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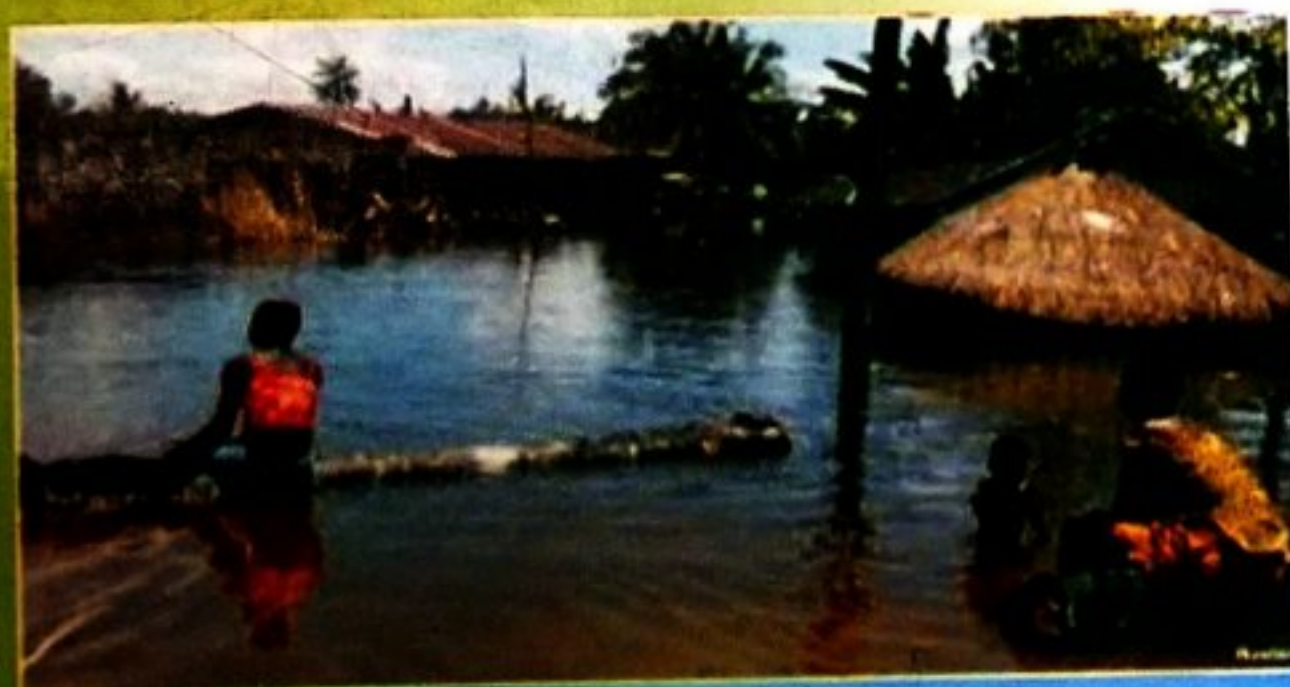
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ADAPTATION OF URBAN AGRICULTURE TO CLIMATE CHANGE IN NIGERIAN CITIES: A CASE STUDY OF MINNA, NIGER STATE

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Abstract

Adaptation in urban agriculture to climate change is important for impact and vulnerability assessment and for the development of climate change phenomenon in urban areas. A wide variety of adaptation options has been proposed as having the potential to reduce vulnerability of agricultural systems in urban area to risks related to climate change. This paper develops a typology of adaptation to climate change by urban agriculture practices. It differentiates adaptation options in urban agriculture, the intent, timing and duration of employment of the adaptation; the form and type of the adaptive measure; and coping strategies to reduce risks associated with climate stresses. Quantitative approach was used in data collection and stratified random sampling was used to select respondents by dividing the city into different strata, and random sampling of urban farmers was employed. The result of the research on adaptation options in urban agriculture identifies four main categories: technological developments, government programs and insurance, farm production practices, and farm financial management. In addition to these direct adaptations, there are others such as information provision that may stimulate adaptation initiatives. The results reveal that most adaptation options are modifications to existing urban farming practices with respect to a changing climatic conditions (including variability and extremes) and non-climatic conditions (political, economic and social). To implement adaptations to climate change in urban areas, it is recommended that, there is a need to understand the relationship between adaptation options and existing practice; and between decision-making processes and risk management frameworks.

Keywords: Adaptation, Agriculture, Climate change, Response options, Urban Environment.

