AGRON. AFR. XVIII (2) : 85 - 185

ISSN n° 1015-2288

AGRONOMIE AFRICAINE

CORAF / WECARD

Tiré à part

AOÛT / AUGUST 2006

Revue Scientifique coéditée par l'Association Ivoirienne des Sciences Agronomiques (AISA/IAAS) et le Conseil Ouest et Centre Africain pou r la Recherche et le Développement Agricoles (CORAF/WECARD)

Scientific Journal issued by the Ivorian Association for Agricultural Sciences (AISA/IAAS) and the West and Central African Council For Agricultural Research and Development (CORAF/WECARD)

CHARACTERIZATION OF INLAND-VALLEYS FOR SMALLHOLDER DAIRY PRODUCTION In WEST AFRICA

K.AGYEMANG 1,.5, C.V. YAPI-GNAORE 2 , B. OUOLOGUEM 3, P.P. BARJE 4 and S.A.ADEDIRAN1,5

1International Livestock Research Institute. Ibadan, Nigeria.

2 Centre Nationale de Recherche Agronomique. 01 BP 1740 Abidjan 01, Côte d'Ivoire. evayapi11@yahoo.fr

3 Institut d'Economie Rurale. Sotuba, Mali. bara.ouologuem@ier.ml

4 National Animal Production Research Institute, Zaria, Nigeria. larai11@yahoo.com

5 International Trypanotolerance Centre. P.M.B. 14 Banjul, The Gambia. k.agyemang@itc.gm or niyi.adediran@itc.gm

ABSTRACT

A two-level (village or town, household level) characterization of inland-valley areas was undertaken in order to assess the potentials and constraints associated with inland-valleys agriculture production in a crop-livestock system in 3 west african countries (Côte d'Ivoire, Mali and Nigeria). User groups and opinion leaders in 71 villages and towns and over 630 farm households were surveyed. Results show that information obtained from the village or town level (semi-detailed) substantiates those from the household lever (detailed). In the three countries, 89 - 95 % of the villages/towns surveyed were located at less than 10 km to major roads or highways and 55 - 90 % at less than 20 km from commercial centres, except in Mali (25 %). In Nigeria, 38 and 88 % of the *villages/towns* had population size greater than 5000 inhabitants, whereas few village or town had that size in Mali (22 %) and Côte d'Ivoire (5.3 %). Flooding of the valley bottom occurs almost every year, with a period extending from june to december or january, depending on the country). Farmers were aware of benefits drawn from the use of the inland-valleys to increase food and livestock production, as well as increasing cash incomes -and the health status of children. They were also aware of the constraints a5sociated with their use. These included inadequate animal feed, livestock respiratory diseases, trypanosomosis, limited animal genotype capacity and the lack of appropriate technologies. Household utilization of inland-valleys for livestock varied within and across the three countries. Nevertheless, results showed the presence of livestock in the inland-valleys and the existence of a growing market oriented dairy activities.

Key words: Inland-valley, crop production, cattle, dairy, West Africa.

RESUME

CARACTERISATION DES BAS-FONDS POUR UNE PRODUCTION LAITIERE CHEZ LES PETITS FERMIERS EN AFRIQUE DE L'OUEST

Des caractérisations semi détaillées et détaillées pour définir les potentialités, opportunités et contraintes liées à *l'utilisation des bas-fonds pour la production laitière dans un système d'association agriculture -élevage, ont été faites auprès des chefs de groupes de* 71 *villages ou villes et de plus de 630 chefs de ménages au Nigeria, en Côte d'Ivoire et au Mali.*). *Les villages ou villes enquêtés sont situés pour la plupart* (89 - 95 %) à *moins de* 10 *km des routes principales et* à *moins de* 20 *km des centres urbains* (55 - 90 %), *sauf au Mali* (25 %). *Au Nigeria,* 38 *et* 88 % *des villages ou villes ont une toille de populations supérieure* à *5000 ;. alors que peu de villages ou villes ont cette toille au Mali* (22 %) *et en C6te d'Ivoire* (5,3 %). *L'inondation des bas-fonds a lieu presque tous les ans avec des périodes allant de juin* à d*écembre ou janvier, selon le pays. Les informations fournies par les chefs de ménage confirment celles des chefs de groupes. Ainsi, les fermiers reconnaissent le rôle bénéfique des bas-fonds dans l'accroissement de la production végétale et animale, du revenu, et de la santé des enfants. Ils sont aussi conscients des contraintes liées* à *leur utilisation,* à *savoir, le manque d'aliment pour le bétail, les maladies respiratoires, la trypanosomiase, les limites de production des races d'animaux et l'absence de technol6gies de production appropriées. L'utilisation des*

bas-fonds et de leurs ressources varie entre les trois pays et à *l'intérieur d'un même pays. Cependant les résultats ont montré* la *présence de cheptel dans les bas-fonds et l'existence d'activités croissantes de production laitière* à *but commercial. Ceci montre les potentialités des bas-fonds en production laitière.*

Mots clés: Bas-fond, production vivrière, élevage, bovin, production laitière, Afrique de l'Ouest.

