Lowland development in Mali

In the Sudanian area of western Africa, the agricultural potential of flood basins can be very high. Local inhabitants and researchers are combining their efforts to develop this potential in the lesser lowlands of southern Mali.

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The Sikasso region in southern Mali, representing 10% of the country's area, is home to more than 30% of its 8 million inhabitants (Fig. 1). The climate of the region is Sudano-Sahelian in the north and Sudano-Guinean in the south. It plays a vital role in Mali's production of several rainfed crops: 100% for cotton, 63% for maize and 37% for millet and sorghum. Encouraged by the Compagnie malienne pour le développement des textiles (CMDT), farmers have, for the most part, adopted draft animals for crop cultivation.

Lowland development

The flood basins, primarily lowlands and small plains, have not benefitted from the development projects that focus on cotton cropping. They make up nearly 5% of the total area of southern Mali, about a fifth of which is under cultivation (Table 1). With limited rainfall, these flood basins, where rain and groundwater runoff converge, are potential sites for secure and diversified farming.

Figure 1. Position of Mali's Sikasso region and the catchment basin of the Kobani.

Table 1. Southern Mali's flood basins: area and utilization (in km^2).

	Total area	Cultivated area
Region	122 724	28 206
Flood basins	5 325	973
Lowlands	740	199

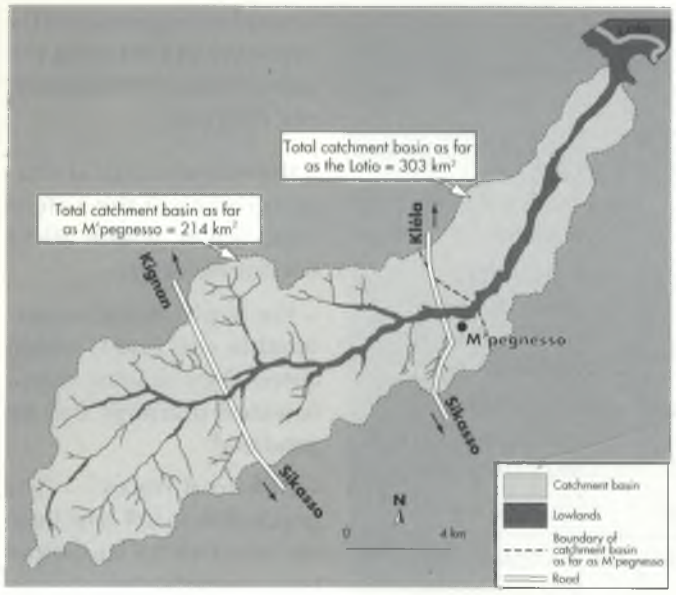


Figure 2. Catchment basin of the Kobani and M'pegnesso lowlands.

