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Landuse, Labor Dynamics, and Household Production Strategies: The Senegal River Valley

by

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ACRONYMS

AE	Adult equivalent
BIRD	Banque Internationale pour la Reconstruction et le Développement (IBRD: International Bank for Reconstruction and Development; The World Bank)
CAB	Cellule Après-Barrages
CNCAS	Caisse Nationale du Crédit Agricole du Sénégal
CSE	Centre de Suivi Ecologique
ENDA	Environnement et Développement du Tiers-Monde
FAO	Food and Agriculture Organization (UN)
FED	Fonds Européen de Développement (European Development Fund)
GERSAR	Groupement d'Etudes et de Réalisations des Sociétés d'Aménagement Régional
GIE	Groupement d'intérêt économique
GIS	Geographic Information System
GPI	Grands Périmètres Irrigués
HCR	[UN] High Commissioner for Refugees
ISRA	l'Institut Sénégalais de Recherche Agricole
KfW	Kreditanstalt für Wiederaufbau
NGO	Nongovernmental Organization
OAV	Organization Autonome de la Vallée
ORSTOM	Institut Français de Recherche Scientifique pour le Développement en Coopération
PADEC	Association Panafricaine pour le Développment Communautaire
PDRG	Plan Directeur de Développement Intégré pour la Rive Gauche de la Vallée du Fleuve Sénégal

PIP	Projet Intégré de Podor
PIV	Périmètres Irrigués Villageois
PNUD	Programme des Nations Unies pour le Développement (UNDP)
SAED	Société d'Aménagement et d'Exploitation des Terres du Delta du Sénégal et des Vallées du Sénégal et de la Falémé
SRBMA	Senegal River Basin Monitoring Activity
SUMA	Section d'Utilisation du Matériel Agricole
UAI	Unité Autonome d'Irrigation
UNE	Unité Naturelle d'Equipement
UNICEF	United Nations Children's Fund

EXECUTIVE SUMMARY

I. PROJECT BACKGROUND AND RESEARCH OBJECTIVES

In recent years, the government of Senegal has become increasingly preoccupied with the status of food security, especially a growing dependency on imported cereal grains to feed the nation's burgeoning rural and urban populations. Partly in response to persistent drought and environmental instability in the last several decades, development authorities have embarked on an ambitious program to bolster agricultural production and mitigate against food shortages in the Senegal River Valley by promoting irrigation technology. The completion of two dams, the Diama antisaline intrusion barrage near the Atlantic coast in 1985, and the Manantali Dam upstream in Mali in 1988, was expected to further three goals:

- The generation of hydroelectricity to supply both urban centers and rural hinterlands.
- The attainment of regional food sufficiency in cereal production, particularly rice, through irrigated agriculture.
- The realization of an internal port of trade at Kayes, Mali and inland riverine development of regional and local centers of trade and commerce through inland navigation.

In order to attain these objectives, the river's downstream flow must be regulated and stabilized throughout the year, essentially eliminating the peak flow and the flooding cycle at the height of the wet season. This regularization of the water regime poses a direct threat to the livelihoods of approximately one million rural inhabitants of the river valley who rely on the annual flooding of their fields for their agricultural and pastoral production systems and fisheries.

At the request of the Senegalese government and under the sponsorship of USAID/Dakar, the Institute for Development Anthropology (IDA), through its Cooperative Agreement, "Systems Approach to Regional and Sustainable Resource Assistance" (SARSA), launched a multiyear research initiative in 1988, the Senegal River Basin Monitoring Activity (SRBMA), to explore the socioeconomic and environmental impacts of river impoundment at Manantali on communities located downstream in the Middle Senegal River Valley. The study was undertaken in consultation with the Senegalese government counterpart agency responsible for post-dam development in the Senegal River Valley, the Cellule Après-Barrages (CAB).

Research was implemented in two phases. Phase I, undertaken from 1988 to 1990, involved intensive household studies at three village sites—Thiemping, Doumga Rindiaw, and Boyenadji Roumde—located in the Department of Matam in the Middle Senegal Valley. During this period, data were collected on household consumption, production, labor allocation, land tenure, revenues, and expenditures. Drawing on findings of the initial study, field research for Phase II was carried out from 1990-1992 by expanding the scale of investigation to 331 households in 32 villages in the departments of Matam and Podor. In this manner, preliminary

observations and working hypotheses from Phase I could be further explored and tested on a much larger scale. Most importantly, empirical study and observation at the regional level allows conclusions about emergent patterns of human social behavior and adaptive responses to environmental constraints to be more easily validated and generalized.

The focal point of the SRBMA research has been to explore the socioecological and political-economic parameters of production in the Middle Senegal Valley, and to understand the differential responses of smallholding households to changing conditions of river hydrology and flooding resulting from impoundment of the Senegal River. In this context, project research has been shaped by three broad objectives:

(1) to assess the costs and benefits of terminating an annual flood at regional and national levels;

(2) to understand the nature of resource diversification and the components of the farm and off-farm household economy (including dryland farming, irrigation, flood recession cultivation, animal husbandry, fishing, commerce, and migration); and the relation of these various components to household food security and disposable income;

(3) to promote a policy of economic development that provides for the safeguard and enhancement of a sustainable natural resource base.

In the second project phase (SRBMA II), research has focused on understanding the impact of the changing regime of the Senegal River on the socioeconomy of the Senegal River Valley. The goal has been to determine how Middle Valley households make use of scarce resources in responding to perceived opportunities and dealing with perceived obstacles. The research indicates which combinations of opportunities, constraints, and external circumstances affecting households prove to be beneficial in achieving an optimal mix of productive activities, and which more often lead to loss and failure. An understanding of the heterogeneity of farming households is essential for the realization of broadly based participatory development in the region.

The mix of floodplains and irrigation schemes in an area was therefore an important criterion in the selection of research sites. Using the relative presence of recession and irrigation land (strong, average, weak) as a major criterion, geographical knowledge of the area (including the fact that irrigation is much more widespread in the Department of Podor than in Matam),

and various map resources[1] providing spatial images of each zone, four types of agricultural regions were distinguished (Table 1).

Table 1. Types of Agricultural Regions[a]

Category	Waalo	Irrigation	Location
1	weak	weak	Extreme southeast of the Department of Matam
2	strong	weak	Center and west of the Department of Matam
3	strong	strong	Center and east of the Department of Podor
4	weak	strong	Extreme west of the Department of Podor

[a] Waalo is flood recession land.

The first category—weak waalo/weak irrigation—is found in the extreme southeast of the Department of Matam (Arrondissement of Semme). Spurred by the Sahelian drought of 1967-1974, small-scale irrigation spread rapidly in the Middle Valley. By 1985, 522 small perimeters, which extended over an area of 10,000 hectares and involved over 35,000 households, had burgeoned on both sides of the river (Diemer and Van der Laan 1987:47). The area of Semme was not so favored, however. This omission was probably prompted by higher rainfall in the Semme area than in the downstream regions, even in the deficit years. Higher rainfall has also caused Semme to be favored by many herder groups, whose permanent villages are upstream but who gather here at the outset of the rainy season to allow their animals to graze and browse, hoping to gain cultivation rights to land in the *jeeri* (rainfed agricultural land).

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[1] In this effort several map resources were consulted. These include:

- The work carried out in 1971-1973 by André Lericollais and Yveline Diallo, which appeared in 1980 under the title, *Peuplement et cultures de saison sèche dans la vallée du Sénégal* (ORSTOM). The work consists mainly of a series of maps at the 1/50,000 scale (Lericollais and Diallo 1980).

- The 1986, 1988, and 1989 SPOT maps of the flood, commissioned by OMVS and reproduced at a 1/50,000 scale by Samba Dia of OMVS (Dia 1987, 1989).

- The SAED maps for the *délégations* of Podor and Matam (SAED 1985). These 1/100,000 scale maps indicate the location of irrigated perimeters and their surface area.

- The 1969 FAO/PNUD/OERS maps at a 1/50,000 scale (FAO, PNUD, OERS 1969).

The second category—strong waalo/weak irrigation—includes the rest of the Department of Matam. It is in the lower portion of the department (Arrondissement of Thilogne, roughly between Kobilo and Orefonde) however, where one encounters this extreme contrast between the presence of vast tracts of *waalo* land and the nearly total absence of irrigation. The Diamel, a distributary of the Senegal River, originates downstream from Matam, feeding several cuvettes that supply water to irrigated schemes on both sides of the river. Starting near Kobilo,[2] it disperses among a vast number of *marigots* (creeks) that culminate in what is known as the Plain of Thilogne. Accordingly, this part of the valley is among those best endowed with waalo land, but with few permanent sources of water that would make irrigation possible. These very features have given the area a high population density but also, with deteriorating conditions of hydrology and rainfall, large-scale emigration. Ironically, this emigration has made it one of the most prosperous regions in the Fuuta.[3]

A fairly large number of irrigation perimeters, especially village irrigated perimeters (*périmètres irrigués villageois*—PIVs), exist in Matam's arrondissements of Kanel (center-east) and Ogo—formerly known as Ourossogui—(center-west), along large areas of floodplain. In general, however, access to recession cultivation is much greater than access to irrigation in these arrondissements.

The third category—strong waalo/strong irrigation—is found primarily in the east and center of the Department of Podor. In this region, where uncertain rainfall makes rainfed agriculture very hazardous, another distributary, the Doue, runs parallel to the Senegal River and to smaller defluents (such as the Gayo) for approximately 150 km, enabling both recession and irrigation farming to take place.

Downstream from Podor (Arrondissement of Thille Boubacar), the alluvial valley narrows, creating a considerably smaller floodplain. Recession cultivation is restricted largely to horticultural production on the riverbanks, or falo, where relatively large garden plots may be found. A substantial amount of irrigation compensates for the scant possibilities for recession cultivation and the precarious conditions of rainfall, putting this area in category four.

The basic unit of analysis in SRBMA II has been the **production space (PS)** exploited by a group of historically connected villages (Figure 1 and Table 2). In the nine production spaces that have been selected (containing 32 villages overall), the relative dominance of floodplain (recession cultivation, herding, fishing) and irrigation activities is assessed by examining the comparative productivity of these systems in terms of land, labor, and capital, and by determining household production goals and labor strategies in the context of a set of

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[2] A mid-sized irrigated perimeter that was envisaged for Kobilo as part of SAED's program for Matam, Phase III, had to be deferred because of anticipated water supply difficulties.

[3] Generally, the region inhabited by the Fulbe, largely herders.

Figure 1. Research Zones: Departments of Matam and Podor

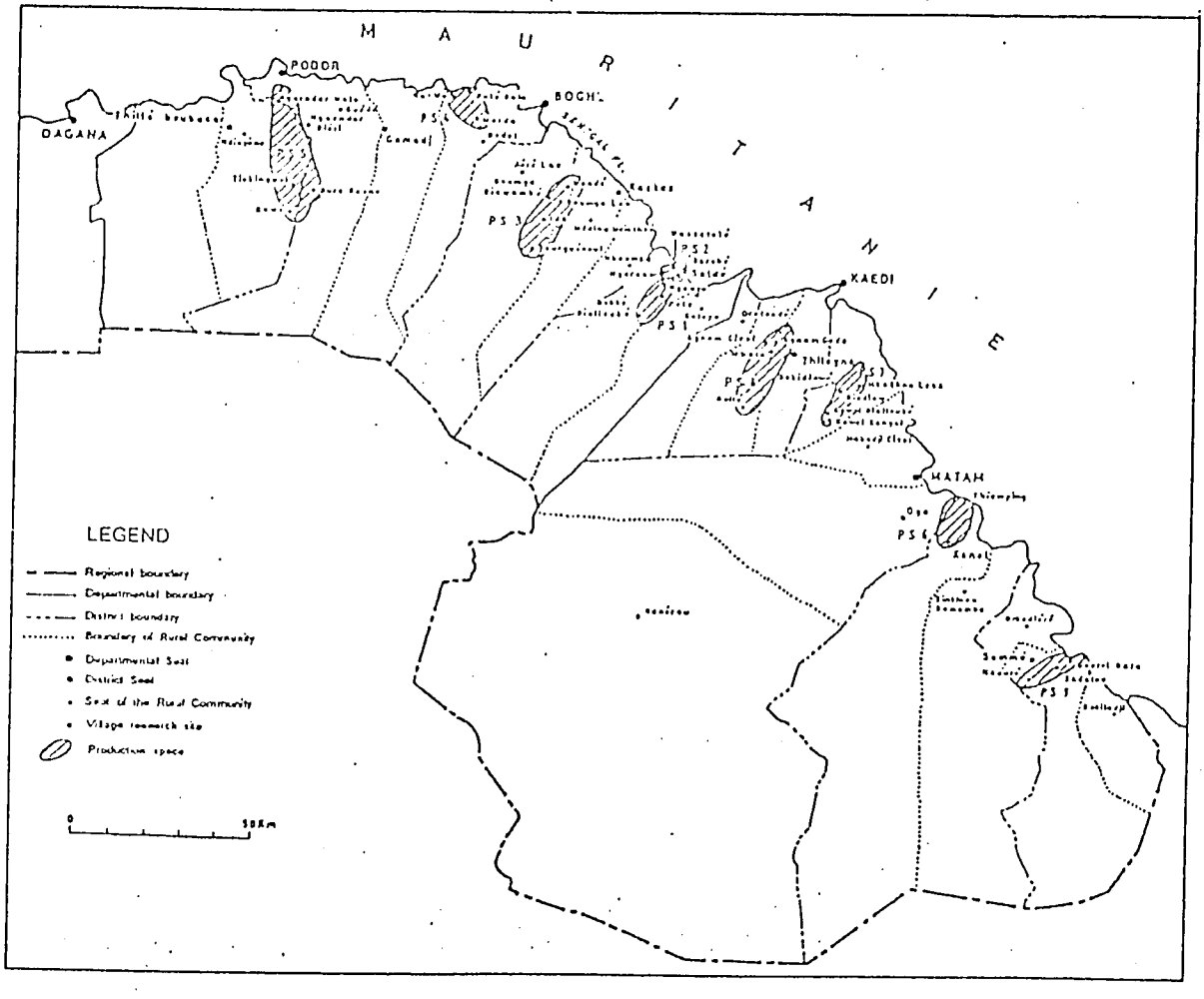

Table 2. Production Spaces (PSs) Studied under SRBMA II

Department	Arrondissement	PS No.	Villages	Research Assistant
M A T A M	SEMME	PS 9	Haoure Sadatou Gourel Dara	Mamadou Oumar Diallo
	KANEL	PS 6	Thiemping Kanel	Moussa Diop
	OGO	PS 7	Doumga Rindiaw Kaawel Dialloube Kaawel Cangal Mbakhna Less	Nafissatou Sow
	THILOGNE	PS 8	Agnam Godo Agnam Civol Belle Mberla	Mamoudou Athie
P O D O R	SALDE	PS 1	Ngouye Pete Boke Dialloube	Moussa Kane
		PS 2	Wassatake Barobe Ngarane	Moussa Ba
	CASCAS	PS 3	Doumga Lao Doumga Diawambe Wande Ida Tourguenol	Mohamadou Camara
	GAMADJI	PS 4	Pate Galo Wa-Wa Marda	Elimine Sow
	THILLE BOUBACAR	PS 5	Nguendar Jeeri Nguendar Waalo Kawe Ouro Boune Tekinguel	Aissata Ba

incentives and constraints. In this fashion, one production space was identified in each of the arrondissements of Semme, Kanel, Ogo, Thilogne, Cascas, Gamadji (the former Arrondissement of Ndioum), and Thille Boubacar. The Arrondissement of Salde in the Department of Podor was considered sufficiently complex to require two PSs.

II. THE POLICY CONTEXT

The summary findings from Phase I (Horowitz and Salem-Murdock 1990) reveal a changing policy environment with respect to river basin development and hydrological management of the Manantali Dam. The policy optic of the tri-member river basin authority, OMVS (Organisation de Mise en Valeur de la Vallée du Fleuve Sénégal), initially envisaged a

period of transition in which seasonal variation in river flow (flood peaks and dry-season troughs) would gradually be evened out resulting in a nearly constant flow throughout the year. Area farmers would be allotted a short period of time (approximately ten years) in which to make the transition from customary recession farming to full-time engagement in irrigated agriculture. In the meantime, controlled water releases from the Manantali Dam were to simulate natural flood conditions and enable the local peasantry to continue to undertake cultivation of the fertile floodplain bottomlands.

Based on the research findings of SRBMA I (summarized below), a revised policy stance in favor of the long-term maintenance of a controlled flood was adopted by the government of Senegal (Horowitz and Salem-Murdock 1990). Hydrological data demonstrated conclusively that in all but the severest drought years (of which there were only eight between 1904 and 1984), a controlled release from Manantali assuring a minimum flood of 50,000 ha would not jeopardize the minimum hydroelectric output desired of 86 megawatts of power (ibid.:33). In this respect, the government of Senegal had taken a bold stance in opposing the position of its neighboring states and constituent members of OMVS, Mauritania and Mali, who continue to embrace a policy of flood cessation and a full transition to irrigation technology at the cost of total abandonment of recession farming.

Despite the Senegalese position, the early phase of post-dam management at Manantali has yet to set a clear policy guideline with respect to instituting a controlled flood release for the benefit of area farmers, fishers, and herdsmen. Close monitoring of dam releases at Manantali from 1988 to 1991 indicates that in only the first year, 1988, was any successful attempt made to replicate the natural flood cycle. From 1989 to 1991, water releases have either been too small to affect a flood (1990) or poorly timed in relation to discharge from two principal distributaries, the Faleme and the Bakoye.

In a macroeconomic context, current policy directives aimed at restructuring the Senegalese economy work to the disadvantage of the individual smallholding peasant. Agrarian reform initiatives carried out by the state, such as the New Agricultural Policy (1984) and an IMF-mandated Structural Adjustment Program in the 1980s, have created a policy environment in which commodity markets in land, labor, and capital are being liberalized and disengaged from the public monopsonies of the state. In particular, the withdrawal of government subsidies for producer inputs (infrastructure, seed, fertilizer) from the agricultural sector is placing a greater share of the capital burden on the shoulders of the smallholder. In the Middle Senegal Valley, this structural change will translate into rising producer costs for irrigated rice farmers who are already hard pressed to invest adequate sums of capital at current low levels of crop output.

III. SUMMARY OF SRBMA I RESEARCH FINDINGS

The findings of SRBMA I research argue in favor of preserving a seasonal wetland ecosystem by means of a regularized controlled flood from the Manantali Dam. Such a strategy would enhance the array of diversified production activities available to area smallholders on and

off the farm. It is posited that the net benefits accruing at local, regional, and national levels under such a dam management strategy will exceed those that would result from a planning strategy that suppresses natural flood conditions in order to maximize hydroelectric and irrigation output (Horowitz and Salem-Murdock 1990:11-35).

The SRBMA I research advocates a policy position of resource *diversification* (by instituting a controlled flood) rather than resource *homogenization* (by an exclusive commitment to irrigation technology) on economic, environmental, and sociopolitical grounds. The most salient findings from the initial research phase supporting this conclusion are addressed below.

A. Economic Considerations

1. A Cost-Benefit Comparison of Recession and Irrigated Agriculture

Principal Research Finding:

> *Recession agriculture provides a comparative advantage over irrigation in two out of three production factors, labor and capital.*

The ability of many families to meet their reproductive needs, particularly in food production, depends in large part on their labor capacity and capital resources. Each family is faced with a critical decision affecting its reproductive welfare during the course of its domestic developmental cycle—when to retain labor for on-farm production, and at what point to export it for the economic needs of the household. The research findings from SRBMA I demonstrate in quantitative terms that recession farming, with its low input requirements, is the agricultural strategy most compatible with optimizing the mobility of labor and capital, both on-farm in producing food crops, and off-farm in generating revenue in urban areas. Irrigated farming, on the other hand, proves to be the most constraining of all production alternatives, leaving little room for allocating labor and capital in other productive domains.

While this simple finding may be self-evident, it is this basic observation, supported by hard data, that is grossly overlooked in the current planning of the river basin. Development authorities in the region are easily beguiled by the convincing logic of superior crop yields, or returns per unit land, in rice cultivation. But it is the central adaptive feature of customary floodplain farming—the modest endowment of labor and capital—that proves highly compatible with the uncertainties of a mutable regional ecology and flagging socioeconomy. By continuing to practice a form of low-input agriculture, Middle Valley smallholders are able to minimize risk on the farm while concurrently optimizing the allocation of scarce labor and capital both for on- and off-farm subsistence and for revenue-generating opportunities. Herein lies the oppositional logic of the peasant and the state: the survival of the former is defined by a strategy of diversifying resources and minimizing risks; the national and regional food-security objectives of the latter are defined by a policy of homogenizing resources and maximizing production.

The conclusions here are supported by a cost-benefit analysis comparing the returns to land, labor, and capital in a sample study of recession cultivators and irrigated rice farmers at three village sites in the Middle Valley (Horowitz and Salem-Murdock 1990:11-19). In comparing the crop yields attained in both systems, the superior output of irrigated crops goes unquestioned. The relative success of irrigated agriculture in boosting crop productivity beyond that found in customary regimes, however, involves a sizable investment of labor and capital that is generally downplayed by irrigation proponents. When production outlays (land use and cash costs) are factored into the cost-benefit equation, irrigation loses much of its edge as a superior production strategy. Data from the cost-benefit analysis show that while rice production outstrips sorghum yields by a considerable margin, a disproportionate increase in the amount of labor and capital is required in order to achieve higher yields.

2. Floodplain Intensification

Principal Research Finding:

> *Intensification on the floodplain, including returns to farming, fishing, and herding, exceeds that on irrigated perimeters.*

Attempts to bolster irrigation production by the government of Senegal have been based on a projected rate of intensification of production of 1.60 (GERSAR/CACG et al. 1990:96). This means that of the total surface area developed for production, 160 percent will be farmed in a given year. This translates into a double cropping season (wet and dry seasons) in the irrigated perimeters. Horowitz and Salem-Murdock (ibid.:20) point out, however, that the current per annum rate of intensification is only about half the projected figure above, or 0.83. Goals by the state to double the rate of intensification in a short time frame, then, seem highly optimistic and very difficult to attain.

Customary use of the floodplain for farming, fishing, and herding activities provides a rate of intensification that is unmatched by irrigation regimes, however. The sequence of recession farming, floodplain fishing, and herding on the valley bottomlands enables area smallholders to exploit the wetland ecosystem during much of the year, and thus provide for an extensive network of exchange of grain, fish, and dairy products among the diverse communities of the region. An estimation of the market value derived per hectare from the primary products of the floodplain—sorghum, fish, and livestock—proves to surpass that generated from rice production in the irrigated perimeters (Horowitz and Salem-Murdock 1990:20-26).

B. Environmental Considerations

1. Forest Regeneration

Principal Research Finding:

> *The* Acacia nilotica, *a valuable woodland species in the Senegal River Valley, is dependent on periodic flooding of the valley floor for its regeneration and survival.*

The Senegal Valley floodplain is colonized by vast tracts of *Acacia nilotica* (French: *gonakié*), a large portion of which has been cleared over time to make full use of the land for floodplain recession agriculture. This hardwood species is extremely important to the regional ecology and economy, and it is integrally linked to the river's natural flood regime for its survival. Germination occurs through such natural seed-dispersal mechanisms as flooding and the grazing and browsing of the seed pods by small ruminants. The tree is cut for fuelwood and used as local building material, and the forests provide a refuge for large nesting bird flocks (van Lavieren and van Wetten 1990:21). Woodland galleries like these provide not only a protective canopy for the seasonal migration and refuge of many European birds and waterfowl, they also provide shelter to rapidly dwindling numbers of small primates such as the red monkey, and act as a fertile habitat for the seasonal migration and reproduction of riverine fish.

2. Fisheries Regeneration

Principal Research Finding:

> *The annual volume of freshwater fisheries is directly dependent on the magnitude and duration of flooding of the inner-lying plains that serve as the vital feeding grounds for spawning and biological reproduction of riverine fish.*

The annual flooding of bottomlands provides a temporary aquatic habitat essential to the growth and proliferation of freshwater fish. Their reproductive success is integrally tied to the flooding of these lowland plains where the seasonal discharge of sediment and decomposition of deposited plant and animal detritus creates a nutritional environment ideal for the spawning and growth of young fry. The maintenance of biospecies diversity of fish populations in the region depends on the annual flooding of the region's inner plains.

3. Domestic Water Supply

Principal Research Finding:

> *Catchment areas in the Senegal Valley reduce surface runoff by absorbing much of the rainfall and seasonal floodwaters, thus acting as a natural reservoir for ground aquifer recharge.*

Groundwater recharge in the Middle Senegal Valley has been demonstrated to come, in part, from the valley wetlands. Concern over cessation of natural flooding and the effects on potable water supply was raised in the SRBMA I study (Horowitz and Salem-Murdock 1990:29-30). Hydrological studies by Hollis (August and November 1990) confirm that shallow aquifer recharge is flood dependent. Horowitz and Salem-Murdock (1990:30) estimate that a drop in water tables and loss of potable water supply would necessitate the drilling of 64 borehole wells at a cost of approximately 9,590,400,000 FCFA. This finding exemplifies a lack of foresight on the part of river basin planners. Furthermore, it underscores the need for hydrological monitoring of groundwater tables in post-dam downstream operations in the region.

C. Other SRBMA I Findings

1. Social and Political Considerations

A decision to terminate flooding of the valley plains will reduce the production options available to local smallholders and raise the risk of human conflict by increasing competition for a dwindling resource base (Horowitz and Salem-Murdock 1990:3). This was the case in 1989, when violent conflicts over land on the Mauritanian right bank of the Senegal River led to the expulsion of thousands of villagers into Senegal and wide-scale expropriation of their valuable farm lands. The influx of refugees places added pressures on a shrinking resource base in Senegal and heightens the potential for future conflict.

2. Irrigation and Migration

In farming communities heavily dependent on customary recessional regimes, the loss of such fertile lands and the consequent shift to irrigation farming could have the paradoxical effect of accelerating rather than impeding migration outside the region. Research findings from the SRBMA I study suggest that adult male labor may increasingly seek off-farm wages in order to finance the rising capital costs of production in village rice schemes (Diemer and Van der Laan 1987:93,104; Horowitz et al. 1991:223). If one of OMVS's goals is to retain rural farm labor through the expansion of irrigation technology in the river basin, this observation points to a possible inconsistency between means and end.

3. Changing Gender Divisions of Labor

A pattern of extensive wage migration by adult males has prompted a restructuring of the gender division of labor in agriculture, whereby the shifting burden of production is increasingly being assumed by the most disadvantaged sectors of the population, women and children.

It is widely assumed that a restructuring of the age and gender division of labor in agriculture in the Senegal River Valley has placed a disproportionate burden of the workload on women and children. This position is partially borne out by the findings of SRBMA I on time studies of labor allocation in recession farming, where women make up a significant portion of the total labor force and provide approximately the same proportion of total labor input. Labor-

time allocation data on youth and children below the age of 15, on the other hand, are inconclusive, perhaps suggesting that they are underutilized in recession farming.

The strongest evidence of changing gender roles is in irrigated rice farming, where women are actively engaged in previously male-defined tasks such as weeding, seeding, and transplanting. In one study, women constitute a majority of the labor force available and provide nearly one-half the total labor invested in the perimeters.

4. Declining Productivity of Irrigation Perimeters

Poor performance on irrigated perimeters is related to their heavy production expenses and labor requirements and to customary land distribution and inheritance practices that gradually undermine producer group cohesiveness (Horowitz and Salem-Murdock 1990:17-18).

Farmers have become progressively indebted since 1986, as an era of state devolution and structural adjustment has shifted costs to the producer. A process of "disguised wage labor" has been observed in the SRBMA I study (Horowitz et al. 1991:216). Farmers short of capital, but with sufficient labor power, sharecrop the fields of landholders who find themselves in the opposite situation: short of labor but able to buy production inputs. Thus, the government aim to democratize land ownership through the establishment of irrigated perimeters has not been achieved. A dwindling number of rich farmers are financing the capital inputs of a growing majority of cash-poor farmers who are no longer able to cultivate their own fields. The long-term effect of this growing polarization between resource-rich and resource-poor farmers may be an increasing disparity in access to land and an intensification rather than diminution in the level of socioeconomic stratification among smallholders in irrigation.

Since the acceleration of irrigation agriculture in the Middle Valley in the 1970s, large numbers of perimeters have experienced deteriorating conditions of production, both physically, in terms of breakdowns in scheme infrastructure, and socially, in terms of the erosion of membership and organization in the PIVs. The smaller number of participants remaining in the cooperatives are called on to invest increasing amounts of labor in the repair of canals and maintenance of the schemes. The result has been a high rate of abandonment of perimeters. For every 2,500 ha of new lands brought into production each year, approximately one-half that amount is abandoned. Farmers who continue to work in the perimeters become more and more indebted as production costs must be shared by fewer and fewer participants. In response, a common strategy among smallholders until recently has been to reorganize cooperatives and establish new perimeters, benefiting from government subsidies for inputs. The movement of farmers from one scheme to another after accumulating heavy debts has been observed and described elsewhere in Matam Department as a strategy of "shifting irrigation" (Nuttall 1990:10-11).

5. Household Budgets and Food Security

SRBMA I's biweekly monitoring of income flows, expenditures, and food consumption patterns at the household level reveals that peasant families in the Middle Valley are heavily dependent on revenue generated outside the agricultural sector. Labor migration and petty trade are the primary sources of off-farm income, accounting for between 45 and 72 percent of household income in the study sample (Horowitz et al. 1991:261). From 50 to 80 percent of total household expenditures is spent on food (ibid.:263). As household incomes earned off the farm are critical in maintaining food security, families prefer to engage in agricultural activities that do not divert substantial sums of household revenue to production. Recession farming, which is virtually free of capital costs, takes precedence over irrigation in this respect, giving participation in a flood-dependent agrohaliopastoral production complex the advantage of freeing up labor seasonally for a broad array of farm and nonfarm activities necessary for the household's reproductive well-being.

In conclusion, the findings of SRBMA I demonstrate that it makes sound sense, on both economic and environmental grounds, to sustain downriver production patterns that are compatible, not competitive, with demands for hydroelectric power generation and capital-intensive irrigated agriculture.

IV. SUMMARY OF SRBMA II FINDINGS

It is important to note at the outset that the environmental context in which the SRBMA II study was carried out has been critical in shaping the outcome of the research findings. Seasonal deficits in precipitation in both Podor and Matam departments for 1990, 1991, and 1992 resulted in nominal, and often no, harvests on rainfed lands. These shortfalls in harvest were coupled with no floods or poor floods in 1990 and 1991 and ill-timed water releases from the Manantali Dam, which meant that smallholders lost floodplain crops as well. Market prices of sorghum rose precipitously in many of the areas of study at a time when farmers were forced to become buyers rather than sellers of this subsistence grain.

The SRBMA II researchers gathered information through formal questionnaires and informal interviews about a wide range of activities relating primarily to farm production and income generation. The most salient findings of the research, summarized below, include analyses of land tenure, labor time allocation by age and gender, returns to factor inputs, labor migration strategies and their implications for agricultural development, and household consumption patterns.