INTRODUCTION

In West Africa, agricultural productivity, expressed in kg per capita, has been on the decline for nearly 30 years, at least up to the mid 1980s. Self sufficiency rates continue to decline as well for crops, such as, rice (Adesina, 1992). Increases in absolute terms for most major crops were achieved largely through expansion of cultivated areas, rather than increases in yields per unit area (Windmeijer *et al.,* 1994). The expansion of cultivated areas traditionally occurs in arable upland soils. However, there is some evidence that these areas are becoming scarce due to a high population growth in the region (Thenkabail and Nolte, 1995 ; Windmeijer *et al.,* 1994). As a consequence, there is increasing pressure to cultivate the more fragile uplands ; while, at the same time, fallow periods on existing agricultural lands are being drastically shortened (Windmeijer *et al.,* 1994).

In longer term, the accelerated use of croplands and marginal unproductive lands can cause environmental degradation. It is hypothesized that the process of degradation could somewhat be slowed down if the vast potentials of the lowlands, especially the inland-valleys, are exploited. These areas offer an extensive, fairly unexploited potential for agricultural production (Thenkabail and Nolte, 1995). Their capacity to contribute to African food production if exploited to a greater extent, is substantial (Izac *et al.,* 1991) given that productivity in tropical swamps is higher than in upland areas (Denny, 1985 ; Etherington, 1983). According to some estimates, lowlands cover approximately 240 million ha in sub-Saharan Africa, of which 130 million ha are in West and Central Africa (Ruanet, 1982). These are vastly under exploited, with only 2 % of the total sub-Saharan Africa under cultivation (Garrity, 1985). In West Africa, approximately 50 million ha of the lowlands are inland-valley bottoms and hydromorphic fringes.

Because of the important potentials of the inland-valleys for crop production, some research and development-based organisations have been developing and testing technologies for farmers using these systems. To complement these efforts, a livestock (dairy)-based research project, which main objective was to increase indigenous dairy production in the areas around inland-valley systems. This was achieved through better feeding strategies using resource grown on residual moisture in the inland-valleys was developed and implemented by the International Livestock Research Institute (ILRI) and National Agricultural Research System (NARS) institutions in Mali, Côte d'Ivoire and Nigeria. Inland-valley system characterization was aimed at generating data for a better understanding of the systems and the identification of production constraints and opportunities for increased livestock (dairy) productivity.

MATE RIAL AND METHODS

STUDY SITES

The study sites were Zaria and Kufana in Kaduna State in Nigeria, Bouaké and Korhogo in Côte d'Ivoire, and Sikasso in Mali. A multi-scale characterization approach, similar to that used at IITA (Izac *et al.,* 1991), was adopted in this study.

DATA COLLECTION

Data were collected at village or town level (semi-detailed characterization) from 71 villages groups and opinion leaders to describe crop-livestock systems in the inland-valley areas and to determine the role of livestock in the systems and the state of dairy development activities. Data (detailed characterization) was collected at a smaller scale, at the farm household level (630 households).

Similar questionnaires were used in all three countries to facilitate cross-site analysis. For the semi-detailed characterization, one or two key areas in each country were purposely selected to include the valley systems, the existence of population or market gradients and of dairy-based systems. Approximately 5-10

villages or towns were randomly selected in each key area, and 2-3 groups or key informants per village interviewed on demographic and socioeconomic characteristics. For the detailed characterization, 50-100 households per key area were selected after drawing a sample frame of households with access to livestock, mainly cattle. Approximately 80-90 % of the households were required to have access to inland-valley plots, while the remaining 10-20 % were not. This scheme was intended to enable the testing of pre-formulated hypotheses that required these two categories of households. Market surveys on prices of crops grown in uplands and inland-valleys and livestock products were collected to complement prices recall data obtained during the formal surveys. Distances from major roads or commercial centers, characteristics of group leaders, were necessary to estimate market accessibility; whereas household environment define by urban, peri-urban or rural was to indicate the administrative setting.

DATA ANALYSES

In order to quantify the results obtained from group (village level) and individual household interviews, descriptive statistics (frequencies, means, variances) of the demographic and socio-economic characteristics have been calculated. F-tests were used to determine the homogeneity of variances among groups in order to guide the choice of the proper t-test to use (equal or unequal variance).

RESUL TS

VILLAGE-LEVEL CHARACTERISATION

Locations characteristics

Twenty villages/towns were surveyed in the Zaria area, representing the drier part of the northern guinean savannah. Eleven (55 %) of the 20 villagesltowns surveyed were located at less than 20 km from commercial centres, and 18 (90 %) of them at less than 10 km to major roads or highways (Table 1). Twenty-three percent of the villages had population between 500-1000, 38 % between 1000-5000, and another 38 % greater than 5000. In the wetter parts of the northern guinean savannah zone, represented by the areas around Kufana, South of Kaduna, 88 % of the 8 villages or towns surveyed had population greater than 5000 (Table 1). These latter villages were mostly located at less than 5 km from major access roads and 5-10 km from Kufana Township.