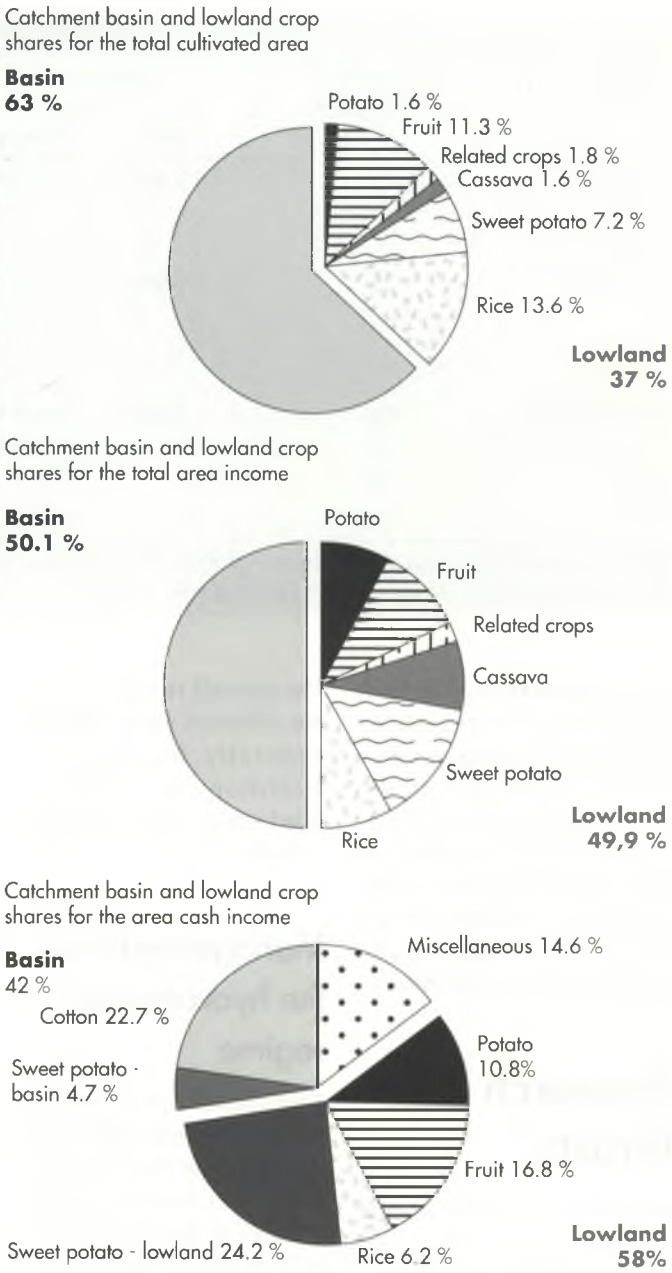


Figure 3. M'pegnesso area in 1993. Distribution of land types and crop revenues.

An important source of income

The importance of lowlands in the region's production systems is often underestimated: only rice growing is counted in agricultural statistics. Rice is primarily cultivated by women which provides extra income and meets the family's needs for rice. Rice, however, is only offered to guests and eaten on festive occasions, and in this region rice growing therefore has a limited role in farm operations. In contrast, fruit cropping, market gardening and tuber production (sweet potato, cassava, potato), all of which take place in the lowlands and surrounding areas, are very important to regional production. They account for a large part of the rest of the country's supplies of these staples and also exports to Côte d'Ivoire are being developed.

Lowland village fields can be as important as lands above flood level. Such is the case, for instance, in the village of M'pegnesso, 20 km north of the regional capital Sikasso (Figs. 2 & 3). Lowlands make up 37% of the village's cultivated area. They contribute 50% of the area's net income and almost 70% of its cash income. Rice growing accounts for 38% of lowland farming and produces 16% of farmers' net income.

Actions taken

During the 1970s and 1980s, actions and development projects in the flood basins sought to encourage intensive rice growing on the floodplains. However, rarely more than half of the planned capacity of these projects to be in actual use. This low success rate is most often blamed on the projects' unsuitability to the socioeconomic environment, the fact that they were exclusively designed for rice growing, and an insufficient knowledge on the physical characteristics of the sites, in particular soil permeability.

More recently, since the 1980s research and development efforts have focused on projects to improve the way small lowland plots are farmed. This had been one of the main planning concerns voiced by the villagers themselves. The idea behind these projects has been to involve farmers more closely in flood basin development and to induce them to speculate on something other than rice, and to further investigate the hydrological and agricultural features of the area. In the field, the result has been that non-governmental organizations (NGOs) and the Malian government have carried out many projects with the assistance of the specialized services of CMDT (Table 2).

Table 2. Sikasso region development projects: background and outlook.