A. Land Tenure

A broad survey of land tenure in 32 villages in the 9 production spaces (PSs), involving 3,405 households or 28,803 persons, reveals the primacy of waalo recession lands in the repertory of production activities among area smallholders. Producers have greater access to waalo recession lands (68 percent) than to either falo river gardens (17 percent) or irrigation

parcels (30 percent).[4] This prominent position of floodplain agriculture in the Middle Valley suggests that curtailment of flooding would have serious consequences for a large number of households. A smaller, more detailed study of 331 households, shows that fewer than 40 percent were able to undertake waalo cultivation because of poor flood conditions during the study period. Many of these households are located in areas where access to an alternative production strategy, such as irrigation, is not geographically feasible. Thus they depend on ample flooding of the valley bottomlands for survival. Prolonged absence of flooding may force greater numbers of young males to seek wage labor opportunities outside the region or significant numbers of families to move to large urban centers such as Dakar.

1. Land Distribution

Access to agricultural lands is highly variable within any given production system and from one system to another. The findings that follow, on access by system and caste, result from the study's survey of waalo, falo, and irrigated systems.

- **Waalo lands.** Of 3,405 households, 1,090 or 32 percent have no access to waalo fields, while another 37 percent, or 1,253 households, have access to a single field (Table 3). This difference in access to land may be a function, in part, of the location of a given village: a village in the jeeri drylands, for instance, may be at some distance from an interior floodplain. The unique history of each locale also shapes patterns of land use that are determined by the social composition of caste groups in each setting.

Table 3. Distribution of Waalo Fields by Caste (number of households with access)

Caste	Number of Fields										
	0	1	2	3	4	5	6	7	8	10	Total
Fulbe	259	208	143	47	20	12	3	2	0	1	695
Toorobbe	322	464	296	102	31	9	3	1	0	0	1,228
Jaawambe	26	46	24	10	10	6	0	0	0	3	125
Sebbe	44	58	43	17	5	3	2	1	0	0	173
Subalbe	121	142	48	16	3	1	1	1	0	0	333
Nyeenybe	117	71	46	4	0	0	1	0	0	0	239
Maccube	178	243	105	26	10	1	1	0	1	0	565
Other	23	21	2	1	0	0	0	0	0	0	47
Total	1,090	1,253	707	223	79	32	11	5	1	4	3,405

[4] These percentages add to more than 100 because some households have access to more than one kind of land.

- **Falo lands.** Access to falo fields is even more restricted than access to waalo. Some 2,840, or 83 percent of all households surveyed had no access to river garden lands (Table 4). An additional 446 households, or 13 percent, had access to one field, leaving fewer than 4 percent of households with more than one field.

Table 4. Distribution of Falo Fields by Caste (number of households with access)

Caste	Number of Fields						
	0	1	2	3	4	5	Total
Fulbe	638	47	10	0	0	0	695
Toorobbe	1,066	141	19	2	0	0	1,228
Jaawambe	120	4	1	0	0	0	125
Sebbe	122	42	7	2	0	0	173
Subalbe	120	145	42	21	3	2	333
Nyeenybe	219	19	1	0	0	0	239
Maccube	510	46	8	1	0	0	565
Other	45	2	0	0	0	0	47
Total	2,840	446	88	26	3	2	3,405

- **Irrigated lands.** Access to irrigated plots is similar to access to falo. Of the 3,405 households, 2,386, or 70 percent, had no access to irrigation, while another 20 percent, or 671 households, had access to a single plot (Table 5).

Table 5. Distribution of Irrigation Fields by Caste (number of households with access)

Caste	Number of Fields								
	0	1	2	3	4	5	6	7	Total
Fulbe	607	76	8	3	0	1	0	0	695
Toorobbe	820	230	162	11	4	1	0	0	1,228
Jaawambe	120	4	1	0	0	0	0	0	125
Sebbe	126	41	6	0	0	0	0	0	173
Subalbe	94	154	58	17	5	2	1	2	333
Nyeenybe	181	43	11	2	1	1	0	0	239
Maccube	398	119	46	1	1	0	0	0	565
Other	40	4	2	1	0	0	0	0	47
Total	2,386	671	294	35	11	5	1	2	3,405

Further findings on land access in relation to social standing (caste status) reveal differential levels of ownership and use rights within the various production systems. As noted, this is to some extent a function of the geographical location of the various social groups in relation to the environmental niches in which particular production activities are carried out. Below is a summary of some salient findings concerning the status of caste groups with respect to land tenure.

- **Toorobbe.** The most pertinent finding about this maraboutic caste of prominent social position is their advantaged position vis-à-vis access to irrigated lands (except for large-scale perimeters, only one of which was examined in the sample). Table 5 for the survey shows that Toorobbe, who comprise 36 percent of the households, had access to 42 percent of the 1,443 irrigation fields.[5] In the more closely studied sample of 331 households, Toorobbe made up 33 percent of the sample households but had disproportionate direct access (as owner/cultivator or as part of a collective group—*in joowre*) to irrigated parcels: 60 percent of the plots in private perimeters, 52 percent in PIVs, and 50 percent in middle-sized perimeters. This appears to be in part a result of the sociopolitical power and position of this group in controlling land allocation and access to strategically valuable resources.

- **Subalbe.** As anticipated, the Subalbe fishermen are favored in their access to river falo lands: although fewer than 10 percent of the households in the survey, they had access to 43 percent of the falo fields. They constitute 8 percent of the households in the study sample, but own or cultivate jointly nearly 48 percent of the available falo plots. This finding confirms the historical position of the fishing caste, which has long held control of the river and its passageways, as well as much of the garden lands adjacent to these watercourses.

- **Fulbe.** The Fulbe (largely herders) control considerably smaller proportions of falo and irrigation land than their proportion of the survey (9 and 7 percent, respectively of the lands; 20 percent of the households). In both the survey and the sample, their access to waalo is about proportional to their representation among households. In rainfed jeeri cultivation areas, however, where large numbers of pastoral settlements are found, the sample shows somewhat higher Fulbe access to plots than their sample proportion. This finding is consistent with the seminomadic lifestyle of many herders, a mode of living that may preclude their engaging in agricultural activities on an extensive basis.

- **Nyeenybe.** The Nyeenybe are underrepresented in their access to all agricultural systems. As artisans, they have not been as dependent on land for their livelihoods as other castes. Their historically subordinate status in relation to their higher-status patrons remains intact insofar as it is reflected in their marginal position as landholders in the various agricultural production activities.

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[5] The number of fields, from the bottom line of Table 5, is 671x1 + 294x2 + 35x3 + 11x4 + 5x5 + 1x6 + 2x7, or 1,453.

- **Sebbe.** The Sebbe, former warriors compensated in land for their defense and protection of high-status maraboutic families, today maintain control of considerably more waalo plots than their proportions in the survey or the sample. Their access to falo also is relatively high in the survey.

- **Maccube.** The Maccube, former bond servants working largely as laborers in the fields of their masters, comprise nearly 17 percent of the survey and had access to 15 percent of waalo fields and only 9 percent of falo. The more detailed information of the sample, where Maccube made up over 20 percent of the households, indicates they have direct control over only 12 percent of waalo and 2 percent of falo fields, suggesting their continued marginal status as landholders in the Middle Valley.

2. Land Tenure in Irrigation

Irrigation units in the Middle Valley have undergone important changes in control from year to year. Those obtaining de facto ownership of perimeter parcels by such means as inheritance or purchase in the informal market are becoming more numerous, while original scheme participants are fewer. Several important findings on land use practices in irrigated perimeters may be drawn from the SRBMA II study.

- Regardless of the age of the perimeter, **the original recipients of parcels** ***(premières attributaires)*** **today remain the large majority of landholders,** averaging 68 percent of all owners. In only eight years (the average age of the perimeters studied), however, approximately one-third of all parcels have changed ownership. Thus, the jural principles of land registration by the state, meant in part to allow for more democratic access to land, are being eroded by actions of producer groups at the village level.

- The **redistribution of parcels** occurring at the initiative of the producer group, through subdivision and replacement of landholders, varies between 15 and 20 percent of all parcels issued, depending on the period during which the perimeter was created. This proportion is highest (20 percent) in perimeters created between 1988 and 1990.

- Land **access through inheritance** involves 8 percent of all parcels (194 out of 2,435). This figure is influenced by the age of the perimeter, however. The number of parcels inherited equals or surpasses 10 percent in irrigation units that are more than 12 years old (established before 1980).

- The **sale of parcels** constitutes an illegal transaction, but it occurs, nevertheless, involving 4 percent of all land (104 parcels). This is not a function of the age of the irrigated perimeter. Only 1 percent of all parcels in perimeters created between 1975-1978 were sold, while 9 percent were sold in perimeters established in 1979.

- **Access by women is limited.** In the irrigation units studied, women represent only 6 percent of all landholders (152 out of 2,435). They constitute barely 4 percent of present

holders who are original owners of land. Among all women cultivators, 16 percent obtained their parcels through inheritance. Women occasionally obtain irrigated land through purchase as well. Ten percent of all parcels held by women were obtained in this manner. The actual level of access by women to irrigated land remains modest, falling far short of their labor contribution in production and their economic role in the region.

- **Gerontocracy in the perimeters.** Irrigation is marked by the gerontocratic organization of production. Although the population in the Middle Valley engaged in irrigated production is relatively young, the average age of landholders in the schemes is older, 54 years. The average age of those owners holding parcels as original scheme participants (*première attribution*) is 56, while those subsequently receiving land by replacement of the original landowner or by inheritance is relatively young: 46 years for the former and 42 years for the latter. It is through inheritance, then, that the rejuvenation of membership within the producer group takes place.

- **Absenteeism in irrigation.** The absentee rate among landholders is relatively high, involving 19 percent (466 of 2,435) of all scheme members. This absence, largely of migrant landholders who earn income away form the irrigated perimeters, may be viewed both as a potential constraint, creating problems of absentee management, and as an advantage, a way of generating capital for purchasing production inputs.

These observations on land tenure in irrigated agriculture are especially important in relation to national policy on agrarian land reform. The National Domain Law of Senegal, promulgated in 1964, has yet to achieve its goals. Attempts at jural land reform, such as the National Domain Law and the Territorial Administrative Reform, have been undermined and restructured according to customary land use practices at the local level, practices that remain very strong in irrigated perimeters.

A second finding is that certain social groups that are heavily engaged in the region's economy, including women, youth, migrants, and castes of lower social standing, have been marginalized in their access to irrigated land. The traditional gerontocratic and aristocratic social structure has assumed a central role in the control of land in irrigated perimeters. The existence of these disparities, despite ideological concerns for equity and democratization, may become a major constraint on agricultural development in the region.

3. Summary Observations on Irrigation

Observations from the SRBMA I study on irrigation have been re-examined in SRBMA II. Expanding the scale of analysis to the 22 villages (of the 32 villages in the study area) that participated in irrigation farming, a number of conclusions derived from the initial pilot study were confirmed. These are summarized under three subjects:

(1) Organization of producers and land tenure practice in the perimeters

- access to irrigated land is not as democratic as has been assumed;
- peasant cooperatives, because of problems of land inheritance, gradually lose their cohesion and ability to mobilize labor;
- as the number of members forced to withdraw from production rises, it becomes increasingly difficult for the remaining producers to manage the sizable perimeters;
- as members withdraw and group cohesion erodes, costs of production become excessive for the remaining producers;
- the eventual result is dissolution and reorganization of producer groups and the creation of new perimeters.

(2) Paying for production costs

- irrigation is financed primarily by earnings from migration, but migration creates a scarcity of labor for production on the perimeters;
- producers without migratory remittances must finance production by selling off livestock, consequently reducing the level of inputs (such as fertilizer), and thus reducing crop yields.

(3) Tightening of the land tenure system

- the absence of a legal commodity market in land has resulted in share-tenancy arrangements that are contrary to the spirit of the National Domain Law, and in the abandonment of parcels, which keeps intensification ratios low;
- because of the acquisition and accumulation of land by a social stratum of gerontocratic elite, individuals of inferior social strata, women, and the young are excluded from organizational management and often from access to the perimeters.

B. Labor Time Allocation

1. By Type of Agricultural System

Distinct age and gender divisions of labor are a salient feature of agricultural production in the Middle Senegal Valley. In tandem with the growing absence of adult males from farm production in search of off-farm income, it is widely assumed that those segments of the population remaining on the farm—in particular women, children, and the aged—are increasingly being called on to make up for the resultant scarcity of labor. The research findings of SRBMA I noted earlier (section 3.3.3) only partially confirmed this hypothesis. Data collected on labor time allocation studies in SRBMA II point to the substantial involvement of women in most farming activities and are consistent with the preliminary findings of SRBMA I. The most important findings on labor deployment in each agricultural system include the following:

• Waalo lands. In a subsample of 15 households in each of 9 production spaces (135 households in total) we found that the contribution of men in recession farming was somewhat greater than that of women (60 percent vs. 40 percent). This is most evident in age groups 8 to 14, 46 to 60, and 60 and over (Table 6). **In the 15-to-45 age group, however, women contributed nearly the same amount of labor time as men (24 percent vs. 29 percent for men), suggesting that the labor contribution of the most productive segment of the female population is crucial to the reproductive welfare of Middle Valley households.** As has been noted, the significant involvement of women in this age group reflects primarily the sizable absence of male cohorts who have left the farm in search of migrant wages.

Table 6. Average Hours of Labor per Household in Waalo Fields, by Age and Gender: 1991-1992 (54 households)

Agricultural Operation	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total	0-7	8-14	15-45	46-60	61+	Total
Field Preparation	0	0.37	5.35	1.20	1.06	7.98	0	0.15	0.91	0.17	0.06	1.28
Planting	4.09	35.87	65.43	14.74	9.17	129.30	5.02	27.91	86.20	3.61	1.46	124.20
Replanting	0	0.52	2.50	0.39	0.15	3.56	0	1.30	1.83	0	0	3.13
Fence Construct.	0	4.44	1.78	1.70	0.41	8.33	0	0	0	0.07	0.28	0.35
Weeding/hoeing	1.43	45.63	86.48	23.89	11.28	168.70	0	0.31	6.46	1.50	0	8.28
Fertilizing	0	0.19	0.19	0	0	0.37	0	0.19	0.09	0	0	0.28
Transplant./thin.	0	0	0.26	0	0.20	0.46	0	0	0.41	0	0	0.41
Guarding	3.13	29.46	28.78	14.50	7.83	83.70	4.65	27.87	53.96	17.31	10.50	114.30
Harvesting	0.30	4.31	14.07	2.74	1.70	23.13	1.85	6.15	19.61	3.13	1.11	31.85
Threshing	0	0	7.28	0.59	0.15	8.02	0	0.52	7.65	0.35	0.89	9.41
Transporting	0.13	1.94	5.70	1.11	0.30	9.18	0.26	0.50	1.98	0.13	0	2.87
Other	0	0	0.19	0	0	0.19	0	0	0	0	0	0
All	9.07	122.74	218.00	60.87	32.24	442.92	11.78	64.89	179.11	26.28	14.30	296.35

• Falo/foonde lands. Older women, particularly those over 45, contributed more time (relative to men's time) to falo production in 1991/92 than to any other agricultural activity, with the exception of irrigated vegetable gardens. Overall, falo cultivation is the primary domain of women, who contributed 55 percent of total labor time in the fields (Table 7). Falo gardens offer women an important economic niche for generating small household revenues.

As with the falo gardens, foonde lands are farmed largely by women, who use them for small-scale production of vegetables, grains, and legumes. The proportion of labor time invested by women in foonde gardens is slightly greater than that in the falo and the highest among all regimes, at 62 percent of total labor inputs, with men providing 38 percent.

Table 7. Average Labor Hours per Household in Falo Fields, by Activity, Age, and Gender: 1991-1992 (46 households)

Agricultural Activity	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total	0-7	8-14	15-45	46-60	61+	Total
Field Preparation	0	0.65	3	1.59	0.57	5.80	0	0.13	1.5	2.09	0.07	3.78
Nursery Preparation	0	0	0	0	0	0	0	0	0.65	0	0	0.65
Planting	0.22	2.98	12.28	4.52	2.37	22.37	0.35	3.5	38.30	10.48	0.83	53.46
Replanting	0	0.04	1.39	0	0	1.43	0	0.13	1.15	5.28	0	6.57
Fence Constr.	0.15	1.57	5.65	1.87	0.35	9.59	0.78	1.02	2.07	0.63	0.04	4.54
Weeding	0.26	4.11	29.63	4.52	4.96	43.48	1.72	2.04	6.37	1.48	0.67	12.28
Irrigating	0	0	0	0.26	0	0.26	0	0	0	0	0	0
Fertilizing	0	0	0	0.021	0	0.02	0	0	0	0	0	0
Transplanting	0	4.96	10.54	0.35	0.11	15.96	2.89	3.41	8.41	1.98	1.70	18.39
Guarding	0	10.26	43.80	3.63	13.89	71.59	6.50	8.95	27.02	31.61	2.07	76.52
Harvesting	0	4.11	7.80	0.37	1.54	13.83	2.74	4.15	20.80	5.09	3.07	35.85
Transporting	0	1.91	5.65	0.07	0.43	8.07	1	1.74	8.78	0.85	0.52	12.89
Other	0	0.39	1.04	0	0	1.43	0	0.93	1.20	3.39	0	5.52
Total	0.63	30.98	120.80	17.20	24.22	193.83	15.98	26.02	116.26	62.87	8.96	230.09

- Jeeri lands. Production on jeeri lands was carried out almost entirely by boys and adult males between the ages of 8 and 60 (Table 8). Overall, males provided 85 percent of the total labor in the production system; males between 8 and 60 provided 75 percent. In both 1990 and 1991, the number of producers harvesting a rainfed crop was nominal (19 of 59 farmers who planted on jeeri in 1991, and 38 of 77 farmers in 1992) because of the scant and erratic nature of rainfall. Rainfed farming is the only agricultural regime in the region in which women are notably absent from production. This may be due in part to the arduous nature of weeding and field clearing, which are carried out almost exclusively by males.

Table 8. Average Labor Hours per Household in Jeeri Fields by Task, Age, and Gender: 1991-1992 (88 households)

Agricultural Operation	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total Task	0-7	8-14	15-45	46-60	61+	Total Task
Unknown	0	0.05	0.045	0.05	0	0.14	0	0	0	0	0	0
Field Preparation	0	9.88	12.61	4.94	3.28	30.72	0	0.10	0.60	0.14	0	0.83
Planting	2.28	24.36	39.68	6.68	6.64	79.62	2.73	7.63	24.18	3.01	0.96	38.50
Replanting	0.20	0.69	0.72	0.20	0	1.78	0	0	0.14	0	0	0.14
Fence Construct.	0.10	15.56	27.24	6.48	5.58	54.94	0.22	0.34	0.48	0.14	0	1.18
Weeding/hoeing	9.89	88.30	138.80	29.14	18.96	285.07	0.32	1.16	3.50	1.20	0.23	6.41
Irrigation	0	0	0.05	0.11	0.19	0.34	0	0	0.06	0	0	0.06
Transplant./thin.	0.08	0.15	0.31	0.30	0	0.83	0	0.30	0.30	0	0	0.59
Weeding/irrig.	0	0	2.97	0	1.63	4.59	0	0	0	0	0	0
Guarding	10.64	16.69	24.10	10.32	6.85	68.59	3.90	12.13	12.75	1.14	1.70	31.62
Harvesting	0.60	5.61	11.29	1.21	2.41	21.11	0.08	1.85	10.44	0.74	0.13	13.24
Threshing	0	0	0	0	0	0	0	0.07	0.07	0	0	0.14
Transporting	0	1.24	4.26	0.66	0	6.16	0.06	0.36	1.74	0.07	0.09	2.31
Other	0	0	0.18	0	0	0.18	0	0	0	0	0	0
Total	23.76	162.49	262.24	60.06	45.52	554.07	7.31	23.93	54.23	6.43	3.10	94.86

- Irrigated lands. Despite its high labor and capital demands and its relatively recent emergence in the area, irrigation has become an important component of the agricultural production system in the Middle Senegal Valley. Theoretically, irrigated parcels are cultivated three times a year—in the rainy season, the off-cold season, and the off-hot season—but the reality is otherwise. While 48 of our subsample households cultivated private village perimeter (PIV) plots in the rainy season, only 18 households cultivated in the off-cold season and 10 in the off-hot season. There are substantial seasonal differences in labor hours as well. While the average household in PS 6, for example, expended 2,549 labor hours in the rainy season, the off-season average number of labor hours amounted to only 217 (Table 9). When the difference between energy expended in the rainy and cold seasons is small it is not because farmers are putting more energy into the off-season crop, but because farmers could not or would not work for many hours on the rainy season crop, as in PS 1.

Irrigated rice farming is very labor intensive, easily surpassing the labor demands of jeeri farming and recession cultivation, especially when we consider labor per hectare. Yet the net returns per unit of labor are low, ranging from minus 6 FCFA for PS 1 to plus 150 FCFA for PS 4.

Table 9. Average Hours of Labor per Household in PIV Fields in Three Seasons, by PS: 1991-1992[a]

PS	Rainy Season	Cold Season	Hot Season
1	189	168	0
2	670	0	0
3	581	283	0
4	586	46	160
6	2,549	217	0
7	621	0	238
9	125	125	0

[a] PS 5 and PS 8 have been excluded because they had no PIVs.

2. Labor Inputs in Agricultural, Nonagricultural, and Domestic Farm Activities

Three sectors of household labor activity were observed and recorded in relation to age and gender: agricultural, nonagricultural, and domestic. Findings from these three data sets provide the observations that follow.

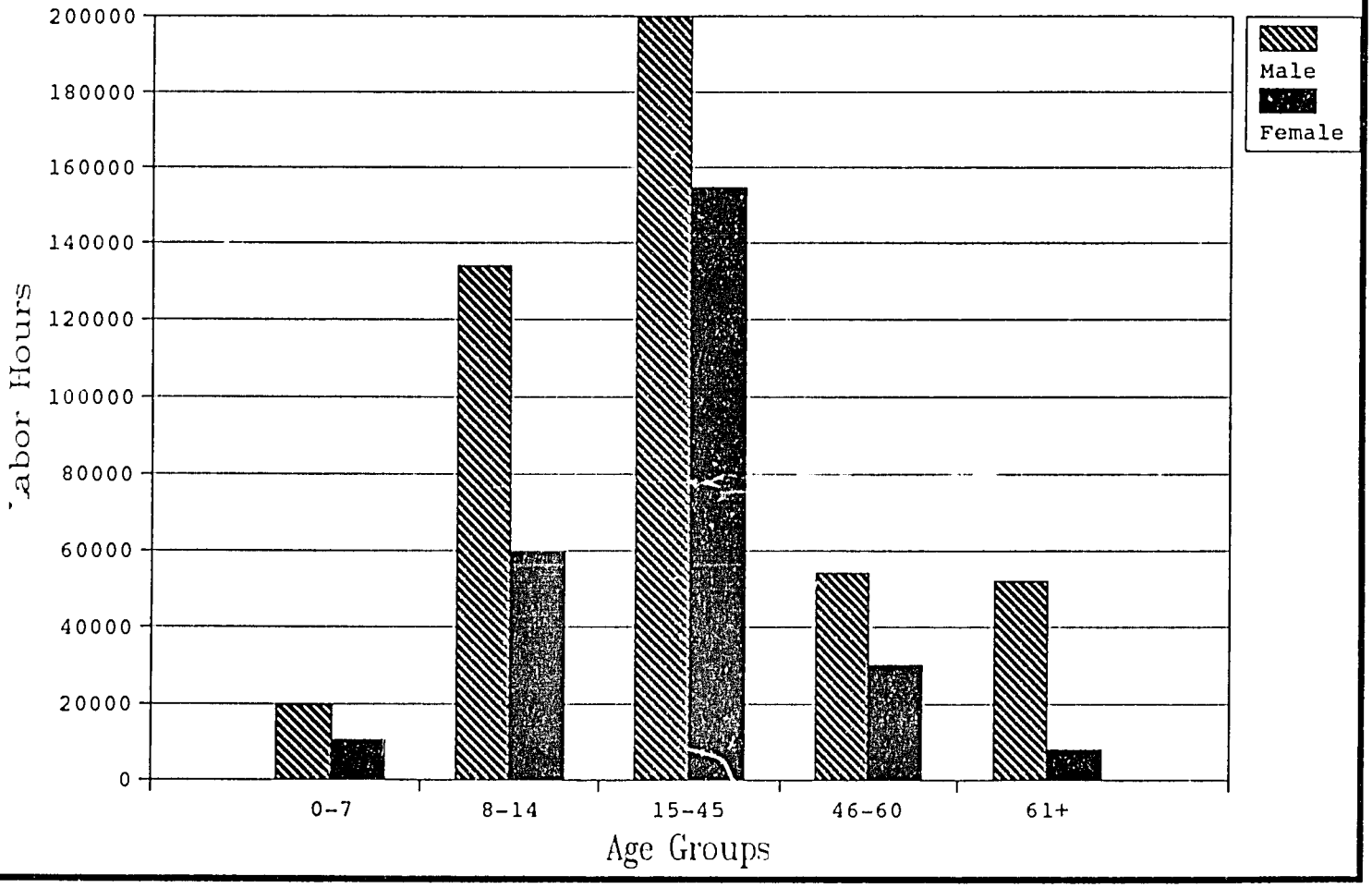
- **Agricultural labor**

Two different sets of data were collected with respect to agricultural activities. Farm-level data, referring specifically to agricultural field tasks, were gathered from a subsample on a biweekly basis during the course of each production cycle. A second data set on household agricultural labor was collected monthly throughout the course of a year. This information was solicited in a 24-hour recall period and involved the entire sample of 331 households. The labor data presented below involve all agricultural production systems in the study zones (recession, rainfed, and irrigation).

For all agricultural tasks, and in all age groups, men spend more hours in agricultural activities than women (Figure 2). Of the total hours recorded for production, male labor constituted 63.7 percent; those of ages 15-45 provided the largest proportion (27.7 percent). Women of this same age group contributed the next largest proportion of labor (21.4 percent) of total hours. This finding confirms the observation made earlier above that women in their most productive adult years contribute significantly to farm production in the absence of their adult male counterparts.

Fig. 2. Male and Female Differential

Agricultural Labor Input



Nonagricultural labor

As Figure 3 shows, men are much more involved in nonagricultural tasks than are women. These include commerce, fishing, artisanry, such service-oriented activities as tailoring, baking, and butchery, salaried labor, herding, hunting and gathering, and schooling. Among all activities considered nonagricultural, the category that for all schooling activities (including French, Arabic, Koranic, and Pulaar literacy), is the single most time-consuming activity for men. Since education in all its forms is geared much more toward males than females, especially in the age groups 8-14 and 15-45, the inclusion of schooling skews the data on nonagricultural activities in favor of males. While males in these two age groups spend 108,319 and 78,799 hours respectively on schooling, females cohorts spend only 29,119 and 25,139 hours (Figure 4).[6] In the age group 46-60, however, men and women are almost equally likely to be involved in schooling—in this case literacy training—with women exceeding men by a small margin.

The largest gap in schooling activities is in the age groups 8-14 and 15-45. For the youngest group, children 7 and under, almost half as many girls attend school as boys. The proportion of boys to girls increases as they get older (8-14), as girls are pulled out of school at an earlier age than boys. Girls in the age group 15-45 spend more hours on schooling activities, on average, than those between 8-14, however. The gender gap in the age group 15-45 narrows because some boys also leave school as they get older and some attend school elsewhere. The upper end of this age group includes adults attending literacy training classes, in which the number of women sometimes exceeds the number of men.

Thus, the narrowing of the schooling gap between women and men aged 46-60 may be a function of the dramatic increase of literacy in Pulaar in the Senegal River Valley. Literacy teachers say that women frequently are far more enthusiastic about literacy than men and attend classes more regularly. The proportion of women declines after the age of 61.

A quite different portrait emerges when we examine involvement in nonagricultural activities by gender but exclude schooling (Figure 5). While the male/female gap in nonagricultural activities remains, the magnitude is far less. Gender differences in age groups 0-7, 46-60, and 61 and older are almost unchanged, but the gaps between the male and female age groups 8-14 and to a lesser extent 15-45 are substantially reduced: in the school-age groups, girls attend school with far less frequency than boys, and the gap between boys and girls increases as the age goes up.

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[6] Schooling as a nonagricultural activity covers only what occurs in the village. Boys and girls who attend school outside the village are included in the category "miscellaneous activities," although they are coded as being absent from the village for schooling purposes.