In Mali, 9 groups from 9 villages were interviewed. Fifty-five percent of the villages were located at 11-20 km from the administrative capital of the Sikasso region, with approximately 250.000 human populations. Nearly all the villages (90 %) were within 20 km of a major road network. In 44 % of the locations, human population was between 1000 and 5000, with another 44 % having population between 500 and 1000.

In Côte d'Ivoire (Table 1), 47 % of the 32 (villages or towns) surveyed were located within 5 km of the administrative capitals of Bouaké (mid-country) and Korhogo (North), and another 42 % of locations within 11 and 20 km to these capitals. A high percentage of the locations (89 %) were situated within 10 km of major road networks. Most towns or villages (84 %) were al 50 located within 20 km of commercial centres. Human populations were less than 500 in most (55 %) locations, although 21 % had populations ranging from 1000 to 5000.

All the locations in the Zaria region of Nigeria experienced flooding in the inland-valleys, almost on annual basis (Table 2). Most of the respondents (90 %) reported that flooding usually starts in august and ends either in october or november (6 weeks after the start of the rains and six weeks after the last rains). In the Kufana area, all the respondent experienced flooding, which began as early as july and many areas could remain flooded until december. In Mali, 66 % of the flooding of valley bottoms were said to be common on an annual basis or at least once every 2 to 4 years (Table 2). Particularly in wet years, the valley bottoms could remain flooded for as long as 7.5 months, and, in most cases, the standing water could be one meter deep (0.3 - 2 m). Flooding of the valley bottoms usually starts at about 6 weeks after the onset of rains and recedes at about 5 weeks after the last rain. In normal years, the flooding period runs from august to november. Similarly, the inland-valleys of the savanna region of COte d'Ivoire were said to be subjected to flooding, which occurs almost yearly (Table 2). Floods could start as early as june and, in some areas, remained partly flooded until december or january, some two months after the end of the rain. The valleys systems were described, in most cases, as flat or gently undulating and the soils were said to be only moderately drained.

Table 1 : Distribution of the group leaders in relation to location, distances and populations.

Répartition des localités des chefs de groupes par rapport aux distances et aux populations.

Countries	Sites	Distances		Populations	
		Classes	Frequencies (%)	Classes	Frequencies (%)
Côte d'Ivoire	Bouaké et Korhogo N =32	<la km from major road	89.5	<500	55.2
		<5 km from commercial center	47.4	500-1000	18.4
		10-20 km from commercial center	42.1	1000-5000	21.0
		>20 km from commercial center	10.5	>5000	5.3
Mali	Sikasso N=9	<20 km from major road	90	500-1000	44
				1000-5000	44
		< 20 km from commercial center	25		
				>5000	22
Nigeria	Kafuna N=8	< 10 km from major road	95	<5000	22
		< 10 km from commercial center	95	>5000	88
	Zaria N=22	<10 km from major road	90	500-1000	23
				1000-5000	38
		< 20 km from commercial center	55		
				>5000	38

Table 2 : Flooding characteristics of the locations surveyed.

Caractéristiques des inondations des localités enquêtées.

Countries	Locations	Frequency of flooding	Period of flooding	Duration of flooding from the 1st to the last rain	
				Debut after 1st rain	End after last Iain
				weeks	
Côte d'Ivoire	Bouaké et Korhogo N=32	Annually (100 %)	June to December / January	4	10
Mali	Sikasso N=9	Annually or 1 every 2 years (66 %)	August to November	6	5
Nigeria	Kafuna N=8	Annually (100 %)	July to December	6	6
	Zaria N=22	Annually (90 %)	August to October / November	6	6

Most of the inland-valley plots were family-owned, and purchase or lease agreement were the main ways of acquiring them in the Zaria area. On the other hand, in the Kufana area nearly 60 % of the inland-valley plots were privately or individually owned. As in the Zaria area, nearly all plots in the Bouaké and Korhogo regions were family-owned, and acquisition was mostly through gifts, as was the case in Mali. In two of the three countries (Mali and Côte d'Ivoire), users of inland-valleys in the locations surveyed believed that, inland-valley cropping in their areas, created situations where they had more fallow lands and longer fallow periods than comparable settlements, where there were no inland-valley systems. These perceptions were particularly strong in Mali, where 67 % of the respondent villages believed that they had more fallow lands, and 60 % had longer fallow periods.