Period	Number of projects	Area involved (ha) Total	Average	Sponsor
pre-1983	27	15 800	585	CMDT/EDF local development committees
1983 - 1992	45	1 500	33	CMDT/IBRD various NGOs; CMDT with Dutch cooperation
1993 - 1997	100	1 800	about 18	CMDT/ADB
	12		about 10	Rural engineering/ADB
	50		about 5	CMDT/World Bank
	20		about 5	Various NGOs

EDF: European Development Fund; IBRD: International Bank for Reconstruction and Development. ADB: African Development Bank.

These projects have all built up a fund of experiences that should now be pooled. Moreover, because of the uncertain economic climate farmers are in need of new solutions that can be rapidly implemented. Research is seeking to fulfil both of these expectations.

Research thrusts

Action is required at several levels in order to implement these projects.

At the regional level there is a need for consistency between actions undertaken in the field in response to one-time village requests. At the local level, the project must be suited to the constraints and advantages of the farms concerned. For this purpose, a rapid analysis of the physical, social and economic factors is carried out. A technical lowlands development project is then designed (management and farming systems). Progress is monitored and assessed in relation to the economic and social environment.

The overall results vary for the different sites, but they generally focus on the hydrological regime of lowlands and cropping systems.

Management and the hydrological regime

The important feature of lowland soils of the Sikasso region is that they are extremely permeable: water sinks in at the rate of 35-75 millimeters per day, as compared to 3-20 mm in a typical rice paddy. Hence, when there is no groundwater as much as sixfold the maximum evapotranspiration may be required in order to keep a layer of water on the rice crop.

Accordingly, groundwater fluctuations must be regulated if lowland water management is to be improved. It is mainly because this principle was ignored that there were difficulties with floodplain projects (diversion dams, rudimentary irrigation networks) carried out in southern Mali during the 1970s. Conversely, the success of half-sunk dams in managing small lowland plots like those of Kambo (Fig. 4) can in a large measure be explained by the attention paid to groundwater circulation.

Three factors are directly involved in choosing the water management approach and dam size:

– the morphological characteristics of the catchment basin, which affect flood forecasting;

– the depth of the impermeable soil layer, which determines to what extent lowland drainage can be regulated;

– deferred flows — it is impossible to tell how large an area can be supported by groundwater outside flood periods, or for how long, unless these are known.

These factors can be taken into account in simulation models, and the effects of lowland development under variable rainfall conditions can now be forecast.

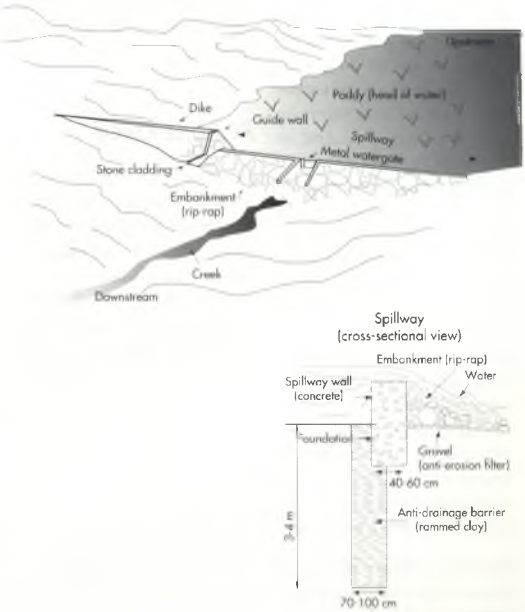


Figure 4. Half-sunk microdam.

Many management possibilities

In southern Mali, three kinds of water management projects have been built:

– Weirs in the mean-water bed. These weirs are constructed in compact lowland areas but serve a relatively large area, generally more than 200 ha.

– Weirs with hydro-agricultural areas. The idea is to absorb floodwaters and ensure even submersion of downstream plots (Fig. 5). This type of weir has proved effective especially for year-round watercourses, as dry-season crops also benefit from irrigation.