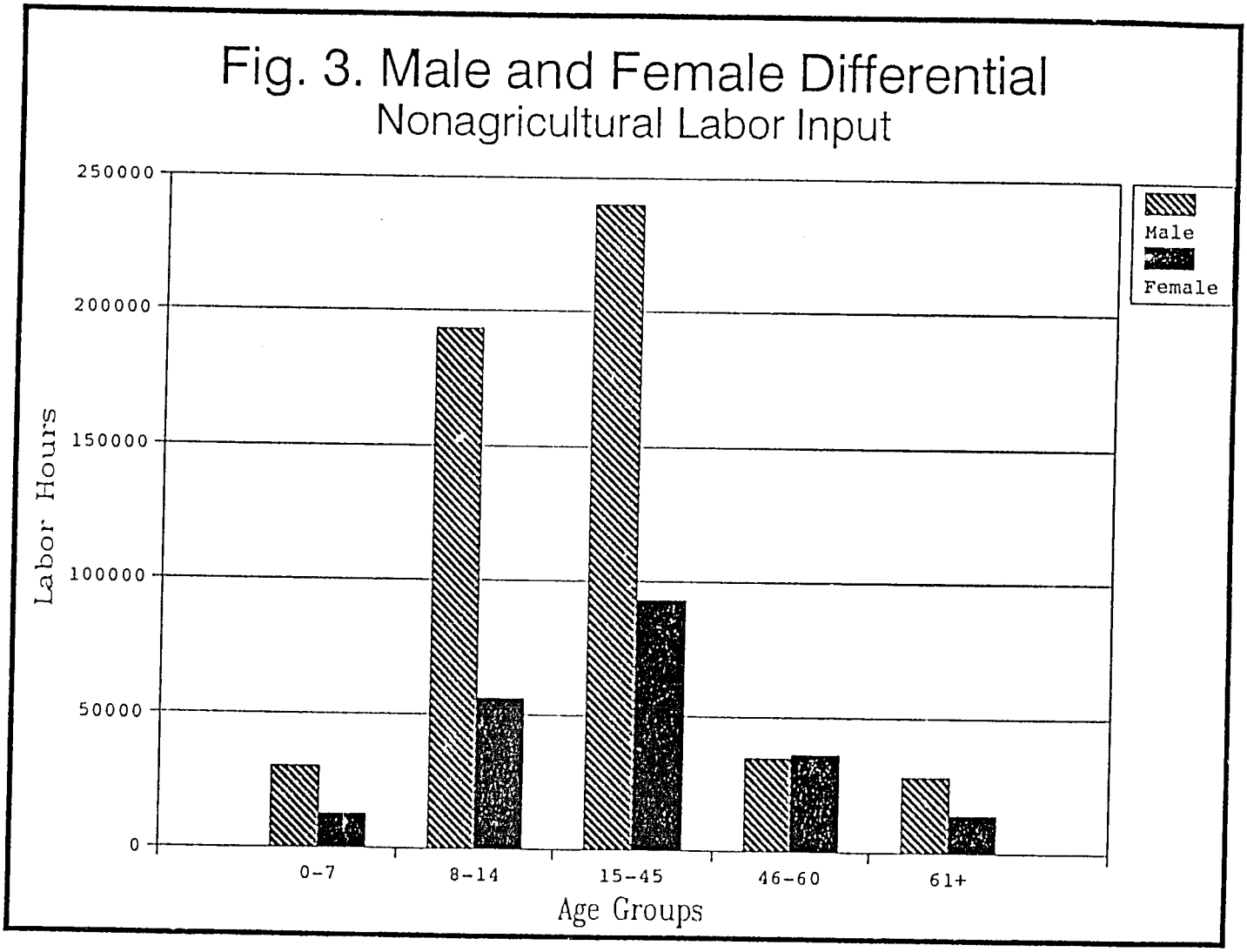


Fig. 3. Male and Female Differential
Nonagricultural Labor Input
250000
200000
150000
100000
50000
0
Labor Hours
0-7
8-14
15-45
46-60
61+
Age Groups
Male
Female

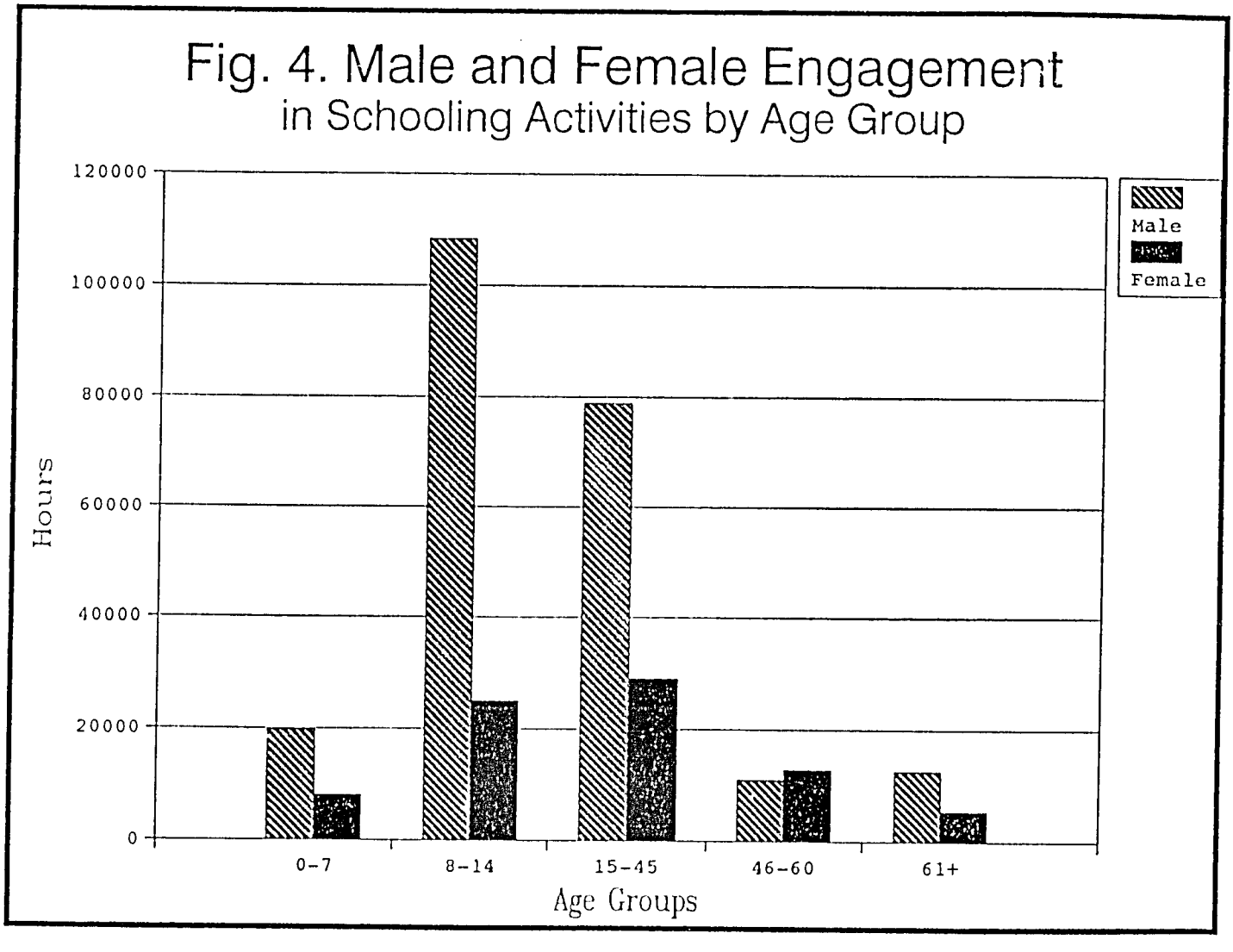
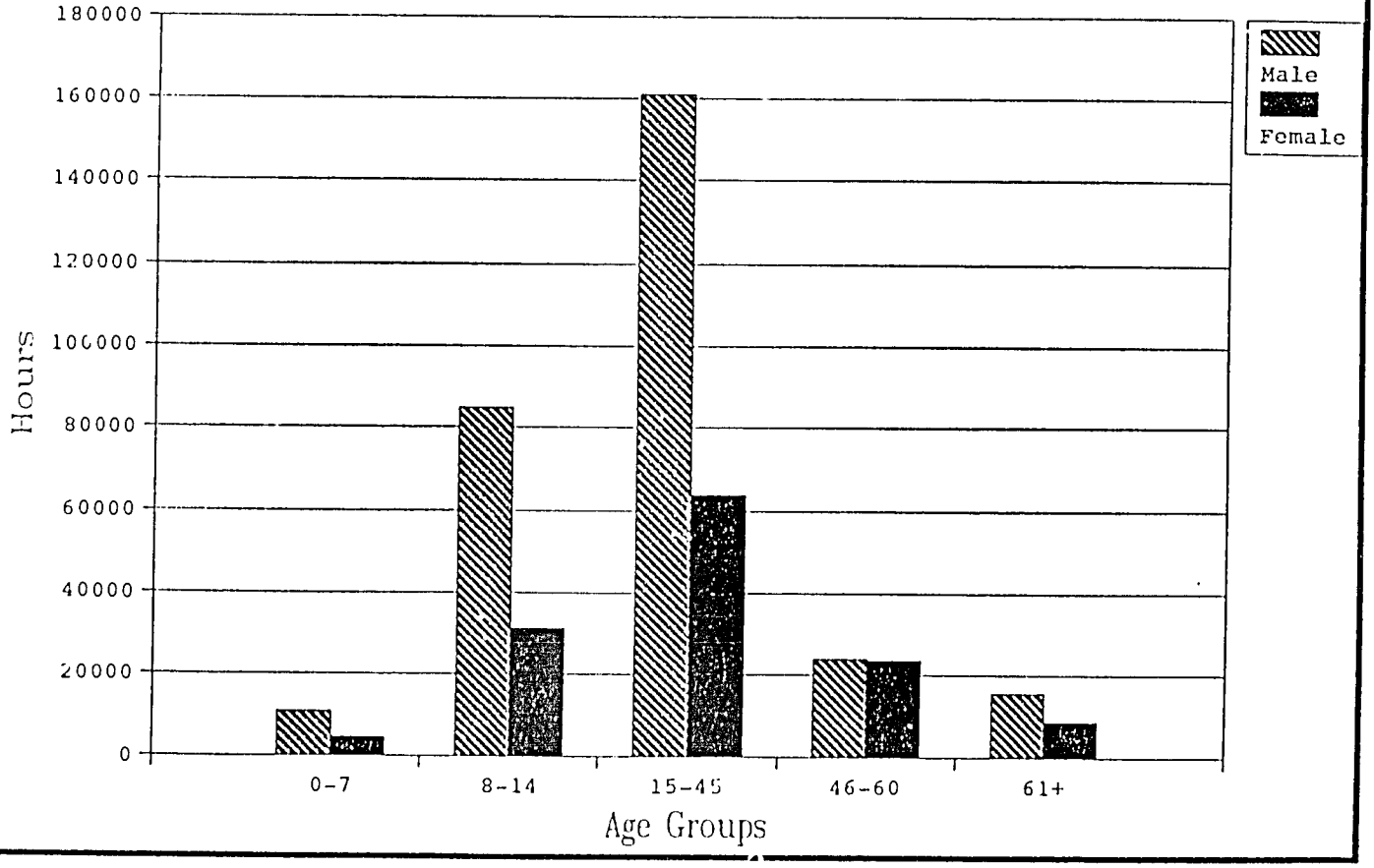


Fig. 4. Male and Female Engagement
in Schooling Activities by Age Group
120000
100000
80000
60000
40000
20000
0
Hours
0-7
8-14
15-45
46-60
61+
Age Groups
Male
Female

Fig. 5. Male and Female Engagement in Nonagricultural Activities Excluding Schooling



Domestic labor activities

Women are much more involved in domestic activities than men, as would be expected. The level of activity steadily increases after childhood and declines only late in life, after age 60 (Figure 6). The activities most commonly engaged in are food preparation and the collection of firewood and water.

C. Returns to Production Factors: Land, Labor, Capital

Table 10 compares average yield per hour of labor, average yield per hectare, average expenditure per hectare, and average labor hours per hectare for irrigation, distinguishing among large-scale perimeters (GPI), middle-scale perimeters (CIN), private irrigated perimeters (PIP), village irrigated perimeters (PIV), and irrigated vegetable gardens (MJF); waalo (WLO); falo (FLO); jeeri (JRI); and foonde (FND). Among the 405 parcels cultivated by the subsample from which we gathered extensive farm labor data, one-third (131 of the 405) yielded no harvest, telling evidence of the risks associated with agriculture, especially dryland farming, in the Senegal River Valley.

Table 10. Land, Labor, and Capital Productivity: 1991-1992 (405 parcels)

Agricultural System	Average Yield per Hour (FCFA)	Average Yield per Ha (FCFA)	Average Expenditure per Ha (FCFA)	Average Hours of Labor per Ha
Irrigation: Mid-Scale Perimeters (CIN)	252	385,436	80,336	1,531
Falo (FLO)	160	220,939	4,512	1,381
Foonde (FND)	24	13,207	1,410	557
Irrigation: Large-Scale Perimeters (GPI)	275	209,508	52,630	761
Jeeri (JRI)	27	5,562	869	209
Irrigated Vegetable Gardens (MJF)	17	27,358	17,656	1,589
Irrigation: Private Irrigated Perimeters (PIP)	5	13,644	37,520	2,849
Irrigation: Village Irrigated Perimeters (PIV)	135	196,581	35,040	1,454
Waalo (WLO)	140	37,772	1,836	271

In order to make comparisons among the differently valued crops, we converted the physical weights (in kilograms) into monetary values, using average prices received by farmers or average market prices for a given season.

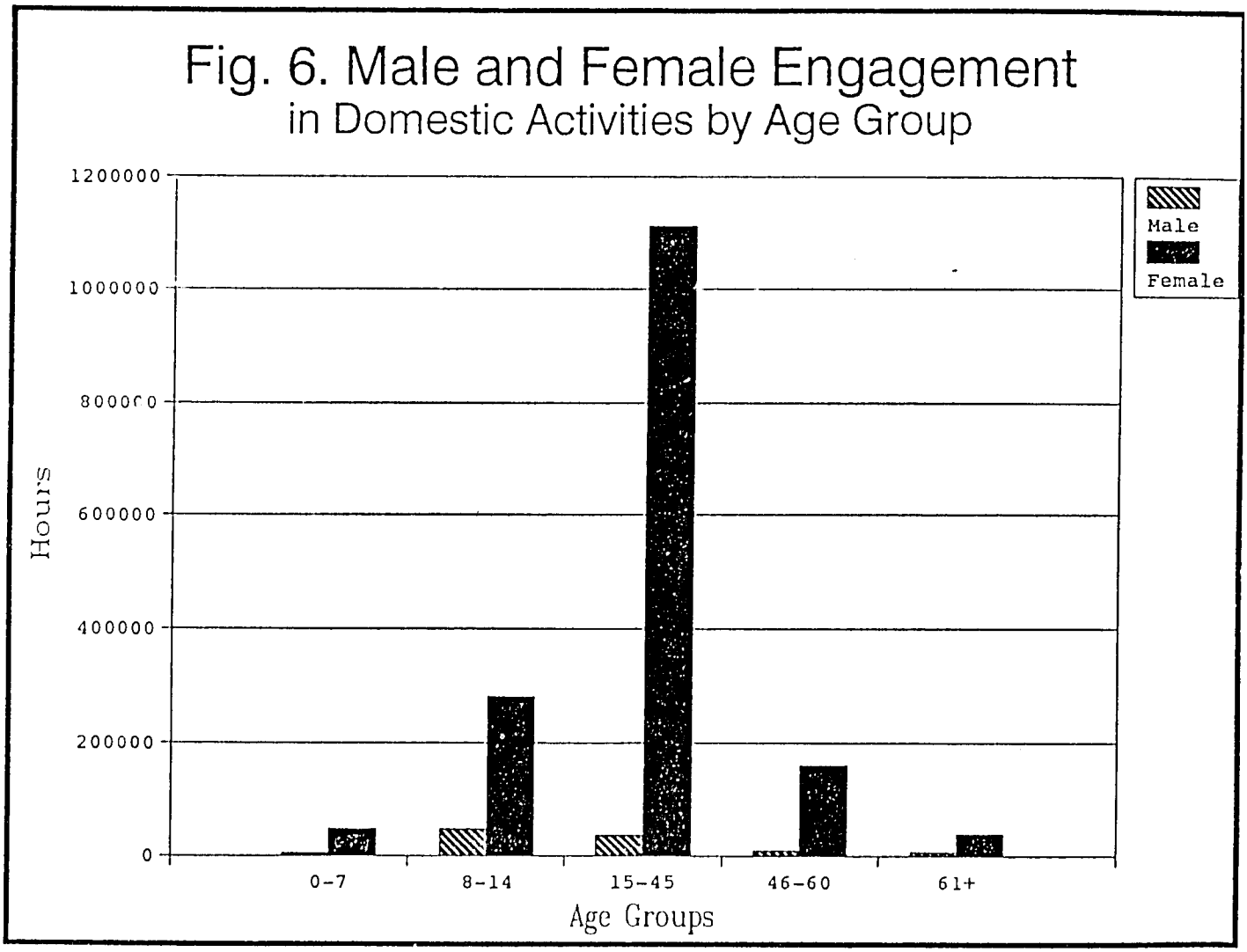


Fig. 6. Male and Female Engagement
in Domestic Activities by Age Group
1200000
1000000
800000
600000
400000
200000
0
Hours
0-7
8-14
15-45
46-60
61+
Age Groups
Male
Female

In terms of yields per labor hour in FCFA (Table 10 and Figure 7), the larger irrigated parcels, whether large-scale irrigated perimeters (GPI) or middle-scale perimeters (CIN), appear the most rewarding. This is predominantly a function of the much heavier use of machinery in irrigated agriculture, especially in large-scale, middle-scale, private, and village irrigated perimeters, a variable that was not factored in when we calculated labor. This overvalues the labor hour of a person on a tractor, given its heavy cost. In an attempt to resolve this problem, we started by calculating the number of animal and machine hours recorded on the various parcels, as presented in Tables 11 and 12.

Table 11 and Figure 8 reveal that among irrigated parcels, only village irrigated perimeters reported using animals (mostly donkeys or animal-drawn carts), in large part to move harvests. As to machinery (Table 12), only two types of parcels, private irrigated perimeters and village perimeters, reported employing heavy machinery (specifically harvester/threshers and tractors), with PIPs reporting 18 hours of harvester/thresher use, and PIVs reporting 21 hours of tractor use.

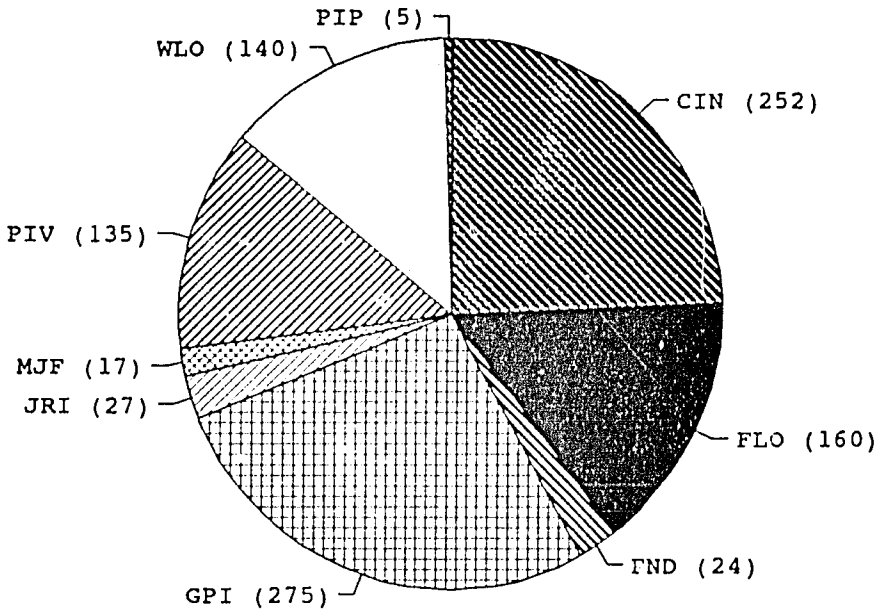
Table 11. Number of Animal Hours by Type and Agricultural System: 1991-1992

Agricultural System	Donkey	Horse	Plough	Animal-Drawn Cart
Falo (FLO)	41	0	0	38
Foonde (FND)	0	0	0	16
Jeeri (JRI)	0	266	543	124
Village Irrigated Perimeter (PIV)	40	8	0	21
Waalo (WLO)	14	22	27	102

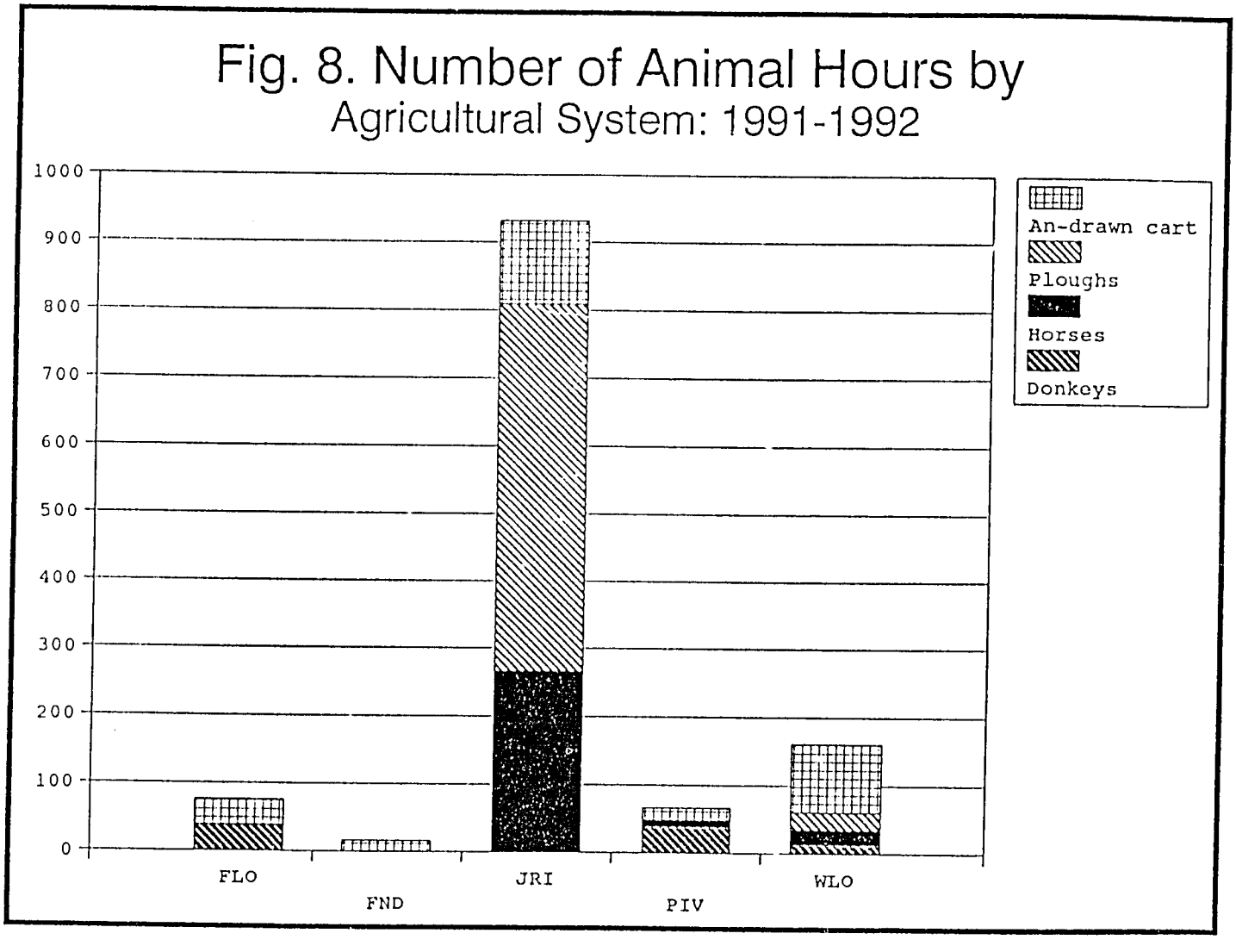
Table 12. Number of Machine Hours by Agricultural System: 1991-1992

Agricultural System	Harvester/Thresher	Tractor
Private Irrigated Perimeter (PIP)	18	0
Village Irrigated Perimeter (PIV)	0	21

Fig. 7. Average Yield per Labor Hour: 1991-1992 (in FCFA)



PIP	Private irrigated perimeter
CIN	Middle-sized irrigated perimeter
FLO	Falo
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
PIV	Village irrigated perimeter
WLO	Waalo



FLO Falo
FND Foonde
JRI Jeeri
PIV Village irrigated perimeter
WLO Waalo

As we know that both tractors and harvester/threshers are used in at least two other types of irrigated parcels, large-scale and medium-scale perimeters, we looked at production charges to discover the amounts of money that farmers reported having paid for machine services (Table 13).[7] For hiring tractors, farmers spent FCFA 107,400 on large-scale perimeters (9 instances of use), 105,000 on private perimeters (3 instances of use), 86,000 on middle-scale perimeters (18 instances of use), and 78,000 on village-irrigated perimeters (14 instances of use) (Figure 9). Average cost per use varies widely among systems, from the high reported for the three private irrigated perimeter instances to the considerably lower cost per use of the mid-scale and village perimeters.

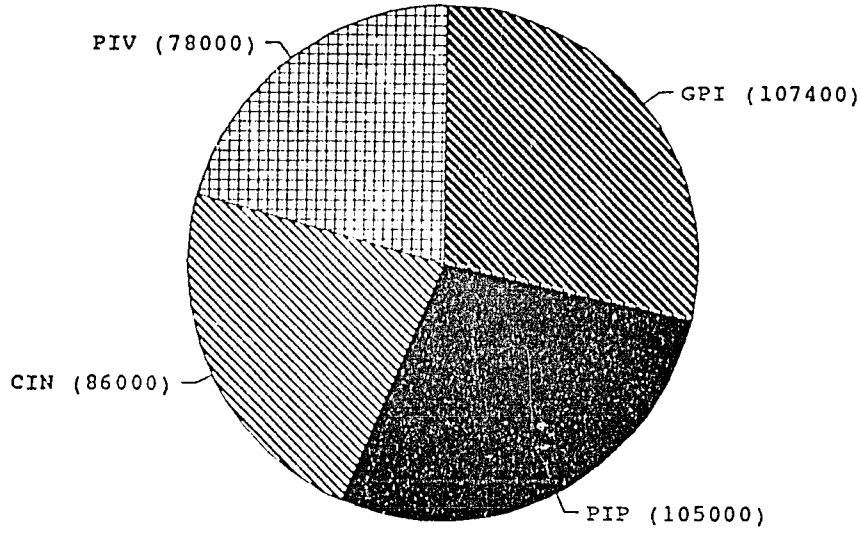
Table 13. Tractor Use by Agricultural System, Number of Uses Reported and Cost: 1991-1992

Agricultural System	Number of Uses Reported	Total Cost (FCFA)	Cost per Use (FCFA)
Large-Scale Perimeters (GPI)	9	107,400	11,933
Mid-Scale Perimeters (CIN)	18	86,000	4,778
Private Irrigated Perimeters (PIP)	3	105,000	35,000
Village Irrigated Perimeters (PIV)	14	78,000	5,571
All	44	376,000	8,555

Leaving aside the complications of returns to labor because of mechanization in the irrigated systems for the moment, a comparison of yield per labor hour among the unirrigated systems shows falo and waalo farming to be the most rewarding, with per hour yields of, respectively, 160 FCFA and 140 FCFA (Table 10). The generally low labor returns are a result of the disastrous agricultural year, with—as noted above—out of 405 parcels cultivated, 131 or 32 percent reporting no harvest.

[7] Farm labor and cost data were collected in the fields, cost data on a monthly basis, and labor data every two weeks. Many of the heavier agricultural operations, such as plowing and harvesting on government-operated irrigated schemes, be they large-, medium-, or village-level, are coordinated and operated by the government or a designated agency. Fees for such services are recorded as part of the credit that each farmer/parcel owes and are charged against harvest, if there is any, at the end of the season. Accordingly, farmers (and therefore research assistants) often do not know what these charges are until some time after the season is over and gains and losses are calculated.

Fig. 9. Use of Tractors by Agricultural System 1991-1992 (in FCFA)



PIV Village irrigated perimeter
GPI Large-scale irrigated perimeter
PIP Private irrigated perimeter
CIN Middle-sized irrigated perimeter

In yield per hectare, the value of output of falo is almost six times that of waalo, 220,939 FCFA as opposed to 37,772 FCFA (Table 10). Village irrigated perimeters, at 196,581 FCFA, are closer to falo than to waalo in per-hectare yield. As expected, on irrigated parcels that rely on heavy machinery, whether large- or middle-scale, yield per hectare is quite high: 385,436 FCFA on middle-scale perimeters and 209,508 FCFA on large perimeters, though falo returns per hectare in our sample exceeded returns on the large-scale perimeters (Table 10 and Figure 10).

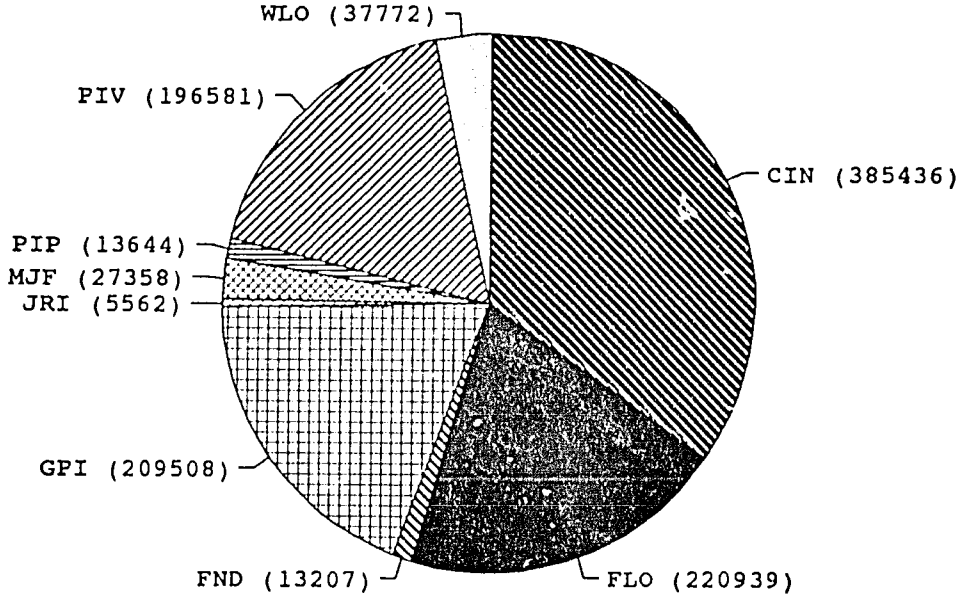
Largely because of the use of heavy machinery, fuel, insecticides, and herbicides, the cost of production per unit of irrigated land, for middle-scale perimeters (80,336 FCFA), large-scale perimeters (52,630 FCFA), private irrigated perimeters (37,520 FCFA), and village irrigated perimeters (35,040 FCFA) are high (see Table 10 and Figure 11). Cost of production for falo cultivation, 4,512 FCFA, exceeds that of waalo (1,836 FCFA), foonde (1,410 FCFA), and jeeri (869 FCFA). Compared to the cost of production on irrigated gardens (17,656 per hectare)—the least costly among irrigated parcels—however, falo production costs seem quite modest. In calculating cost, we note that farmers did not report seeds saved from the previous year's harvest as a cost.

Despite the use of heavy machinery, which increases the value of labor, as seen above, larger-scale irrigated farming is still very demanding of labor. Private perimeters reported 2,849 labor hours per hectare, middle-scale perimeters 1,531 hours, village irrigated perimeters 1,454, and large-scale perimeters 761 (Table 10 and Figure 12). As was also mentioned earlier, falo gardening is labor intensive (1,381 hours per hectare), but this is justified by higher returns, especially returns to units of land and labor. While falo gardening demands an average of 173 person-days on the basis of eight hours a day per hectare, a little less than what is required on PIVs (182 person-days), waalo farming, among the least demanding of the systems, requires 34 person-days. (Labor hours as used here are unweighted.)

D. Fisheries

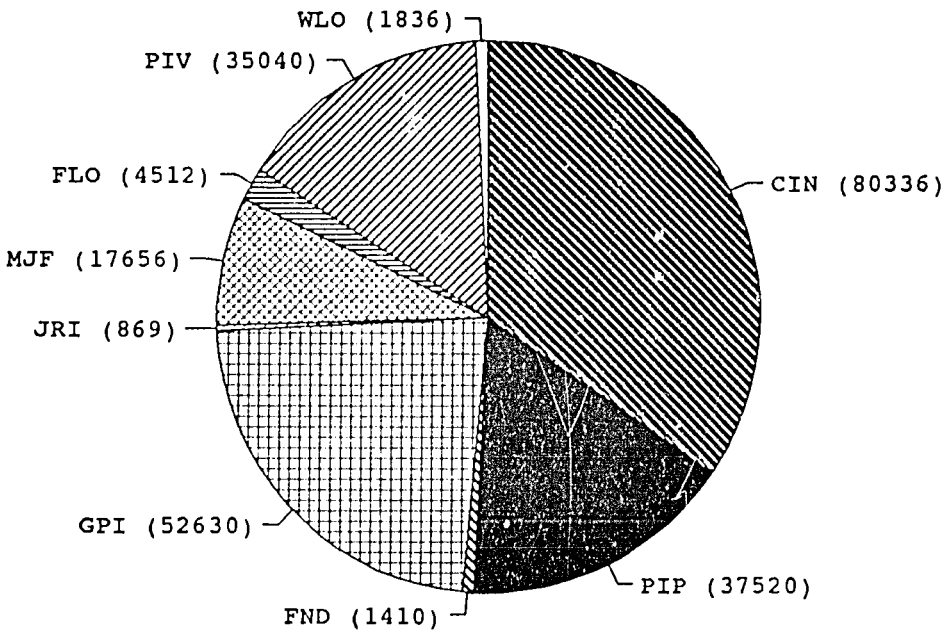
Research from the SRBMA I study highlighted the importance of maintaining a seasonal annual flood of the inner-lying basins in order to assure the reproductive viability of freshwater fish populations in the river valley. On-site observation of the effects of poorly timed water releases from the Manantali Dam in 1991 reveal the detrimental consequences for downstream fisheries. The repeated release of waters at Manantali washed fish populations downstream toward Richard Toll, making it difficult for fishers to bring in good catches. The timing of a flood release from the dam is thus critical to the seasonal migration, feeding, and spawning patterns of riverine-wetland fish and affects the livelihoods of thousands of fishing families throughout the valley.

