Inland Valleys in West Africa: An Agro-Ecological Characterization of Rice-Growing Environments

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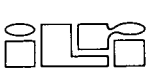

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Introduction

In 1981, the International Institute of Tropical Agriculture/IITA at Ibadan, Nigeria, submitted a proposal for the Wetland Utilization Research Project/WURP to The Netherlands' Directorate General for International Cooperation/*DGIS*, with a request for technical and financial assistance. The main objective of the Project was to develop the inland valley bottoms, which occur, characteristically and abundantly, in the West African landscape, for wetland rice cultivation. The first phase of this Project consisted of an inventory of existing information in order to identify the extent and categories of wetlands, including the valley bottoms, in West Africa and to assess their capabilities and constraints for rice-based smallholder farming systems.

The collection and synthesis of the available information started in August 1982 in The Netherlands as a joint undertaking by the International Institute for Land Reclamation and Improvement/ILRI, the then Netherlands Soil Survey Institute/*STIBOKA**, and the Royal Tropical Institute/*KIT*. ILRI had the overall responsibility of coordination (J. de Wolf). Contributions were made by P. Hekstra (Team Leader) on the climatological and hydrological aspects, by W. Andriesse on geology, geomorphology, and soils, by C.A. de Vries and G. Bus on the agro-socio-economic aspects, and by W. Linklaen Arriëns on water-borne diseases. The results of this inventory, covering the (humid) Equatorial Forest Zone and the (sub-humid) Guinea Savanna Zone of West Africa, and including all coastal countries from Guinea Bissau through Cameroon, came out in April 1983 as the WURP Report, which comprised four volumes, including one volume with five maps (Hekstra et al. 1983). This Report, however, has never been published officially and remained in a grey literature circuit, available only with difficulty to researchers outside The Netherlands.

In view of the great interest shown in the Report by many organizations and institutions, the continuing high topicality of increasing rice production in West Africa in the actual programs of national and international agricultural research institutes in the region, and the availability of new information, ILRI decided, in cooperation with the Winand Staring Centre/WSC, to officially publish, in its Publication series, an updated edition of the WURP Report. At the same time, in order to widen the geographic scope of the study, it was decided to include in its coverage the (semi-arid) Sudan Savanna Zone, north of the original inventory area.

The result of this update, as edited by P.N. Windmeijer and W. Andriesse, both of the Winand Staring Centre, is presented here. The information about the ecology of West Africa was compiled by Ms. L. Jansen (WSC). Drafts of (part of) the text were critically read by R. Oosterbaan (ILRI), E.M.A. Smaling (WSC), and O. Gordon (Land and Water Development Division, Sierra Leone). Special words of thanks go to the International Soil Reference and Information Centre/ISRIC, Wageningen, for the use of the library and cartographic collection.

* In 1990, The Netherlands Soil Survey Institute merged with the Institute for Land and Water Management Research, the Department of the Environment of the Institute for Pesticide Research, and the Department of Landscape Planning of the Research Institute for Forestry and Landscape Planning, to form the new Winand Staring Centre for Integrated Land, Soil, and Water Research.

Contents

1 Background, Area, and Subject of This Study

Over the last decades, the total agricultural production in West Africa has increased quite reasonably. In a large number of West African countries, however, a rapid growth in population, the prevalence of traditional farming systems, and increasing urban migration have caused per capita agricultural production to increase only slightly, or even to decrease. Domestic production that lags far behind the demand for a number of food crops has resulted in a strong increase in imports of these staples.

These general statements about the agricultural problems in West Africa are particularly valid for the production, consumption, and import of rice. Even though total rice production in West Africa has increased by about 75% over the last fifteen years, rice imports have increased a multiple thereof.

