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**Contribution of Inland Valleys Intensification to Sustainable Rice/vegetable Value Chain Development in Benin and Mali: *Constraints, opportunities and profitable cropping systems***

By

Adetonah, S.; Coulibaly, O.; Sessou, E.; Padonou, S.;  
Dembele, U.; and Adekambli, S.

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# **Contribution of Inland Valleys Intensification to Sustainable Rice/vegetable Value Chain Development in Benin and Mali: *Constraints, opportunities and profitable cropping systems***

S. Adetonah,<sup>1</sup> O. Coulibaly,<sup>1</sup> E. Sessou,<sup>1</sup> S. Padonou<sup>1</sup>, U. Dembele<sup>3</sup>, S. Adekambli<sup>2</sup>

<sup>1</sup> *Institut International d'Agriculture Tropical Cotonou, Benin;*

<sup>2</sup> *Institut National des Recherches Agricoles du Bénin Programme Analyse de la Politique Agricole B.P. 128 Porto-Novo*

<sup>3</sup> *Institut d'Economie Rurale, Sikasso, Mali*

Intensifying inland valley systems will require the promotion of high value commodity chain system involving rice and vegetable with increased productivity and low per unit cost of production and natural resources. The objective aim to identify the current production systems assesses their constraints and analyzes the profitability of best bet rice and vegetable cropping systems under different levels of input use and access to market. A total of 235 producers selected in Benin and Mali according to input use and access to product market. The value chain approach used to analyze the performance associated with productivity. The results show that four main chain stakeholders operate in the inland valley: producers, processors, trader and consumers. This study specifically focuses on producers and major constraints reported by this group are attacks of the insects and birds, the poor access to products markets and the unavailability of key inputs (seeds, pesticides, small equipment,) in both countries. Other constraints are high costs of transport, post-harvest losses and poor conservation of fresh vegetables and tubers.

The most profitable systems in the inland valley are the ones based on rice and vegetable (Gboma: *Solanum* sp) using improved seeds, follow-up of the system containing rice and "gboma" using improved varieties of rice like NERICA associated with chemical fertilizers and herbicides. Rice associated with improved varieties of potato and mineral fertilizers is more profitable in Mali. Rice as sole crop is not profitable in both countries. Women are more involved in the sole cropping of rice in Mali.

**Keywords:** Promotion, Value chains, Rice/Vegetable, Benin, Mali

## **1. Background and justification**

The food and nutrition insecurity and rural poverty are increasing and exacerbated by the depletion of soil fertility due to degradation of natural resources in Africa south of Sahara. In this context, the development of lowland intensification through increased productivity and diversification of systems based on rice and vegetable crops contributes to food security and nutrition and the substantial increase in farm income and non-farm income. The previous studies show that Mali and Benin have potential available arable land in the lowlands up to 205,000 ha and 300,000 ha respectively. In Benin since the 90s, the degradation of rainfed land and population pressure have stimulated a movement of diversification and intensification of the lowlands. The rice and vegetable cultivation are attractive alternative options for small producers. In the famrest strategy, these two value chain are integrated and complementary use of lowland climate to changing circumstances and market signals (FAFA, 2009). In Southern Mali, the lowlands provide over 11% of national paddy production, the majority of fruit crops (mango, citrus, bananas), vegetables and tubers (sweet potato and cassava) and almost all of the approximately 50,000 tons of potatoes. During the dry season, herds, more and more, use the land as lowland pasture and watering points (Dacko et al., 2006). Research shows that 16% and 6% of available land is cultivated in Benin and Mali, respectively (Dacko et al., 2006 and AHS 2006). In Mali, the lowlands provide over 11% of national production of paddy rice, almost all the 50,000 tons of potatoes produced per year. Majority of fruit crops (mango, citrus, bananas), vegetables and tubers (sweet potato and cassava) also produce the Southern Mali. During the dry season, herds increasing use of the land as lowland pasture and watering points (Ahmadi et al., 1996). The rice and vegetable cultivation in lowlands are activities that generate income for farmers and particularly women in urban and rural areas in southern Mali. The promotion of sectors based on crops with high potential for sustained productivity and factors of production to low cost and natural resource production will require an upgrading of slums in Benin and Mali. The project Implementation of the agricultural potential of the lowland areas (RAP) of Africa Rica Rice Centre in partnership with the International Institute of Tropical Agriculture (IITA-Benin) have a vision to promote the value chain of rice and vegetable crops while protecting the

environment to facilitate market access for small producers and the improvement of the incomes of lowland in Benin and Mali.