Constraints to agricultural activities

ln Nigeria, the majority of respondents (80 %) identified poor soil fertility, insufficient land (30 %), disease or pest, damage from livestock and high cost of labour as the most important constraints to cultivation on uplands. Similarly, for valley bottoms, low soil fertility, insufficient land, drought, pest and diseases were reported (Table 5). Forty-two percent of the respondents indicated that land shortage was a problem, and 63 % said the availability of inland-valleys for cultivation had eased land shortage problems. In Sikasso, Mali, two-thirds (67 %) of the surveyed locations perceived land shortage as becoming a problem, and 22 % thought that land shortage was already a serious problem. In forty-four percent (44 %) of the locations, the availability of inland-valleys has eased land shortage problems. Poor soil fertility, insufficient land and drought were the most common production constraints in uplands systems (Table 3). These problems were also true for the fringes. However, for the valley bottoms only, 50 % of respondents reported insufficient land and soil fertility as a problem. In about 38 % of the locations, drought at the valley bottoms was considered as a problem. lack of appropriate technologies for inland-valley farming and the presence of pest damage were reported to be important constraints to production in 40 % of the locations. Similarly, in nearly 65 % of the villages surveyed in Côte d'Ivoire, land shortage was a concern, and nearly 45 % of the villagers believed that the availability of inland-valleys had somehow eased the land problem. However, 55 % of the villagers stated the problem of land shortage has not been improved despite the use of inland-valleys.

With respect to livestock production in the inland-valley areas of Nigeria, constraints were listed as shortage of feed or fodder (85 % of respondents), disease or pests, and conflict with crop farmers. In Mali (Table 3), feed shortage or fodder was cited as the first livestock production constraints in all nine locations, followed by pests and diseases (100 % of the locations), seasonal livestock disease epidemics (67 %) and conflict with farmers (33 % of the locations). Nearly all respondents (98 %) agreed that inland-valleys contribute to reducing livestock feed constraints. Similarly, in Côte d'Ivoire, constraints to livestock production at the village or town level were listed as shortage of feeds or fodder, conflict with farmers, and diseases and pests (Table 3).

HOUSEHOLD CHARACTERISATIONS

Household farm environment

In the Zaria region of Nigeria, 56 % of the 205 farming households surveyed were located in peri-urban environments, while the remainder were located in rural areas. On the other hand, all households in the Kufana area were considered to be in a rural setting (Table 4). In Mali, all households were considered to be in a peri-urban setting. In contrast, 51 % of all households in the Korhogo region (Côte d'Ivoire) were located in urban and 14 % in peri-urban areas of Korhogo, the remaining 36 % in a rural setting, whereas in the Bouaké region 28 % percent of the households were located in urban Bouaké, 23 % in peri-urban and 49 % in rural setting (Table 4).

Characteristics of sampled households

Nearly all (99.5 %) of the households interviewed in the Zaria region of Nigeria had male heads, with an average age of 47 years, the majority (63 %) of them had Islamic education and only (Table 5), 24 % had Islamic as well as western education. Only 8 % of the household heads did not have formal education. Although in the Kufana area, 85 % of the household heads were of different ethnic backgrounds from the dominant Hausa-Fulani group in Zaria. All were males, but a higher proportion of them had western education, up to the primary level. In Mali, all household heads were men with an, average age of 60 years, mostly Senoufo (78 %), and basically with no formal western education (57 %) and another 30 % with Islamic education only. A vast majority (81 %) of the households had no other business activity outside agriculture. In both Korhogo and Bouaké regions of Côte d'Ivoire, all households were males, with an average age of 54 years in Korhogo and 46 years in Bouaké.

Unlike Bouaké, where 30 % of household heads had western education up to secondary level, a vast majority (74 %) of the family heads in Korhogo had no formal education (Table 5), and only 7 % had Islamic education, and 11 % primary and post-primary western education. With the exception of Sikasso in Mali, most household heads engaged in non-agricultural activities in addition to farming.

The farm labour force (Table 5) in the Zaria was 3.1, of which, 1.3 was hired. Nearly two thirds of the households employed labour on a permanent basis. In the Kufana area, the labour force was 7.ln Mali, where labour force was 10.7, only 1.8 was hired labour. Fifty-one per cent of households used permanently employed labour. Similarly, in Korhogo, labour was mostly supplied by family members as 94 % of the households do not have permanently employed labour. The household size averaged 13.7 with an average labour force of 7, of which one 1.7 is hired on a temporary basis. In contrast, Bouaké had an average number of persons per household (9) with a labour force of4.7, of which 1.6was hired. Of the hired labour 1.4 was for livestock activities on a permanent basis.

Table 3: Perceived elements as major constraints to agricultural activities.

Eléments perçus comme contraintes majeures aux activités agricoles.

	Countries		
Constraints	Côte d'Ivoire	Mali	Nigeria
Sol! infertility	No	Yes	Yes
Land shortage	. Yes	Yes	Yes
Conflict with crop farmers	Yes	Yes	Yes
Damage from livestock	No	No	Yes
High labour cost	No	No	Yes
Disease & pest	Yes	Yes	Yes
Drought	No	Yes	Yes
Shortage of feed / fodder	Yes	Yes	Yes
Lack of appropriate inland technology	Yes	Yes	No

Table 4 : Location of the households in relation to the nearest town.