– Half-sunk microdams constructed in the high-water bed (Fig. 4). These dams, which are smaller and do not involve any change in rice growers' farming techniques, serve to regulate water flow in various parts of the lowlands during the rainy season. The secure water supply this affords allows more intense rice cropping in the flooded areas and also helps sweet potato, groundwater-fed rice and maize production in areas dependent on groundwater. At the outset of the dry season, these dams slow the fall of the water table and make it possible to grow certain out-of-season crops (market gardening, potato) as well as fruit (banana, papaya and pineapple).

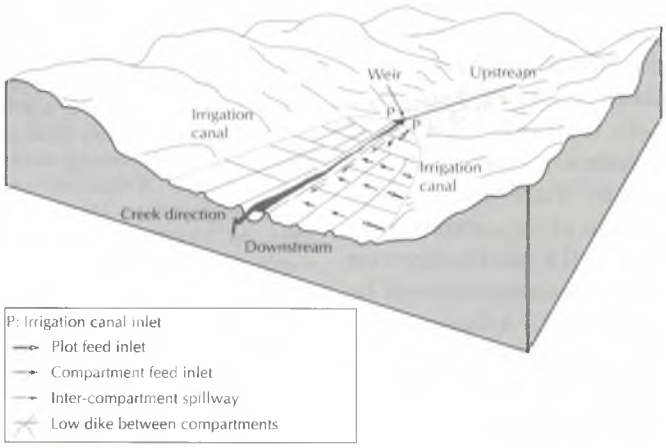


Figure 5. Weir development with a hydro-agricultural area.

Farming system improvements

During the rainy season, farmers use the medium- and low-elevation zones of the lowlands, which are subject to flooding, for rice growing; yields are around 1 t/ha when manual weeding is carefully done. The higher ground, rarely flooded but with groundwater near the surface, is used for tubers and fruit orchards. Very little rice is grown there for lack of suitable varieties.

During the dry season, market gardening and potato growing are carried out in low-lying areas, while groundwater is still sufficient for manual irrigation from wells. Production is influenced by the level of the water table, which determines how long irrigation can be carried on; it may therefore be irregular.

Experiments conducted over more than five years at several sites in the Sikasso region (Kléla, Bamadougou) have shown that techniques are available for improving rice-growing productivity without necessarily building hydro-agricultural structures.

Productivitiy of traditional rice paddies can be increased by 40-50% using relatively simple techniques: improved varieties, better soil preparation. Appropriate manuring, in addition to these other techniques, can double yields.

Early weed control is crucial for rice production. Under the traditional broadcast sowing method, about 60 days of work per hectare was required, but this can be cut in half by furrow sowing and using a small multi-row planter, which makes manual weeding easier.

There can also be substantial savings by using a 3-year schedule of fertilization with natural phosphate produced in northern Mali.

At higher elevations, the use of new rice varieties, intermediate between aquatic types and true rainfed rice, promises production equal to that of rice grown on floodplains. Moreover, crops can be diversified when maize and groundnuts are introduced.

Table 3. Profitability of various crops. 1992 growing season, Kléla site.

	Yields (kg/ha)	Margin (CFA francs)	Working time (days)	Pay per working day (CFA francs)
Rainfed crops				
Cotton	1 800	95 225	99	962
Sorghum	1 200	35 420	45	787
Maize	2 000	63 335	60	1 055
Lowland crops				
Flood rice	3 000	141 120	93	1 517
Groundwater rice	2 750	109 850	75	1 465
Groundwater maize	2 000	40 700	35	1 163

There are also good prospects for improvement in potato growing. Alhough average yields are now around 16 t/ha, yields of as much as 35 t/ha have been obtained.

Hence, without any development, but only a few innovations done in cooperation with farmers, lowland crops can become competitive with cotton, the main cash crop in the region (Table 3). Some of the techniques recommended are actually being applied by producers on experimental sites and, outside these sites, being prepared for wider dissemination by CMDT.