Fig. 10. Average Yield per Hectare: 1991-1992 (in FCFA)



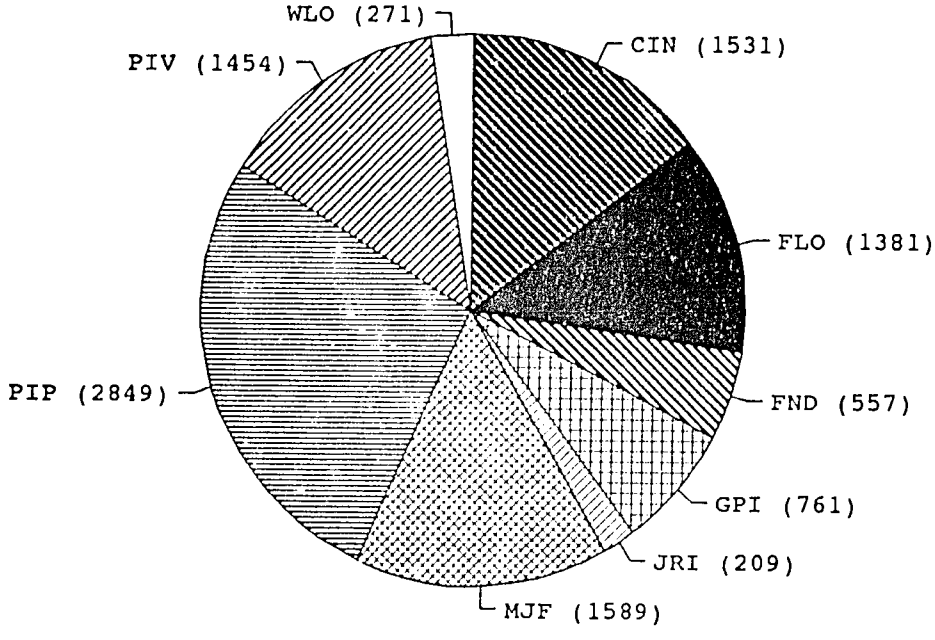
WLO	Waalo
CIN	Middle-sized irrigated perimeter
FLO	Falo
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
PIP	Private irrigated perimeter
PIV	Village irrigated perimeter

Fig.11. Average Expediture per Hectare
1991-1992 (in FCFA)



WLO	Waalo
CIN	Middle-sized irrigated perimeter
PIP	Private irrigated perimeter
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
FLO	Falo
PIV	Village irrigated perimeter

Fig. 12. Average Total Labor Hours per Hectare: 1991-1992



WLO	Waalo
CIN	Middle-sized irrigated perimeter
FLO	Falo
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
PIP	Private irrigated perimeter
PIV	Village irrigated perimeter

E. Migration

One of the most important findings from the SRBMA I study was the pervasive nature of both seasonal and long-term wage migration among adult men. This phenomenon has significant implications in shaping the outcome of on-farm production, for which adequate labor must be mobilized strategically in a seasonal fashion among a broad array of activities in farming, fishing, and herding.

A general survey of regional demography in SRBMA II reveals the extensive nature of migration outside the valley. In a sample of 331 households involving 3,476 persons, 737 or 21 percent were absent. Among males aged 15-45, a large number—52 percent—were absent. For females of the same age group, the rate was only 14 percent. The potential impact of this very high rate of migration on the availability of labor in the Middle Valley is evident. With nearly half of the active males absent (444 of 915, or 48.5 percent of those aged 15-60), serious labor bottlenecks are likely to present themselves in peak agricultural seasons. Paradoxically, it is this high rate of labor migration that finances the capital intensive demands of irrigated agriculture among Middle Valley households.

The SRBMA II study has closely examined two aspects of migration. First, a comparative topology of migration patterns has been identified for the Podor and Matam departments. This enables one to compare and assess the implications of migratory destination for the sending communities in the region. Second, seasonal migratory patterns in relation to the various contexts of involvement in irrigation and recession agriculture have been identified and elaborated.

1. Incidence and Patterns of Migration

Among the absent, migrant destinations include other regions of Senegal (69 percent), other countries in Africa (25 percent), and areas outside the continent, principally Europe (6 percent). Contrary to popular opinion, migration in the Department of Matam (20 percent of the population) is slightly less than in the Department of Podor (22 percent). On average, remittances to their village households are greater among Middle Valley migrants living in other African countries than among migrants remaining in Senegal, due in part to greater distances from family members who require considerable financial support.

The highest rate of nonremittal of income by migrants (37 percent) occurs among migrants remaining in Senegal. This very likely reflects the difficult economic conditions that obtain in the country and the high concentration of river-basin migrants in Dakar who are unable to find gainful employment. Migrants in other African countries and outside the continent had nonremittal rates of approximately 21 and 24 percent, respectively.

Migrants in other African countries contributed the largest amount of remittances per household for a one-year period, averaging 285,402 FCFA. The next largest source of remittance income was from migrants within Senegal. Long-term migrants remitted 140,575

FCFA while seasonal migrants sent back 66,181 FCFA. Only 17 sample households had migrants outside Africa. For those who sent money home, however, remittances per household were higher than those from migrants within Senegal and lower than from those in other African states, at 214,524 FCFA. The higher remittances of migrants in non-Senegal Africa than those overseas may result from the difficult economic conditions that migrants encounter outside the continent. In turn, this may reflect the greater cultural familiarity and ease with which migrants assimilate in an African context as opposed to the more unfamiliar milieu of a European or American setting.

The distribution of remittances by age, gender, and destination shows that among seasonal migrants within Senegal, men over 60 remitted the highest annual per capita amount (82,275 FCFA a year). The next largest amount for seasonal migrants was sent by men between the ages of 46 and 60 (54,075 FCFA). Men aged 15-45 remitted an average of 49,224 FCFA. Women, too, migrate seasonally and send home remittances, although in every age group women migrants in the sample remit on average less than men. A large majority (70 percent) of female seasonal migrants are between the ages of 15 and 45. Those aged 60 and over remit the largest sums of money (25,386 FCFA per capita). This is an important finding, as it has been widely believed that women of the region play no significant role as migrants.

Among long-term migrants remaining in Senegal, remittances were greater for both men and women than remittances of seasonal migrants. They were highest for men in the 46-to-60 age category (143,995 FCFA per capita), and for women in the 15-to-45 age category (70,048 FCFA per capita).

Migrants to other African countries, 80 percent of whom cited commerce as their main occupation, sent per capita annual remittances that were substantially higher than those of migrants staying in Senegal. The highest per capita amounts were remitted by men age 46 to 60 (412,197 FCFA), almost three times as large as those from Senegal. Per capita amounts remitted by women in non-Senegal Africa averaged slightly less than the amount remitted by female seasonal migrants and considerably less than the amount remitted by women migrants remaining in Senegal. Only women in the 15-to-45 age group sent home remittances (averaging 21,454 FCFA). Women's rates of participation in this type of migration, moreover, was lower than the participation rates of seasonal and long-term women migrants in Senegal.

The principal residence of 19 migrants was overseas in Europe (France) or the United States. These individuals remitted 41 percent less per household than did migrants living in African countries other than Senegal. Per capita remittances were highest among men aged 46 to 60 (168,993 FCFA). On the other hand, women who migrated to countries outside the continent remitted considerably more than either seasonal or long-term female migrants in Senegal or in other African nations, averaging 173,571 FCFA per capita in the 15-to-45 age group.

Summary statistics on the incidence and profitability of migration by destination, gender, and age show that households with migrants in Africa had the highest rate of remittal and on

average the highest annual remittance earnings. Thus, among SRBMA II's sample households, and contrary to popular belief, Europe and the United States were not the most profitable destinations for migrants. Men between the ages of 15 and 45 participated most heavily in migration, but it was men between 46 and 60 who sent home the most per capita. Among women, the 15-to-45 age group was most active in migration and remitted the most income per capita. In terms of participation rates, seasonal migration and longer-term migration within Senegal engaged the most households. Except where seasonal migration is concerned, women participated only marginally in migration.

2. Migration and Agricultural Development

A key concern of agricultural development in the Senegal River Basin is the large outflux of men that impedes the development and expansion of irrigation in the region. Analysis of SRBMA I data demonstrated the contradiction associated with irrigation and migration. On the one hand, migration draws labor from the region, labor that could be used on the farm, particularly on irrigated perimeters. On the other hand, migration is an extremely important source of revenue for households, helping households to cover food costs, especially in years when rainfall and floods are inadequate. Most importantly, it is crucial in financing irrigation inputs.

The data from SRBMA II show that remittances were less important for households with access to irrigation than for households with access to flood recession agriculture. The 331 sample households were sorted into eight groups, differing by their access to the various combinations (from zero to three) of recession, rainfed, and irrigated agriculture (Table 14). Groups 1-4 have access to irrigation, groups 5-8 have little or no such access; groups 1, 2, 5, and 6 have access to land for recession agriculture, groups 3, 4, 7, and 8 have not; and groups 1, 3, 5, and 7 have access to rainfed agricultural land, while groups 2, 4, 6, and 8 do not. This finding about remittances appears in annual household remittances as well as in the number of migrants per household. Migration rates were slightly lower for households with access to irrigation than for households that farmed flood basins, suggesting that to a certain extent the presence of irrigation tends to curb the flow of migrants from the region.

With respect to crop yields in irrigation, several important variables are critical in determining levels of output. These include income, the type of perimeter farmed, and the amount of labor deployed in other production systems. The amount and percentage contribution of remittances in income are important in determining which households financed production costs themselves. Thus, although the presence of irrigation seems to inhibit out-migration slightly, there is also strong evidence that irrigation continues to rely on remittances for its ongoing survival.

Table 14. Farm and Off-Farm Revenues by Household Configuration Groups (FCFA and percent)

Group	Average Income (FCFA)		Remittances per Household (FCFA; percent)	Average Annual Off-Farm Revenue	Average Annual Income (FCFA; percent) from:				
	Total	Per Capita			Recession Agriculture	Irrigated Agriculture	Rainfed Agriculture	All Farm	Livestock
1	321,782	37,948	115,657 35.9%	201,570 62.6%	34,046	61,110	3,801	101,461 31.5%	18,751 5.8%
2	489,532	50,899	212,794 43.5%	258,057 52.7%	111,800	86,972	723	215,306 44.0%	16,169 3.3%
3	361,859	50,794	89,873 24.8%	269,569 74.5%	0	62,475	2,828	58,890 16.3%	33,400 9.2%
4	357,383	42,912	51,096 14.3%	224,545 62.8%	0	89,833	0	86,301 24.1%	46,537 13.0%
5	480,355	49,047	223,893 46.6%	346,830 72.2%	90,016	-3,675	10,889	107,625 22.4%	25,900 5.4%
6	456,479	58,456	246,379 54.0%	392,918 86.1%	40,545	0	4,221	44,726 9.8%	18,835 4.1%
7	329,127	41,973	205,477 62.4%	275,204 83.6%	-2,060	0	9,165	9,160 2.8%	44,763 13.6%
8	327,294	45,011	237,680 72.6%	319,363 97.6%	-1,510	220	399	-218 0.0%	8,151 2.5%

F. Household Consumption

SRBMA II data allow us to examine the impact a poor flood period has on food consumption patterns of households classified by income and access to production systems. It is hypothesized that high-income households are less vulnerable to changes in climate and dam management policies and thus in a better position to feed themselves. Low-income households, by contrast, are directly harmed by poor flood conditions. Because of their limited access to resources, particularly to cash income, they rely heavily on traditional flood and rainfed production methods. In years of poor flooding and rainfall, they are unable to compensate fully for reduced agricultural output by purchasing food or engaging in capital-intensive production. As a result, they consume less food, including such staples as rice, sorghum, and millet, than do households with higher incomes and depend more heavily on gifts, borrowing, and exchanges as sources of food.

Analysis of data from one research site in SRBMA I supported this hypothesis, revealing that wealthy households relied less on traditional production methods to feed themselves than did poorer households. Large land and labor resources and high cash incomes allowed wealthy households to engage in irrigation and to purchase a large part of what they ate. Households

with fewer resources depended more heavily on low-cost traditional flood recession and rainfed production methods.

In examining the SRBMA II data, an initial analysis by income deciles, ignoring effects of climate, geography, and infrastructure, yielded somewhat unexpected results. While consumption patterns differed among household income groups, the differences were not large. Low-income groups tended to consume less per capita than high-income groups, but the sources of food and the composition of diets did not differ substantially among income groups (Table 15).

Table 15. Value of Annual Total and Per Capita Household Consumption by Income Decile

Decile of Per Capita Income	Average Number of Consumers per Household[a]	Income Per Capita (FCFA)	Annual Household Food Consumption (FCFA)	Annual Food Consumption Per Capita (FCFA)
1	8.40	5,865	392,865	46,770
2	9.57	12,096	391,805	40,941
3	9.17	17,217	502,662	54,816
4	9.34	21,335	438,285	46,926
5	8.00	26,364	582,258	72,782
6	7.89	33,739	465,754	59,031
7	8.57	40,422	528,560	61,676
8	7.70	47,979	679,472	88,243
9	9.62	61,702	739,153	76,835
10	7.80	116,475	735,386	94,280

[a] Weights are by age group: children 0-7 years = 0.5; 8-14 years = 0.75; 15-60 years = 1.0; 61 and over years = 0.75.

Our findings indicate that the value of food consumed by low-income households was substantially less than the value consumed by high-income households. Although the correlation is imperfect, the value of per capita food consumption in the four lowest income deciles is well below that of the highest four deciles (Table 15). Purchases are also lower among low-income households than among high-income households (Table 16). Furthermore, when we group households by access to production systems as well as income, we find that the value of grains consumed is less for low-income households than for high-income households. These findings also support our hypothesis. An additional finding is that food received by low-income households as gifts or through exchange is higher than it is for high-income households. Food obtained on credit, however, is substantially higher among high-income households (Table 16). Overall, gifts, exchanges, and credit provided the lowest income groups with a small proportion of the total food they consumed—from 7 to 19 percent in the lowest four deciles. This does not

differ from the proportion for the highest deciles (ranging from 10 to 20 percent), but the composition differs, as indicated: more in gifts and exchanges at the low-income level, more in credit at the high end. Our findings do not allow us to conclude definitively that high income households produced and consumed more irrigated rice in poor flood years.

Table 16. Sources of Food Consumed, by Income Decile (FCFA and percent)

Decile of Per Capita Income	Purchase	Exchange	Gift	Credit	Household Production	Land Payments	Other	Total
1 FCFA	267,900	14,245	28,708	30,175	37,703	12,895	1,240	392,865
Percent	68.2	3.6	7.3	7.7	9.6	3.3	0.3	100
2 FCFA	265,578	12,334	23,199	14,072	57,834	14,821	3,968	391,805
Percent	67.8	3.1	5.9	3.6	14.8	3.8	1.0	100
3 FCFA	314,056	22,044	49,451	16,450	87,408	7,549	5,705	502,662
Percent	62.5	4.4	9.8	3.3	17.4	1.5	1.1	100
4 FCFA	295,843	7,214	9,178	14,066	99,956	7,422	4,607	438,285
Percent	67.5	1.6	2.1	3.2	22.8	1.7	1.1	100
5 FCFA	408,855	10,029	63,908	26,119	66,712	3,621	3,013	582,258
Percent	70.2	1.7	11.0	4.5	11.5	0.6	0.5	100
6 FCFA	308,964	15,832	7,571	49,541	70,617	8,478	4,752	465,756
Percent	66.3	3.4	1.6	10.6	15.2	1.8	1.0	100
7 FCFA	342,299	15,542	13,530	74,005	79,425	3,041	718	528,560
Percent	64.8	2.9	2.6	14.0	15.0	0.6	0.1	100
8 FCFA	506,767	5,668	6,613	71,215	81,257	4,615	3,337	679,472
Percent	74.6	0.8	1.0	10.5	12.0	0.7	0.5	100
9 FCFA	589,125	6,584	5,785	59,105	73,625	2,387	2,540	739,153
Percent	79.7	0.9	0.8	8.0	10.0	0.3	0.3	100
10 FCFA	550,330	8,084	17,824	51,079	89,102	11,096	7,872	735,386
Percent	74.8	1.1	2.4	6.9	12.1	1.5	1.1	100

G. Household Budgets and Income

1. Sources of Revenue

The data show that households diversify the sources of their income quite widely. The degree of this diversification and the total and proportions of the amount earned from diverse activities varies by production space (PS) and, to a lesser degree, by caste. Twenty different sources of income are reported in Table 17. Of the twenty sources of income listed, most PSs resort to at least fifteen of them, although the degree of reliance on a particular activity, measured in terms of the total income generated, varies widely.

The highest average household income observed is in PS 6, which relies heavily on migratory remittances (accounting for 45 percent of total income). This production space, along with PS 7, PS 8, and PS 9, is located upstream in the Middle Valley, in Matam Department. On average, a greater proportion of total income for all these PSs is generated by migratory remittances (58 percent) than the proportion found in the other PSs. These other production spaces, which are downstream in Podor Department, average 28 percent of income generated by remittances. Conversely, the portion of total revenues derived from agricultural activities is twice as great in the Department of Podor (27.6 percent) as in Matam (13.6 percent). To what extent this is a function of geographical location is not yet clear: the presence or absence of substantial access to irrigation, for example, is important.

In sum, diversification is a necessary survival strategy in the Middle Senegal Valley. In most areas, we see a very high dependency on migratory remittances, followed by agriculture and herding. Other sources of revenues, regarded individually, look much less impressive. Aggregated, however, they contribute importantly to household survival.

2. Crop Transactions

Crop production is largely for local subsistence rather than market exchange. Crop purchases exceeded sales by a wide margin, in part, due to poor growing conditions in 1991 and 1992. As a result, large quantities of imported cereal grains (rice and sorghum) were bought on the market to make up for severe shortfalls in local cereal production.

Differences in the market price of crop sales and purchases indicate that smallholders in the Middle Valley are caught in a spiral of declining terms of trade. In general, peasant households purchase imported food grains (rice and sorghum) in the marketplace at prices greater than prices at which locally produced grains (paddy rice, millet, and recession sorghum) can be sold. Unfavorable climatic conditions that did not allow many local farmers to produce a surplus crop for the market forced households to buy imported grains, at higher prices than local grains sell for when they are available.

Table 17. Percentages of Household Income Earned, by Revenue-Generating Activity and PS

PS	1	2	3	4	5	6	7	8	9
Number of Households	32	25	37	32	35	34	53	38	45
Total Income (FCFA)	14,488,854	7,269,396	8,445,265	13,572,601	8,606,532	29,283,975	10,309,575	15,250,931	19,039,223
Total Income (percent)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Revenue Source									
Farm Income	2.37	49.21	21.70	35.08	29.80	22.52	15.09	14.82	2.24
Sale of Livestock	7.69	2.08	28.16	1.64	23.10	0.40	4.01	6.17	11.08
Hunting	0.00	0.00	1.75	0.00	0.00	0.00	0.00	0.00	0.00
Fishing	2.51	1.54	3.49	0.18	2.17	1.52	3.65	5.10	1.14
Artisanal	0.71	0.13	1.06	2.22	0.52	1.75	0.56	4.46	0.81
Service	6.76	5.48	4.24	5.54	5.09	0.85	0.41	1.12	2.35
Commercial	1.17	0.00	2.00	2.86	15.09	0.27	2.04	1.08	0.00
Small Shop	0.12	0.00	0.60	0.00	1.75	0.09	0.09	1.02	0.66
Transport	0.00	0.00	0.04	0.94	0.67	0.60	0.00	0.44	0.00
Ag. Equip. Rental	0.69	0.00	1.63	0.96	0.00	3.51	0.01	0.30	0.48
Rental Property	6.22	4.21	1.73	0.00	0.03	3.93	0.19	0.86	0.23
Sale of Personal Effects	2.36	2.30	0.59	0.53	0.56	0.24	0.14	0.51	0.41
Marabout	2.58	0.00	0.00	0.93	3.46	3.37	0.00	1.07	0.05
Government	0.97	0.00	0.00	0.00	0.05	4.06	0.00	0.03	0.00
Herding	0.00	0.00	0.32	0.00	0.00	0.20	0.00	0.00	0.13
Food Sale	0.03	0.00	0.00	0.00	0.00	0.06	0.01	0.00	0.03
Migration Remittances	32.87	31.39	25.95	41.26	9.60	45.01	67.22	47.52	71.28
Retirement	8.29	2.26	0.00	0.02	1.20	3.46	2.33	2.29	0.00
Private Sector Salaries	6.35	0.28	0.00	1.47	0.00	0.03	0.09	0.22	0.00
Other	18.31	1.11	6.74	6.37	6.90	8.02	4.17	13.00	9.11

3. Livestock Transactions

The sale of animals exceeded purchases considerably during this study due to drought-like conditions during the two-year period. Geographically, a disproportionately large number of sheep were sold in two production spaces, PS 3 and PS 5. Fulbe-headed households were the caste group most prominent in sales of these animals.

With respect to the purchase of sheep, distinctions were noted by PS and caste. PS 6 had by far the most households purchasing sheep (23 of 63 households, or 37 percent) and the most sheep purchased (61 of 134 sheep purchased, or 46 percent). This may well reflect the greater purchasing power among households in this production space: average household income is almost twice as great as that of the other PSs. Among caste groups, the Toorobbe were the most prominent buyers of sheep.

The greatest proportion of goats purchased (more than 50 percent of the total) occurred among households in PS 3 and PS 4. As with sheep purchases, the Toorobbe were the most prominent buyers of goats.

Only three purchases of cattle (cows and bulls) were recorded in the sample survey. Sales were much more frequent, probably reflecting the deteriorating environmental and economic conditions during the study period. A large number of the animals sold (44 percent) occurred among a relatively small proportion of households in PS 9. Fulbe were the most frequent sellers of cattle. Oxen, as well, were more frequently sold than purchased. Again, Fulbe were the prominent group selling these animals. No distinction in geographical location could be discerned, however. For all cattle and oxen sold, the average income of the owners was substantially above mean income for the entire study sample. Sheep and goats, especially the latter, are within the means of low-income households; cattle are usually not.

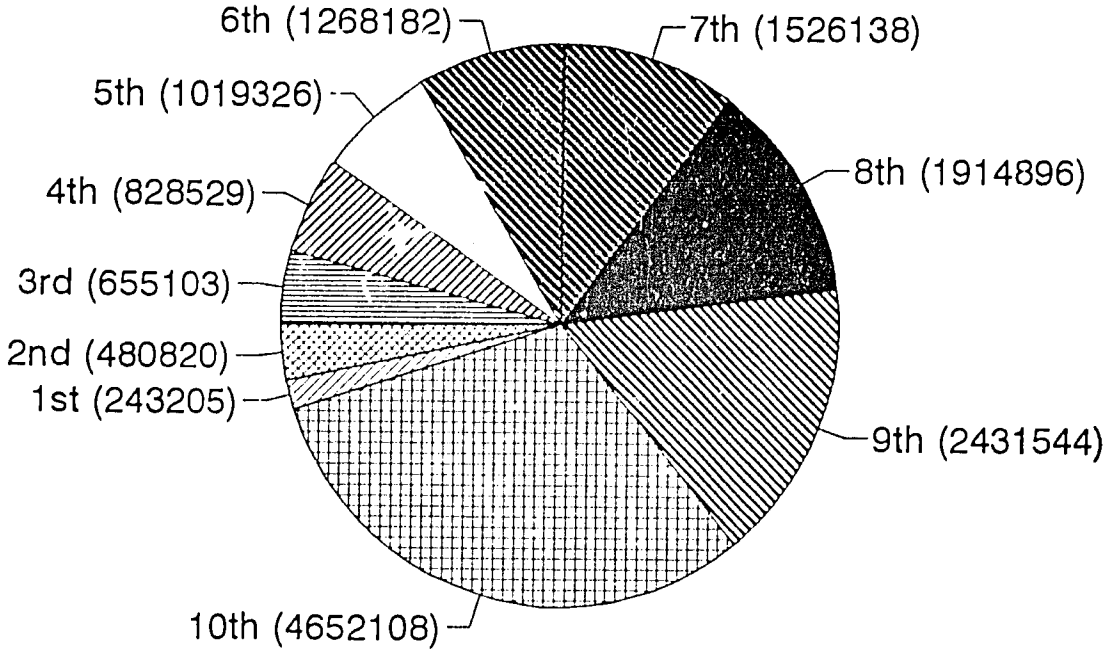
4. Income Levels by Caste

Levels of household revenue generation by caste reveal that one group, the Jaawambe (former advisors to the Toorobbe), have incomes far in excess of the other groups. Interestingly, their revenues are generated from a less diversified range of activities than that of the other groups, relying equally on agriculture, migration, and other nonfarm income sources.

5. Distribution of Income

Significant disparities are noted in the overall distribution of household income by deciles (Figure 13). Nearly half of all income goes to the wealthiest 20 percent of all households in the sample. While the lowest decile controls less than 2 percent of total income (1.62 percent), the highest controls almost 31 percent (30.97 percent). The lower half of income receivers control 21 percent, the upper half 79 percent of income (in kind and in cash) of the sampled households. In absolute terms, the minimum per capita income of households is 1,455 FCFA, while the maximum rises to 339,711 FCFA, while the average household income (45,377 FCFA) exceeds

Fig. 13. Income Distribution by Decile Among Middle Valley Sample Households (FCFA)



the median (34,695 FCFA) by nearly a third, another manifestation of the skewing of the income distribution toward high-income households.

V. RECOMMENDATIONS

The following recommendations are based on the understanding that the Government of Senegal has opted for the simultaneous maintenance of a controlled annual flood from water releases from the Manantali Dam—in other words the development of all flood-related activities, including recession cultivation, herding, and fishing—and the expansion of irrigation. Our recommendations should be considered in the context of what our data reveal as the four major obstacles to development: (1) poor crop productivity in all agricultural production systems; (2) severe capital shortage and low disposable household incomes; (3) chronic labor scarcity due to high out-migration in search of cash income; and (4) a dislocation of cooperative social organization and local institutional structures.

In addition, development planning and assistance in the river valley must be placed in the larger macroeconomic context of structural adjustment. As the burden of economic development shifts from the public to the private sector, state support in the form of heavy infusions of capital for infrastructure and subsidies to the agricultural sector will be increasingly scarce, and foreign donors and the private sector will be solicited to provide the bulk of capital investment and serve as the primary engines of development. Hence, proposals for even the most modest levels of capital expenditure are not likely to be absorbed by the area smallholder, as witnessed by the rapid deterioration in rice production that has accompanied the shift of the financial burden to the farmer since 1987. In this context it is imperative that aid strategies be cost effective and grounded in the local reality of a capital-scarce socioeconomic environment. Before addressing specific target areas of intervention, two other issues will be addressed: socioeconomic diversification and environmental and socioeconomic sustainability.

A. Issues of Socioeconomic Diversification

Until now, development aid in the Senegal River Valley has been heavily oriented toward capital-intensive agriculture, narrowly focused on improving rice production. This requires significant infusions of both capital and labor, a demand often poorly suited to the socioeconomic and demographic realities of the area. When financial returns on investment are considered, the results are mediocre at best, if one examines the track record of rice production in the Senegal River Valley during the past two decades. The proposals set forth below therefore adopt a more modest, low-cost approach to development, avoiding many of the expensive high-technology remedies that have characterized development in the region thus far.

Future aid must encompass more of the diversity of economic activities that already exists within the local economy. Efforts should focus on the gamut of small informal, subsistence sector, on-farm activities that have the potential of providing greater household revenues if developed properly. At present, this sector has received virtually no attention from development officials. Activities such as vegetable gardening and cereal cropping in customary

agriculture, small livestock husbandry and dairy production, fisheries, local artisanry, and petty commerce constitute the base of the local economy. Our findings reveal the important cash revenues that are derived from customary falo and foonde horticultural gardens, for example; yet little research or donor support has been devoted to either activity. The data also show that those households with the highest gross annual incomes have the most diversified sources of on- and off-farm revenues. Moreover, a substantial portion of locally generated revenues come from commerce, agriculture, fishing and livestock sales. Thus the research suggests that considerable potential for small-scale income generation is possible if an array of informal sector activities are developed simultaneously.

Successful ventures in more capital-intensive enterprises such as improved rice agriculture will be realized by local smallholders only **after** they have begun to increase substantially their on- and off-farm disposable incomes. Yet, an a priori assumption of current development policy appears to be that of developing a modern agricultural sector at the expense of an underdeveloped or neglected subsistence farm sector. This approach is equivalent to the logic of the cart leading the horse. The choice is not between a policy that builds on existing indigenous knowledge and production systems, or one that favors an externally imposed model of modern high-input agriculture. We want to strike a balance between the two, based on the conviction that development of the former is a prerequisite for the successful attainment of the latter.

B. Environmental and Socioeconomic Sustainability

Development in the sense advocated here must concentrate not only on raising family incomes by improving on- and off-farm productive capacity, it must also be sustainable in both environmental and socioeconomic terms. The decision to preserve or abandon floodplain agriculture is not simply an agronomic or hydrological issue. The decision to transform the biological diversity of the plant and animal habitat of the floodplain into a more homogeneous landscape for rice cultivation will mean increased risk of environmental degradation. In the short term, the clearing and leveling of the floodplain by extensive felling of trees and removal of shrubs for new irrigation perimeters will exacerbate current low levels of fuelwood supply and the excessive energy demands already being felt in the region (GERSAR-CACG et al. 1989:21-24).

The replacement of traditional polycultures by more modern agricultural methods that rely heavily on chemical fertilizers and monocropping will mean a decrease in the natural resiliency of the floodplain ecology and a greater risk of collapse of the artificially created habitat during periods of drought or other environmental stress. In the long term, the possible lowering of groundwater aquifers, which rely on an annual recharge from the natural flood, may have grave economic consequences for the many villages that depend on such sources for their potable water supply. The loss of natural refertilization of the floodplain soils from nutrients deposited each year during the flooding season may imply, as well, a gradual decline in soil fertility over the long run and an eventual fall in agricultural productivity on the irrigated perimeters.

The transformation of floodplain ecology may have many other far-reaching implications for the human populations exploiting the natural resource base. The loss of traditional grazing routes and fodder supply for livestock, of spawning and feeding grounds for riverine fish, and of cropping systems that provide a nutritionally varied diet will threaten a traditional way of life and the basis of subsistence for diverse socio-occupational groups that depend on this habitat. Thus, the true value of a natural ecosystem is difficult to quantify. If alterations in the system are to be environmentally sustainable over time, the full economic costs in maintaining that system may well exceed the benefits to be derived from it.

In socioeconomic terms, development interventions must be sustainable. The financial benefits accruing to the producer must be high enough to absorb the operating costs. At present, the recurrent costs of production in rice agriculture for most producers in the Senegal River Valley outweigh the financial benefits to be derived. In economic terms, the profit margin to the smallholder is nominal, as production levels barely cover the capital outlays required. As long as household revenues from on-farm production continue to remain low, most families will be unable to support the recurrent costs of rice cultivation to be anticipated in the future.

C. Target Areas for Development Interventions

The specific measures proposed here adopt an integrated, multidisciplinary approach to development assistance. An ongoing dialogue and a team approach integrating both physical and social scientists will be required. The scope of work of the Cellule Après-Barrages (CAB), which is in charge of development activities in the Senegal River Basin, might be expanded to include the facilitation of improved channels of communication and the establishment of a more coherent and consistent development policy among the donor agencies active in the region. At present, a competitive and untrusting atmosphere prevails among the bilateral aid agencies, with each donor group having carved out its own turf. The end result is a potpourri of projects, contradictory objectives, mixed messages to the farmers in the valley, and a poorly articulated global development strategy for the basin. The present no-man's-land philosophy of "doing your own thing" is a self-serving approach that belies the interests of those whose well-being international aid should be benefiting.