Localisation des ménages par rapport à *la ville la plus proche.*

Countries	Sites	Type	% respondents
Côte d'Ivoire	Bouaké N=69	Urbain	28
		Peri-urban	23
		Rural	49
	Korhogo N= 151	Urbain	51
		Peri-urban	14
		Rural	36
Mali	Sikasso N=72	Peri-urban	100
	Kafuna N=133	Rural	100
Nigeria	Zaria N=205	Peri-urban	56
		Rural	44

Table 5 : Characteristics of the household heads and labour force of the households.

Caractères des chefs de ménages et main *d'oeuvre utilisée dans les ménages.*

		Household head			
Countries	Sites	Sexe	Education	Average age (years)	Labour force *
Côte d'Ivoire	Bouaké N=69	Male Western (100 %)	(30 %)	46	4.7
	Korhogo N=151	Male None (100 %)	(74 %)	54	7.0
Mali	Sikasso N=72	(100 %)	Male Islamic (30 %)	60	10.7
Nigeria	Kafuna N=133	Male Western (100 %)	(85 %)	54	7.0
	Zaria N=205	(99.5 %)	Male Islamic (63 %)	47	3.1

*Average number of males and females (family or hired) 18 years or older working on the farm

Crop production

With the exception of the Bouaké region of Côte d'Ivoire (Table 6), animal traction was widely used for land preparation in all the locations. In the Zaria region of Nigeria, nearly 80 % of households used animal traction. In Mali, 90 % of households reported using animal traction, while in Korhogo region of Côte d'Ivoire 67 % of households used animal traction. In Nigeria, bulls (entire) were mostly used while in Mali and Côte d'Ivoire, oxen were the most widely used (Table 6).

In both Nigeria and Mali, valley bottoms and fringes were rarely cleared before planting food crops. However, stubbles from the previous season's farming activities were burnt before planting, which in Nigeria could start as early as april. In Mali, rice planting starts in may if there are enough rains. The harvesting of wet season crops starts in november. For dry season cultivation, land preparation may extend over a relatively short time, late november to early december, after which, crops such as tomatoes, sweet and Irish potatoes are planted. Weeding was an almost continuous activity in the inland-valley plots. Fertilization, with both chemical fertilizer and manure occurred at during weeding periods. Dry season crops harvests may start in february and extend to may.

Livestock production and management

In Nigeria and Côte d'Ivoire, cows were not usually managed separately from the rest of the herd. This was also true for Mali, except when some of the herds needed to undertake short term transhumance, in which case cows were kept behind to provide milk. In the Zaria region, 55 % of the respondents kept their bulls with the rest of the herd.

Most respondents in all sites and countries let the ca lves stay with their dams throughout the day (if calves were old enough to go out for grazing on their own), but calves are separated from their dams during the night. In the systems studied, virtually all ca lves get milk from their dams through sucking. Castration of young male cattle was a common practice in all countries (Table 6). In Nigeria, 58 % of respondents castrated young males. In the Korhogo region (Côte d'Ivoire), as many as 90 % of the respondents castrate their animals. The percentage was slightly (63 %) lower in Bouaké. Only a handful had kept their animals in roofed structures during the night. Cows were milked twice a day by 66 % of respondents in Zaria. Cows were given water at least twice daily in all countries. The majority of respondents (77 % in Nigeria, 60 % in Côte d'Ivoire and 67 % in Mali) used rivers as the source of water supply. Cows were used to provide manure to upland crops (92 % of respondents in Zaria and 30 % in Korhogo) and also in inland-valley plots.

Dairy products marketing

Nearly 88 % of respondents in the Zaria region sold fresh or sour milk. For those who sold milk, more producers sold milk in december, january, june and september (Table 6). In contrast, only 24 % of respondents in the Kufana area sold fresh or sour milk, mainly during the period between june and october. Forty-three percent (43 %) of household in Zaria indicated that they were likely to sell more milk if collection schemes were to be put in place. Another 37 % did not know how they will react, while 20 % said they would not take advantage of the scheme to produce more dairy products.

In the case of Mali, those who extracted milk from their cows, 67 % sold fresh milk, mostly to collectors, who come to the farm gate to purchase milk. For those who sold milk, most was sold in june through september. In the Korhogo region, 55 % of milk sellers indicated that may through august (Table 6) were the months when most of the milk was sold. In the Bouaké 78 % of milk sellers identified april and may, and September to december as the months in which most milk was sold.