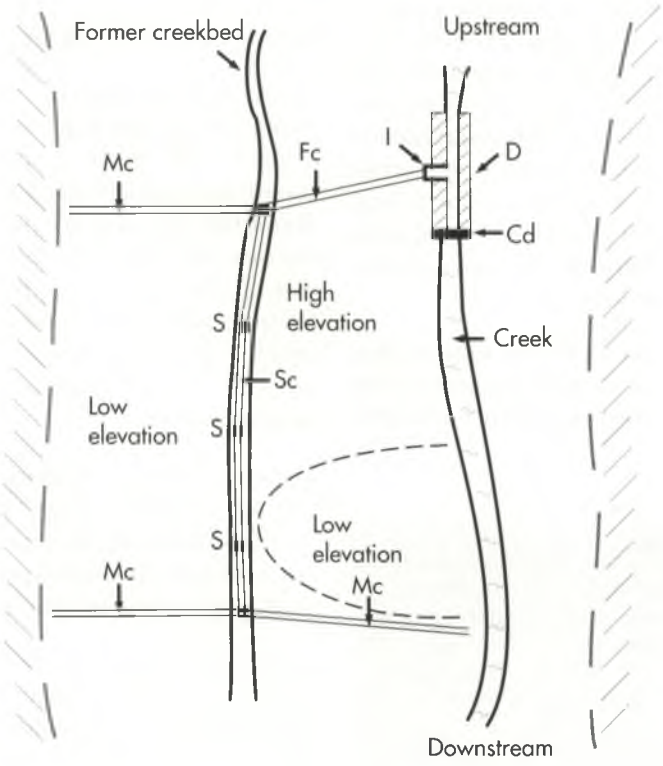
However, much progress is still required in lowland agriculture: there is no ready-made answer to its very diverse physical and social situations. Research is therefore continuing.

A new concept

A new concept for agricultural management and development of the lowlands has emerged from knowledge acquired on the various study sites: an attempt is made to accentuate the natural hydrological features of the various lowland zones.

In a simple new arrangement being implemented in the Kobani lowland (on M'pegnesso village land), water is diverted by means of a weir and check dam into a network of recycling canals. The filtering soil layers are very deep and the half-sunk dams already common elsewhere cannot be used here. Groundwater fluctuations are regulated by recycling so as to safeguard and increase the production potential of downstream crops. The development, which in all will cost 7 million CFA francs, is being financed by the villagers, who are supplying the labour and have undertaken to finance and maintain it thanks to a local investment fund underwritten by the French Fonds d'aide et de coopération (FAC). The per-hectare cost of the development will be 280 000 CFA francs. This model may be progressively extended to the whole of the Kobani lowland, some 30 km in length.

This experience is of interest to the CMDT for the possible future development of some twenty lowland areas by the African Development Bank.



Cd check dam., I: inlet, D: dike, Fc: feed canal, Sc: seepage canal, Mc: maintenance canal, S: spillway

Figure 6. Plan of the experimental development at M'pegnesso. Total area 25 ha, 10 at high elevation, 15 at low.

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Who is involved

This research project, on the development of village land in southern Mali with a lowland component, is being carried out jointly by the Institut d'économie rurale du Mali, CIRAD and the Compagnie malienne pour le développement des textiles (CMDT). ORSTOM and the Université des Sciences et Techniques du Languedoc (Montpellier, France) are also involved.

The study of southern Malian lowlands was begun in 1985 and is continuing with the current project, which has been receiving funding since early 1993 from the French Fonds d'aide et de coopération as part of the 'Mali-Sud' programme.