The areas outlined here for target intervention serve simply as general topical indicators to guide development policy. They are presented at a broad conceptual level and do not spell out a detailed step-by-step technical approach to solving each problem. Substantive solutions at this level will require the professional input of planners, economists, engineers, and social scientists, working together. The proposals delineated below address the four major constraints encountered by smallholders: (1) crop productivity, (2) household revenues, (3) labor scarcity, and (4) local institutional organization.

1. Crop Productivity

a. Environmental Engineering of the Floodplain

Under conditions of controlled flooding from the Manantali Dam, we envision a rational policy of land use management, in which a spatial compatibility is sought between traditional recession and modern rice agriculture, by optimally exploiting the different geomorphological features of the floodplain. Rather than promoting one production system to the exclusion of others, we advocate a sort of microengineering of the floodplain, in which the most productive low-lying areas of *hollalde* soils are designated for recession cultivation, and the higher adjacent *foonde* soils are developed for irrigation. Perimeters could be situated in such a manner as to provide seasonal drainage into the waalo. This would have the advantage of increasing soil fertility in the hollalde by providing nutrient runoff from the rice schemes. It would also assure the productive life span of the perimeters by introducing a system of periodic flushing of the soils, a technique that is essential in maintaining soil fertility in irrigation.

This engineering of the floodplain will require a mastering of its hydrological features in order to understand the nature of the water flow and the varying rates of soil immersion by the flood, according to topography and soil type. At present, virtually no scientific knowledge of the internal hydrological dynamics of the floodplain is available. A thorough analysis along these lines will be necessary to determine the economic feasibility of transforming much of the floodplain for rice agriculture. The contours of the plain and the physical features of the small feeder tributaries vary greatly from one bottomland to another, and within the bottomlands as well. In most instances, the costs of attempting to reconstruct the landscape for irrigation through leveling and of pumping water from the feeder streams to the perimeters may prove to be prohibitive. In the case of the floodplain Cangay Dow Seyji, discussed in the body of this report, the principal ravines providing water are at a considerable distance from the plain, and the smaller streams traversing the interior are very shallow and wide. Feeder canals for irrigation would be extremely long, and pumping costs very expensive.

A geographical model designed to permit a harmonious exploitation of both recession and irrigation systems in the floodplain area has been proposed by Nuttall (1989). This would entail the introduction of physical infrastructure in the form of small sluice gates placed in the main floodplain channels to regulate the height and duration of flooding at specified elevations in the plain. Areas above a certain elevation could then be protected from flooding and designated for irrigation. Sluice gates placed at strategic locations near the river could also serve as small bridges for transport over major waterways that disrupt travel during the rainy season between the villages and larger towns such as Matam. The construction of sluice gates for controlled water flow has already been introduced in the ferlo region of the Lower Valley at Lac de Guier, in the 1960s (Gac and Cogels 1986). This has been highly effective in managing the water levels of the lake and providing an important source of potable water for the capital, Dakar. An added benefit has been an increase in the fish population of the lake. The Lac de Guier project might serve as an appropriate model for application in the floodplains of the Senegal River Valley.

b. Agricultural Research

Applied research in agriculture should focus on boosting the yields of traditional cereal grains, such as sorghum and millet. These indigenous crops have received little attention, and few efforts have been made to develop improved high-yield varieties. The introduction of more drought- and insect-resistant plants, in combination with controlled flooding, could provide significant increases in crop yields. Experiments with controlled flooding alone have produced dramatic improvements in sorghum yields in the Lac R'kiz region of Mauritania, where crop yields of over 2,000 kg/ha have been recorded (Baltzer 1988). Research and development efforts could focus on the following four areas:

- **Plant and insect research.** One of the major problems faced by area farmers is the constant threat of crop losses from attacks by plant viruses and insects. Energies need to be concentrated on developing seed varieties more resistant to these predators. High yield varieties resistant to drought should be researched as well. Improved seed must be available at little or no cost initially if it is to be adopted by farmers.

- **Insecticides and fertilizers.** Manual and aerial application of insecticides is one of the most cost-effective initiatives that could be taken to improve crop yields. The results of both applications in 1989 in the recession zone studied testify to the impressive gains that can be made simply by assuring protection of crops from insect attack. Aerial spraying is obviously expensive and difficult to carry out logistically on a yearly basis. Manual use of insecticides however, can be extremely effective if carried out properly. Such resources are currently available to villages in the Matam Department through the local office of the state agricultural service. Serious problems exist of equitable distribution, inadequate storage facilities, poor dissemination of information, and difficulties in transporting the insecticides to the rural areas. Considerable financial and logistical support will be necessary to assure better access to government subsidized agricultural inputs such as these.

  Experiments have been undertaken to boost crop yields in rainfed and recession agriculture by the use of fertilizers such as nitrogen and phosphate (Poulain, Sapin, and Reynard 1968). Positive results have been attained but under experimental conditions only. Initially, the cost of fertilizers will have to be absorbed by the state or other outside sources.

- **Cropping systems.** Experiments should be undertaken to explore with farmers different crop mixes in traditional agriculture. It is possible that production could be improved by developing better agroforestry principles in certain systems, such as the rainfed jeeri. Cash crops that bring a high market value may be mixed with subsistence crops. In the floodplain, for example, beans are cultivated and sold at high prices to merchants coming from the Dakar region. Efforts to expand commercial production will require development of improved feeder roads and market conditions as well.

• **Crop protection.** Another major cause of crop loss is predation by birds and animals. Small ruminants occasionally enter fields protected by thorn fencing and ravage the crops. Improved fencing would be particularly useful in the falo, jeeri, and irrigated perimeters. Crop storage facilities as well could be improved. Mud granaries used by families are inadequate for preventing infestation by insects and rodents.

c. Agricultural Extension

The success of applied research in agriculture will depend highly on the quality of extension services and village-level training programs. Increased funds for training and logistical support are necessary for agricultural extension agents; moreover, an incentive structure might be created to stimulate rural agents to provide more effective service to villages. For example, cash bonuses or other material benefits could be linked to production quotas. A stronger follow-up and monitoring unit should also be introduced to see if farmers are adopting ideas and agricultural techniques proposed by extension agents and equitably receiving services they provide. Vehicles, motorcycles, spare parts, and fuel are all in scarce supply at present, preventing many agents from carrying out their work. Village-level training programs in improved agricultural techniques, basic accounting, and organizational management of cooperatives should be linked with agricultural extension. Emphasis should be placed particularly in developing the organizational capacity of women's groups, as women are now carrying such a large burden of agricultural responsibility in the villages. Most importantly, extension services should be strongly linked to functional literacy programs in which village-based training occurs in the local language (generally Halpulaar), and, preferably, is carried out by indigenous speakers from the region. Such a program should be executed over an extended period of time.[8]

2. Household Disposable Income

The fundamental obstacle encountered by smallholders, one that restricts the growth of the local economy, is a chronic shortage of household income, particularly income generated from on-farm production activities. Research findings indicate that household disposable income is at present derived primarily from off-farm wage labor and migratory remittances. On-farm revenues from agriculture, fishing, livestock, commerce, and artisanry are very low. These sectors of the local economy have received little development attention despite their potential for generating substantial revenues. Data on falo river gardens from SRBMA I, for example, show that smallholders derived more cash income from this production system than from irrigated rice cultivation. An accumulation of small amounts of revenue from a diversified farm sector provides more security and spreads risk for the smallholder. Therefore, an emphasis should be

[8] A successful pilot program of village-based adult literacy incorporating skills in accounting, organizational management, health care, agriculture, and a host of other functional activities has been introduced by a Dakar based NGO, Associates in Research and Education for Development (ARED), Inc.

placed on increasing revenues that build on existing local knowledge by improving production techniques in the rural sector activities of customary farming, fishing, and small livestock production. A decision to focus revenue generation on one particular activity (irrigation) at the exclusion or neglect of others (recession farming) only narrows options to the farmer and swells the risk of financial hardship under unforeseeable circumstances of climatic uncertainty. Increased disposable income may be achieved by developing a well-balanced mix of the following local farm sector activities: dryland farming, recession cultivation, irrigation, fishing, herding, and commerce.

3. Labor Scarcity

One of the most significant accomplishments of the SRBMA research has been to document the manner in which labor in the rural sector is deployed, both seasonally and long-term, to mitigate risk and optimize the revenue-generating capacity of the household. Thus rural smallholders generally prefer to engage in farm activities that minimize the demand on labor and capital, freeing up these resources for use in a wider range of on- and off-farm subsistence- and income-producing activities. Development objectives set forth in the farm sector should seek to **enhance** rather than **constrain** the mobility of labor in choosing among a range of production options. Recession farming strategies are well adapted to this objective since they allow for the seasonal movement of labor on and off the farm and are modest in their requirements for capital. Conversely, irrigation is highly intensive in its use of these resources. Thus, policy should be directed toward finding the appropriate fit between irrigation and recession activities. This will require sound sociological inquiry and site specificity in identifying the repertoire of production activities at each locale.

Production strategies should be tailored to the existing constellation of farm activities found in each setting. Where irrigation is the only available farm strategy, it should be expanded and improved on, using information drawn from a thorough sociological assessment of community organization and social structure. Where recession farming is the only viable option, agronomic and infrastructural improvements such as those proposed above should be adopted. When recession and irrigation systems are found side by side, policy should be aimed at striking a balance between the two regimes, seeking to bolster production in each system without causing dislocation of either activity. In such situations, the temporal demands on labor must be conscientiously taken into consideration to see that periods of peak labor output do not conflict or become competitive among the various systems.

The important point here is to avoid a monolithic approach to development or the application of a universal "development template." Natural and human resource endowments are unique within each community. Development initiatives should attempt to build upon these existing social and environmental features as opposed to radically restructuring or dismantling them.

4. Local Institutional Organization

The SRBMA research has documented the problematic nature of irrigated cultivation in the Middle Valley. Poor performance and the eventual abandonment of production has been attributed to two primary causes: excessive demands on labor and capital, which frequently result in technical breakdowns or extensive downtime in production, and customary land distribution and inheritance procedures that slowly erode group cohesion within the perimeters.

One of the most seriously neglected areas of research and development within the region is the comprehensive analysis of social organization and those socio-institutional features that directly affect the ongoing operation and longevity of irrigated perimeters. Policy initiatives should be directed toward a more thorough re-examination of the sociology of irrigated rice and vegetable cultivation with an emphasis on creating new institutional structures better configured to the social dynamics of each community. Smaller organizational units based on kin and patron-client ties may be more appropriate than current village-wide communal structures that are often marked by intragroup dispute and contestation over water and resources. Structural reorganization might shift from the larger village cooperative model of irrigation or PIV (Périmètre Irrigué Villagois) to the smaller individualized GIE (Group d'Intérêt Economique). Particular aspects of social organization within the perimeters to be re-evaluated and targeted for specific policy change include:

- **Procedures for land inheritance and land distribution.** It is important that jural mechanisms of land allocation and *de facto* use rights in land be consistent. Currently, land is often entrusted, through inheritance, to family members who might not have time, labor, or adequate resources for its optimal exploitation. As a result, land is often left uncultivated or loaned out under disadvantageous terms.

- **Gender organization of production and decision-making.** Increasingly, women are assuming heavier work burdens in the perimeters. In the decision-making processes that directly affect their economic well-being, however, they are relegated to the position of passive objects. Policy directives must take into account the central role of women in production and introduce measures that will increase their autonomy and protect their rights as active farmers.

D. Collaborative Research and Development

The policy recommendations noted above call for a multidisciplinary and collaborative approach, where social and physical scientists work hand in hand. More importantly, host and Senegal-based institutions such as ISRA (Institut Sénégalais de Recherche Agronomique), CSE (Centre de Suivi Ecologique), and ENDA (Environnement et Développement du Tiers-Monde) should be invited to provide their expertise in establishing an ongoing monitoring unit charged with the documentation of social, environmental, and economic changes occurring throughout the river valley. For example, an extensive ecological inventory of the full range of flora and fauna in the various production niches (jeeri, waalo, falo, foonde, jeejegol), as well as seasonal monitoring of variations of fish species in the main river channel and the floodplain should begin

soon and continue over time, in order to discern how dam management strategies impact the natural resource base downstream. Among the resources that should be monitored longitudinally are:

- **Vegetation.** This should include tree, bush, and grass species composition.

- **Water.** This should include quality, flow, and volume of all hydrological sources, including riverine-wetland, aquifer, rainfall, and runoff water supplies.

- **Fauna.** This should include small and large livestock (cattle, horses, camels, sheep, and goats), fisheries (riverine and floodplain), and aquatic reptiles.

- **Soils.** The structure, composition, and processes of soil aggradation and degradation in the various microenvironments should be documented.

I. INTRODUCTION: HISTORY OF THE SENEGAL RIVER BASIN MONITORING ACTIVITY (SRBMA)

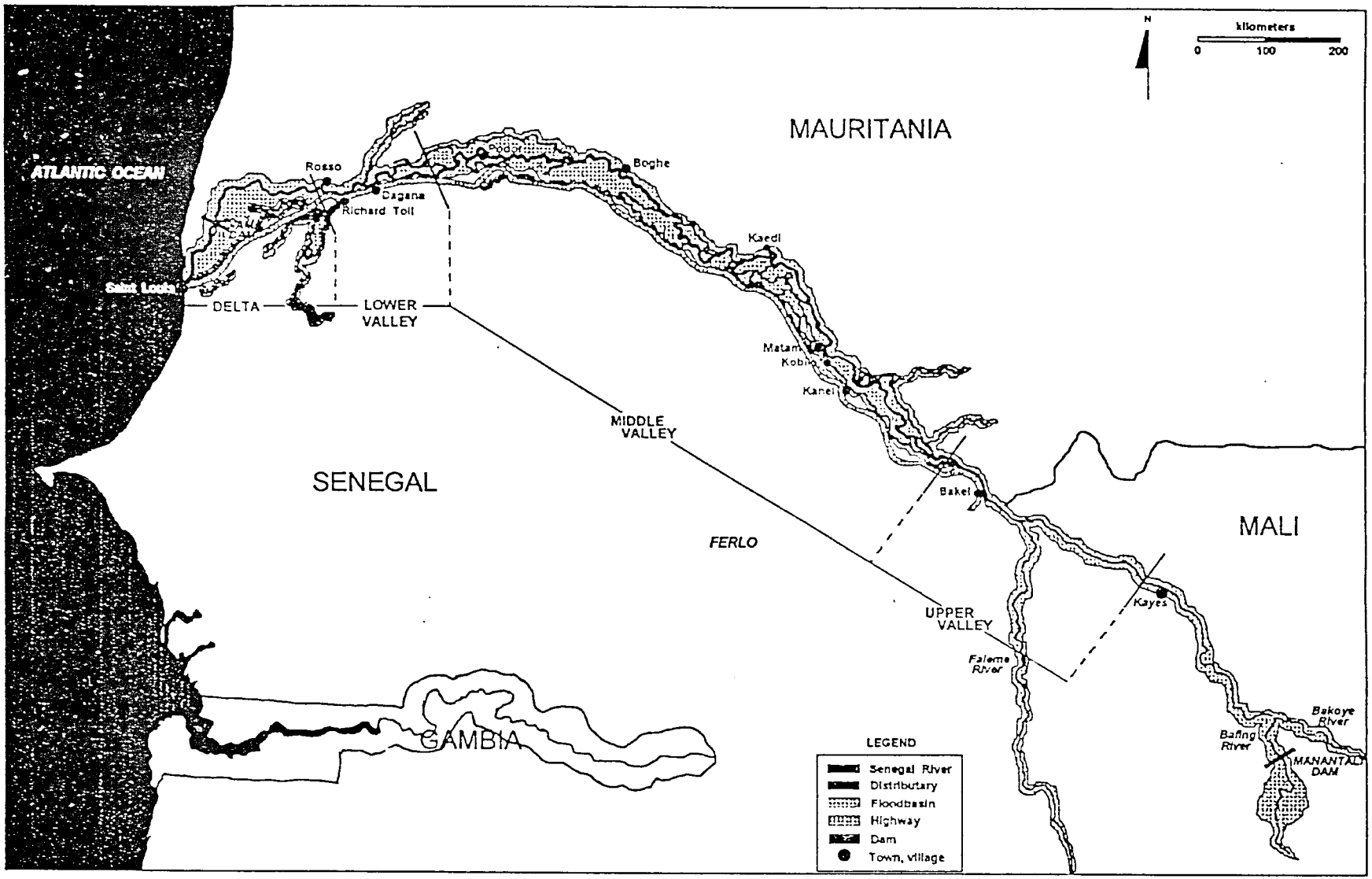
For centuries, the flooding of Africa's rivers has made possible the production of crops, fodder, and fish for farmer, herder, and fisher populations. It has also facilitated forest regeneration and groundwater recharge. During the last century, however, many river regimes have been permanently altered by the construction and operation of large mainstream dams, whose primary purpose is the generation of hydroelectric power and the development of irrigation. Research has shown that these dams have detrimental impacts on the environment by increasing river bank erosion, inhibiting aquifer recharge, and limiting floodplain and forest regeneration (Horowitz et al. 1991:297). The impact of large dams on downstream populations has been less well documented, although studies by Adeniyi (1973) and Adams (1985) on the Bakolori and Kainji dams in northeastern Nigeria discuss the socioeconomic costs of dam operation for downstream populations.

Since 1987, the Institute for Development Anthropology (IDA) has been conducting research in the Senegal River Basin on the socioeconomic and environmental impacts of the Manantali Dam, located upstream in Mali. Carried out under the Cooperative Agreement "Systems Approach to Regional and Sustainable Resource Assistance" (SARSA), in consultation with the Senegalese government bureau in charge of post-dam development in the Senegal River Valley, the Cellule Après-Barrages (CAB), the Senegal River Basin Monitoring Activity (SRBMA) research has been guided by three broad objectives: (1) to examine the costs and benefits at regional and national levels of terminating the annual flood; (2) to research the relationship of a diversified agricultural and nonagricultural economy (including dryland farming, irrigation, flood recession cultivation, animal husbandry, fishing, commerce, and migration) to household food security and income generation; and (3) to protect the natural resource base.

The Senegal River originates in the Fuuta Jallon highlands of Guinea, where the Bafing and Bakoye, two of the river's three main tributaries, have their source. At the point where the Senegalese, Malian, and Mauritanian frontiers meet, the river enters the final 600-km stretch of its 2,000-km journey. For these 600 km the river is flanked by alluvial plains whose soils, when flooded, are the locus of farming, herding, and fishing activities. The Middle Senegal Valley, where the research was conducted, contains the largest tracts of floodplain land. Near Matam, the plain extends away from the river for as far as 30 km. The vast areas flooded in this zone are fed by two major distributaries, the Diamel and Diolol. Four climatic regions characterize the river basin: the Sudano-Guinean, Sudanian, Sahelo-Sudanian, and Sahelian, in order of decreasing rainfall. Rainfall varies from 100 to 200 mm in the north to 700 mm in the southern reaches (Figure 1.1).

Close to one million people live on the left bank of the Senegal River from Bakel to St. Louis. Most make their living by exploiting productive opportunities in and outside the agricultural sector. Within the agricultural sector, the varied agrohaliopastoral activities of farmers, fishers, and herders depend heavily on the annual flooding of the river banks and alluvial plains whose water-retaining vertisols are ideal for the production of sorghum, maize, and cowpeas.

Figure 1.1. Map of River



These soils also produce crop stubble, grasses, shrubs, and trees on which livestock graze, and, when flooded, they provide the correct environment for spawning fish. Farming, herding, and fishing on flood recession lands are complemented by millet cultivation on levees (*foonde*) and rainfed lands (*jeeri*); vegetable production on hand-watered village plots; irrigation on large, medium, and small-scale schemes; and herding in upland areas. The particular combination of activities and the forms they take vary temporally and spatially as flooding patterns, topography, climate, social organization, and political economy change. This diversified agrohaliopastoral sector provides sustenance to people from different socioeconomic and statutory groups. Outside the agrohaliopastoral sector, other revenue-generating opportunities exist, principally in commerce and through migration. Most households take advantage of both agricultural and nonagricultural productive opportunities in an attempt to maintain household reproduction, and, if possible, generate a surplus.

The purpose of the Manantali Dam, completed in 1988 and with a reservoir capacity of 11 billion cubic meters of water, is to regulate the river's flow to allow for electricity generation, irrigation, and navigation. As of May 1993, however, neither turbines nor transmission lines were in place. A second dam, the salt intrusion Diama Dam, first operating in 1985 and located 26 miles from the mouth of the Senegal River at Diama, has permitted large-scale expansion of irrigation in the delta by blocking the upstream encroachment of saline Atlantic waters.

The development strategy supported by OMVS (Organisation pour la mise en valeur du fleuve Sénégal), the tri-state body of Senegal, Mali, and Mauritania that is responsible for the management of the Manantali Dam, calls for control of the downstream flow of waters from the Bafing River (the principal tributary of the Senegal River), the generation of electricity, the development of irrigation, and the establishment of year-round navigation. When first formulated, this strategy was to be implemented only after a ten-year transition period, during which farmers were to continue farming on the floodplain while familiarizing themselves with irrigation technology. The planned transition has not occurred. From 1988 to 1991, the dam has replicated the natural flood only once, in 1988. In the three other years, there either has been no artificial release, or releases were poorly coordinated with flows from the Faleme and the Bakoye. In 1990, for example, an OMVS decision to test the holding capacity of the dam resulted in controlled releases too small to create a flood. The 1992 flood, on the other hand, is reported by some farmers to have been fairly good, although not equaling that of the 1988 flood.

Under Phase I of the SRBMA research, intensive studies were conducted at three village sites—Thiemping, Doumga Rindiaw, and Boyenadji Roumde—located in Matam Department of the Middle Senegal Valley. During the period 1988-1990, data were collected on household consumption, production, labor allocation, land tenure, revenues, and expenditures by IDA field researchers Madiodio Niasse (a Senegalese geographer), John Magistro (an American anthropologist), and Christophe Nuttall (a French geographer). The field research began during the rainfed and recession seasons of 1988, the first year in which there was a controlled release from Manantali and an unusually high flood, surpassing 4,000 cubic meters per second at Bakel.

In 1989 the release generated a more modest flood but with two peaks rather than one. Some farmers who sowed immediately after the first peak had to replant when the second flood washed out seeds. These years also saw significant infestations of locusts and grasshoppers, and, in 1989, ethnic conflicts that caused thousands of Pulaar and Fulbe, who were deported from or fled Mauritania, to settle in or near Senegalese villages along the river.

Important findings related to dam management, agricultural productivity, the socioeconomic dynamics of irrigated agriculture, labor allocation, consumption, and land tenure were drawn from SRBMA I. These findings are summarized here:

1. The OMVS dam-management strategy assumes an incompatibility between the generation of 86 megawatts of electricity and the maintenance of a dam-controlled flood able to inundate at least 50,000 hectares. SRBMA I demonstrated that, in fact, during the period 1904-1984, except in the driest years (1913, 1977, and 1979-84), there would have been sufficient water in the dam's reservoir both to generate 86 megawatts of power and to flood at least 50,000 hectares (Horowitz et al. 1991:36).

2. Production on flood recession lands yields higher returns per unit of labor and of capital than does irrigation, while irrigation yields higher returns per unit of land (ibid.:18, 19).

3. Intensification on the floodplain, including returns to farming, fishing, and herding, exceeds that on irrigated perimeters (ibid.:23-29).

4. Because of the allocation of larger plots to sharecroppers than to landholders on *waalo* land (recession land in the floodplain), the two groups take home the same amount of grain at harvest time. This suggests that notwithstanding a hierarchical social system based on control of waalo land, the society has established a distributive mechanism to assure wide and equal access to floodplain harvests (ibid.:112).

5. Poor performance on irrigated perimeters originates in their heavy production expenses and labor requirements and in customary land distribution and inheritance practices that gradually undermine producer group cohesiveness (ibid.:21).

6. Off-farm activities, notably migration and commerce, account for between 45 and 72 percent of household income. These very important revenue-generating activities are accommodated by a flood-dependent agrohaliopastoral production system that does not use labor intensively (ibid.:261).

7. Food purchases account for between 50 and 80 percent of household expenditures. Surplus capital available for investment in productive activities is thus quite small for most households (ibid.:263).

In October 1990, IDA began Phase II of the Senegal River Basin Monitoring Activity (SRBMA II), which continued through September 1993. During SRBMA II, a methodology for monitoring the impact of different flood patterns on the production systems of the Middle Senegal Valley was developed in consultation with Senegalese counterparts from CAB. Nine field research assistants were trained in data collection and entry. Data were collected at the production system, production space, village, farm, and household levels. Geographic, physical, political, and historical information was gathered at the production system, production space, and village levels. Factor input and harvest data were collected at the farm level, and data on labor allocation, consumption, agricultural and livestock transactions, and off-farm revenues were compiled at the household level. The research sample originally consisted of 345 households located in 32 villages in the departments of Matam and Podor. Because some households dropped out before completion of the study, however, this number dropped to 331.

SRBMA II coincided with a very poor flood period. In 1990, the absence of a controlled release, together with low rainfall levels, resulted in poor sorghum and millet harvests. In 1991, unannounced multiple releases repeatedly washed out certain floodplain areas sown by farmers. The field assistants noted in their diaries that grain prices increased substantially in this period, while livestock prices dropped as herders tried to sell off dying animals.

II. RESEARCH METHODOLOGY

To initiate an evaluation of the impacts of the changing water regime on downstream production systems, SRBMA I conducted an exploratory, intensive study in the Middle Valley of the Senegal River.[1] The study was carried out in three Halpulaar villages in the Department of Matam that represent the three integrated production zones of the region: riverine, recessional, and agro-silvo-pastoral. In addition, secondary sites in complementary zones with significant socioeconomic, political, historical, and exchange relationships with the primary villages were examined. Data were collected qualitatively and quantitatively, using such techniques as formal and informal individual, group, and community interviews; participant observation; life histories; and structured surveys and questionnaires carried out at regular intervals: weekly, biweekly, monthly, bimonthly, or seasonally. In their investigations, the researchers covered the main components of the production system: waalo, *falo* (recession lands located on riverbanks), jeeri, irrigation, fishing, herding, petty commerce, and labor migration. The findings and conclusions of SRBMA I were presented to the Government of Senegal and to donors, nongovernmental organizations (NGOs), and researchers at a seminar in Saly-Portudal in November 1990.

SRBMA II focuses more narrowly on the understandings of floodplain and irrigation production systems that emerged during SRBMA I (Horowitz et al. 1991), but more systematically and over a wider geographic area. The goal is to determine how Middle Valley households make use of scarce resources in responding to perceived opportunities and in dealing with perceived obstacles. An understanding of the heterogeneity of farming households is essential for the realization of development that is participatory and broadly based in the region.

The basic unit of analysis is the production space exploited by a village or a group of historically connected villages. In the nine such production spaces that were selected (containing some 32 villages overall), we assess the relative dominance of floodplain (recession cultivation, herding, fishing) and irrigation activities, examine their comparative productivity in terms of land, labor, and capital, and, to the extent possible, determine household production goals and labor strategies. Five types of relationships between floodplain cultivation and irrigation manifest themselves in the area: predominance or sole presence of floodplain cultivation; domination of floodplain cultivation over irrigation; relative balance between floodplain cultivation and irrigation; domination of irrigation over floodplain cultivation; predominance or sole presence of irrigation. The configuration of this relationship within a particular area and within a household varies in place and in time according to such factors as the extent of the inundated plain (which declines from east to west), the presence of irrigated perimeters (more are present on the Ile à Morphil and in western Podor), rainfall patterns, flood patterns, household production goals, and differential access to resources.

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[1] See the various reports and documents produced under SRBMA I, terminating with Senegal River Basin Monitoring Activity Phase I: Final Report (Suivi des Activités du Bassin du Fleuve Sénégal: Rapport Final Intégré), 1990; revised May 1991 (Horowitz et al. 1991).

A. Sampling Methods and Research Site Selection

1. Research Area

Also known as the "Middle Valley," the alluvial floodplain of the Senegal River Basin occupies a stretch of land (about 10,000 km²) approximately 600 km long and 5 to 25 km wide along the banks of the river between Bakel and Rosso (Lericollais and Diallo 1980:5). For purposes of this study, the Middle Valley is defined as the area along the left bank of the Senegal River that extends from the Arrondissement of Semme, Department of Matam, westward to the Arrondissement of Thille Boubacar, Department of Podor, and from the left bank of the river southward to the sandy upland areas (jeeri) below the national highway. Administratively, the area corresponds roughly to the departments of Matam and Podor (Figure 2.1). It does not form a homogeneous geographical or sociopolitical entity, but rather is differentiated by climate and rainfall patterns, production activities, and administrative structures.

a. Rainfall Variability

The area is characterized by rainfall patterns that vary in intensity, timing, duration, and distribution. Within this generally variable pattern, precipitation is greater in the southeastern regions and less in the northwestern regions. Rainfall-dependent activities are more important in the Department of Matam than in Podor, and in the eastern stretches upstream of Matam than in the western ones downstream.