## **2. Objectives**

The overall objective is to promote value chains based cropping systems more profitable with a low environmental cost Southern Benin and Mali.

Specifically this study aims to:

- Identify and categorize the different actors involved in value chain for rice and vegetable crop
- Identify dominant cropping systems rice
- Identify the constraints and opportunities linked to the intensification of systems and promotion of value chain
- Evaluate the financial profitability of cropping system and promoting the most profitable value chain

### 3. Literature review

3.1. Concept of value chain. The value chain concept is introduced by Michael Porter in his book. The value chain can break down the activity of the company into a sequence of elementary operations and identify potential sources of competitive advantage. According to Gervais (1995), the value is the amount that customers are willing to pay for the product that is offered. It resulted from different activities performed by suppliers, the firm and distribution networks. According to Sonja Vermeulen et al (2007), the value chain includes all activities undertaken by transforming raw materials into semi-finished or finished goods for sale or consumption. Value Chain describes all the activities required to bring a product or service from conception through production stages (involving a succession of physical and uses of various services), distribution to final consumers and its destruction after use. The overall performance of the value chain can be enhanced both by strengthening each link and by strengthening the connections between the links.

#### 3.2. Concept of value added

The value added is a concept of economy that can measure the value created by an economic actor. It is equivalent to the total value generated by the operators in the chain. According to McCormick and Schmitz (2001), value added per unit of product is the difference between the sale price obtained by a trader in the chain of value and the total expenses incurred to procure goods and services it transforms. This "value that is added to a property or service at each stage of production or distribution"

The analysis of economic phenomena is based on a division into periods of time (usually years), can distinguish goods and services that are:

- Factors of production that are fully processed (consumed) during a period: what are the inputs;
- Factors of production are only partially used (spent) during a period, the total degradation of the production process occurring over several periods, it is investment.

If  $C_i$  is the value of intermediate consumption and  $P$  value of the product, so the difference  $P - C_i$  represent the value that the agent was added to the initial value of the destroyed (intermediate consumption) through the production process / processing during an accounting period.

The value added of the whole industry is:

Value Added = Output sector of the industry - Intermediate Consumption of the industry

Or additivity values added by the algebraic sum of value added produced by each agent in the

industry:

$\Sigma$ Value Added of the sector = Value Proposition Agents in the sector.

### 3.3. Definition of lowland

The lowland areas are generally low compared to surrounding areas and periodically flooded. They are the characteristic features of the landscape of West African Sudanian and Sudano Sahelian on crystalline basement. These drained areas of water, have deposits of elements from erosion by rain and soil are generally deeper, richer and more humid. The lowlands have drawbacks including traditional dry crops: risk of flooding and heavy soils. However, some crops grown on mounds and ridges meet to keep the plant areas dewatered. Market gardening is practiced in some lowland as dry season culture after the floodwaters recede (BEN/84/012 Project, 1990).

The lowlands island are flat lowlands or axis of a concave flow which is temporarily flooded during a time of year and where there are waterlogged, and drain a catchment area which is less than 75 km<sup>2</sup> According to (Cell Lower Depths, 2002), the culture is fed by rain water either directly or through surface runoff. There are two types of lowland ie lowlands developed and undeveloped lowlands.

In the different depths, producers and producers engaged in the growing rice and / or vegetable crops alternately in the rainy season and dry season. Thus, in addition to rice cultivation practiced in some lowlands in the rainy season, some growers and producers are rotated by vegetables (especially leafy local) during the dry seasons. Similarly, some lowlands have only the rice in the rainy season or dry season, vegetable crops.