In an attempt to improve agricultural production in Africa, the Food and Agriculture Organization of the United Nations has identified four main problems that have to be addressed if programs for agricultural development are to be successful (FAO 1986):

- In West Africa, there is limited scope for the expansion of rain-fed cultivation. There are only limited reserves of good arable land relative to population growth. Large areas are only marginally suitable or are too dry for rain-fed agricultural production. If grazing and forest land requirements are taken into account, the situation is even more critical;
- Rural labour shortages are a significant constraint. These shortages are the result of the prevalence of traditional cropping systems employing manual labour only, low labour productivity, low rural incomes with subsequent rural-urban migration, low status of agricultural labour and, finally, women, who are responsible for many farming activities like weeding and harvesting, are spending more and more time on non-farming activities like collecting water and fuel;
- Although, in many places in West Africa, enough water is present to irrigate large areas, large-scale irrigation projects are not the solution for increased food production. Even in cases where both the need *and* the potential exist, irrigation may not be viable, financially. Modern irrigation development in Africa, with full water control, tends to cost two to three times as much as in India. With such costs, it is impossible to irrigate staple food crops and earn a satisfactory return on capital;
- Finally, it has been proposed that the 'green revolution' technology could be readily transferred to Africa. This is generally not correct. New varieties of rice and wheat that formed the basis of the green revolution in Asia yield well only if reliable rainfall or irrigation provide sufficient moisture. Large areas of West Africa suffer from highly unreliable rainfall while irrigation, as stated above, is generally too costly for staple food production.

In view of these considerations, inland valleys, which occur so abundantly in West Africa's undulating landscape, appear to have a high potential for the development of rice-based smallholder farming systems at village scale, without major inputs. Their favourable production potential, for rice, is mainly due to the specific hydrological

conditions prevailing in the valley bottoms where (ground)water is at or near the surface during most of the year or seasonally, depending on the climatological zone. In the transition between these valley bottoms and the adjacent uplands, lateral inflow of groundwater from the higher parts of the landscape effectively prolongs the growing period for crops.

Inland valleys are defined here as the upper parts of river drainage systems. Although, naturally, any valley occurs 'in-land', and the term inland valley implies a pleonasm, the name inland valley has been adopted in this study because of its widespread use in (anglophone) West Africa. It refers to the valleys, inland in respect to the main rivers and main tributaries, where river alluvial sedimentation processes are absent or imminent only: they do not yet have any distinct floodplain and levee system. In francophone West Africa, inland valleys are best known as *bassins versants*.

The concept of inland valleys as used in this study comprises the toposequence, or continuum, from the uplands to the valley bottom. A continuum is in itself a landscape concept describing an environment in which a diversity of ecosystems occur. The upland/inland swamp continuum refers to a sequence of land types and associated ecosystems located along the slopes of the local topography. The ecosystems vary from upland in the highest parts, through hydromorphic conditions lower down the slopes, to swampy in the valley bottoms. Soil and water key-parameters, determining the potential for (rice) cultivation, are closely related to the location on the toposequence.

Based on differences in morphology and flooding regime, two types of inland valleys can be distinguished:

- **Stream inland valleys,** which are defined here as the uppermost parts of the natural drainage systems. They have a centrally-located stream which is shallow and only up to a few metres wide, or it does not exist at all. Flooding of stream inland valleys is mainly the result of the accumulation of surface runoff and groundwater flow from the adjacent uplands and from rainfall (inflow flooding regime);
- **River inland valleys** are situated downstream of the stream inland valleys. They are wider, have a larger, and more distinct, water course and there is some floodplain development. The main source of flooding water is the river itself, overflowing its banks (overflow flooding regime).

This study is an inventory of the physical, biotic, agronomic, and socio-economic aspects of inland valleys in West Africa, and is aimed at their agro-ecological characterization for rice cultivation. As such, the present publication is an update of the inventory report of the Wetland Utilization Research Project/WURP (Hekstra et al. 1983).

Geographically, the WURP Report covered the area of West Africa with a growing period of 165 days or more. For this update, the inventory area was expanded to include the zone with a growing period of 90 days or more. It therefore now covers the (humid) Equatorial Forest Zone, the (semi-humid) Guinea Savanna Zone, and the (semi-arid) Sudan Savanna Zone. The extent of the inventory area is about 3.14 million km^2, and the following countries, or parts thereof, are covered: Senegal, The Gambia, Guinea Bissau, Guinea, Mali, Sierra Leone, Liberia, Ivory Coast, Burkina Faso, Ghana, Togo, Benin, Nigeria, Niger, and Cameroon (Figure 1.1).

