are predominantly carried out by machinery. A reduction in labour costs, as well as an increased rate of production, enables a company to produce a larger quantity of one product at a lower cost than using traditional, non-linear methods. However, mass production is inflexible because it is difficult to alter a design or production process after a production line is implemented. Also, all products produced on one production line will be identical or very similar, and introducing variety to satisfy individual tastes is not easy. However, some variety can be achieved by applying different finishes and decorations at the end of the production line if necessary.

Tropical Forest Soils and Trees

Many tropical forest soils are very old and impoverished. They are sometimes so weathered that they are largely devoid of minerals like phosphorus, potassium, calcium, and magnesium, which come from "rock" sources, but are rich with aluminum oxide and iron oxide, which give tropical soils their distinctive reddish or yellowish coloration and are toxic in high amounts. But they support tremendously vegetation owing to the rapid nutrient cycling characteristic of the rainforest. In the rainforest, most of the carbon and essential nutrients are locked up in the living vegetation, dead wood, and decaying leaves. As organic material decays, it is recycled so quickly that few nutrients ever reach the soil, leaving it nearly sterile. This explains why complete deforestation for agriculture has not advanced sustainable food production even with high external inputs (HEIs).

But tropical rainforest trees are well-adapted to their environment and have mastered the problem of poor soils. Since the first 15 - 20 cm of soil is a compost of decaying leaves, wood, and other organic matter, it is the richest source of nutrients on the ground. To tap this resource, canopy trees are shallow rooted, whereas most temperate tree roots extend beyond 1.5 m deep. Many tropical species have roots that actually grow out of the ground to form a mat on the forest floor in order to more efficiently collect nutrients.

These tiny roots form a network that, along with the mycorrhizae fungi, rapidly absorb nutrients. Apart from this, many tropical tree species have extensive root systems while others, especially tall emergent species, have evolved buttress roots, which aid in water uptake and storage, increase surface area for gas exchange, and collect leaf litter for additional nutrition.

Thus, when forest trees are cut and burnt, the rainforest system which allows vigorous growth on poor soil are being destroyed. Burning the dead wood and vegetation release enough nutrients into the soil to allow crops to grow for several years, but without the mycorrhizae, and other soil organisms to fix nutrients, soils will be rapidly leached by the harsh tropical sun or washed away by heavy rains. Essential minerals will not be replaced by new decaying matter since there is no longer forest above to drop leaves and wood. Within a few years, the soil will become nutrient deficient and can no longer support productive yields of conventional crops.

Not all rainforest soils are so poor; some rainforests grow on nutrient-rich floodplain and volcanic soils. Some of the best soils are found on steep slopes because minerals are released when the exhausted topsoils erode. Such rich soils are found in the Amazonian floodplains, Andean foothills, and volcanic areas of Southeast Asia (Java), Africa, Central America, and the Caribbean. However, without proper management, these soils as well can be rapidly leached of nutrients by heavy rains and the sun.

Climate Change

Climate change is any long-term significant change in the "average weather" that a given region experiences (http://en.wikipedia.org/wiki/Climate_change). Average weather may include average temperature, precipitation and wind patterns (National Academies, 2008; http://www.epa.gov/climatechange/index.html). It involves changes in the variability or average state of the atmosphere over duration ranging from decades to millions of years. These changes can be caused by dynamic processes on earth, external forces including variations in sunlight intensity, and more recently by human activities.

Apart from being an environmental issue, climatic change is also a development issue. It poses significant threats to the achievement of the Millennium Development Goals (MDGs) especially those related to eliminating poverty and hunger and promoting environmental sustainability.

Greenhouse gas emissions, one of the drivers of climatic change (Pidwirny, 2007) have caused global temperatures to rise by 0.74 degrees Celsius since the beginning of the 20th century. If these gasses are not reduced it is likely the increase in global temperature this century will exceed 2 degrees. It is estimated that 60% of current human migration is caused by climate change and natural disasters. The melting of glaciers, which increases the risk of flooding also encourages the rise in sea levels and could oblige the forced displacement of over 200 million people (http://www.epa.gov/climatechange/index.html). Green gas emission will also negatively impact agricultural harvests particularly in Africa where 60-70% of the population is dependent on the agricultural sector for employment (Ulsrud and Eriksen, 2007) and farming activities mainly depend on rainfed agricultural systems.

By 2100 Chad, Niger and Zambia risk losing almost their entire agricultural sector. The health impact of climate change on the poor is extreme. Diarrhoea caused by lack of access to clean water is responsible for the deaths of 5 million people (90% children). It is estimated that climate change, at current levels, could lead to a 10% increase in cases in some regions by 2030. At current rates, by 2015 around 2,170 million people around the world will still lack basic health services and 650 million will not have access to drinking water.

As more scientific information about global warming accumulates, climate change is emerging as perhaps the greatest environmental challenge of the twenty-first century. What is more, a virtual Pandora's box of major global threats, such as hunger, poverty, population growth, armed conflict, displacement, air pollution, soil degradation, desertification and deforestation are intricately intertwined with and all contribute to climate change, necessitating a comprehensive approach to a

solution. Clearly, climate change is a major source of uncertainty in natural resources management.