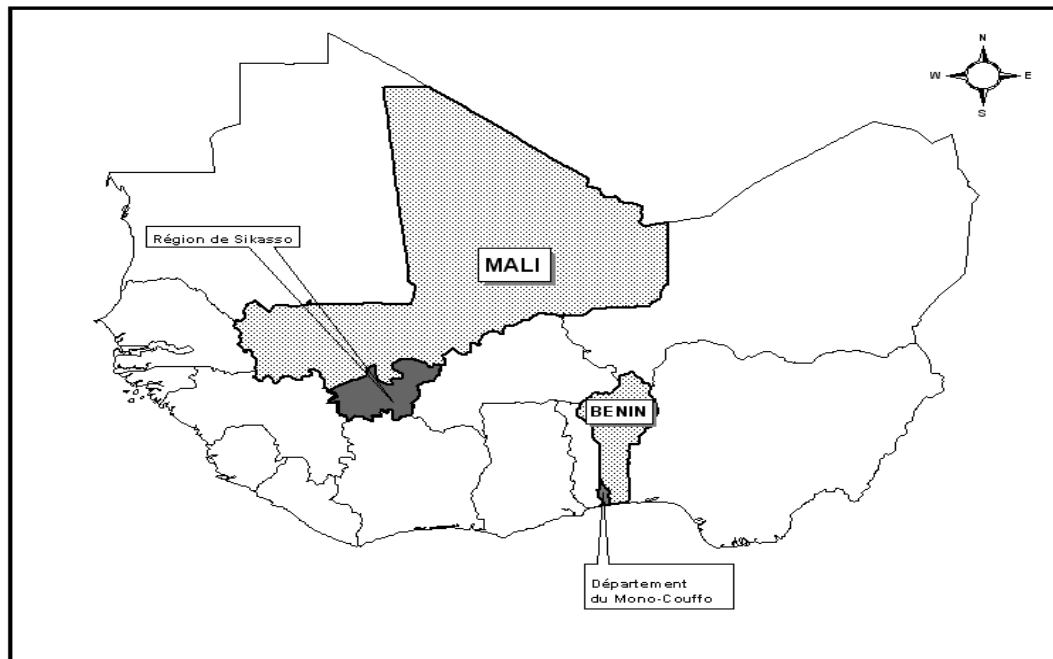
## **4. Methodology**

### **4.1. Study area**

This study was carried out in Benin and Mali where the lowlands are a significant potential for intensification and diversification of crops (rice, cotton, vegetables and fish). Benin is a country in West Africa covering an area of 763 km<sup>2</sup> de114 and subdivided into 12 departments including Mono and Couffo up the surroundings study in Benin. The departments of Mono and Couffo are located southwest of the Republic of Benin and cover an area of 4,110 km

<sup>2</sup> 3.5% of national territory including 2250km<sup>2</sup> and 1860km<sup>2</sup> Couffo for Mono (GPHC, 2002). Mali is a country in West Africa covering an area of 1,241,238 km<sup>2</sup> and is divided into regions; one located in Sikasso in the south of the country spread over 71,790 square kilometers. The common Doumanaba and Zangaradougou were chosen in the circle of Sikasso. The first products come from the great rain season while during the small rain season, off-season crops are produced. In Benin, the shallow wells have converted Arles. In Mali, the lowland is the main source of fresh water and income for local populations. The sample sites selected for lowland southern Mali and Benin are examples for an analysis of the potential for intensification and diversification of production systems in promoting agricultural value chains.

Figure 1: Map of Lowlands island in Southern Benin and Mali



#### 4.2. Sampling and Data analysis

The sample of actors is composed of four (4) categories: producers, processors of rice, traders and consumers of products from inland valleys to southern Benin and Mali. The study sample consists of a total of 220 producers including 50 per cent female, 17 processors, 37 traders and 134 consumers in Benin and Mali (Table 1).

Table 1: Sample of actors in the lowland island in Southern Bénin and Mali



Countries	Producers N=220	Processors N=17	Traders N=37	Consumers N=134
Benin	107	1	18	63
Mali	113	16	19	71

Source: Survey from Benin and Mali (2009)

The approach of the value chain is used to analyze and improve the potential for creating value added at each segment of the chain-based production systems of rice, potatoes and vegetables to increase the contribution of networks in improving food security and nutrition and reducing poverty from the income created while preserving natural resources. The chain is composed mainly of indirect actors (research, extension, seed certification) that contribute to effective and efficient supply chain through innovation and capacity building of all stakeholders at all levels. The direct stakeholders are the most important links in the chain they ensure the operation by ties of input supply, production, processing, storage / retention and marketing. The functionality of the chain and its effectiveness depends on consistency and low cost of transactions between actors. The chain governance is important and defines the roles of each actor, the quality control of products (inputs, outputs) and services (public and private) and ensure equity in access to factors of production and income. Governance contributes to the lower level of negative externalities (pollution of water, soil and air). The performance of the chain is evaluated through indicators such as effectiveness, efficiency, gender and equity and sustainability.