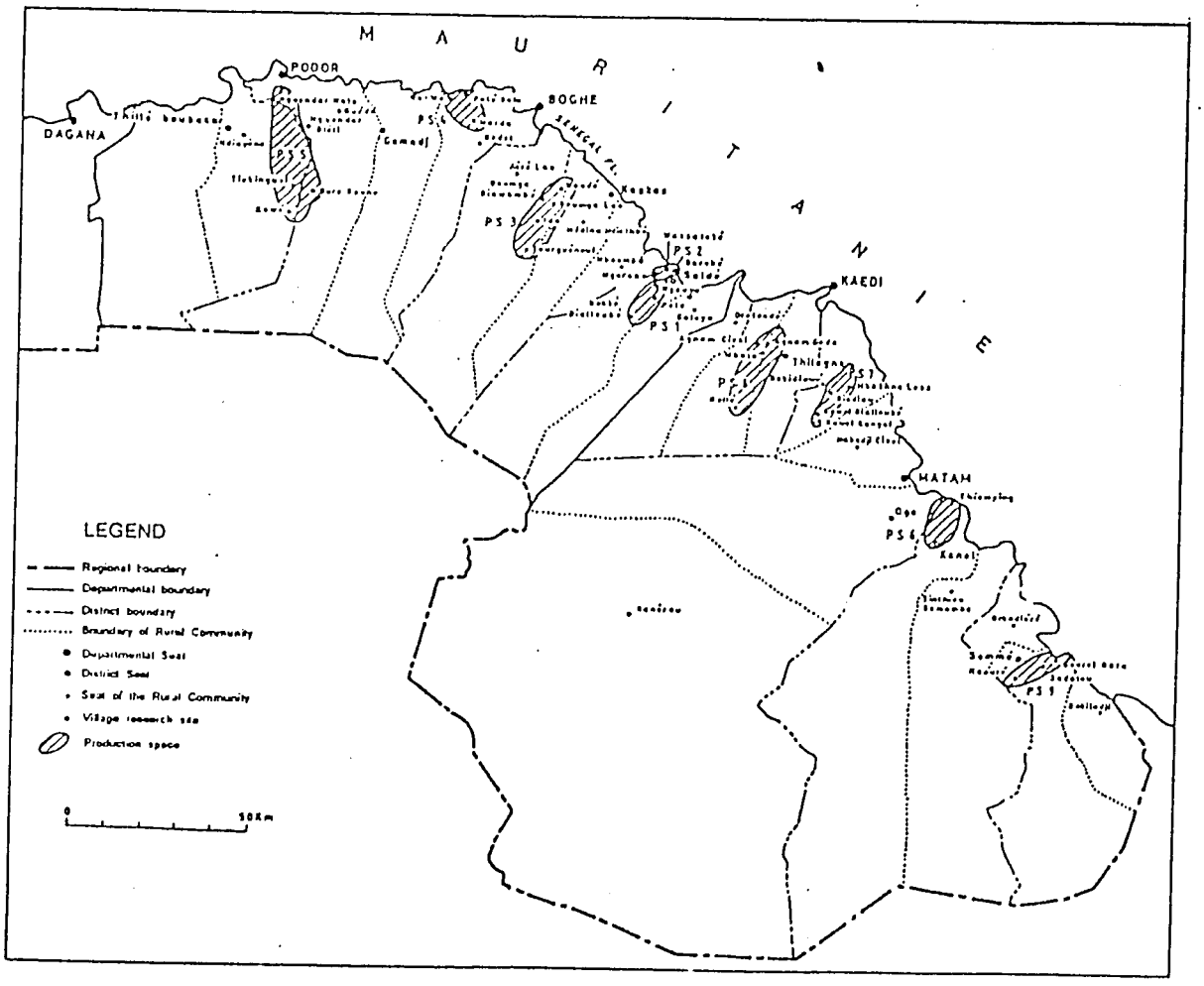
b. Production Activities

Four main production activities in association with the regime of the Senegal River can be identified in the area: recession cultivation, including falo and walo; irrigation, including large, medium, and small (both village cooperative and individual privatized) perimeters, and irrigated vegetable gardens; fishing, both in the main river channel and in flooded cuvettes; and herding. Activities dominant in a particular village are outcomes of its geographic location vis-à-vis the river. Main-channel fishing and falo cultivation are prominent productive activities in riverbank villages. Floodplain villages focus on recession cultivation, fishing of the inundated cuvettes, and irrigation, while those on the higher sandy plains or jeeri lands south of the river concentrate on dryland farming and herding. The populations have adapted to this spatial specialization by establishing strong socioeconomic linkages among villages at various distances from the river, that is, among villages with ready access to different ecological niches. Residents of these villages move freely from one to the other, making use of their established rights to exploit as many of the productive resources as possible.

c. Administrative Structures

Administratively, the area is divided into *départements* (provinces), *arrondissements* (districts), and *communautés rurales* (CRs or rural communities). The research area is composed of 2 departments, Matam and Podor, each divided into 4 arrondissements, and further

Figure 2.1. Research Zones: Departments of Matam and Podor



subdivided into 22 communautés rurales, 12 of them in the Department of Matam and 10 in Podor (see Table 2.1).

Table 2.1. Concessions,[a] Households, and Population by Administrative Division: 1988

	Concessions	Households	Population
DEPARTMENT OF MATAM	**18,982**	**25,536**	**220,913**
Arrondissement of Semme	3,700	4,781	48,597
CR of Bokiladji	939	1,244	13,486
CR of Orkadiere	1,480	1,582	16,190
CR of Semme	1,281	1,955	18,921
Arrondissement of Kanel	3,412	4,692	44,506
CR of Sinthiou Bamambi	1,753	2,446	23,206
CR of Kanel	1,659	2,246	21,300
Arrondissement of Ogo (formerly Ourossogui)	7,535	10,153	83,743
CR of Ogo	2,455	3,322	25,891
CR of Nabadji Civol	1,853	2,475	21,319
CR of Bokidiave	2,378	3,257	26,487
CR of Ranerou	849	1,099	10,046
Arrondissement of Thilogne	3,483	4,725	33,345
CR of Thilogne	1,700	2,224	15,325
CR of Agnam Civol	1,012	1,394	9,900
CR of Orefonde	771	1,107	8,120
Matam Urban Zone	852	1,185	10,722
DEPARTMENT OF PODOR	**16,005**	**19,381**	**144,945**
Arrondissement of Salde	2,514	3,341	24,929
CR of Galoya Toucouleur	1,248	1,780	13,369
CR of Pete	1,266	1,561	11,560
Arrondissement of Cascas	4,663	6,033	41,926
CR of Mboumba	1,139	1,494	9,526
CR of Medina Ndiathbe	1,587	2,053	13,413
CR of Ayre Lao	1,937	2,486	18,987
Arrondissement of Gamadji (formerly Ndioum)	5,247	5,952	46,338
CR of Doofle	1,452	1,729	13,706
CR of Gamadji Sarre	1,528	1,677	12,136
CR of Guede	2,267	2,546	20,496
Arrondissement of Thille Boubacar	2,704	3,043	24,283
CR of Ndiayene	1,390	1,628	12,627
CR of Fanaye	1,314	1,415	11,656
Podor Urban Zone	877	1,012	7,469

[a] Concession is a technical term for tax purposes, usually, but not always, a unit consisting of an extended family including one or more households.

Source: Sénégal, République du, 1988.

2. Sampling Units

In the context of the Middle Valley, several possible units of observation and analysis present themselves: individual producers; the *fooyre* (pl. *poye*), the smallest domestic production unit among the Halpulaar; the *galle* (pl. *galleeji*) or the compound, sometimes composed of several poye; the village; the communauté rurale (CR); the Groupement d'Intérêt Economique (GIE); or a spatial production unit (e.g., a cuvette). The particular unit used at any level of the survey depends on that level's particular objectives. For example, to obtain village-level baseline data, the unit of observation is the village. Information on the general geophysical attributes of a cuvette or floodplain depression is gathered by studying the cuvette in question. However, the units most widely used in this study are the fooyre, loosely translated as "household," and the "production space." The fooyre is selected rather than the galle (compound) because autonomous units of production and consumption that carry different family names are usually found at this level.[2] Commonly, the fooyre is the locus of decision making for production (including the allocation of land, labor, and capital), distribution, and consumption.

The fooyre is not a homogeneous production unit. Poye, which are largely kin-based, are highly differentiated decision-making units. Members of a single fooyre, as differentiated by age, gender, kinship, etc., may have conflicting goals and priorities. The realization of an individual member's goals depends in part on his or her relative power within the unit, power determined by a member's control over resources.

3. Sample Design[3]

Because of the nature of the problem to be investigated (i.e., testing a large number of variables over a wide geographic area) and what that entails in terms of personnel, time, and logistics, a multistage sampling strategy was pursued.

To reflect the geographic, climatic, socioeconomic, and administrative differences in the area, the population was divided into eight strata that correspond with the administrative boundaries of the eight arrondissements—Semme, Kanel, Ogo, and Thilogne in the Department of Matam, and Salde, Cascas, Gamadji, and Thille Boubacar in the Department of Podor. These strata also correspond roughly to the east/west variability of rainfall patterns and climatic conditions. Using the arrondissement as the first level of stratification also offers the additional

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[2] In some instances, more than one domestic unit or fooyre may join together in the compound (galle) to form a collective unit for family production and consumption. Such occasions are infrequent, however.

[3] This section reflects the work of Philip DeCosse, SRBMA II consultant on information management and statistical analysis.

advantage of having a unit of measurement easily understood among governmental and nongovernmental institutions and donors.

Normally, the next level of sample design would be to select from each arrondissement a representative sample of villages that practice the mix of economic activities we are interested in monitoring. This procedure, however, would have failed to capture the historical linkages that exist among villages located on different kinds of land, at different distances from the river, that nonetheless have access rights to the same resources. We call the area that contains this network of villages a production space, defined as the area in which a group of people have specific rights of cultivation, herding, and fishing. Hence, we decided that the production space would be the appropriate unit of observation and analysis.

Ideally, the next step would be the random selection of a sample of the production spaces that represent the mix of production systems and labor strategies within each arrondissement. However, since the notion of a production space is a conceptual one, a random sample drawn from a list of all possible production spaces with their component villages was out of the question. The only feasible way of proceeding was to identify, in consultation with local authorities and inhabitants, areas that exhibit the production opportunities within each arrondissement, select a village from each area, and proceed to identify the other villages that form a part of the same production space. In this fashion, one production space was identified in each of seven arrondissements: Semme, Kanel, Ogo, Thilogne, Cascas, Gamadji, and Thille Boubacar. The production system in the Arrondissement of Salde, in the Department of Podor, was judged too complex to be represented by one entity. Accordingly, two spaces were selected from that region, resulting in a total of nine production spaces that incorporate 32 villages.

4. Stratified vs. Simple Random Sampling

Three reasons are cited in the literature (e.g., Scheaffer et al. 1986:80) for favoring stratified sampling over simple random sampling:

- Stratification may produce a smaller bound on the error of estimate than would be produced by a simple random sample of the same size. This result is particularly true if measurements within strata are homogeneous.

- The cost per observation in the survey may be reduced by stratifying the population elements into convenient groupings.

- Estimates of population parameters may be desired for subgroups of the population.

These subgroups should then be identifiable strata.

Research conducted under SRBMA I points out that differential access to resources is important in determining Middle Valley household labor strategies. Accordingly, a sampling procedure was undertaken that stratifies the population in each production space in terms of

differential access to productive resources. The ideal would be to do this by selecting from an exhaustive inventory of all resources on hand, in addition to a measure of each household's ability, through various contacts, to obtain access to other resources. Unfortunately, precise measures of wealth are extremely difficult to obtain, especially when that information is required before relations of confidence have been established between the researcher and the population. Nevertheless, a measure of differential access to resources can be established by asking key questions on household demography, the occupations of various members, and access to land and to other forms of capital. Therefore a questionnaire soliciting information on differential access to resources of land, labor, capital, and nonfarm revenues was prepared and administered to 3,405 households, occupying the 32 villages in the 9 production systems. From responses to this questionnaire we derived an index of total resources that is used in defining strata for sampling the households that were to be the subjects of the detailed surveys.

5. Total Resource Index: Weights[4]

Computer data entry was carried out using Paradox 3.5, a relational database program. Four indexes of access to resources (farm labor [FL], nonfarm revenue [NFR], land [L], and capital [C]) were constructed by assigning relative weights to the various components of each index as follows:

(1) FL = (0.50) * (# members aged 6-10) +
(1.00) * (# members aged 11-55) +
(0.50) * (# members aged >55)

(2) NFR = (1.00) * (# salaried members) +
(1.00) * (# pensioned members) +
(0.35) * (# artisans) +
(3.00) * (# migrants)

(3) L = (1.25) * (# waalo plots) +
(0.50) * (# falo plots) +
(0.66) * (# irrigated plots)

(4) C = (5.00) * (# cattle) +
(1.00) * (# sheep and goats) +
(30.00) * (# tractors) +
(1.00) * (# plows) +
(2.00) * (# carts) +
(3.00) * (# horses) +
(0.50) * (# donkeys) +

[4] For a summary of the procedures for sample selection, see Annex A 2, "Summary of Algorithm, from Data Entry to Sample Selection."

(3.00) * (# canoes) +
(8.00) * (# camels) +
(15.00) * (# pumps)

where:

FL	=	farm labor
NFR	=	nonfarm revenue
L	=	land
C	=	capital

Weights for land resources (L) were derived by using a multiplicative combination of productivity per hectare and average plot size for different land types as shown in Table 2.2.

Table 2.2. Waalo and Falo Land Productivity

Land Type	Productivity per Ha*	Average Plot Size (ha)	Index Weight
Waalo	0.50	2.50	1.25
Falo	10.00	0.05	0.50
Irrigation	2.00	0.33	0.66

* Estimated from yields per hectare of sorghum (waalo), rice (irrigation), and vegetables (falo) in conjunction with their market values (see Horowitz et al. 1991).

Adding the four indexes results in an unstandardized total resource index.

6. Total Resource Index: Standardization

To facilitate comparability, the resource value of each household was standardized in reference to the average value for each group of observations (FL, NFR, L, C), giving an "index" of each resource. First, averages were calculated for each group, with the following results:

Averages		
FL	=	5.52
NFR	=	0.70
L	=	1.84
C	=	24.82

Next, each observation was divided by the mean value of its group and multiplied by 100. From this, a standardized total resource index (TRI) was generated using the formula:

$$TRI = FLI + (3 * NFRI) + LI + CI$$

where: FLI = farm labor index
NFRI = nonfarm revenue index
LI = land index
CI = capital index

Nonfarm revenue is given three times the weight of the other components of the index to take into consideration the importance of cash remittances in determining the labor strategies of farm households.

Prior to the calculation of a cumulative resource index, data were reviewed and edited, basic summary statistics were calculated in order to assure internal consistency, data entry errors were cleaned, and missing values and outliers were identified and corrected. This was done using the following operations (Paradox 3.5):

1. Check for blanks (enter "checkplus" in the record field and write "blank" in the field of interest).

2. Check for simple frequency distributions of each variable (enter "calc count all" in the field of interest).

3. Calculate frequency distributions of combinations of fields. In addition to verification, this procedure affords the researcher with a first glimpse of what the data collected signify.

7. Strata Boundaries

From the total resource index, strata cutoff points were determined as follows: first, households were sorted on the basis of their total access to resources (TRI), and a cumulative resource index was generated (TRICUM). The cumulative total (the sum of TRI) was divided by three to demarcate three household strata. Stratum 1 includes all households that fall below the cumulative total for the first third of total resources (low resource households); stratum 2 are households that fall in the middle third (medium resource households); and stratum 3 are in the last third (high resource households). As a crude indication of the distribution of resources (as measured by the weighting system used), stratum 1 included 62.8 percent of the 3,405 households, stratum 2 included 24.4 percent, and stratum 3, 12.8 percent.

Strata were calculated at the level of total population, rather than within each production space so that low-, medium-, and high-resource households would fall within the same resource-access boundaries. across production spaces. This allows for comparisons within resource groups and across production systems that would not be possible if cutoff points were made at the production space level.

From the cumulative resource index file a separate file was created for each of the nine production spaces. All ten files (the cumulative index as well as each of the nine individual resource indexes) were exported from Paradox 3.5 to Systat 5.

Within Systat 5, the following calculations were carried out for each of the ten files:

- number of observations;
- minimum;
- maximum;
- mean;
- variance;
- standard deviation;
- standard error.

These statistics appear in Annex A.

8. Sample Size[5]

The sample size required is a function of the variance of the population, the size of the population, the degree of precision desired, the cost of collecting a given observation, and the total resources available for the completion of a survey.

To calculate the sample size, n, for each of the nine production spaces, we apply a formula that provides a stratified sample size for estimating the population mean. The formula used in this study is:

$$n = \frac{\left(\sum_{i=1}^{L} \frac{N_i \sigma_i}{\sqrt{c_i}}\right)\left(\sum_{i=1}^{L} N_i \sigma_i \sqrt{c_i}\right)}{N^2 D + \sum_{i=1}^{L} N_i \sigma_i^2} \qquad (1)$$

where:

i is the stratum index (i = 1, 2, 3), referring, respectively to low-, medium-, and high-resource households;

N is the population size for a given production space;

N_i is the number of units (households) in stratum i of the population;

[5] This section is based on the consultancy work of Philip DeCosse.

σ_i is the standard deviation of the TRI for stratum i;

c_i is the cost of collecting data for stratum i [because it seemed reasonable to assume that the collection cost was constant between strata, c_i cancels out of the numerator of equation (1)]; and

$$D = \frac{B^2}{4}. \tag{2}$$

The desired bound on the error of estimation, is, theoretically:

$$B = 2\sqrt{V(\overline{TRI})} \tag{3}$$

that is, twice the standard error of the population mean (mean of TRI) for the production space.

Because no previous estimates of total resources exist, and, moreover, a weighted index of resources was being used for selecting the sample, no estimates of the variances of the estimators exist; therefore B cannot be calculated from known variances. In such a case, an acceptable method is to select a given percentage of the estimated population mean (DeCosse 1991:10). For purposes of selecting the sample size for each production space, B was set at 10 percent of the mean of the total resource index (TRI) for the production space (PS).

The required sample size was then allocated by stratum in such a way that:

$$n_i = n\frac{N_i\sigma_i}{\sum_{i=1}^{L} N_i\sigma_i} \tag{4}$$

The formula was plugged into a QPro table. Using the statistics generated by Systat (Annex A), the required sample size was calculated for each production space and allocated by stratum. Sample and substitute households were then selected with the aid of a table of random numbers.

B. Criteria for Specific Site Selection and Description of Production Spaces

1. Selection of Research Sites

A main objective of SRBMA II has been a better understanding of the impact of the changing regime of the Senegal River resulting from construction of the Diama and Manantali dams on the socioeconomy of the Senegal River Valley. The selection of specific research sites was driven by OMVS's decision to discontinue the annual flood of the Senegal River after a transition period of about 10 years. In the interim, farmers are expected to move gradually from recession to irrigation cultivation. This study has therefore concentrated on those production activities most affected by the OMVS decision: activities such as recession cultivation and fishing that are threatened by a discontinuation of the annual flood, and irrigation, the activity proposed to replace the customary regimes.

Thus the mix of floodplains and irrigation schemes in an area was an important criterion in the selection of research sites. Using the relative presence of recession and irrigation land (strong, average, weak) as a major criterion, geographical knowledge of the area (including the fact that irrigation is much more widespread in the Department of Podor than in Matam), and various map resources[6] providing spatial images of each zone, four types of agricultural regions were distinguished in the Middle Valley (Table 2.3).

The first category—weak waalo/weak irrigation—is found in the extreme southeast of the Department of Matam (Arrondissement of Semme). Spurred by the Sahelian drought of 1967-1974, small-scale irrigation spread rapidly in the Middle Valley. By 1985, 522 small perimeters, which extended over an area of 10,000 hectares and involved over 35,000 households, had burgeoned on both sides of the river (Diemer and Van der Laan 1987:47). The area of Semme was not so favored, however. This omission was probably prompted by higher rainfall in the Semme area than in the downstream regions, even in the deficit years. Higher

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[6] In this effort several map resources were consulted. These include:

- The work carried out in 1971-1973 by André Lericollais and Yveline Diallo, which appeared in 1980 under the title, *Peuplement et cultures de saison sèche dans la vallée du Sénégal* (ORSTOM). The work consists mainly of a series of maps at the 1/50,000 scale (Lericollais and Diallo 1980).

- The 1986, 1988, and 1989 SPOT maps of the flood, commissioned by OMVS and reproduced at a 1/50,000 scale by Samba Dia of OMVS (Dia 1987, 1989).

- The SAED maps for the delegations of Podor and Matam (SAED 1985). These 1/100,000 scale maps indicate the location of irrigated perimeters and their surface area.

- The 1969 FAO/PNUD/OERS maps at a 1/50,000 scale (FAO, PNUD, OERS 1969).

rainfall has also caused Semme to be favored by many herder groups, whose permanent villages are upstream but who gather here at the outset of the rainy season to allow their animals to graze and browse, hoping to gain cultivation rights to land in the jeeri.

Table 2.3. Types of Agricultural Regions

Category	Waalo	Irrigation	Location
1	Weak	Weak	Extreme southeast of the Department of Matam
2	Strong	Weak	Center and west of the Department of Matam
3	Strong	Strong	Center and east of the Department of Podor
4	Weak	Strong	Extreme west of the Department of Podor

The second category—strong waalo/weak irrigation—includes the rest of the Department of Matam. It is in the lower portion of the department (Arrondissement of Thilogne, roughly between Kobilo and Orefonde), however, where one encounters this extreme contrast between the presence of vast tracts of waalo land and the nearly total absence of irrigation. The Diamel, a distributary of the Senegal River, originates downstream from Matam, feeding several cuvettes that supply water to irrigated schemes on both sides of the river. Starting near Kobilo,[7] it disperses among a vast number of marigots (creeks) that culminate in what is known as the Plain of Thilogne. Accordingly, this part of the valley is among those best endowed with waalo land, but with few permanent sources of water that would make irrigation possible. These very features have given the area a high population density but also, with deteriorating conditions of hydrology and rainfall, large-scale emigration. This emigration, ironically, has made it one of the most prosperous regions in the Fuuta.

A fairly large number of irrigation perimeters, especially village irrigated perimeters (*périmètres irrigués villageois*—PIVs), exist in Matam's arrondissements of Kanel (center-east) and Ogo—formerly known as Ourossogui—(center-west), along large areas of floodplain. In general, however, access to recession cultivation is much greater than access to irrigation in these arrondissements.

The third category—strong waalo/strong irrigation—is found primarily in the east and center of the Department of Podor. In this region, where uncertain rainfall makes rainfed agriculture very hazardous, another distributary, the Doue, runs parallel to the Senegal River and to smaller defluents (such as the Gayo) for approximately 150 km, enabling both recession and irrigation farming to take place.

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[7] A midsize irrigated perimeter that was envisaged for Kobilo as part of SAED's program for Matam, Phase III, had to be deferred because of anticipated water supply difficulties.

Downstream from Podor (Arrondissement of Thille Boubacar), the alluvial valley narrows, creating a substantially smaller floodplain. In this fourth category, recession cultivation is restricted largely to horticultural production on the riverbanks, or falo, where relatively large garden plots may be found. A substantial amount of irrigation compensates for the scant possibilities for recession cultivation and the precarious conditions of rainfall.

2. The Production Space (PS)

Like "sphere" (Bohannan 1955; Barth 1967) and "production sphere" (Salem-Murdock 1989), "production space" is a heuristic device created to describe the space, comprising several villages where a certain number of interrelated activities such as dryland farming, recession cultivation, herding, and fishing take place. People who occupy that space exploit its resources and assure widespread distribution through long-established exchange ties. Like spheres and production spheres, production spaces are neither mutually exclusive nor mutually inclusive of one another. From a geographical point of view, villages can and do form parts of several production spaces that are not themselves necessarily interlinked physically or spatially. Socially, however, villages may be linked within the same production space due to a complex web of social ties defined by kinship, communal production relations, and matrimonial as well as commercial exchanges. Moreover, which villages form a particular production space varies, depending on the person asked and the activity pursued. In order to deal with the complexities in defining the production space (PS), the task was approached at four levels.

a. Historical

The information collected during SRBMA I shows that the traditional organization of space among the Halpulaar, the *leydi* (pl. *leyde*), has not totally disappeared. Jean Schmitz notes that the leydi is a territorial unit that has:

> dans une sorte de topographie idéale, en son centre un gros village d'agriculteurs (*ceddo* ou *tooroodo*) situé souvent à la limite du *waalo* et du *jeeri* ; un quartier ou un village de pêcheurs (*cuballo*) surplombant le fleuve à partir d'un bourrelet de berge, proche des fosses du lit mineur ; enfin, un chapelet de hameaux de pasteurs *pullo* qui s'égrènent perpendiculairement au fleuve, le long des pistes de transhumance qui conduisent au *jeeri* lointain (1986:364).

Defined in terms of territorial control, Schmitz's description may be seen as a "confederation of the leydi" in which each subsistence group exercises autonomous control over a portion of the space.

In general, the Fulbe control the rangeland, including access paths, in addition to a considerable part of the floodplain. Toward the end of the eighteenth century, with the decline of the Fulbe dynasty of Denyanke and the triumph of the Islamic revolution of the Toorobbe, the Toorobbe and the Sebbe were able to control substantial territories previously in the hands of the Fulbe. On the other hand, lands along the river and the numerous watercourses have been

under the control of fishing villages. Although in the past the Fulbe and Toorobbe chiefs (respectively *ardo* or *joom*, and *ceerno*) were hierarchically superordinate to the Subalbe chief (*jaltaabe*), these title hierarchies have disappeared.

Agriculture, herding, and fishing are superposed on each other, with one activity succeeding another as the season advances. For example, inundated floodplains serve as fishing grounds for the Subalbe (sing. Cuballo). As the water retreats, farmers start planting; once harvested, the fields are pastured by animals belonging to herders. This land use system necessitates a degree of coordination among the chiefs of different user groups (e.g., the ardo, the ceerno or *elimaan*, and the jaltaabe). Because of the existing complementarities among the three ecological niches of the area, the *daande maayo* (riverbanks), the *jeejegol* (intermediate zone between the waalo and jeeri), and the jeeri (rainfed zone), animal and fish products of the waalo, falo, and jeeri are exchanged along a line perpendicular to the river.

On the other hand, matrimonial exchanges, which are strictly endogamous within each caste, follow a line parallel to the river and occur over a much larger area than the leydi or the confederation of leyde. Because of inheritance laws, matrimonial exchanges frequently engender the dispersion of land rights. In consequence, leydi boundaries are becoming increasingly imprecise. This impression is accentuated by three phenomena:

- The traditional triumvirate constituted by the ardo, the jaltaabe, and the elimaan was made redundant by the Conseils Ruraux (Rural Councils), which were created as a part of the local administrative reform and implemented in the region of Saint Louis in July 1980.

- The crisis that is affecting traditional activities, especially rainfed cultivation, recession cultivation, herding, and fishing, has handicapped exchange relationships among the various ecological niches in favor of new commercial centers that have emerged along the national highway, orienting activities toward Saint Louis and Dakar.

- Large- and middle-scale irrigated perimeters polarize villages along lines different from the boundaries of the leyde. Moreover, the irrigated perimeters, usually constructed in the higher elevations of the waalo (known as foonde), have frequently interfered with traditional land use, in certain cases denying livestock access to watering grounds. To the extent that irrigated perimeters follow a land use logic that is different from customary practices, they resemble enclaves within a leydi where the rights and authority of the customary heads do not apply. The state (i.e., SAED) becomes the sole joom (master of the) leydi; thus the use of the term *ngesa laamu* ("fields of the state") by the local populace when referring to irrigated perimeters.

For these reasons, the leydi is no longer considered to be a territorial unit pertinent for socioeconomic study, despite the fact that any spatial definition cannot fully overlook those features of customary organization in the leydi that remain.

b. Geophysical

In order to identify a production space according to geophysical parameters, the UNE (unité naturelle d'équipement), developed by FAO in the 1970s (FAO 1977), may be considered. The UNE enables one to delineate, on the basis of topographic criteria used in demarcating zones of irrigation easily amenable to diking, distinct geographical areas of hydraulic networks bordered by a levee. The UNEs cover most of the alluvial valley and provide, for each unit, estimates of floodplain areas inundated and cultivated in 1970-1971, as well as soil types.

A study carried out from 1970 to 1974 by Lericollais and Diallo (1980) uses, with slight modifications to accommodate the administrative divisions of departments and arrondissements, the concept of the UNE, which it refers to simply as the "unité naturelle" (UN). This study adds a socioeconomic dimension—demography and flood-related activities—to the spatial unit defined by the FAO team.

In terms of the SRBMA II study objectives, however, both the UNE and the UN pose more disadvantages than advantages.

- First, a UN, because it is defined from a spatial perspective, does not account for—and may distort—human realities. For example, in the area of Doumga Rindiaw, Kaawel, and Mbakhna, the UN that Lericollais and Diallo label "MOC" encompasses the entire village of Kaawel's waalo land; yet the village, situated further south, is separated from its waalo land by the UN "MOD," where Doumga Rindiaw and its waalo lands are located. Taking such a unit as a base is to risk studying a silent space—a cultivated area without cultivators.

- Further, as the UNs were delineated prior to the advance of irrigation, they do not incorporate one of the two principal parameters in our choice of research sites. Irrigation and its accompanying infrastructure have definitively modified the spatial realities depicted in the UNs.

- Finally, the movement of agricultural labor contained in the work of Lericollais and Diallo no longer corresponds to the geopolitical realities of the river basin, particularly with respect to the movement of labor across the river.

c. Administrative

Created by an administrative reform that seems to have been inspired by the traditional territorial organization of the leydi, the communauté rurale was initially considered a unit better suited to define the SRBMA study areas than the arrondissement. In the text of the Réforme de l'Administration Locale, the CR is described as "constituée par un certain nombre de villages appartenant au même terroir, unis par une solidarité résultant notamment du voisinage, possédant

des intérêts communs et capables de trouver les ressources nécessaires à leur développement."[8] In addition, the rural council heads who manage CRs have powers that are reminiscent of those of the joom leydi: they deliberate over questions relating to land allocation and to land and water usage and rights within their territories. Logistic and budgetary constraints were central in the decision to use the arrondissement as an administrative unit, since CRs are smaller units that would accordingly require larger village and household sample sizes. Moreover, CRs are frequently cut in a very arbitrary fashion, with villages and their lands sometimes located in different CRs. This has become a source of many problems in the application of the Loi sur le Domaine National.

d. Selection of Production Spaces

To account for the geopolitical, socioeconomic, and demographic realities of the area yet stay within the administrative boundaries of the arrondissement, the concept of production space (PS) was adopted, combining some elements of the leydi (particularly land use and allocation rights) with other socioeconomic, historical, geographic, and exchange elements. We define the PS as the area in which a group of people have specific rights of cultivation, herding, and fishing. The notion of production space illuminates the historical linkages that exist among several villages, located on different kinds of land and at different distances from the river, that nonetheless have access rights to the same resources. In its spatial and economic dimensions, the concept of production space is congruent with that of the "terroir" described in French geographical writing on the valley, but it also includes important social and ideological dimensions. SRBMA II defines the production space as an area whose agricultural, herding, and fishing resources are exploited by a group of villages that have historical ownership rights to these resources. The ownership rights of a fishing village are over water, and are exercised by the jaltaabe (master of the water). Ownership rights over agricultural lands and rangelands are in the hands of the joom leydi or the ardo (a title carried by the heads of some Fulbe families).

Selecting PSs lasted from about mid-February to mid-March 1991 and entailed the following steps. We classified each of the eight arrondissements in the departments of Matam and Podor in terms of access to waalo and irrigation lands, expecting to select a PS from each that reflected that mixture. Using the Lericollais and Diallo (1980) maps for village locations, the 1989 SPOT-OMVS (Dia 1989) maps to estimate the area under inundation, SAED (1985) maps for the placement of irrigated schemes, and consultation with local authorities and inhabitants, one or two villages were preselected in each arrondissement. This was followed by site visits to each village to speak to villagers, and to verify and complete information. Additional interviews were conducted with the inhabitants of the initial and nearby villages to ascertain the linkages among them. This operation, which took at least several days in each location, allowed us to define the nine PSs and select the villages that form the principal users.

[8] Art. 1 de la Loi 72-25 du 19 avril 1972 relative aux Communautés Rurales.

The two arrondissements of Kanel and Ogo (the former Arrondissement of Ourossogui) were exceptions to this rule. Because they had been part of the research sites of SRBMA I, retaining them allowed us to use previously collected information. The site of Thiemping, in the Arrondissement of Kanel, was thus selected again, but area boundaries were redefined to include the village of Kanel and its cultivated area. In the Arrondissement of Ogo, the site of two research zones in SRBMA I, Doumga Rindiaw was selected over Boynadji.[9]

As noted earlier, one production space was identified in each of the arrondissements of Semme, Kanel, Ogo, Thilogne, Cascas, Gamadji (the former Arrondissement of Ndioum), and Thille Boubacar. Because the Arrondissement of Salde, Department of Podor, has a strong orientation toward irrigation in the Ile à Morphil area in the north but much less irrigation south of the Doue, it is represented by two PSs, completing the total of nine production spaces with 32 villages listed in Table 2.4. A research assistant (RA) was located in one of the villages in each PS.