A advantages of agricultural enterprises

In the Zaria region of Nigeria, 89 % of respondents indicated that their farm incomes from crops were greater than from livestock (Table 7). Only 24 % of respondents obtained more incomes from livestock than other non-agricultural enterprises. Fifty-three percent (53 %) of respondents obtained more income from live animal sales than from dairy products, whereas 47 % indicated the opposite. Sixty-five percent (65 %) obtained more income from dairy products than sale of animal dung. Seventy-six percent of the respondents indicated that their income from the sale of crops grown in inland-valleys during the dry season was greater than that of the dry season milk sales. Similar views were expressed by respondents in the Kufana

area, although the proportion of respondents who obtained higher income from cropping, than from livestock activities (Table 7) was smaller (63 %), compared to Zaria region. In Côte d'Ivoire, the pattern was the same both in the Bouaké and Korhogo regions. However, in Korhogo income from the sale of livestock products during the dry season was higher than that of dry season cropping (Table 7) according to 70 % of the respondents. In Mali, nearly 53 % of respondents said that they obtained more income from crops than livestock (Table 7). Livestock income was greater than that from non-farm activities according to 85 % of respondents. Equal percentage of respondents (47 %) reported obtaining more income from dairy product sale than live animals or vice versa. Seventy-eight percent (78 %) of respondents indicated that dry season cropping yielded more incomes than dairy in dry season (Table 7), mainly because potatoes which is an ex port crop in the area. The cost of acquisition of chemical fertilizer was considered by most respondents (88 %) in Mali as higher than the time and effort used in kraaling cattle on plots. With the exception of the Kufana area of northern Nigeria, larger proportions of households obtained higher income from dairy product sales than from the sales of live animals. As was the case in Mali, 66 % of respondents in the Zaria indicated that the cost of chemical fertilizers to manure plots was greater than the total cost of labour used in kraaling the animals on farm plots, or for carrying manure from the house to the plots.

Perceived benefits

When asked whether they have noticed any improvement in various categories of household welfare after acceptation to cultivate in inlandvalleys, 97 % of respondents in the Zaria area (Nigeria) indicated increases in total quantity of food harvested, greater variety of food (99 %), more food sales (97 %), and more cash incomes from crops (94 %). Similar response patterns were obtained from the Kufana area. In Mali, most respondents (92 %) sa id that inland-valley crop farming enabled them to have more variety of crops (63 %), more foods sales (59 %), to increase cash incomes (86 %), and more dairy products consumed (63 %). However, the inclusion of inland-valley cropping did not lead to lesser number of total plots cultivated (88 %), lesser combined area cultivated (90 %), lesser family labour used for farming (59 %), increased woman labour (88 %). In the Kufana area however, the inclusion of inland-valleys in cropping, has led to the reduction in the number of plots cultivated, according to 83 % of respondents, although the total combined area (uplands plus lowlands) did not decrease.

In the Korhogo region, nearly all respondents (99 %) said that they had increases in crop yields from uplands and inland-valleys exploitation (Table 7), more crop varieties (99 %), more food sale (87 %) and increasing family incomes (75 %). In contrast, inland-valleys exploitation in the Korhogo region did not lead to a lower number of plots cultivated or lesser family labours (76 % of households). Similar response patterns were observed in Bouaké (75 %), where fewer number of plots cultivated were not associated with the use of inland-valleys (98 % of households), fewer combined areas cultivated (90 %), lesser family labour (100 %).

When household heads were asked whether they have noticed any improvement in various household welfare indicators after they added milking or dairying to their cropping activities, 98 % of respondents in the Zaria region indicated increases in family cash incomes, more dairy products consumed (93 %), fewer number of plots cropped (54 %). Jess area of land cultivated (52 %), improved children health (74 %), increased working hours and increased labour for women (41 %). In the Kufana area, 85 % of respondents reported an improvement in the health status of the children. Similar observations were made in both Korhogo and Bouaké regions in Côte d'Ivoire. However, in Côte d'Ivoire, there was a opposing view on the question as to whether woman labour has increased with the development of dairy enterprises. Whereas, 64 % of household heads in Bouaké did not think woman labour had increased, 70 % of household heads in Korhogo believed the contrary.

Table 6 : Characteristics of livestock management and marketing of dairy products.

Caractéristiques de gestion du cheptel et de commercialisation de produits laitiers.

Countries	Localities	Use of animal traction	Type of cattle used	Castration of young male	Form of milk sold	Period of sale
Côte d'Ivoire	Bouaké N=69	No	-	Yes	Fresh (100 %)	April, May, September-December
	Korhogo N=151	Yes (67 %)	Oxen	Yes	Fresh (100 %)	May-August
Mali	Sikasso N=72	Yes (90 %)	Oxen	Yes	Fresh (67 %)	June-September
	Ku fana N=I33	Yes (60 %)	Bull	Yes	Fresh *1* sour (24 %)	June-October
Nigeria	Zaria N=205	Yes (80 %)	Bull	Yes	Fresh *1* sour (88 %)	December, January, June, September

Table 7 : Perceived benefits from using inland-valleys.