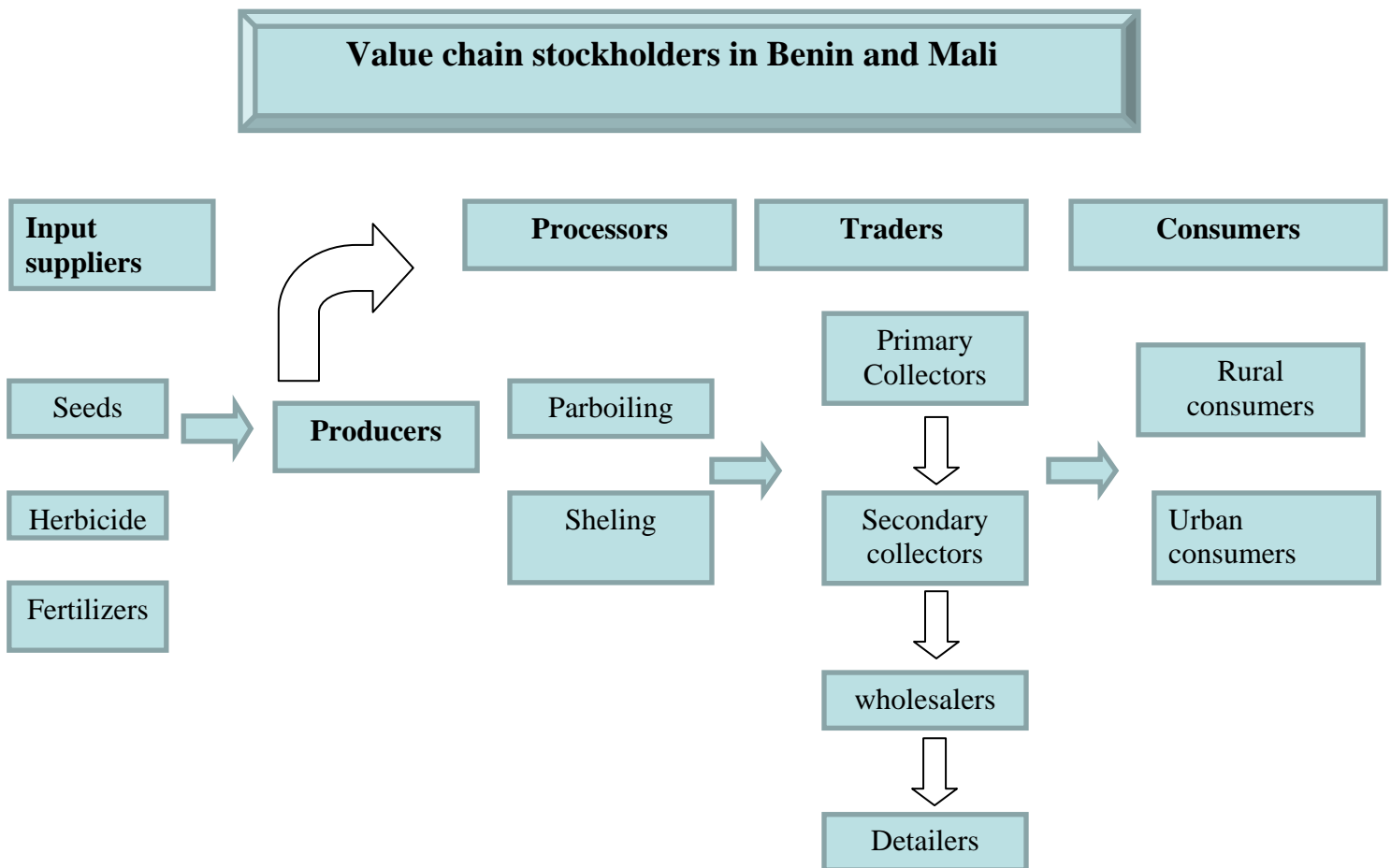
## 5. Results and Discussions

### 5.1. Presentation of the actors of production in the lowlands in Benin and Mali

Results showed that 05 actors a direct role in the value chain. There are suppliers inputs (seeds, pesticides, and fertilizers), producers, processors, traders and consumers. The main producers are rice farmers, producers of potato, vegetable farmers, fishermen, farmers and growers in both countries. Apart from fishing, farming and arboriculture mainly performed by men, others activities are practiced by both men, women, older than the young people in Mali (Sidibe, 2008). The number of traders in the production systems of the lowland is still low in both countries

showing the role of the private sector and limit the need for its reinforcement in the promotion of value chains through intensification. As consumers, they represent a large portion of our sample (63 and 71) in Benin and Mali, respectively. (Table1).