Forests, which are and are haven of natural resources and are cleared for agricultural production have four major roles in climate change: they currently contribute about one-sixth of global carbon emissions when cleared, overused or degraded; they react sensitively to a changing climate; when managed sustainably, they produce woodfuels as a benign alternative to fossil fuels; and finally, they have the potential to absorb about one-tenth of global carbon emissions projected for the first half of this century into their biomass, soils and products and store them - in principle in perpetuity. Sustainable management of forests for multiple use is therefore imperative, if not for sustainable use of arrays of products there-in, at least for multiple use of forest lands.

However, just as impossible it is fighting climate change without considering the rising energy needs of poor people and countries, effective address of global poverty without accounting for the impacts of climate change on agriculture, disease patterns, and violent weather events, all of which particularly impact the poorest countries is equally doubted.

Principles of Sustainable Food Production

The most central principle to sustainable food production is not to use the land and other resources therein faster than they renew because of the problems of maintaining fertile soil in many areas of the world (Nigeria inclusive). Apart from this, land and other natural resources therein cannot be treated in isolation but as a complex system. Hence, the system cannot be broken up into parts with the hope of acting on individual parts to satisfy a particular whim. Thus, nature must be treated as it is, and not as every individual wants it to be. The latter can only work briefly, with unsustainable soil and energy practices. As reposed by Shyamsundar (2002), food availability is related to production and thus to natural resources management.

With the land resources that we can use sustainably, we will get water resources, and the combination of land and water food resources gives us the population that can be sustained. Also worthy of note is that the world changes dramatically at times and so human population should not be run at the limits of food production. Rather, a safety factor is built into considering optimum population limit. This is expected to give a cushion to the production resources, in case of climate change to warmer or colder, drier or wetter, and all that might go with such change. Thus, it is imperative to maintain a factor of safety in population, below that of the maximum theoretical.

Participatory Extension Approach to Sustainable Food Production

Balancing effective and sustainable food production with economic, social and environmental factors is one of the important key challenges in natural resource management. Also, the importance of working with the farmer community to conserve agro-biodiversity and ensuring food security through sustainable agriculture cannot be overstressed (Ramprasad, 2007). Apart from these, the environment and fora in which decisions concerning natural resource management are made are evolving as a result of global trends such as the globalization of the economy; growing awareness of and response to environmental concerns; decentralization and devolution of

government control: the need for secured property rights: and increasing pressure for democratization. Thus, there is need for evolvement of development information generation, analyses and delivery system and services. This is extension, which Arokoyo (2005) submitted as the yard stick for determining development and quality of life of people in any country. The submission was reposed at the Elsenburg website (2008) where parts of the suggested mitigations to threats of climate change were:

- Acknowledgement of human-induced (industrial, agriculture) and natural climatic change threats;
- Adjustment of management plans accordingly;
- Adoption of open-mindedness, proactive, and adaptable approach to planning; and
- Participation in collaborative management across the landscape through existing structures such as farmer organisations, conservancies, Land Care Forums, Water Forums and Fire Protection Agencies etc

Sustainable food production amidst climate change threats demands a synergy of different interests and hence systems' thinking approach. Systems' thinking is in particular suitable to study complex dynamic issues that have to do with human behaviour for example. Traditional analysis focuses on separating the individual pieces of what is being studied; in fact, the word "analysis" actually comes from the root meaning "to break into constituent parts." Systems thinking, in contrast, focus on how the thing being studied interacts with the other constituents of the system of which it is a part. The Nigerian national agricultural extension system (which incorporates all renewable natural resources extension) has evolved over four decades from a rudimentary, export crop-focused service to an averagely efficient and effective professional service (Arokoyo, 2005). The training and visit (T & V) extension system currently practiced under the Agricultural Development Programmes (ADP) promotes blanket recommendations for most technologies (agricultural, agroforestry, forestry and women in agriculture). Under the system, farmers' involvement and participation in technology development is very low.

However, the farmers' environment is highly diverse with patches of high and low fertility, different soil types, microclimate, social, cultural, psychological and institutional variables which influence the performance of technologies. The optimal management of such spatial, social, cultural, psychological and institutional diversities can only be achieved if farmers themselves are knowledgeable about appropriate technologies and are capable of adapting them to their conditions. Also, transferring blueprints does not help in managing environmental and social complexity, farmer to farmer advice and learning by doing will be most appropriate (AGRITEX, 1998). This is where Participatory Extension Approach (PEA), which is an ideal tool for institutionalizing sustainable food production in Nigeria, becomes imperative.