1. Introduction

Adaptation is an important component of climate change impact and vulnerability assessment, and is one of the policy options in response to climate change impacts [1]. 1999). Indeed, the significant role of adaptation as a policy response by government has been recognized internationally. Article 4.1b of the United Nations Framework Convention on Climate Change [1] states that parties are committed to formulate and implement national and, where appropriate, regional programs containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change. The Kyoto Protocol (Article 10) further commits parties to promote and facilitate adaptation, and deploy adaptation technologies to address climate change [3]. Nigeria, like many other countries, recognizes adaptation as an important component of its climate change response strategy and is exploring adaptation

options in several sectors [4].

Agriculture is inherently sensitive to climate conditions, and is among the most vulnerable sectors to the risks and impacts of global climate change [5]. Adaptation is certainly an important component of any policy response to climate change in this sector [6]. Studies show that without adaptation, climate change is generally problematic for agricultural production and for agricultural economies and communities; but with adaptation, vulnerability can be reduced and there are numerous opportunities to be realized [7]. In Nigerian agriculture, studies have identified climate change risks and have noted needs and opportunities for planned adaptations [8]. While adaptation is often considered as a government policy response in agriculture, it also involves decision-making by agri-business and producers at the farm-level [9]. Adaptations in agriculture vary with respect to the climatic stimuli to which adjustments are

made (i.e. various attributes of climate change, including variability and extreme events) and according to the differing farm types and locations, and the economic, political and institutional circumstances in which the climatic stimuli are experienced and management decisions are made [8]. Many potential agricultural adaptation options have been suggested, representing measures or practices that might be adopted to alleviate expected adverse impacts. They encompass a wide range of forms (technical, financial, managerial), scales (global, regional, local) and participants (governments, industries, farmers) [10].

The purpose of this paper is to develop a typology of agricultural adaptation options to climate change in Minna, North Central Nigeria. The paper is a review of current knowledge about adaptation in agriculture from studies of climate impacts, adaptation and vulnerability, and from research on the dynamics of agricultural production and economics. It also incorporates information and insights from the stakeholders who make decisions in the agriculture sector gained through workshops and other communications with representatives from the scientific community, producer organizations, farm groups and government agencies, and individual producers [11]. In particular, a national workshop on Risks and Opportunities for Climate Change for the Agricultural Sector [12] provided information from Nigerian agricultural producers and policy makers. The paper identifies important attributes of climate change for adaptation in agriculture and relates insights about decision-making from several fields of scholarship to agricultural adaptation to climate. A critique of the main dimensions of adaptation provides the basis for the typology of adaptation options in agriculture.

2. Climate Stimuli for Adaptation

In order to understand what adaptation options in Nigerian agriculture are possible, it is important to identify the climatic variables to which the adaptations relate, and to consider the role of non-climatic factors that influence the sensitivity of agriculture to climate change. Traditionally, the impacts of climate change on agriculture have been discussed with respect

to current average (or 'normal') growing season conditions and possible future normal conditions [6]. Conventional climate impact scenarios usually focus on the changes in average (mean) temperature and moisture. Some have also considered other climatic characteristics such as the growing season length and the timing, and climate-related factors such as pests and diseases, invariably for an average year sometime in the future [12]. While most impact studies have considered changed average (mean) climate conditions usually in a comparative static manner, analyses of agricultural vulnerability indicate that the key attributes of climate change are those related to climatic variability, including the frequency of non-normal conditions [8]. Recent debates focussing on the relationship between climate change stimuli and adaptation in agriculture recognize that climate change includes not only long-term changes in mean conditions, but also a change in the year-to-year variation in growing season conditions, and the frequency and magnitude of extreme weather events [12]. Understanding that climate change includes climatic variability and extreme events are important in analyses of adaptation. Despite the important influence of climate change, including variability and extreme events, adaptation in agriculture does not function and evolve with respect to these climatic stimuli alone. Non-climatic forces such as economic conditions, politics, environment, society and technology, clearly have significant implications for agricultural decision-making including adaptive decision-making [8].

3 Analytical Approaches to Adaptation in Agriculture

Insights into agricultural adaptation to climate change come from a variety of research approaches, which consider various scales (plant, plot, field, farm, region, sector, national and international) and employ several different perspectives [10]. These approaches include research on climate change impacts; natural hazards; agrarian political economy; innovation adoption; agricultural systems and farm decision-making; risk management; agricultural vulnerability and adaptation. Several factors affect adaptation to agriculture which are Conventional Climatic Change

Impact Assessment [10]; Natural Hazards [10]; Agrarian Political Economy [12]; Innovation Adoption [12]; Agricultural Systems and Farm Decision-Making [11]; Risk Management [11] and Agricultural Vulnerability and Adaptation [12].