**Graph 1:** Value chains actors in lowland island in Benin and Mali



### 5.1.1. Suppliers inputs

The input supply is poorly organized in both countries. The recommended inputs are substituted by cotton inappropriate which is dangerous for human health and the environment. The supply of improved seeds is low, the seed sector certified rice is very limited, with 16 multipliers and certified seeds of seven community banks in the region who cannot meet demand, resulting in a heterogeneous and non-use controlled varieties. Seeds of vegetable crop are not available and very costly for producers.

## 5. 1.2. Producers

### a) Socio-demographic

A slight predominance of men (51%) than women (49%) is observed on all producers surveyed. Women operate over the lowlands in Benin than in Mali (Table 2). Most farmers in the lowlands are indigenous in both countries (94% in Benin and 64% in Mali). The strong presence of indigenous (85%) in the lowlands in Mali is due to the concept of solidarity and cultural factor within community. Everyone living in the village has a right to use land and lowland

Tableau 2: Caractéristiques sociodémographiques des producteurs des bas-fonds

<i>Socio-demographics</i>		<i>Benin</i>	<i>Mali</i>
		<i>N=107</i>	<i>N=113</i>
Sex	Men	46%	56%
	Women	54%	44%
Average age		42	44
Origin	Autochthons	94%	64%
	Allochtons	6%	36%

Most farmers in Benin are Adja (63%) and Sahouè (37%). In Mali, several ethnic groups coexist in using lowlands. However, Senufo (55%) and Samogo (20%) are the largest and the most important.

### b) Socio-economic characteristics

The level of education and literacy for men is higher than women in both countries (Table 3). The rate of lack of education is higher (50%) in Benin than in Mali (40%). Women do not have access to training.

Table 3: Educational level of lowland farmers in Benin and Mali.

Educational level		Not any	Primary	Secondary	Islamic
		(%)	(%)	(%)	(%)
Benin	<b>Men</b>	<b>23</b>	<b>16</b>	<b>10</b>	0
	<b>Women</b>	<b>50</b>	<b>7</b>	<b>1</b>	0
Mali	<b>Men</b>	<b>33</b>	<b>13</b>	<b>0</b>	17
	<b>Women</b>	40	3	1	6

Source : Surveys from Benin and Mali (2009)

Majority of producers belong to a group or an association of farmers in Benin and Mali. Membership in an association allows producers to benefit from advantages such as access to inputs (seeds, pesticides, herbicides,,), to training, agricultural credit, and market access in both countries. The exorbitant interest rates, the requirement of a guarantee, the repayment terms are not adapted to the context of production and the relatively small amount to cover investment needs. Are the four main constraints identified for the acquisition producer Credits.

Table 4: Status of access to agricultural credit and groups producers

Socio-economic characteristics		Benin	Mali
		%	%
Groups producers	Yes	99	72
	No	1	28
Access to credit	Access	74	40
	No access	26	60

Source: Surveys from Benin and Mali (2009)

The extension agent of Regional Research Center (CERPA, IER) periodically visited to producers in Benin and Mali (Table 4). The themes of monitoring is focused on pest management, use of botanical aqueous extracts of neem for crop protection, traditional methods of processing of paddy rice (parboiling for example) for domestic consumption, conservation

rice, sweet potato and potato in Mali. The practices for planting rice by producers are learned. Agriculture and trade are the main activities of the majority of farmers.

### 5.1.3. Processors

The processing is small and consists only in shelling or drying of paddy rice in the two countries. The equipment is a mobile sheller and semi-mechanized. The demand is high and shellers is not available on the market supply of the villages along the shoals in these two countries. The vegetables crops are not processed by producers mainly rural women. The processing of rice is practiced by adults women.

### 5.1.4. Traders

Vendors are made up of adults and youth (41 and 26) in Mali and Benin. The majority of traders are women (94% and 63%). in both countries. Women buy the rice or other crops and sell them t off-season to increase income and meet their needs and those of the family (Table 5).