3. Descriptions of Production Spaces

a. Production Spaces in the Department of Matam

(1) PS 7: Doumga Rindiaw/Kaawel Dialloube/Kaawel Cangal/Mbakhna Less (Arrondissement of Ogo)

As indicated above, the sector of Doumga Rindiaw in the Arrondissement of Ogo was chosen largely because ongoing research had been conducted in this village since August 1988. Moreover, information collected earlier in this area had contributed substantially to the conceptualization of the production space (PS) and its application throughout the Middle Valley.

The village of Doumga Rindiaw, or Doumga Bossea, is situated on the national highway, some 30 km northwest of Ogo. The production area stretches from the Diamel, a distributary of the Senegal River, to southwest of the national highway and contains within it recession cultivation, fishing, rainfed agriculture, and rangeland zones. It includes the Fulbe villages of Saracoura, Diolol, Kaawel, and Pade near the jeeri fields, the Toorobbe village of Doumga Rindiaw in the intermediate zone (jeejegol), and the two Subalbe fishing villages of Mbakhna Dow and Mbakhna Less on the bank of the Diamel.

The assemblage of fields exploited by Doumga Rindiaw constitutes a tract of land extending about 15 km; some of this land stretches from the bank of the Diamel (to the west of Mbakhna Less) to the edges of Pade Boyngal to the south, on the other side of the national highway. Before the village of Doumga Rindiaw was established, the area was controlled by

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[9] The selection of Doumga over Boynadji was prompted by the fact that the SRBMA I researcher who resided in this village was still part of the team and was appointed as field coordinator under SRBMA II.

the Fulbe village of Kaawel Dialloube, situated in the jeeri about 10 km to the south of Doumga, a little beyond Pade Boyngal.

Table 2.4. Production Spaces Studied under SRBMA II

Department	Arrondissement	PS No.	Villages	Research Assistant
M A T A M	SEMME	PS 9	Haoure Sadatou Gourel Dara	Mamadou Oumar Diallo
	KANEL	PS 6	Thiemping Kanel	Moussa Diop
	OGO	PS 7	Doumga Rindiaw Kaawel Dialloube Kaawel Cangal Mbakhna Less	Nafissatou Sow
	THILOGNE	PS 8	Agnam Godo Agnam Civol Belle Mberla	Mamoudou Athie
P O D O R	SALDE	PS 1	Ngouye Pete Boke Dialloube	Moussa Kane
		PS 2	Wassatake Barobe Ngarane	Moussa Ba
	CASCAS	PS 3	Doumga Lao Doumga Diawambe Wande Ida Tourguenol	Mohamadou Camara
	GAMADJI	PS 4	Pate Galo Wa-Wa Marda	Elimine Sow
	THILLE BOUBACAR	PS 5	Nguendar Jeeri Nguendar Waalo Kawe Ouro Boune Tekinguel	Aissata Ba

The oral tradition indicates that the founder of Doumga Rindiaw originated from the village of Rindiaw in Mauritania, upstream from Kaedi. Because of rivalries between him and his half brothers over the headmanship of the village, he had to quit Rindiaw at the death of his father and move to the left bank. Because of his already established reputation as an Islamic

scholar, he was very well received by the maraboutic families of Orefonde.[10] Afterwards he was invited by the Almamy Abdoul of Kobilo to join his council; this allows us to date the event to the late eighteenth or early nineteenth century.[11] At the time, the Almamy was occupied with the pacification and Islamization of the Fuuta, and had clashed with the Fulbe aristocracy, who were well implanted in such provinces as Bossea (Arrondissement of Thilogne) and Nguennar (Arrondissement of Ogo).

This confrontation between the Fulbe aristocracy and the almamyat had two principal causes: (1) the Fulbe had remained essentially animists, practicing a superficial form of Islam, which went against the fundamentalist fervor of the new caste of Toorobbe headed by the Almamy; (2) a large part of the land, particularly the waalo, was controlled by the Fulbe, and the Toorobbe aristocracy was unable to exercise political power on a lasting basis without assuring control over land. Moreover, Sebbe warrior and Toorobbe marabout allies, like the founder of Doumga Rindiaw, had to be rewarded for their support.

The founder of Doumga Rindiaw, Elimaan Rindiaw, was compensated for his loyalty to the Almamy within the context of a large-scale redistribution of land in the Fuuta (termed the "feccere Fuuta" or "partitioning of the Fuuta"). The Elimaan played a primary role in the conversion to Islam of the Ardo of Kaawel, Aly Diam Ka, by the Almamy Abdoul. In return, the Almamy installed him on a part of the land that was controlled by the Ardo and that today forms the territory of Doumga Rindiaw. This entire area became the *njiimandi* of the elimaan, a term that applies to the lands (*bayti*) extracted from the large domains of the almamyat, managed by the Almamy in the name of the Islamic community and given to those close to the theocratic regime.[12] Elimaan Rindiaw became the joom leydi, a title transmitted to his descendants.

The village created by the elimaan in the midst of this territory carries the name of Rindiaw, after his native village in Mauritania. Even though the new village is situated in the province of Nguennar, it is still referred to after the original province of its founder and principal inhabitants: Bossea.

A strong similarity exists between the leydi conceived by Schmitz (1986) and the village lands (or leydi) of Doumga Rindiaw. An important element is missing in this comparison, however: in the Doumga leydi no other ethno-territorial group is found.

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[10] Rindiaw on the right bank, and Orefonde on the left bank belonged to the ancient province of Bossea.

[11] Abdoul Kader Kane of Kobilo, the first Almamy after the 1776 Islamist revolution of the Toorobbe ruled for approximately 30 years, from 1778 to about 1808 (Wane 1969:12).

[12] See Minvielle (1977:18).

The ethno-territorial structure of the area of Doumga contains ecological niches that are linked to specific statutory groups of the zone (Subalbe on the border of watercourses, Toorobbe in the jeejegol, and Fulbe in the jeeri).[13] None of these groups can live independently of the others. The Fulbe need to dispose of their livestock products and the fishermen of their fish; the farmers want to add animal protein to their diets. But conceived in this manner, the leydi remains a vague notion, applicable anywhere fishermen, agriculturalists, and herders coexist. While the ecological dimensions of group interaction among the three groups may be ascertained in the area, the political dimension, involving a central authority responsible for the management of the area in a manner assuring each group's viability, is much more difficult to establish. This political aspect constitutes the second axis along which the study of the area has been drawn.

The existence of a leydi assumes the presence of a joom leydi who assures the "ecological policing" of the area. Short of identifying an ecologically viable leydi in the Doumga Rindiaw region, it was necessary to expand the geographical area of the ecosystem. This involved an extension from the jeeri to the waalo, including a section of the Diamel, the ponds, the floodplain, irrigated and wooded areas, rangeland, and fishing, farming, and agropastoral/herding villages. None of the territories controlled by Mbakhna, Doumga Rindiaw, and Kaawel individually fit these criteria. Together, however, these communities appear to function as an ecosystem whose contours may be identified in terms of agricultural, fishing, and herding use rights.

- **Fishing Rights.** Fishing rights examined in this study explore those pond areas linked to the Diamel, where fish are caught after the closure of feeder channels or distributaries as flood waters begin to recede. The village of Mbakhna exercises rights over the pond of Sahoum which feeds the *kolangal* (pl. *kolaade*: recession cuvette) of the same name belonging primarily to Doumga Ouro Thierno. At the start of the fishing season, the first large fish gathered at this pond are traditionally given in a symbolic act to the Ardo of Kaawel and the Elimaan Rindiaw (the village chief). In contrast, in the pond of Honi, it is the Sebbe of Bokidiawe who have the exclusive rights to catch fish. This right is justified on the grounds that the marsh (*caangol*) called Siw-Siw and Wendou Honi (Honi Pond), while located on the lands of Doumga Rindiaw, belong to the leydi of the Neganabe of Bokidiawe.

- **Agricultural Land Use Rights.** The cultivated lands controlled by Doumga Rindiaw lie, for historical reasons, within the territory of Kaawel. The domain of Kaawel becomes narrow at the borders of the waalo of Doumga, but extends to the distant jeeri beyond the Diamel. The territory of Mbakhna, minimal in size, is located on falo land that extends along the riverbank lands of Doumga. These latter lands are for the most part exploited by the inhabitants of Mbakhna, generally on the basis of annual rental contracts. Mbakhna, lacking waalo land, sharecrops in the cuvettes of Kaawel and Doumga. The jeeri lands of Doumga rest largely under the authority of the Ardo of Kaawel.

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[13] These niches incorporate the leydi of Doumga but extend beyond it and exist on a much larger scale.

- **Rights of Passage for Animals.** Although most of the land that belonged to Kaawel was distributed to the villages of Doumga Rindiaw and Doumga Ouro Thierno, the Ardo managed to hold the vital corridor (*lappol*) that allows the livestock of Kaawel to water at the river and to cross it to graze the kolaade after the waalo harvest (*nyaayngal*). The Ardo also maintained control over the pond of Sahoum, which retains water after the jeeri ponds dry up, facilitating the watering of animals that exploit the dry-season foonde pasture.

In the corridor leading to Kaawel's kolaade and the pond of Sahoum, the Ardo forbids the utilization of space that might create conflicts with pastoral practices. This prohibition does not apply to the rainy season cultivation period, however, when jeeri ponds are full of water and animals may remain there to feed on fresh grasses and water. Livestock from surrounding villages (Saracoura, Diolol, Pade Boynga, Doumga, etc.) may be permitted access to this passageway while the livestock of Kaawel move freely on other paths (between Doumga Ouro Thierno and Doumga Ouro Alpha, and one passing by Saracoura between Bokidiawe and Dabia) that lead to the Diamel. On these paths, however, the Ardo of Kaawel has no authority and exercises no control over events that may disrupt the movement of his herds.

The Functioning of the PS. In the rainy season farmers cultivate jeeri fields to the south of the village, foonde lands to the north and east, and a part of the *lappol* (cattle paths located along the cultivated fields) of Kaawel. Farmers from Mbakhna cultivate the jeejegol[14] during this period. Livestock at this time graze near the village and to the south, where pastures are green. Jeeri harvest begins in October, and as the harvested fields are opened to animals (the period of nyaayngal), Kaawel herds can graze on distant jeeri fields until the last ponds dry up. Later, with the start of the nyaayngal on the jeeri and foonde fields of Doumga and Kaawel, the herds approach the jeejegol and water in the Wendou Sahoum.

As the water recedes, cultivation begins in the waalo fields of Doumga and Kaawel, and fish caught by the fishermen of Mbakhna at Wendou Sahoum are exchanged in Kaawel and Doumga for dairy products and millet. When the nyaayngal begins on the cuvettes of the Diamel's right bank, fishers guide livestock across the defluent. These livestock leave behind heavy deposits of manure in the jeeri fields.

Starting in April-May, the herds shuttle between the jeeri, where the pastures are dry, and the waalo, where the animals water at a permanent water point near Mbakhna and at the Wendou Sahoum pond. At this time the fishermen of Mbakhna use special gill nets (*gubbol*) as they move from one fishing hole (*luggere*) to another, migrating up the Diamel and down the Senegal. As the rainy season approaches and the supply of pasture dwindles, herders start cutting tree branches (*bajaal*) along the sides of the corridor to feed the animals. The cycle is renewed after the first rains.

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[14] A sandy foonde area south of Mbakhna similar to the jeeri.

In sum, in the context of Doumga Rindiaw, the concept of a leydi—as an integrated and autonomous territorial unit functioning on the basis of interdependent interest groups under the direction of a political authority—does not correspond to the present leyde, which are areas that emerged from the segmentations of land occurring under the Almamyat and during colonial rule. In the period stretching from the time of the last Saatigui Souley Ndiaye to the pacification of the Fuuta by France, the leyde have been transformed by political forces in the context of the gradual opening of the Senegal River Valley to the market economy. A process of sedentarization ("*ordre sédentaire*") that has supplanted an earlier era of pastoral mobility ("*ordre pastoral*") has not taken into account the internal mobility of social groups inherent to the functioning of the leydi ecosystem.

In the region of Doumga Rindiaw, the vast leydi existing prior to the Toorobbe revolution (pretheocratic) appears to be more viable ecologically than the territories constituted thereafter on the basis of political clientelism. The leydi, therefore, should be identified at another level as a confederation of lands, each managed by its own chief (the joom leydi for Doumga and Kaawel, the jaltaabe for Mbakhna). In the Doumga area, this includes the Ardo of Kaawel, who has political guardianship over the nearby Fulbe villages of Saracoura, Diolol, and Pade as well as the Wolof village of Thiehel Pade; the Elimaan of Doumga Rindiaw; and the Jaltaabe of Mbakhna, each reigning over his fief and consulting with the others on issues of common interest.

In this production space (PS 7), recession cultivation is more prevalent than irrigation. Nonetheless, despite a large floodplain area (as that of Kaawel Dialloube), recession cultivation is less important than in the Arrondissement of Kanel. At the same time, the level of access to irrigation within the PS is variable: Kaawel Dialloube and Kaawel Cangal have no irrigated perimeters; Doumga Rindiaw and Mbakhna have had irrigated perimeters since 1978, the former having three PIVs.

(2) PS 9: Haoure/Sadatou/Gourel Dara (Arrondissement of Semme)

The village of Haoure, on the national highway three km southeast of Semme, was the first site to be selected in the Arrondissement of Semme. It is a large market town—originally a Fulbe village as evidenced by the village chief's lineage (Fresbe)—with 346 households at the time of the census. The chief serves as joom leydi, with authority over a large expanse of land extending from the riverbank to the *Ferlo* (an area of pastureland) and including many surrounding villages. The vast holdings in land account for the regional prestige of this village and explain, in part, the relatively sizable population. A long period of sedentarization has witnessed the transformation of this community from a herding to a farming village, in which the population identifies itself as Toorobbe, while simultaneously acknowledging its Fulbe origins.

The population of the Fulbe village of Sadatou came from Kobilo (Arrondissement of Thilogne) in search of pasture during the drought of the 1970s, and remained. The small village of Gourel Dara, the majority of whose population is Toorobbe, with a few Subalbe fishing

families, controls one of the most important falo (recession) areas of the zone. In addition, it practices rainfed and recession cultivation on land that principally constitutes a part of the domain of Haoure.

The complementarity of the production systems, the superposition of forms of exploitation of the land, and the near uniformity of eminent rights to land are the features that determined the choice of these three villages, and consequently, the delineation of intervillage territories and production spaces.

Despite the extent of the lands under the control of Haoure, the potential for recession cultivation, as elsewhere in the Arrondissement of Semme, is limited. Among the numerous waalo lands (kolaade) surveyed in this PS, only six were flooded in 1988 and 1989. These were only partially flooded, largely because sand had accumulated in the feeder marigots.

The only village irrigated perimeter in the PS is that of Gourel Dara. This is a very small PIV, whose farmers come from Gourel Dara and Sadatou, with 5 ha for 53 parcels. This perimeter is cultivated more as a vegetable garden than a rice perimeter and has not been exploited for at least three years.

Rainfed cultivation, then, is the principal agricultural activity in this PS and, in general, in the entire Arrondissement of Semme. Herding is also rather prosperous in this zone. Sadatou, a Fulbe village, has a cattle herd estimated at thousands of head.[15]

(3) PS 6: Thiemping/Kanel (Arrondissement of Kanel)

The fact that Thiemping has been surveyed since Phase I was a significant factor in its selection. It is a village of the descendants of ancient Sebbe warriors, situated on the banks of the Senegal River about 20 km upstream from Matam. Charged in the past with the protection of the left bank from the threat of the Maures, the inhabitants of Thiemping have benefited from compensation for this service in the form of extensive agricultural lands, both waalo and falo. Defining a production space in this zone was not simple, partly because the elements of a leydi headed by a joom leydi have almost totally disappeared, probably because of the enforcement of local political power under colonization. Kanel was, in fact, a strong political center during this period. Except for the large kolangal of Cangay Dow Seyji, the lands of Thiemping were a gift from the traditional authorities of Kanel, which means that the former *joom ngesa* (master of the fields) resides at Kanel. The reorganizations that occurred afterwards profoundly affected the administration of land rights in Kanel and Thiemping. With few exceptions, Kanel and Thiemping control lands that are adjacent, rather than enjoying common rights to the same resources. The recession basins of Baari Pate and Cokobel, where communal exploitation and co-ownership exist, are exceptions to this.

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[15] Some villagers provide an estimate as high as 15,000 head, but this figure seems excessive.

Kanel is now a large market town, the prime site of the arrondissement, with a population of 572 resident households. It is among the most prominent Fuuta villages in terms of waalo land ownership. Rainfed cultivation of millet is practiced in the sandy jeeri south of the national highway, and sorghum cultivation occurs in the higher lands of the alluvial valley (foonde). Located more than ten kilometers from the river, Kanel has no irrigated perimeters, and villagers show little interest in this activity.

In contrast, a PIV was founded in 1976 for the village of Thiemping. This perimeter went out of production three years later, but in 1980 another perimeter—Thiemping II—was attempted. Thiemping II had little more success than the first. Thiemping III, a third perimeter, was introduced in 1988 and was exploited for the first time in the rainy season of 1990. Thus, traditional agricultural activities remain most important in the PS as well as in the rest of the arrondissement. Rainfall being very capricious, two successive years of fairly good flood (1988 and 1989) raised a lot of hope in the area. The waalo potential in this zone is enormous: 29 kolaade—all inundated in 1988 and 1989—have been inventoried. It is not surprising, therefore, that the subject of traditional cultivation and the management of the dam are of considerable interest in this zone.

(4) PS 8: Agnam Godo/Agnam Civol/Mberla/Belle (Arrondissement of Thilogne)

In the Arrondissement of Thilogne we see great differences among the alluvial valley (waalo), the riverine zone on the banks of the Senegal River (falo), and the lands along the national highway (jeeri). The valley has irrigation perimeters, some of them among the first in the region. Except for the area of Orefonde, the falo is devoid of perimeters because it has no reliable watercourse; it is by far the most populous of the three areas. In terms of agriculture, the extensive waalo cuvettes constitute the only hope for the area. Massive migration gives an air of prosperity to the PS.

Agnam Godo, the first village selected in this sector, portrays this situation perfectly. Reputed to be very old, the village controls spacious recession lands, fed by marigots from the Diamel, where waalo (floodplain recession) and falo (riverbank recession) cultivation are practiced. The villages of Agnam Godo and Agnam Civol and their waalo fields are contiguous, making demarcations of village lands sometimes very difficult, especially in light of multiple lineage relations between the two Toorobbe communities, which have engaged in the transfer back and forth of large parcels of land. The selection of Agnam Civol was therefore natural. Despite its age, Agnam Godo was settled after the founding of the Fulbe village of Mberla, which controlled most of the land in the area. Large parcels were later expropriated from Mberla for the benefit of Agnam Godo. Situated near the national highway (as are Agnam Civol and Agnam Godo), Mberla today is a dry-season camp (*sedaano*), used during the period when recession farming occurs. The herders of this zone use Belle, farther to the south, as a rainy-season camp (*rumaano*). Although Belle and Mberla are separate communities, both have the same village head, and the selection of one for this study implies selection of the other.

In practice, then, many cuvettes in this PS are controlled and exploited jointly by the villages of Agnam Godo, Agnam Civol, Mberla, and Belle; this is the case, for example, with the immense waalo area of Ubooji, Ngnapatti, Iting, and Ngudu. Some users of the land come also from other nearby localities such as Agnam Toulel Thialle, Agnam Thiodaye, and Barga. The four villages chosen, however, reflect sufficiently the conditions of the region: a clear domination of waalo, insignificant amounts of irrigation, and a substantial presence of Fulbe (in Mberla and Belle), Toorobbe, and Sebbe (in Agnam Civol and Agnam Godo).

b. Production Spaces in the Department of Podor

In this zone, with its low rainfall levels (300 mm/year) and ample supply of water-courses, especially on the Ile à Morphil, recession cultivation and irrigation are the predominant agricultural activities. Indeed, the strong presence of irrigation is evident as soon as one enters the Department of Podor, coming from Matam. The degree of this presence, however, varies greatly as one moves from the Ile à Morphil to the jeejegol, and further south into the jeeri. This variability is so evident in the Arrondissement of Salde that we selected two production spaces, PS 1 and PS 2, the first one to the south and the other one to the north, to represent the area.

(1) PS 1: Ngouye/Pete/Boke Dialloube (Arrondissement of Salde)

PS 1, which encompasses the villages of Ngouye, Pete, and Boke Dialloube, lies in the southern part of the Arrondissement of Salde, bordering the marigot Doue. It is the most experienced of the PSs in irrigation, with the large-scale perimeter Pete (80 ha), now abandoned, dating back to the period of the OAV (Organization Autonome de la Vallée), well before the creation of SAED (Société d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal et des Vallées du Fleuve Sénégal et de la Falémé).

Ngouye, a Subalbe fishing village of some 90 households, was the first selected in this zone. In recent years, however, fishing activities have diminished in this locality, while falo cultivation has come to constitute one of the pillars of the village economy. Irrigation, as noted above, has existed for some time in the area. The average plot size per household is considered to be inadequate for the food needs of each family.

The intervillage production space starting at Ngouye was defined on a historical basis. The Fulbe village of Boke Dialloube, situated in the jeeri, historically held control over all the land in the sector. The domain of this village extended all the way from the jeeri near Wassatake to the border of the river. During this period, the fishing village of Ngouye played a strategic role in facilitating the movement of people and livestock of Boke Dialloube between the two banks of the Doue. In the past, the Fulbe community at this site practiced transhumance between the jeeri and the Ile à Morphil. Today, the two sites have emerged as distinct villages: Boke, in the jeeri, functioned as a wet-season camp, and Ngarane, in the Ile à Morphil, was the dry-season camp. The Toorobbe village of Pete lies in the intermediate zone between Boke and Ngouye and controls most of the land situated southeast of the Doue.

Ngouye owns and exploits all the falo lands on the Doue. The recession cultivation lands of Jooroodu, Wodos, and Manga Koyli are essentially the property of Pete, but cultivation rights are largely open to the village of Ngouye, which is almost totally without floodplain. Dialloube owns numerous floodplain fields: more than 20 kolaade have been surveyed. The kolaade of Wodos Dialloube, Barol Jombo, Nadda, and Kumba Ali are partly exploited by the villagers of Ngouye. Boke Dialloube shares a part of these lands with Pete and Gadiobe. This latter village is closely related—through historical and kin ties—to the village of Boke Dialloube. Even though within the definition of a production space we could have expanded this PS to include Gadiobe and Boke Salsalbe, the localities selected—Boke Dialloube, Ngouye, and Pete—are the reference poles of the traditional management of this space and the places best suited to show the complementarity of intervillage land use.

(2) PS 2: Wassatake/Barobe/Ngarane (Arrondissement of Salde)

PS 2 corresponds to the Toorobbe/Subalbe village of Wassatake, the contiguous Toorobbe village of Barobe, and the small Fulbe village of Ngarane, the former dry-season camp of Boke Dialloube. The recession cultivation lands of Ngarane are the same as those of Boke Dialloube. Of these, the only fields exploited by the inhabitants of Ngarane are those situated in the Ile à Morphil, not too far from the village. Earlier, Barobe seems to have had closer linkages to Galoya, a village situated more to the east and having large domains of waalo. The introduction of the middle-sized irrigation scheme Salde-Walla in 1988, however, which incorporated the first-generation PIVs that had provided for Barobe and Wassatake, tied the destinies of these two villages more closely to each other. Most of Wassatake's rainfed and recession cultivation lands are shared with the village of Sori Malé, on the Mauritanian side of the Senegal River. Since the Senegal-Mauritania conflict of 1989, however, Wassatake has lost control over these lands. The conflict has also severely limited fishing possibilities on the Senegal River for this village. With little hope of regaining immediate access to its lands on the right bank, Wassatake is concentrating on irrigation. In Barobe and Ngarane, on the other hand, despite the importance of irrigated lands, villagers continue to hope for a good flood that will enable them to pursue recession cultivation. In sum, the population of PS 2 has better access to irrigation than to recession cultivation.

(3) PS 3: Doumga Lao/Doumga Diawambe/Ida/Tourguenol/Wande (Arrondissement of Cascas)

Like PS 6, PS 3—comprising the villages of Doumga Lao, Doumga Diawambe, Ida, Tourguenol, and Wande—portrays the archetypal constellation of complementary exploitation of resources: Fulbe villages in the jeeri, a Toorobbe village in the jeejegol between the waalo and the jeeri, and a Subalbe village on the bank of the Doue River. The site first chosen was the Toorobbe village of Doumga Lao, situated in the jeejegol near the national highway, to the east of the town of Ayre Lao. With respect to the other components of the production space, Ida, a hamlet of the Fulbe Diawbe, was selected. The joom leydi for the region resides in this hamlet and manages territory jointly with Doumga and Wande. Tourguenol and Doumga Diawambe are essentially districts of Doumga Lao. Tourguenol, which lies about 10 km south

of the national highway, is a camp that was founded by Doumga owners of large herds, who, in order to save their animals, adopted a Fulbe lifestyle. Doumga Diawambe, as the name indicates, is the quarter of the Jaawambe (political advisers) of Doumga Lao.

Of the two Subalbe villages on the bank of the Doue, Kehenne and Wande, Kehenne sees itself as oriented more toward Medina Ndiathbe, east of the other villages in the PS. Accordingly, the village of Wande, which practices falo on both banks of the Doue, was selected. The principal waalo lands of Doumga Lao and Ida (Foulkourou, Wallam Hello, Tethiane, Arloua) are exploited by farmers of Wande as well as by their own farmers. Most of Ida's land is on the Ile à Morphil. Wande has a PIV that is situated on traditional lands of Doumga, which explains why one finds among the members of the *groupement* that uses the perimeter several inhabitants of Doumga, which is served by two PIVs.

(4) PS 4: Pate Galo/Wa-Wa/Marda (Arrondissement of Gamadji)

Composed of the villages of Pate Galo, Wa-Wa, and Marda, PS 4 departs to some extent from the fairly typical constellation seen above in PS 7 and PS 3. Here, rather than observing a complementary exploitation of resources among several villages, it is more common to see individual villages divided among the jeeri, jeejegol, and daande mayo (falo). This strategy, illustrated clearly in the village of Pate Galo, will also be seen below in Nguendar (PS 5).

Pate Galo, situated on the bank of the Senegal River, is a "tooroodized" Fulbe village, as evidenced by the title of the village chief as joom leydi rather than ardo. The population of Pate Galo, as well as that of Ngoral and Bowde on the Mauritania right bank, originates from Marda, on the Doue, whose territory also includes a wet-season camp on the jeejegol (Marda Jeeri). Until recently, all four localities (Marda, Pate Galo, Bowde, and Ngoral) were controlled by one joom leydi. The four villages hold and exploit about 20 kolaade, mostly situated between the Doue and the Senegal, and cultivate falo land on the left bank of the Senegal above Pate Galo, and on the banks of the Doue, in Marda.

From a historical point of view and in terms of customary land use, the relations between Wa-Wa and Pate Galo may be seen as juxtaposed rather than overlapping or interdependent. In fact, Wa-Wa is closer to Toulde Galle, on the jeejegol, the village of origin of its inhabitants. Relationships between Wa-Wa and Pate Galo are relatively recent and are limited to irrigation: the inhabitants of Wa-Wa exploit perimeters located in Pate Galo. Moreover, some of the falo land situated between the two villages—such as that of Silbe—is jointly cultivated by Wa-Wa and Pate Galo. Despite the availability of waalo land in the two villages, Pate Galo and Marda are very active in irrigation, which has expanded rather rapidly in recent years with the support of the Dutch mission based in Cascas. Pate Galo maintains three PIVs, two private perimeters, and numerous GIEs. Marda maintains two PIVs.

(5) PS 5: Nguendar Waalo/Nguendar Jeeri/Kawe/Tekinguel/Ouro Boune (Arrondissement of Thille Boubacar)

PS 5, in the Arrondissement of Thille Boubacar, centers on the Fulbe village of Nguendar and its satellite hamlets of Ouro Boune, Tekinguel, and Kawe in the nearby jeeri, and Nguendar Waalo in the alluvial floodplain near the Doue. The same principle of a single community stretching from jeeri to riverbank has been alluded to in PS 4. The river valley narrows in this zone, with fewer and smaller flood basins. Even those that exist have been adversely affected by the large-scale irrigation perimeter of Nianga, whose construction has permanently blocked the flow of water into the adjacent flood basins, making flood recession cultivation impossible. The scheme has also adversely affected many pastoral households by shrinking the area available for dry-season grazing. Still, a large proportion of the lineage of the Nguendarnabe has benefited from irrigated parcels, which have proved more profitable than herding to some, encouraging them to settle in a permanent fashion in the jeejegol—Nguendar Jeeri—or in the waalo—Nguendar Waalo. In the jeeri villages of Ouro Boune, Tekinguel, and Kawe, herding remains an important activity, but it is often associated with the exploitation of irrigated parcels on Nianga.

Given the complexity of the area, and time and resource constraints, several errors of exclusion (of villages that should have made a part of a space) and inclusion (of villages that are not sufficiently related from the viewpoint of the criteria utilized to define a space) may have occurred in the selection of our production spaces. The alternative, however, whether village, arrondissement, or communauté rurale, would have been much more hazardous. The concept of a production space, despite its flaws, has a much better chance of reflecting the socio-economic realities of the area.

C. Problems Encountered with Sample Households

1. Attrition and Replacement of Households

As anticipated, a large number of households dropped out of the survey in the first few weeks and had to be replaced with others from the substitute household list, also drawn randomly at the time of sample selection. In some cases, as in Kanel, the rate of attrition was so high, including attrition among substitute households, that the substitute list was not large enough to cover all households that left. In such cases, the availability and willingness of any household to participate in the survey became an important criterion in selecting it as a replacement, as long as the household came from the same village and the same stratum.

Most households that dropped out did so in the first few weeks. They were replaced with little negative impact on the progress of the research. The rate of attrition fell considerably thereafter, but with more serious consequences as the time period between commencement of the initial study and the selection of new replacement households grew. In this manner, the collection of retrospective data on replacement households became increasingly difficult.

Household withdrawals continued throughout the life of the survey, but substitution stopped. Consequently, the effective overall sample size decreased from 357 to 340 households.[16]

2. Reasons for Attrition

a. Misunderstanding the Goals of Research

The population of the Senegal Valley has been subjected to numerous surveys. The goals of such work have rarely been explained to those surveyed, however, and the work has seldom created tangible benefits in the community. While serious efforts were undertaken to explain the goals of this research, some households underestimated the time and effort required, or expected material rewards that were not forthcoming, and hence dropped out.

b. Migration

A considerable number of households had to be replaced because they had migrated from the area in search of food and/or pasture between the time of the general survey (March-May 1991) and the selection of the sample (June-July). This phenomenon was evident in PS 5 in the village of Ouro Boune where, among the six households randomly selected, only one remained. The other five moved with their animals in a southerly or southeasterly direction. It was not possible to replace these households with others from the village since the village was virtually empty by then. Hence two of the five households were replaced by others from Nguendar. The other three could not be replaced, as no other households in Nguendar belonging to the same stratum (stratum 3) were available. The sample size in this PS was thus reduced at the start from 47 to 44.

c. Consolidation of Households

In some cases, households that were reported as independent at the time of the general survey had formed one production and consumption unit with another household. Usually this occurs when a galle is composed of two households headed by two brothers, and one brother departs on migration, entrusting his household to the other brother. The situation manifested itself in two ways:

(1) The two uniting households belonged to the sample. We considered the household whose head was present as having increased in size and the other as having dropped out. We therefore replaced the second one with a household from the same village and stratum.

[16] During the analysis, nine households that were interviewed fewer than eight times each were discarded. This brought down the sample size from 340 to 331.