4 Characteristics of Adaptations

There is a huge number and variety of measures or actions that could be undertaken in agriculture to adapt to climate change [5]. There also exist numerous characteristics by which adaptations can be distinguished, and which could serve as bases for a typology of agricultural adaptations [11]. Among the distinguishing characteristics of adaptation are intent and purposefulness, timing and duration; scale and responsibility; and form. Intent and Purposefulness differentiate between adaptations that are undertaken spontaneously, or autonomously, as a regular part of on-going management from those that are consciously and specifically planned in light of a climate-related risks [11]. Timing and Duration differentiates responses that are anticipatory (proactive), concurrent (during), or responsive (reactive). It also distinguishes responses according to the time frame over which they apply, such as tactical (shorter-term) versus strategic (longer-term) [11]. Scale and Responsibility distinguished adaptation according to the scale at which they occur and the agent responsible for their development and employment. In agriculture, adaptations occur at a variety of spatial scales, including plant, plot, field, farm, region and nation [12]; and Form which occurs via a variety of processes and can take many different forms at any given scale.

5 Types of Adaptation Options to Urban Agriculture in Minna

This section identifies types of agricultural adaptation to climate change, and gives examples of the types. While the typology is rather generic, the examples are mostly drawn from national literature and experience. In particular, valuable information was gained from [4]. This paper takes adaptation to refer to 'adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts' [1]. As a

result, the types of adaptations included here are activities that represent changes in some attribute of the agricultural system (the agriculture sector or farms within it) directly related to reducing vulnerability to climate change. Table 1 indicated the most common adaptive measure used in Minna and Niger State in general.

Agricultural Adaptation Options	Scale of Adaptation
Technological Developments	Low
Government Program	Low
Farm Production Practices	High
Farm Financial Management	Medium

The typology is based on the scale at which adaptations are undertaken and at which the stakeholders are involved. The first two categories are principally the responsibility of public agencies and agri-business, and adaptations included in these categories might be thought of as system-wide or macro-scale. Categories 3 and 4 mainly involve farm-level decision-making by producers. Of course, the categories are often interdependent. For example, an adaptation technology developed by government and the private sector might be adopted to modify farm production practices. Within each category specific examples are considered in light of the distinctions discussed earlier and farm decision-making in general. The main types of adaptations are summarized in Table 2 with examples in each category.

6 Adaptation Processes

The typology illustrates the myriad of agricultural adaptation options available to governments and individual farmers to reduce vulnerability to climate change risks. There are many kinds of technological, public policy and farm management options with potential to moderate problematic climate change effects or to realize opportunities, reinforcing the view that the agricultural sector is very adaptable. Yet the process of adaptation in agriculture itself is rarely researched. There has been very little research on the likelihood that such adaptation measures would actually be adopted, or on the conditions under which such adaptations might be employed in the agri-food sector. Four procedures have been adopted to adapt to climate change in Minna

which are:

- (i). There are distinctive (although inter-related) roles in adaptation for individual farm operators, agri-business (industry), and governments;
- (ii). Decisions to adopt or modify measures or practices are rarely made relative to one risk alone, but in light of the mix of conditions and risks (climate, trade, prices, social norms, etc.) that influence decision-making; and
- (iii). Decisions to adopt or modify measures or

practices are usually made not in a 'once-off' manner, but in a dynamic, on-going 'trial-by-error' process. Adaptation in agriculture involves various 'stakeholders' with different, yet often

inter-related points of view. In order to evaluate and promote practically the adoption of adaptations such as the development of new crops or irrigation, it is necessary to recognize which players are involved and what their roles are with respect to adaptation.