In the inventory area, the diversity and complexity of (agro-)ecological systems is large. In view of the failure of green-revolution technology in Africa, an accurate char-

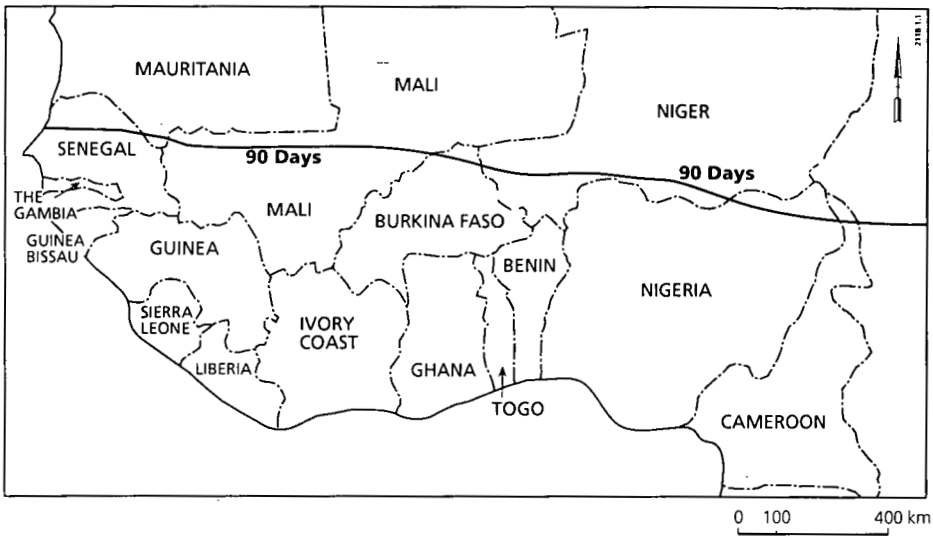

Figure 1.1 The inventory area, south of the 90-day growing period isoline in West Africa.

acterization of West Africa's rice-growing agro-ecosystems is necessary for the efficient planning and targetting of rice research in the region. In the long term, research thus directed should effectively help to increase the productivity of rice cropping systems in West Africa, and ultimately to obtain self-sufficiency.

In this book, the various environmental characteristics that determine the rice-growing environments in West Africa are described. Based on ecological, agronomic, and socio-economic data from secondary sources, this involves a description and grouping, in general, for the whole inventory area. Wherever additional data were available, more detailed descriptions of the inland valleys are given.

Chapter 2 outlines the physical environment of West Africa in terms of its climate and agro-ecological zones, geology and geomorphology, hydrology and drainage, and soils. Four major land regions are distinguished in the inventory area and these have been further differentiated into 27 sub-regions. Within the land regions, 3 major categories of wetlands occur, including the inland valleys. Their morphology, hydrology, and soils are described in specific sub-chapters. The physical characteristics are also shown in the Annexes 1, 2, 3 and 4.

Chapter 3 deals with the ecology of the inventory area. Here, the main characteristics of the forest and savanna ecology and their types of vegetation are described, as well as the uses of, and interventions in, the ecological systems of the inland valleys. Little specific information was found, however, about the ecology of inland valleys in West Africa.

For a long time, inland valleys were disregarded for agricultural uses, one reason for this being the prevalence of water-borne diseases. Chapter 4 discusses the main water-borne diseases of West Africa (malaria, bilharzia, sleeping sickness, river blindness, and guinea worm). Special attention is given to the possible impact of the cultivation of inland valleys on the distribution of these diseases.

Chapter 5 describes various farming systems, defined by the length of the fallow

period and input levels of technical innovations, capital, and labour. It then discusses the different rice-cropping systems (pluvial, phreatic, and fluxial) along the toposequence of the inland valleys.

Demographic and socio-economic aspects of rice production in West Africa are the subject of Chapter 6. Population growth and its density and distribution are discussed as well as the production levels of rice, the imports, and the consumption. (National) self-sufficiency rates are calculated and assesments are made of investment costs and net returns at farm and national level.

Chapter 7 describes the main constraints to rice production in inland valleys and makes some recommendations on fertilizer use and water management in the valleys. This chapter also provides an overview of a number of existing valley-suitability classification systems. A general description of rice-growing environments in West Africa completes this chapter.

Chapter 8 comprises a summary of the information in the preceeding chapters. Additionally, this chapter contains an inventory of the actual state of rice research in West Africa, while also making some recommendations for further research.