Bénéfices perçus suite à *l'utilisation des bas-fonds.*

Benefits	Countries		
	Côte d'Ivoire	Mali	Nigeria
Increase in total food harvested	Yes	Yes	Yes
Greater variety of food harvested	Yes	Yes	Yes
More food for sale	Yes	Yes	Yes
Increased cash income	Yes	Yes	Yes
Increased dairy product consumption	Yes	Yes	Yes
Improved children health	Yes	No	Yes
More income from crop than livestock	No	Yes	Yes
More income from livestock than crop *1* dry season	Yes	No	No

DISCUSSION

The semi-detailed characterisation undertaken here sought to obtain a broad view of inland-'valley agriculture, and livestock in particular, in a relatively short time period by limiting interviews to groups of users and key informants. The study shows a very close relationship between cropping on uplands and inland-valleys, which impose high labour demand on farm households, although hired labour in some locations reduced the load on household members in some months of the year. It also confirmed of the very visible presence of livestock in these areas, and the existence of a growing market-oriented dairy sub-sector.

Feed resources from the cropping systems, particularly crop residues, appear widespread but current strategies in their collection, storage and use are not used up in some of the locations surveyed. Feeds and fodder storages for livestock and animal health were ranked high as major constraints in livestock production. Bernet *et al.* (2001) also acknowledged that the lack of fodder storage in the form of hay or silage had a strong effect when combined with poor herd management. However, Jaitner *et al.* (2001) reported that supplementary feeding was not very common among small ruminant producers in Gambia. The reference to the lack of appropriate technology, as a constraint in some locations could mean that farmers were willing to adopt technologies developed for inland-valley farming systems. One such technology reported for sheep farming in France was the use of «pactice-season» (Bellon *et al.,* 1999). This consisted of using combinations of forage resources not solely based on current biomass production in order to provide some security in the fluctuation of herbage production.

Experience in technology transfer in Sub-Saharan Africa (Matlon and Adesina, 1991) had shown that, in order to be successful, technical interventions must involve incremental changes in the farming systems and significant farmer participation in technology design. In the case of inland-valleys in West and Central Africa, earlier efforts emphasized crop and resource management technologies for systems with full water control. This, in most cases, was done without farmer participation in the design of the technology (AORAO/CBF, 1993).

Detailed characterisations were undertaken to provide more insight into the inland-valley crop-livestock systems, than that provided by semi-detailed surveys. Thus, for the three countries studied, households, using inland-valleys may be subjected to different market and demand opportunities, and their response to intensify production enterprises (crop and livestock-based) may be different. Therefore, proposed technologies would need to consider such differences in opportunities. Thus, one needs to define the recommendation domains (Williams,1994) of such groups of households in order to properly direct interventions that would meet their needs. Classifying households into recommendation domains will assist policy makers in determining where, and for which, groups' efforts should be focused on (Franzel, 1981).

The predominance of males as household heads, who are the principal decision makers on matters relating to inland-valley farming, may have important implications on the format of extension messages passed on from research to end-users of technologies; especially when the use of the inland-valley in the dry season was known to be by females. In Gambia, where most men are cattle herd owners, only a small fraction participated directly in herd management (Jaitner *et al.,* 2003).

It is clear that from the analysis of inland-valley farming activities, and reported for uplands, that overlap in timing of agricultural activities does occur. It also demonstrates the close link between upland wet season farming and inland-valleys. The results further show that farm households who exploit inland-valleys were engaged in both crop and livestock farming. They had their production practices, for the two sub-enterprises, linked through the use of feed resources (crop residues), animal draught power and manure for soil improvement. Further linkages were characterized by substitutions of permanent labour for hired labour. Senior herdsmen were effectively substituted by hired herdsmen during the cropping season in order for the farmer (likely household heads), to concentrate on crop farming (Jaitner *et al.,* 2003).

The study also shows that, in all five regions in the three countries, farmers recognised the benefits from the use of inland-valleys, not only in terms increases in food and livestock production, but a1so, in terms of cash income. Additional perceptible benefits in terms of increased dairy products consumption and improved children health were also identified with the addition of dairy activities to the farming enterprises.

Inland-valley farmers were however concerned with the fact that these benefits could be eroded by the some production constraints, mainly animal nutrition and disease problems, as well as perceived limitations of animal genotype to milk production. Constraints magnitude and corrective measures adopted by producers varied between regions and by market accessibility. A broader range of constraints, as related to the use of inland-valleys, have been identified for several West African countries. These include in order of rating: weeds, lack of water control, lack of inputs, labour shortages, credit, land tenure, etc. (ADRAO/CBF, 1993).

CONCLUSION

Cross-country comparisons of the socio-economic characteristics of households, using inland-valley systems in West Africa for livestock agriculture, showed that the various sites within a given country and between countries were at different stages in the development and utilisation of inland-valley resources. The variations were related to markets accessibility and marketing of dairy and other livestock products characteristics, as well as the degree of Integration of various agricultural enterprises.