Participatory extension is a system thinking processes and mechanisms that enable those people who have a direct stake in the use of any resource to be part of decision-making in all aspects of its

management, from managing resources to formulating and implementing institutional frameworks. It is like a school of trying, where you try out ideas and share your experience with others. Its approaches are a way of improving the effectiveness of rural extension efforts by government agencies, NGOs and other organizations engaged in rural development. The institutionalization of PEA can help to improve organizational performance at the interface between the service provider (the extensionists) and the clients (the farmers'). The following characterizes the PEA:

- Initiation of community mobilization for planning and action with rural development extension and research;
- Encouragement of equal partnership between farmers, researchers and extension agents who can learn from each other and contribute their knowledge and skills;
- Strengthening rural people's problem solving, planning and management abilities;
- Promotion of farmers' capacity to adapt and develop new and appropriate technologies/ innovations;
- Encouragement of smallholder farmers to learn through experimentation, building on their own knowledge and practices and blending them with new ideas. This takes place in a cycle of action and reflection which is called "action learning"; and
- Recognizing that communities are not homogeneous but consist of various social groups with conflicts and differences in interests, power and capabilities.

The goal of PEA is to achieve equitable and sustainable development through the negotiation of interests among groups and factions in rural communities and hence provide space for the poor and the marginalized in collective decision-making. This approach might not always lead to 100% success, but the communities are themselves in charge of the process of arriving at decisions. This is more important because when there is failure, the community will still have the energy and the initiative to retry or modify innovations to suit their specific conditions.

Engendering sustainable change and innovation is not solely a government concern and leaving social change purely to the forces of the market is no recipe for sustainability. In the same vein, technical and economical perspectives have not been able to solve the complex issues related to sustainable development. Therefore, the paradigm of interactivity and dialogue, which combines ideas of systems thinking, (social) learning and multi-stakeholder participation, is imperative.

Action Learning

Although, coming to term with the importance of participation in decision-making on mitigating the threats of climate change in Nigeria is important, using the right participatory process is more important. Action Learning is a participatory process for bringing together a group of people with varied levels of skills and experience to analyze an actual work problem and develop an action

plan. The group continues to meet as actions are implemented, learning from the implementation and making mid-course corrections (Revans, 1998). Also referred to as questioning of action.

Action learning is an educational process whereby the participant studies their own actions and experience in order to improve performance. It is a form of learning by doing in conjunction with others, in small groups called action learning sets. It is proposed as particularly suitable for adults, as it enables each person to reflect on and review the action they have taken and the learning points arising, which should then guide future action and improve performance.

The method stands in contrast with the traditional teaching methods that focus on the presentation of knowledge and skills. Action Learning is a process for bringing together a group of people with varied levels of skills and experience to analyze an actual work problem and develop an action plan. It focuses on research into action taken and knowledge emerges as a result that should lead to the improvement of skills and performance. It has strong links to various philosophies relating to existentialism, the psychology of self-understanding and self-development, and the sociology of group based learning. People had to be aware of their lack of relevant knowledge and be prepared to explore the area of their ignorance with suitable questions and help from other people in similar positions (Revans, 1982). The complexity of combating sustainable food production in a climate constrained environment requires an action learning process. The process will find solutions to underlying root causes of anthropogenic influence on climatic change and determine an holistic strategy to mitigating climatic change influence on food production.

As submitted by Revans (1980) mathematically Action learning, L = P + Q
Where: L = learning,
P = programmed (traditional) knowledge and
Q = questioning to create insight.
Q uses four "major" questions: where?, who?, when?, what?
and 3 "minor" questions: why?, how many?, how much? (Revans, 1980)

Although Q is the cornerstone of the method, the more relaxed formulation has enabled action learning to become widely accepted in many countries all over the world (USA, Canada, Latin America, the Middle East, Africa and Asia Pacific). Simply put, AL is a description of how most people go about solving problems, with a group dimension added.

Principles of Action Learning

Action Learning is a form of Problem-Based Learning, but it goes further in insisting that the problem(s) being worked on must be **real**, in that no-one knows the answer already. They should preferably be non-technical (or at least non-specialist: too much specialization limits the potential contribution of other members of the "set"), and evaluation refers pragmatically to whether the solutions work, rather than to the extent to which participants arrive at a pre-determined optimum solution. (Problems to which the answer is already known are referred to as "puzzles", and although they may have their uses, they are not part of action learning). Even so, arriving at a solution is not the whole story: AL sets differ from task forces or project teams in that the process is managed in order to maximize the learning as well as the outcome.

This can raise the thorny question of what constitutes learning: how do I know (perhaps more important in the business context, how does the boss know?) that I have learned something over and above arriving at a solution to the problem? Participants need to have some investment in finding the solution, so most will bring real problems which they are currently encountering in their work-place. The programme may of course impose limitations on the nature of the problems tackled, so that there can be cross-fertilization of learning between the participants, and so that any taught input (if any) has some relevance to all members of the set.

Conclusion

Although some natural forces are identified with global climatic change aggravation, none is as potent as the anthropogenic forces. Sustainable mass food production, which is targeted at alleviating food security, is also majorly at the whim of human being. Hence, a human-centred solution is needed. Apart from the complexity of evolving a workable relationship between climate change, food security and sustainable economic development, the major actors (human being) are equally complex. In order to change, one first needs to learn. Thus, creating a learning environment is central to sustainable food production within a complex ecological environment nurtured by a dynamic climatic complex.

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