Table 2: Types and Examples of Adaptation Options in Niger State Farming Practices

Types of Adaptation	Examples of Adaptation	Attributes
Technological Developments	Crop development	<ul style="list-style-type: none"> • Develop new crop varieties, including hybrids, to increase the tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions.
	Weather and Climate Information Systems Resource management innovations	<ul style="list-style-type: none"> • Develop early warning systems that provide daily weather predictions and seasonal forecasts. • Develop water management innovations, including • Develop farm-level resource management innovations to address the risk associated with changing temperature, moisture and other relevant climatic conditions.
Government Programmes	Agricultural Subsidy and support programmes	<ul style="list-style-type: none"> • Modify crop subsidy programs to influence farm-level risk management strategies with respect to climate-related loss of crop yields. • Change investment in established income stabilization programs to influence farm-level risk management strategies with respect to climate-related income loss. • Modify subsidy, support and incentive programs to influence farm-level production practices and financial management. • Change ad hoc compensation and assistance programs to share publicly the risk of farm-level income loss associated with disasters and extreme events. • Develop and implement policies and programs to influence farm-level land and water resource use and management practices in light of changing climate conditions.
	Resource management programmes	
Farm Production Practices	Farm production	<ul style="list-style-type: none"> • Diversify crop types and varieties, including crop substitution, to address the environmental variations and economic risks associated with climate change. • Diversify livestock types and varieties to address the environmental variations and economic risks associated with climate change. • Change the intensification of production to address the environmental variations and economic risks associated with climate change. • Change the location of crop and livestock production to address the environmental variations and economic risks associated with climate change. • Use alternative fallow and tillage practices to address climate change-related moisture and nutrient deficiencies. • Change land topography to address the moisture deficiencies associated with climate change and reduce the risk of farm land degradation. • Implement irrigation practices to address the moisture deficiencies associated with climate change and reduce the risk of income loss due to recurring drought. • Change timing of farm operations to address the changing duration of growing seasons and associated changes in temperature and moisture.
	Land Use	
	Land topography	
	Irrigation	
	Timing of operations	
Farm Financial Management	Crop Subsidy	<ul style="list-style-type: none"> • Provide crop subsidy to reduce the risks of climate related income loss.
	Crop shares and futures	<ul style="list-style-type: none"> • Invest in crop shares and futures to reduce the risks of climate-related income loss.
	Income stabilization programs	<ul style="list-style-type: none"> • Participate in income stabilization programs to reduce the risk of income loss due to changing climate conditions and variability.
	Household income	<ul style="list-style-type: none"> • Diversify source of household income in order to address the risk of climate-related income loss.

7. Adaptation Processes

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- (iii). Decisions to adopt or modify measures or practices are usually made not in a 'once-off' manner, but in a dynamic, on-going 'trial-by-error' process. Adaptation in agriculture involves various 'stakeholders' with different, yet often inter-related points of view. In order to evaluate and promote practically the adoption of adaptations such as the development of new crops or irrigation, it is necessary to recognize which players are involved and what their roles are with respect to adaptation.

Ultimately, adaptations in agriculture occur via decisions of producers (to employ a technology, to choose a crop, to change a practice, to alter timing, to modify inputs, to enroll in a stabilization programme, etc.). These decisions are made in the context of prevailing economic conditions, institutional and regulatory arrangements, and of existing technology, policy, financial systems, and social norms [8]. Adaptation processes are articulated through the institutional and

regulatory mechanisms of prevailing agricultural, economic, financial, and management, political and technological systems [8]. The mechanisms through which adaptation occurs are widespread and include public research and extension programs, resource management legislation and regulations, agricultural support programs, and economic policies [20]. Adaptation options in agriculture are adopted relative to these mechanisms, which have the potential to modify the significance of climate-related stresses experienced in agriculture and are important constraints in the farm decision-making process. The connections between adaptation options and existing adaptation processes and mechanisms involve primarily relationships between farm production practices and financial management, and public sector decision-making processes.

8. Conclusions

The international literature on climate change impacts and vulnerability in the agricultural sector is increasingly recognizing the important role of adaptation. In assessments of the 'costs' of climate change, analysts attempt to estimate adaptations that are likely to occur. In programs to reduce vulnerability, practitioners attempt to identify adaptations that would be effective. This study provides an inventory of the many types and levels of adaptation to climate that are possible in the agricultural sector. Furthermore, by relating specific types of adaptation to public and private stakeholders and to the decision processes actually employed in agriculture, it is hoped that this work will contribute to the development of credible and useful adaptation assessments and programs.

This paper focuses on adaptation options in Nigerian urban agriculture to deal directly with the risks related to climate change. There is an immense variety of potential and actual adaptation options available, including many different types which have been characterized into four main categories. Technological developments involve the development of crops, weather and climate information systems and resource management innovations, including irrigation, by government and industry, to be subsequently adopted by producers sometime in the future.

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