Table 5: Average age of traders in the lowlands in Mali and Benini

Average age	Minimum	Maximum	Mean	Ecart-type
Countries				
Benin	26	60	41	7.7
Mali	32	61	37	7,7

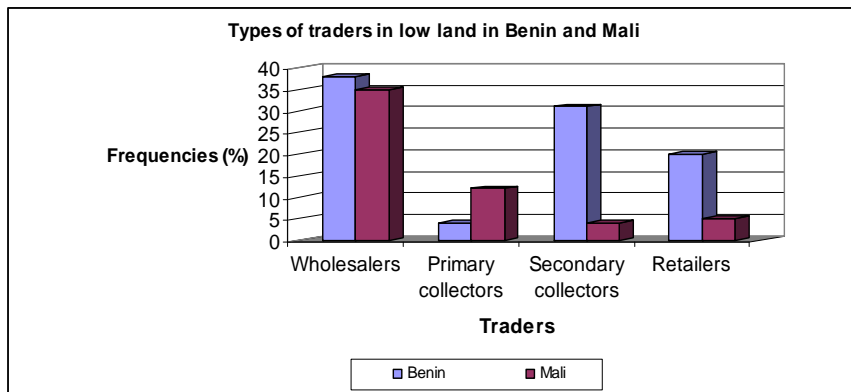
Source : Surveys Benin and Mali, 2009

Four types of traders are identified in the lowlands: wholesalers, retailers, collectors and collectors primary school. The collectors are respectively primary and secondary dealers who buy directly from producers and collectors of the village primary markets are closest to the lowlands. Secondary collectors sell to wholesalers on the markets and they supply the retailers who sell products per kilogram (Figure 2). Contrary to studies conducted by the Department of Producers Union (UDP) (2003) Mono-Couffo (Extension Department covering sites in southern Benin) in other localities, marketing is provided by wholesalers in both countries. After the secondary wholesalers are collectors in Benin and Mali to primary collectors. Traders prefer to buy directly from producers because of low prices (supply exceeds demand at harvest time) and good quality products. The main product markets are lowlands in Benin: The mainly towns are:

Cotonou and Porto Novo (South), Bohicon, Abomey and Parakou (Centre), and Malanville Natitingou (northern Benin).

Rice, crin-crin et la grande morelle squeaking and nightshade *Solanum macrocarpon* large are the products most sold in the lowlands in Benin compared to Mali, where rice, potato, sweet potato and eggplant are products that dominate in the markets. The wholesalers deal directly with individual producers, poorly organized. Transactions are paid on the spot. Producer prices are subjected to large fluctuations from one period to another due to supply, conservation issues and especially the high opportunity cost of liquidity for expenses after harvest. There are the lack of the regulating supply and prices for the producers groups and the storage facilities. Sikasso market is a transit point. The potato collected is transported to the major consumption centers within the country or neighboring countries.

Fig. : Types of traders in lowland in Benin and Mali



#### 5.1.5. Consumers

Consumers are divided into two broad categories in Benin and Mali: urban consumers and rural consumers. Urban consumers are made up of restaurateurs, consumers who purchase individual market. Rural consumers are composed of producers and consumers to consumers in the villages. These results corroborate those of Adegbola et al. in 1996 on the study of the rice sector. Conservators and carriers are also potential customers. Rice and vegetables are much consumed in Mali and Benin. Potato consumption is less because it is expensive and is used during the days of revelry. However, many criticisms are made in relation to the organoleptic characteristics of rice. Consumers are sticky rice and mushy after cooking, smell and the high level of impurities.

Consumers complain the presence of dirt and holes in the leaves in crops

Table 6: Ratings made by consumers on products in the lowlands in Benin and Mali.

<b>Productions</b> <b>Appreciations (%)</b>	<b>Rice</b>		<b>Vegetable</b>	<b>Potato</b>	<b>Sweet</b>
	Benin	Mali	<b>cropping</b>		<b>potato</b>
<b>Very</b>	59	65	84	50	24
<b>Moderately</b>	30	29	14	41	57
<b>Little</b>	11	6	2	9	19

Source: Surveys from Benin and Mali (2009)

## 5.2. Financial profitability of cropping systems in the lowlands in Benin and Mali

Six (6) major systems of production and five (5) systems in Mali were identified respectively in the lowlands in Benin. In Benin, they are:

- Systems of rice in pure culture
- Systems based horsehair mane and rice (first crop dominates the second in area)
- Systems rice-Gboma (Sr-gb)
- Systems rice-bristle hair (Sr-cr)
- Systems based on rice and Gboma (Sri GB), (the area planted to rice cultivation is higher than that "gboma" Solanum macrocarpon) and
- Systems based on rice and crin-crin (Sri (area for rice is higher than crin-crin)

Table 6: Gross and net margins for different types of cropping systems on the sites of Benin