Abstract... Resumen... Résumé

N. AHMADI, F. BLANCHET, M. SIMPARA, B. TRAORE – **Development of lowlands in Mali.**

In areas with limited rainfall, lowlands (flood basins) where run-off waters converge are economically important agricultural zones. Lowlands account for 5% of the surface area in southern Mali and only 1/5 of this is cultivated. It is essential that improvement projects on agricultural water management and cropping systems involve interventions at many levels (e.g. regional and local) and take the physical and social diversity into account. Water management decisions should be guided by three factors: the morphometric features of the watershed (quantitative flood forecasting), the thickness of the impermeable soil layer (possibility of controlling water levels when the ground is highly porous), and delayed run-off (soils with agricultural potential). In the M'pegnesso lowland (Sikasso region), rice cropping has been intensified in low areas using improved varieties, better tillage and suitable fertilization. In highland areas, hybrids of pure rainfed and wetland rice varieties produce the same yields as in flood areas. Maize, groundnut and potato could be grown as companion crops to improve agricultural diversity. Lowland crops could thus become as profitable as cotton crop.

Key words: soil, cropping system, rice growing, lowland, management, diversification, Mali.

N. AHMADI, F. BLANCHET, M. SIMPARA, B. TRAORE – **La valorización de las hondonadas en Mali.**

En un contexto de pluviosidad limitada, las hondonadas (tierras inundadas) donde convergen los flugos de aguas constituyen zonas de agricultura económicamente importantes. Dichas zonas representan el 5% de la superficie del sur del Mali, la quinta parte de la cual es cultivada. Los proyectos de mejora de la gestión del agua y de los sistemas de cultivo deben conciliar varias categorías de intervención – la región y el terruño – y tomar en cuenta la diversidad de las situaciones físicas y sociales. En la selección de los dispositivos de gestión del agua intervienen tres factores: las características morfométricas de la cuenca vertiente (previsión cuantitativa de las crecidas), la profundidad de la capa de suelo impermeable (posibilidades de regulación del nivel de agua cuando los suelos son muy filtrantes), los flujos diferidos (superficies valorizables potencialmente). En la hondonada de M'pegnesso (región de Sikasso), el cultivo de arroz es intensificado en las zonas bajas con variedades mejoradas, una mejor preparación del suelo y una fertilización adaptada. En zonas altas, las variedades de arroz intermedias entre los tipos acuático y pluvial estricto son tan productivas como en las zonas inundadas. El maíz, el cacahuete y la patata son producciones interesantes para diversificar los cultivos. Los cultivos de hondonada pueden ser tan rentables como el algodón.

Palabras clave: suelo, sistema de cultivo, cultivo de arroz, hondonada, ordenación, diversificación, Malí.

N. AHMADI, F. BLANCHET, M. SIMPARA, B. TRAORE – **La mise en valeur des bas-fonds au Mali.**

Dans un contexte de pluviosité limitée, les bas-fonds (terres inondables) où convergent les écoulements d'eaux constituent des zones d'agriculture économiquement importantes. Ces zones représentent 5 % de la surface du sud du Mali, 1/5 est mis en culture. Les projets d'amélioration de la gestion de l'eau et des systèmes de culture doivent concilier plusieurs niveaux d'intervention, la région et le terroir, et tenir compte de la diversité des situations physiques et sociales. Trois facteurs interviennent dans le choix des dispositifs de gestion de l'eau : les caractéristiques morphométriques du bassin versant (prévision quantitative des crues), la profondeur de la couche de sol imperméable (possibilités de régulation du niveau d'eau lorsque les sols sont très filtrants), les écoulements différés (surfaces potentiellement valorisables). Dans le bas-fond de M'pegnesso (région de Sikasso), la riziculture est intensifiée dans les zones basses avec des variétés améliorées, une meilleure préparation du sol, une fertilisation adaptée. En zones hautes, des variétés de riz intermédiaires entre les types aquatique et pluvial strict sont aussi productives que dans les zones inondées. Le maïs, l'arachide et la pomme de terre sont des productions intéressantes pour diversifier les cultures. Les cultures de bas-fond peuvent être aussi rentables que le cotonnier.

Mots-clés : sol, système de culture, riziculture, bas-fond, aménagement, diversification, Mali.