Whereas crop production predominated farming activities, in the valley systems near urban centres (Sikasso in Mali, Zaria in Nigeria), dairy production was also an important activity. This situation perhaps reflects the often established relationships between higher consumption of dairy products and urban populations. The increase in the demand for livestock products often pulls up on production, therefore, raising the prospects that dairy potential in highly

populated inland-valley areas could be exploited. It could be deduced that milk production is not a year -round activity at some study sites, based on sales periods of dairy products in the various countries. However, given the responses that organised milk collection would induce to produce more milk, and the high percentages (≥ 90 %) of respondents who indicated that adding dairying to their enterprises improved household welfare; There is a important potential for dairy farming in these inland-valley areas. The extent to which these potentials can be translated into actual production will depend on the level to which some of the constraints (socio-economics, bio-physical, etc.) are overcome. According to Bernet *et al.* (2001), a flexible model to accurately capture the different production framework, within each country, will be needed to apprehend the complexity of the production system involving crops and livestock.

ACKNOWLEDGEMENTS

We are grateful to the directors of National Research Systems in the three countries (ex-IDESSA *I* CNRA-Côte d'Ivoire, 1ER-Mali, NAPRI-Nigeria) for their administrative support. The financial support of the IDRC-Canada is also acknowledged and appreciated. The secretarial assistance provided by Kemi Olaobaju of ILRI, Ibadan and Florence Muthigani of ITC, Banjul is highly appreciated.

REFERENCES

Adesina (A.). 1992. Economics of rice production in West Africa. State-of-the-art. West Africa Rice Development Agency (WARDA), Bouaké, Côte d'Ivoire.

ADRAO/CBF. 1993. Mise en valeur durable des agro-écosystèmes de bas-fonds en Afrique sub-saharienne. Projet du programme consortium bas-fonds. ADRAO/CBF, Bouaké, Côte d'Ivoire. 67 p.

Bellon (S.), (N.) Girard and (G.) Guerin. 1999. Caractériser les saisons-pratiques pour comprendre l'organisation d'une campagne de pâturage. Fourrages 158 : 115 - 132.

Bernet (T.), (O.) Ortiz, (R. O.) Estrada, (R.) Quiroz and (S.M.) Swinton. 2001. Tailoring agricultural extension to different production contexts : a user-friendly farm-household model to improved decision-making for participatory research. Agricultural Systems 69 : 183 - 198.

Denny (P.). 1985. The ecology and management of African wetland vegetation. Geobotany 6, Dr. W. Junk Publication, Boston. 344 p.

Etherington (J. R.). 1983. Wetland ecology. Studies in Biology N°. 154, Edward Arnold Publication, London, UK. 66 p.

Franzel (S.). 1981. Identifying target groups in an area : Methodology and procedures. CIMMYT, East Africa Economics Programme. Nairobi, Kenya. Farming System Newsletter 4 : 13 - 25.

Garrity (O. P.). 1985. Rice in eastern and southern Africa : The role of international testing. Proceedings of International Workshop on *Rice improvement in Eastem, Central and Southem Africa*. Lusaka, Zambia, 9 - 19 April 1984. IRRI, Los Ba!:lOs, The Philippines: 29 - 45.

Izac (A. -M.), (N.) Swift and (W.) Andriesse. 1991. A strategy for inland-valley agroecosystem research in West and Central Africa. Resource and Crop Management Program, liT A, Ibadan, Nigeria. RCMD Research Monograph N" 5. 24p.

Jaitner (J.), (J.) Sowe, (E.) Secka-Nje and (L.) Dempfle. 2001. Ownership pattern and management practices of small ruminants in The Gambia - implications for a breeding programme. Small Ruminant Research 40: 101 -108.

Jaitner (J.), (N.) Coor and (L.) Dempfle. 2003. Ownership pattern and management practices of cattle herds in The Gambia : Implication for a breeding programme. Tropical Animal Health and Production 35: 179 -187.

Matlon (P.J.) and (A. A.) Adesina. 1991. Prospects for sustainable improvements in sorghum and millet productivity in West Africa. In : Vosti S.A., Reardon T., von Urff W. (eds.), Agricultural Sustainability, Growth and Poverty Alleviation : Issues and Policies. Proceedings of the conference held from 23-37 September in Fedalfing, Germany : 363 - 387.

Raunet (M.). 1982. Les Bas-fonds en Afrique et à Madagascar. Formation, Caractères Morpho-pédologiques, Hydrologie, Aptitudes Agricoles. IRA T, Service de Pédagogies, Montpellier, France. 56 p.

Thenkabail (P. S.) and Nolte (C.). 1995. Mapping and characterizing Inland-valley Agro ecosystems of West and Central Africa. International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Resource and Crop Management Monograph W 16. 52p.

Williams (T. O.). 1994. Identifying target groups for livestock improvement research: the classification of sedentary livestock producers in western Niger. Agriculture Systems 46 : 227 - 237.

Windmeijer (P.N.), (N.) van Duivenbooden and (W.) Andriesse. 1994. Characterization of rice-growing agroecosystems in West Africa. Semi-detailed Characterization of Inland-valleys in Cote d'Ivoire. Technical Report 3. Vol. 1. Main Report. SC-OLO Winand Staring Centre for Integrated Land, Soil and Water Research. Wageningen, Netherlands. 129 p.