Cropping systems	Gross margins (FCFA/acra)	Net margins (FCFA/ha)
	Moyenne	Moyenne
<b>Monoculture Rice system</b>	132 178	129 144
<b>System based crin-crin and rice</b>	182 287	174 134
<b>System rice-gboma</b>		

SRiGb+VarR am+VarGb local	211 433	206 054
SRiGb+VarR am+VarGb am	642 640	633 995
<b>System based rice and gboma</b>		
SBR+VarR am	209 663	202 290
SBR+NERICA+EngrC+HerbC	617 028	614 295
<b>System based rice and crincrin</b>		
SBR+NERICA+EngrC+HerbC	434 702	431 645
<hr/>		
Statistics F de Fisher (ddl=7)	3,189***	3,191***
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Source; surveys from Benin and Mali (2009)

System based rice and potato, rice system in pure culture, system based rice potato associated with eggplant, the system based on potato and rice and the system of rice and potatoes and sweet potato are the principal systems identified In the lowland in Mali. The monoculture of rice is practiced mainly by women.

The profitability analysis showed that among the identified systems, the system based rice with improved variety of potato over mineral fertilizer (150 kg / ha) followed by rice-based system with chemical herbicides and potato land associated with the sweet potato are the most profitable in the lowlands in Mali and the rice-vegetable crop (Gboma: Solanum sp) use of improved seeds, followed by rice-based system and Gboma using varieties improved NERICA type associated with chemical fertilizers and herbicides for rice are profitable in Benin. The monoculture of rice system with mineral fertilizer and weed is the least profitable (with one negative profitability in one Benin's lowland) compared to other systems in both countries, because a large production of rice is sold up for lack of cash. These results are obtained by Chalabi (1994) in his study entitled "Economic evaluation of production units Faranah in Guinea following the development of their lowlands" The production is purchased pre-harvest low prices by a dealer who in return offers seasonal credit to the producer. Vegetable crops grown in off-season contribute to increased income of producers in the lowlands. The women use the rice during the rainy season and the vegetable crop in the off-season.



Table 8: Rice and vegetable systems profitability in Benin and Mali

<b>Countries</b>	<b>Cropping systems</b>	<b>Net margins</b>
<b>Benin</b>	System based rice and maize	287930
	System based rice and gboma	617028
	System based rice and crincrin	209663
	System riz-gboma (improved Var Gb)	642640
	System riz –gboma (local Var	211433
	System rice-crincrin	119827
	System rice culture pure	<b>-134025</b>
	System based crincrin and rice	182286
<b>Mali</b>	System based rice and Potato associated sweet potato	352648
	Système riz- Potato	428971
	System based rice and Potato associated eggplant	18563
	System based rice in monoculture	428971
	System based rice and Potato	414174

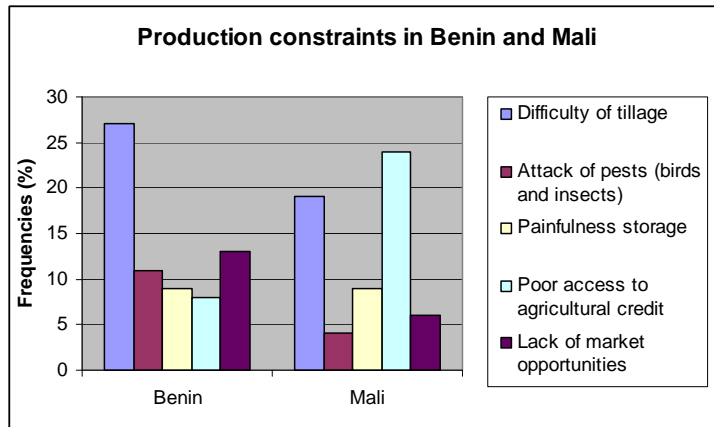
Source: Surveys from Benin and Mali

### 5.3. Constraints and Opportunities related to the exploitation of lowlands, Benin and Mali

#### 5.3.1. Constraints

The main problems identified by farmers in the lowlands in Benin and Mali are the difficulty of tillage, seed-eating birds of the attack on rice and vegetable crops to insects, the hardness of rice storage and potato, poor access to agricultural credit for purchasing inputs and for the payment of hired labor (table ) the lack or inadequacy of opportunities for the marketing of products from the lowlands. However, the frequency of these constraints varies from one country to another. Thus the difficulty of tillage, pest attack and the lack of market opportunities are constraints that producers face in their activities in Benin. Poor access to agricultural credit is often mentioned by farmers in Mali. As for the difficult of storage, it is common in both countries. This is explained by the inadequacy of existing drying and drying time longer and the contamination of mold or fungi. The technical monitoring and capacity building is very low in the lowland of Benin and Mali.

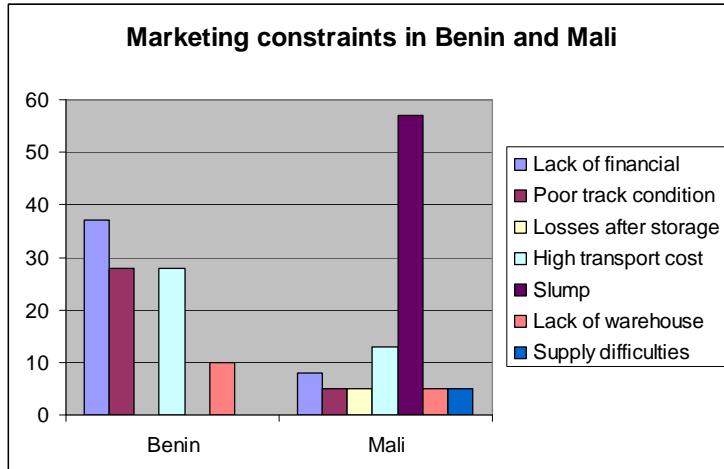
Table 9: Production constraints in Benin and Mali



The major marketing constraints are among others the lack of financial resources, poor roads leading to the increase in transportation costs, loss post due to lack of storage warehouse and supply problems due to rice irregularity of supply and the small amount available

Lack of financial resources, the high purchase price of rice, the poor quality rice, the limit of local production and availability at any place are the major constraints cited by consumers in Benin and Mali.

Table 10: Marketing constraints in Benin and Mali



The producers face enormous difficulties for hulling rice because few shelters are available in Benin. For husking rice production is moved over large distances, which incurs additional costs (transportation, quality of rice, ect ...) reducing net margins in the value chain.

### 5.3.2. Opportunities

Opportunities exist for the promotion of agricultural value chains in the lowlands in Mali and Benin. The development of slums is an opportunity for some efficient exploitation of lowlands. These developments together with water availability in all seasons can increase productivity and production of off seasons that generate higher revenues through a supply higher and diversified. Crop diversification helps to conserve natural resources and ensure the sustainability of farming systems for reducing degradation of soil and water resources and parasite pressure associated with continuous cropping of rice.

## 6. Difficulties

The main difficulties encountered in undertaking this work are related to the synthesis of the results of the two countries. Indeed, data from the two countries during this first phase of the study were not collected at the same time: what has caused a delay in the evolution of our work.

## 7. Collaborations with institutions

This study was done in collaboration with national research structures (NARS) and other components of the project. We also participated in all workshops organized by a component that

deals with the training and evolution of multi-stakeholder platforms. During these workshops, the results and work done by each component are returned to actors in the platform.

## **Conclusion**

The study showed four categories of actors in the lowlands in the two countries: producers, processors, traders and consumers. Systems based rice and Gboma are the most profitable in Benin. In Mali, the rice-based system with an improved variety of potato over the mineral fertilizer is more profitable. The rice system in pure culture is the least profitable compared to other systems in both countries. It is practiced only by women in Mali during the flood season. The area allocated to women are small and vary according to availability of land resources. The land plots vary between 0.1 and 0.5 ha. Women have very limited means and have very narrow margins in their ability to access inputs and credit.

The lowland landscaped water availability in all seasons, the opportunity for diversification of crops and the proximity of the sale markets are opportunities to promote agricultural value chains in the lowlands in the southern Mali and Benin. The main constraints cited by farmers for rice and vegetable crops should be resolved at the level of innovation has put at the disposal of actors through research for development and capacity building of value chains actors. Crop diversification with the use of improved varieties increased productivity and increasing farmers' incomes of rice and vegetable producers. The pure culture of rice is the least profitable. The rice is female and not very productive while the potato is exclusively male in the family fields and organized intensive labor and monetary investment due to the purchase of seeds imported from Europe, Rice and vegetable processors can be grown and diversified in function of economic opportunities.

This requires further study to include analytical elements on other performance criteria (Fair), governance quality control, agricultural policies impact on the profitability of value chains of lowlands and lower costs transactions. Other aspects of capacity building of stakeholders and mechanisms for disseminating information and knowledge through new information technologies and communication (ICT) and the Forums farmers of technological and organizational. Innovations.

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