(2) Only one of the households belonged to the sample. The household whose head remained became a part of the sample but with increased household size.

This merging of households might have affected the representativeness of the sample. Since assignment to the various strata was based on household access to resources in land, labor, and capital, the combined resources of two households could move it from stratum one to stratum two or three, for example.

d. Partial Households

Some households that had declared themselves independent at the time of the general survey proved to be integral parts of other households. In such instances the fictive household was replaced by another from the same village and stratum. To a large extent these declarations occurred because certain people misunderstood the goals of the research, thinking that there would be some material gain such as food or land. They assumed that they would profit by being perceived as independent households.

e. Separation of Households

In other cases, households subdivided between the time of the general survey and the beginning of data collection. If a selected household subdivided into two or three households, only the one headed by the oldest member was retained. As with the merging of households, this splitting affected the representativeness of the sample, since resources divided among two or three households moved a household down one or two strata.

f. Separate but Polygynous Households

In a few cases we encountered households that consisted of a household head and several wives living separately. Those households were considered as one entity and treated as such.

g. Identification

It was impossible to identify certain households for the sample from the general survey since the name given to the research assistants was not well known among villagers. This resulted because the Halpulaar usually carry two first names: a Muslim name given by the father, which is used often for identification in censuses, and the name given by the mother. If the person is known in the village solely by a name other than that used in the survey, proper identification becomes difficult. In such situations households had to be replaced.

III. RESEARCH CONTEXT

A. Geographic Area

The Senegal River stretches for over 1,700 km as it moves westward from its source in the Fuuta Jallon highlands in Guinea to its final destination, the Atlantic Ocean, at the town of Saint Louis in the extreme northwest of Senegal (Grosenick et al. 1990:33). In this long journey, it cuts through physical habitats as diverse as the tropical forests of northern Guinea and the arid and semi-arid regions of Matam and Podor, and four countries: Guinea, Mali, Senegal, and Mauritania.

On the basis of morphological, hydrological, and climatic variations that manifest themselves in different combinations of production activities, the river basin can be divided into three regions: the upper, middle, and lower (delta) valleys.

The Upper Valley, which stretches from the Fuuta Jallon highlands to the town of Bakel in Senegal, includes the three principal tributaries of the Senegal River: the Bafing (site of the Manantali Dam), the Bakoye, and the Falame. The basin is marked by a drop in altitude of more than 800 m between its source and the town of Kayes in Mali, accompanied by a gradual widening of the alluvial floodplain on both sides of the river.

The Middle Valley extends for approximately 600 km, near Bakel in the southeast to the village of Ndeirba, in the northwest corner of the Department of Podor. During this course, the floodplain continues to expand, reaching a maximum width of 30 km in the Plain of Thilogne, downstream from Matam. Three distributaries—the Diolol, the Diamel, and the Doue—branch from the river, feeding the vast floodplains of Matam and Thilogne, and the Ile à Morphil. Beyond Ndeirba, the plain narrows as it enters the Lower Valley, near the town of Dagana.

The Lower Valley is characterized by a number of waterways that split from the river and form a large delta as the Senegal reaches the Atlantic. Because the slope is only about 1.5 cm/km (van Lavieren and van Wetten 1988:24), the waters become increasingly saline as they move toward the ocean. This prompted the construction of the Diama Dam, a salt retention dam, to prevent the upstream flow of saline ocean waters.

In addition to these morphological variations, the three subregions of the Senegal River Basin differ in climate, ethnicity, and mix of productive activities. The Upper Valley receives considerable rainfall, exceeding 1,250 mm a year in the upper reaches of the river. This area is dominated by highland tropical forests that discourage large-scale agriculture. The inhabitants, primarily Soninke, rely heavily on the migration of labor, especially to France, as a source of income.

Precipitation declines gradually, reaching about 600 mm, as the river journeys westward and enters the Middle Valley at the Bakel-Dembakane juncture. The Middle Valley, populated mainly by the Halpulaar ("speakers of Pulaar"), is sufficiently divergent in precipitation, climate,

and soil structure to be viewed as two subregions, roughly corresponding to the departments of Matam and Podor. The Matam area, which occupies the eastern portion of the Middle Valley, usually receives higher rainfall (300-600 mm, declining as one moves west), and has a more moderate climate and soil structure suited to rainfed agriculture. It also incorporates an extensive floodplain that encourages recession cultivation and such related activities as herding, fishing, and, more recently, irrigation.

As one moves from Matam toward Podor, the average temperature rises, and precipitation declines to less than 300 mm, rendering rainfed cultivation on the sandy dunal soils very risky. Residents rely mainly on recession cultivation, herding, fishing, and irrigation.

The Lower Valley, inhabited mainly by the Wolof, has a climate moderated by winds and seasonal rains that originate from the ocean. Irrigation is a prominent activity in the delta. Experimentation with irrigation dates back to 1822, when the French tried to grow cotton, sugarcane, rice, and tobacco at Richard Toll; the experiment was abandoned in 1831 because of poor performance. Irrigated rice growing started to spread in the area in the early 1960s under the direction of the Organisation Autonome du Delta (OAD), which was replaced in 1965 with the Société d'Aménagement et d'Exploitation des Terres du Delta (SAED).

B. Climatic Patterns during the Research Period

1. Rainfall

The erratic and deficit pattern of rainfall that had prevailed in the Middle Valley for over ten years—when a good rain year was more the exception than the norm—recurred during the research period. The year 1990 was difficult. Insufficient rain resulted in very poor or nonexistent jeeri harvests and poor grazing conditions. The severity of these effects on the population was exacerbated by the total absence of a flood that would have made floodplain cultivation and fishing possible.

The year 1991 was even worse. Rains were very late, not only in the Middle Valley but throughout the country. Rainfall registered at the Kanel and Semme rain stations at the beginning of June—19 mm and 16 mm, respectively—was considered insufficient to begin planting. Virtually nothing was recorded in the five stations of the Department of Matam (Semme, Kanel, Matam, Ogo, Thilogne) until mid-July, when Ogo (formerly Ourossogui) and Semme registered an average precipitation of 33 mm in four days. Farmers in these two areas were thus able to start planting, while others in the department had to wait. In Semme, however, the planting came to a disappointing end, as the mid-July rains were followed by 24 days of drought. The seeds dried up in the ground and the farmers had to start over.

Paradoxically, in the Department of Podor, where people are far less dependent on rainfall, there was unexpected precipitation in late August and early September, especially in the arrondissements of Gamadji (PS 4), Thille Boubacar (PS 5), and Salde (PS 1 and PS 2). The Arrondissement of Thilogne (PS 8) and the northeastern part of the Arrondissement of Ogo

(PS 7) in Matam, however, as well as the Arrondissement of Cascas (PS 3) in Podor, received too little precipitation to plant.

The second half of the month of September put an end to the hopes of some—in the arrondissements of Thille Boubacar, Gamadji, and Salde—and confirmed the anticipation of disaster of others—in northeastern Ogo, Thilogne, and Cascas—where drought impeded the regeneration of natural vegetation, forcing herders to prolong their stay in the Ferlo. In some areas rainfall was so scarce that herders who left the Ferlo were forced to shorten their stay in the valley.

Except for PS 6 and the areas of Haoure and Sadatou in PS 9, the severe rainfall deficit[1] of 1991 caused a total failure of the jeeri harvest in the entire research area. Rainfall measurements for May-September 1991 are given in Table 3.1.

Table 3.1. Rainfall in the Departments of Matam and Podor: 1991 (mm)

Station		May	June	July	Aug.	Sept.[a]	Total
M	Semme	0	27.7	47	106.5	70	251.2
A	Kanel	0	19	29.3	150.7	83.3	282.3
T	Matam	3.7	9.9	16.2	77.1	47.5	154.4
A	Ogo[b]	0	5.6	37.1	70.3	41.1	154.1
M	Thilogne	0	0	3.6	46	39.5	89.1
P	Galoya	0	0	4.7	30.9	-	35.6
O	Aere Lao	0	11.8	11.1	21	-	43.9
D	Ndioum	1	2.5	4.8	46.1	-	54.4
O	Podor	2.9	4.6	60.8	17.9	-	86.2
R	Fanaye	0	0	2	0	-	2

[a] Data for the month of September were not available for the Department of Podor and were available for only the first three weeks for Matam.

[b] Formerly Ourossogui.

In 1992 rainfall was slightly worse at most of the Matam stations. While the 1991 rains as measured at Semme, Kanel, Matam, Ogo, and Thilogne for May through September averaged

[1] At the end of August 1991, cumulative rainfall registered at the five stations in the Department of Matam was far below what had been registered for the same period in 1990, by no means a good year: Matam 65 percent, Kanel 32 percent, Ogo (formerly Ourossogui) 57 percent, Semme 58 percent, and Thilogne 79 percent.

186.22 mm per station, in 1992 the same stations recorded an average rainfall of 181.54 mm for those months. As can be seen in Table 3.2, rainfall in May and June 1992 was negligible.

Table 3.2. Rainfall Patterns in the Department of Matam: 1992[a]

Station	May	June	July	Aug.	Sept.	Total
Semme	0	0	57.2	93.3	103.9	254.4
Kanel	0	4	103	45.9	74.5	227.4
Matam	0	1	40.8	62.9	35.6	140.3
Ogo[b]	0	0	80.8	64	79	223.8
Thilogne	0	0	31.5	30.3	0	61.8

[a] Based on information received from the Service de la Météorologie for the Matam station and the Service Départmental d'Agriculture de Matam for the other stations.

[b] Formerly Ourossogui.

2. Flood Patterns

Faced with the failure of rainfed crops in 1991, farmers of the Middle Valley turned their full attention to recession cultivation, but without much hope, recollecting that despite the two dams—or perhaps because of them—there had been no flood the previous year.

Water heights registered at Matam indicate that for hydrological years as different as 1988, 1989, 1990, 1991, and 1992, the configurations for the months of June, July, and early August are quite similar. Hence one can understand people's hopes for a good flood in 1990, 1991, and 1992: the water levels seemed promising between June and August.

In 1990, however, the water level never exceeded 4 meters at Matam. In 1991 the water level reached 5 meters by the end of August and 6 meters before the middle of September, indicating that a flood as good as that of 1988—which exceeded 8 meters at Matam—could have been attained. Unfortunately, the water peaked at 6.6 meters at Matam on 8 September 1991, inundating only the lower bottomlands of the Middle Valley. The decrease in water level from then on was the fastest for four years. Some bottomlands, as in Kanel, Thiemping, and Agnam, were sufficiently inundated to allow their farmers to begin cultivation with a reasonable chance of a good harvest. In other places, such as Doumga Rindiaw, Haoure, Pete, and Doumga Lao, the flood was considered insufficient, and farmers were uncertain about how to proceed. The question on everyone's mind, especially in the areas that were insufficiently inundated, was whether to plant immediately or to wait for a second release from Manantali that would reflood their fields.

In the context of events in the Middle Valley since the construction of Manantali—good flooding in 1988, adequate flooding in 1989 but with two peaks (which forced farmers to reseed their fields), and no flooding in 1990--the farmers' uncertainty as to whether their farms would be sufficiently flooded was completely justified.

- A decision to plant without knowing what the managers of the Manantali Dam might decide to do in the next few days risked the loss of their seeds, which were not always readily replaceable, if there was another big release of water. Many farmers, especially those with a poor jeeri harvest (or none), were forced to consume the sorghum grain they had put aside as seed for the following year. In 1991 this occurred in many households. Scarcity of seed drives the price up. In Agnam Godo, for example, a *muud* (a local measure equivalent to approximately 3.5 to 4 kg) of *samme*, a sorghum variety grown on waalo fields, which normally sold for 300-400 FCFA, fetched 1,500 FCFA in September 1991.

- A decision to delay planting without the assurance of another release, on the other hand, risks losing the entire season, since the loss of soil moisture might not allow for late planting.

Kept in the dark about the decisions concerning the management of the Manantali Dam, Middle Valley farmers have been forced to become reluctant players of Russian roulette, not knowing when the hit will come, but fearful that it will arrive sooner or later.

The river level pattern of 1992 was somewhat different[2]. For the period 1 July to 1 September, the height of the water oscillated between a high of 3.49 meters (1 August) and a low of 1.6 meters (1 July). On 1 September the evening measurement was 3.1 meters. Water started rising quickly thereafter: it was 3.45 meters the morning of 2 September and 6.12 the evening of 7 September. In the period 8-23 September, the water level varied between 6.07 meters (10, 11, and 18 September) and 6.32 on 21 September. By the evening of 25 September, however, it was back down to 5.28 meters.

Data presented above on the variable, erratic patterns of rainfall and river hydrology in the Middle Senegal Valley have important, deleterious consequences for farming households in the region. Seasonal deficits in precipitation in both the Podor and Matam departments for 1990, 1991, and 1992 resulted in nominal, or worse yet, no rainfed harvests. Coupled with poor flood years in 1990 and 1991 and ill-timed water releases from the Manantali Dam, smallholders lost much of their floodplain crop and saw the market price of sorghum rise precipitously in some instances.

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[2] Based on information provided by Mr. Abdoul Razaghou Fall, who did the measurement on behalf of the Département de l'Hydraulique de la Région de St. Louis. Mr. Fall measured twice a day, mornings and evenings.

C. Population

Research conducted under SRBMA I points out that differential access to resources is an essential determinant of Middle Valley household labor strategies. Accordingly, before selecting a household sample, the population was stratified in each production space in terms of its access to productive resources (see Chapter II, above). A questionnaire soliciting information on access to resources of land, labor, capital, and nonfarm revenues was administered to the entire population. In addition to the selection of a stratified random sample, the questionnaire provided information on the demographic and caste structure of the population, and enabled the investigation of correlations between caste and access to resources.

With the help of nine research assistants, 3,405 households were surveyed, comprising 28,803 persons (Table 3.3). Average household size, including members absent and present, varied from one area to another, ranging from a low of 6.54 in PS 5 to a high of 10.87 in PS 6 (Table 3.4). No association was established between household size and the geographic location of a PS or the mix of economic activities.

Most of the population of the area is young (Table 3.5). Of the 28,803 persons surveyed, 14,828 or 51.48 percent are 15 years and under; another 9,010 persons or 31.28 percent are between 16 and 45. Only 4,965 or 17.24 percent are over the age of 45.

Table 3.3. Overall Household and Population Distribution by Village and Production Space (PS)

PS	Village	Number of Households	Population
1	Boke Dialloube	100	986
	Ngouye	76	556
	Pete	237	1,783
	Subtotal	413	3,325
2	Barobe	93	705
	Ngarane	12	142
	Wassatake	112	739
	Subtotal	217	1,586
3	Doumga Diawambe	62	476
	Doumga Lao	108	738
	Ida	52	405
	Tourguenol	42	311
	Wande	62	546
	Subtotal	326	2,476

PS	Village	Number of Households	Population
4	Marda	108	1,122
	Pate Galo	98	818
	Wa-Wa	59	427
	Subtotal	265	2,367
5	Kawe	24	189
	Nguendar Jeeri	117	736
	Nguendar Waalo	7	43
	Ouro Boune	16	105
	Tekinguel	7	45
	Subtotal	171	1,118
6	Kanel	572	6,568
	Thiemping	163	1,419
	Subtotal	735	7,987
7	Kaawel Cangal	10	61
	Doumga Rindiaw	111	672
	Kaawel Dialloube	136	1,071
	Mbakhna Less	117	781
	Subtotal	374	2,585
8	Agnam Civol	248	2,208
	Agnam Godo	176	895
	Belle	38	289
	Mberla	5	55
	Subtotal	467	3,447
9	Gourel Dara	15	208
	Haoure	346	3,188
	Sadatou	76	516
	Subtotal	437	3,912
	TOTAL	3,405	28,803

Table 3.4. Average Household Size by PS

PS	Average
1	8.05
2	7.31
3	7.60
4	8.93
5	6.54
6	10.87
7	6.91
8	7.38
9	8.95
All	8.46

Table 3.5. Population Age Structure by Production Space (PS)

	Age in Years					
PS	0-5	6-10	11-15	16-45	46-55	56+
1	667	536	477	876	387	382
2	276	255	213	500	169	173
3	618	421	243	852	124	218
4	445	397	270	892	142	221
5	230	187	117	414	65	105
6	1,687	1,403	1,074	2,347	635	841
7	624	442	331	781	187	220
8	709	620	454	1,099	308	257
9	889	754	489	1,249	231	300
Total	6,145	5,015	3,668	9,010	2,248	2,717

1. Caste Structure

Although age (which is positively related to seniority rights) and gender are elements that differentiate members of Halpulaar society, caste remains the most important factor in the

structure of differentiation, categorizing every member of the society, from the most noble patrons to their lower status clients. Caste also has some influence on the types of productive activities that each group practices. In broad terms, the society is divided into three social categories, with subgroups.

a. **Rimbe**, or Free Men

(1) The **Fulbe** (sing. Pullo), who are seminomadic agropastoralists, descended from the first local rulers of the Middle Valley (historically known as the Fuuta Tooro). Fulbe titles of nobility include *saatigi*, *ardo*, and *joom*. While historically, some Fulbe expressed mild disdain for agricultural work, many were also landholders of vast tracts of flood recession land. At present, many Fulbe consider themselves—and have often been considered by others—as the noblest of all the groups.

(2) The **Toorobbe** (sing. Tooroodo), people of diverse origin who have dominated the religious and political life of the population and had important control over land distribution historically, often think of themselves, and are identified by others (including the Fulbe), as former or sedentarized Fulbe. At the end of the eighteenth century the Toorobbe, under the leadership of the religious leader, the almamy, replaced the Fulbe as the key political power in the area, confiscating land and redistributing large parcels of it to their political supporters. The titles of nobility among the Toorobbe are *elimaan* and *ceerno*, which signify religious leadership. After the Fulbe, they are considered to be of high social status.

(3) The **Sebbe** (sing. Ceddo) are descendants of warriors who were used by the Toorobbe for defense against the Maures to the north, and in their fight with the Fulbe for political supremacy in the Fuuta. As a reward, the Sebbe were granted large tracts of land that had belonged to the Fulbe.

(4) The **Subalbe** (sing. Cuballo) are fishermen, whose chief is referred to as the jaaltabe, master of the water spirits.

(5) In earlier times the **Jaawambe** (sing. Jaawando) were courtiers, who served in Fulbe and Toorobbe courts.

In their own right, the Rimbe have direct access to resources of land and/or water.

b. **Nyeenybe** (sing. Nyeenyo)

Nyeenybe is a general term applied to a caste group that is composed of artisans (including Maabube: weavers; Waylube: blacksmiths and silversmiths; Lawbe: woodworkers; Burnaabe: potters; and Awlube: musicians and griots). Nyeenybe occupy an inferior position

vis-à-vis the Rimbe, and relate to them in patron-client relationships that are passed from fathers to sons.

c. **Maccube** (sing. Maccudo)

The Maccube, who occupy the bottom of the social hierarchy, are descended from former prisoners who often were made into slaves and treated as property.

2. Caste Distribution

The Rimbe, or freeborn, are the most numerous in the research area. Of the 3,405 households that were surveyed 2,554 or 75 percent were Rimbe (Table 3.6). Toorobbe are the largest Rimbe group (36 percent of the total, 48 percent of Rimbe), followed by the pastoral Fulbe, who constitute 27 percent of the Rimbe (20 percent of the total). The artisans, Nyeenybe, constitute a much smaller percentage of the total (7 percent). Much more important in number than the Nyeenybe are the Maccube, who represent 17 percent of the total.

Table 3.6. Overall Caste Distribution in the Research Area

Caste	No. of Households	Percent
Fulbe	695	20
Toorobbe	1,228	36
Jaawambe	125	4
Sebbe	173	5
Subalbe	333	10
Nyeenybe	239	7
Maccube	565	17
Other	47	1
TOTAL	3,405	100

By PS, households headed by Toorobbe are the largest number in six of the nine production spaces (1, 2, 4, 6, 8, 9) (Table 3.7). Fulbe households comprise the largest number in PS 3 and PS 5, while the fisher caste, Subalbe, have a plurality (some 31 percent) in PS 7. Toorobbe, along with the Maccube, Fulbe, and Nyeenybe, are present in all nine PSs. Despite their small overall numbers, Nyeenybe (7 percent), Sebbe (5 percent), and Jaawambe (4 percent) are important elements of some PSs. The three groups, together constituting 16 percent of the research area's population, form 30 percent of the households of PS 6, which is nevertheless

dominated by Toorobbe and Maccube. In PS 9 Nyeenybe constitute 15 percent of the households, while Sebbe are 19 percent of PS 8 households.

Table 3.7. Household Distribution by Caste and PS

PS	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	Total
1	89	163	3	1	69	41	37	10	413
2	12	113	0	1	52	8	29	2	217
3	91	78	4	0	62	30	59	2	326
4	25	197	0	0	5	5	33	0	265
5	137	3	0	0	0	1	26	4	171
6	51	271	95	65	28	62	144	19	735
7	98	76	4	6	115	7	59	9	374
8	89	141	19	89	0	18	110	1	467
9	103	186	0	11	2	67	68	0	437
Total	695	1,228	125	173	333	239	565	47	3,405

Table 3.8 presents the same cross-tabulation for the population. This distribution differs little from the distribution for households. Toorobbe, Fulbe, and Subalbe populations are largest in the same PSs as are households headed by these groups in Table 3.7.

Table 3.8. Population Distribution by Caste and PS

PS	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	Total
1	878	1,202	20	9	505	330	315	66	3,325
2	142	790	0	6	348	75	214	11	1,586
3	707	542	33	0	546	225	412	11	2,476
4	230	1,824	0	0	41	35	237	0	2,367
5	900	18	0	0	0	10	170	20	1,118
6	507	2,966	1,147	626	330	733	1,525	153	7,987
7	685	474	13	16	773	73	490	61	2,585
8	599	1,093	172	563	0	182	831	7	3,447
9	745	1,794	0	77	17	585	694	0	3,912
Total	5,393	10,703	1,385	1,297	2,560	2,248	4,888	329	28,803

Tables 3.9, 3.10, and 3.11 show the distribution of land (waalo, falo, and irrigation, respectively) by caste.[3] Of 3,961 waalo fields surveyed in the research area (the size of the fields varies), the Toorobbe own 1,556 or 39 percent, a slightly larger percentage than their household representation (36 percent). The second and third largest groups, the Fulbe (20 percent) and the Maccube (17 percent), have direct access to 21 percent and 15 percent, respectively, not very disproportionate to their total numbers. What is striking, however, is the large number of households with little or no access to waalo land. Of 3,405 households, 1,090 or 32 percent have no access at all, while another 37 percent, or 1,253 households, have access to a single field.

Table 3.9. Distribution of Waalo Fields by Caste

Caste	No. of Fields										
	0	1	2	3	4	5	6	7	8	10	Total
Fulbe	259	208	143	47	20	12	3	2	0	1	695
Toorobbe	322	464	296	102	31	9	3	1	0	0	1,228
Jaawambe	26	46	24	10	10	6	0	0	0	3	125
Sebbe	44	58	43	17	5	3	2	1	0	0	173
Subalbe	121	142	48	16	3	1	1	1	0	0	333
Nyeenybe	117	71	46	4	0	0	1	0	0	0	239
Maccube	178	243	105	26	10	1	1	0	1	0	565
Other	23	21	2	1	0	0	0	0	0	0	47
Total	1,090	1,253	707	223	79	32	11	5	1	4	3,405

Understandably, access to falo fields is even more restricted: 2,840, or 83 percent of all households surveyed, have no access. Another 446 households, or 13 percent, have access to one field only. Access to irrigated plots is similar: 2,386 of the households, or 70 percent, have no access to irrigation, and another 20 percent, or 671 households, have access to a single plot.

[3] The figures in these tables are based upon access to land through both ownership and usufructuary rights (lease, loan, and share-tenancy). Data indicate the number of fields cultivated per household.

Table 3.10. Distribution of Falo Fields by Caste

Caste	No. of Fields						
	0	1	2	3	4	5	Total
Fulbe	638	47	10	0	0	0	695
Toorobbe	1,066	141	19	2	0	0	1,228
Jaawambe	120	4	1	0	0	0	125
Sebbe	122	42	7	2	0	0	173
Subalbe	120	145	42	21	3	2	333
Nyeenybe	219	19	1	0	0	0	239
Maccube	510	46	8	1	0	0	565
Other	45	2	0	0	0	0	47
Total	2,840	446	88	26	3	2	3,405

Table 3.11. Distribution of Irrigation Fields by Caste

Caste	No. of Fields								
	0	1	2	3	4	5	6	7	Total
Fulbe	607	76	8	3	0	1	0	0	695
Toorobbe	820	230	162	11	4	1	0	0	1,228
Jaawambe	120	4	1	0	0	0	0	0	125
Sebbe	126	41	6	0	0	0	0	0	173
Subalbe	94	154	58	17	5	2	1	2	333
Nyeenybe	181	43	11	2	1	1	0	0	239
Maccube	398	119	46	1	1	0	0	0	565
Other	40	4	2	1	0	0	0	0	47
Total	2,386	671	294	35	11	5	1	2	3,405

One should note that the above land distribution does not necessarily depict permanent land rights but access to land in a given year.

D. Sample Households

1. Household Profiles

As with the population from which the sample was drawn, the sample population is young. Of a total of 3,476 persons in the sample, including those present and absent, 1,435, or 41 percent, are 14 years and under; another 1,564, or 45 percent, are between 15 and 45 (Table 3.12). Differences observed between the population and the sample are due more to where the age-group boundaries were drawn (population: 0-5, 6-10, 11-15, 16-45; sample: 0-7, 8-14, 15-45) than to real differences. This becomes apparent when we combine the age groups under 46: 83 percent of the population and 86 percent of the sample are under 46.

The sample is almost evenly divided by gender: 1,756 male (50.5 percent) and 1,720 female (49.5 percent).

Table 3.12. Distribution of Sample Household Population by Age, Gender, and PS

		Male						Female					
PS	No. of House-holds	0-7	8-14	15-45	46-60	61+	Total Male	0-7	8-14	15-45	46-60	61+	Total Female
1	32	38	16	78	7	14	153	43	21	65	14	19	162
2	25	20	19	64	6	12	121	23	26	56	11	6	122
3	37	49	37	91	15	14	206	46	35	81	19	9	190
4	32	39	21	68	8	11	147	43	31	85	10	10	179
5	35	35	25	57	10	12	139	45	29	62	10	6	152
6	34	51	42	133	20	17	263	55	41	103	26	12	237
7	53	60	46	115	19	20	260	76	44	139	18	16	293
8	38	48	39	68	14	11	180	23	26	60	14	9	132
9	45	96	37	119	23	12	287	78	32	120	15	8	253
Total	331	436	282	793	122	123	1,756	432	285	771	137	95	1,720

2. Migration

The picture changes considerably when we compare the population present and absent. The Middle Valley exhibits a very high rate of migration. Of the sample of 331 households, containing 3,476 persons, 737 or 21 percent were absent. The figures are even more striking when we look at migration by gender and age group (Table 3.13). Of males aged 15-45, 52 percent are absent; for females of the same age group the rate is only 14 percent. Another 27

percent of males aged 46-60 are absent. The potential impact of this very high rate of migration on the availability of labor in the Middle Valley is evident. With nearly half of the active males absent (444 of the 915, 48.5 percent, of those aged 15-60), serious labor bottlenecks are likely to present themselves in peak agricultural seasons. Paradoxically, as we shall see later, it is this high rate of labor migration that allows Middle Valley households to pursue the labor- and capital-demanding activities of irrigated agriculture.

Table 3.13. Sample Population Absent and Present, by Gender and Age

		Number			Percent		
Gender	Age (years)	Absent	Present	Total	Absent	Present	Total
Male	0-7	51	385	436	11.70	88.30	100
	8-14	40	242	282	14.18	85.82	100
	15-45	411	382	793	51.83	48.17	100
	46-60	33	89	122	27.05	72.95	100
	61+	20	103	123	16.26	83.74	100
Subtotal		555	1,201	1,756			
Female	0-7	40	392	432	9.26	90.74	100
	8-14	22	263	285	7.72	92.28	100
	15-45	109	662	771	14.14	85.86	100
	46-60	7	130	137	5.11	94.89	100
	61+	4	91	95	4.21	95.79	100
Subtotal		182	1,538	1,720			
Total		737	2,739	3,476			

Another way of looking at the impact of labor migration is to calculate the percentages of the various age and gender groups in the totals present and absent (Table 3.14). Close to 56 percent of all migrants are males between 15 and 45. Conversely, fewer than 14 percent of males who are present in the sampled population belong to this age group. Women aged 15-45 form the largest single category of persons present (24 percent). Children from birth to 7 years represent more than 28 percent of the population present in the sample, and men and women in the oldest group—61 and older—comprise another 7 percent.

Table 3.14. Percent of Age and Gender Groups Present and Absent in Sample Population

Gender	Age	Absent	Present
Female	0-7	5.43	14.31
	8-14	2.99	9.60
	15-45	14.79	24.17
	46-60	0.95	4.75
	61+	0.54	3.32
Subtotal*		24.69	56.15
Male	0-7	6.92	14.06
	8-14	5.43	8.84
	15-45	55.77	13.95
	46-60	4.48	3.25
	61+	2.71	3.76
Subtotal*		75.31	43.85
Total		100.00	100.00

* Subtotals are based on actual numbers; percentages are subject to rounding errors.

3. Household Size

If we compare average household size in the population survey and the sample households, we remark that the average sample household size exceeds that of the population in each production space (Table 3.15). In four cases, PS 3, PS 6, PS 7, and PS 9, the difference is rather large: 3.10, 3.84, 3.52, and 3.05, respectively. Overall, the average sample household exceeds the average population household by two people.

Several possible explanations for the discrepancy can be suggested:

- It is likely that persons who were absent or temporarily absent were overlooked in the general survey while more accurate reporting occurred in the detailed sample household study.

- A difficulty already discussed ("Problems Encountered with Sample Households," in Chapter II) is that some households that were counted as independent at the time of the general survey joined other households to form integrated production and consumption units by the time sample households were selected and the more detailed household survey started. Usually, this occurs when a *galle* composed of two households headed

by two brothers is united upon the departure of one brother who migrates. His household is then entrusted to the brother who remains behind.

• Also discussed earlier were "partial households": households that declared themselves independent at the time of the general survey, but that proved to be integral parts of other households. To a large extent this was the result of some households having misunderstood the goals of the research and, anticipating some gain at the conclusion of the study, hoped they could profit by being perceived as separate units.

Table 3.15. Average Household Size by PS: Population and Sample

PS	Average Household Size		Difference
	Population	Sample	
1	8.05	9.84	1.79
2	7.31	9.72	2.41
3	7.60	10.70	3.10
4	8.93	10.19	1.26
5	6.54	8.31	1.77
6	10.87	14.71	3.84
7	6.91	10.43	3.52
8	7.38	8.21	0.83
9	8.95	12.00	3.05
All	8.46	10.50	2.04

4. Distribution of Sample Population and Households by Caste

In the sample, as with the population, Rimbe (freeborn), including Toorobbe, Fulbe, Subalbe, Sebbe, and Jaawambe, are the most numerous group, approximately two-thirds of the sample households (68 percent) as compared to three-quarters (75 percent) of the population's households (Table 3.16; cf. Table 3.6). Some differences appear in the two distributions: the sample has slightly smaller proportions of Toorobbe, Subalbe, Sebbe, and Jaawambe than the population, and slightly higher proportions of Fulbe, Maccube, and Nyeenybe. Among the Rimbe, Toorobbe households are the single largest group, in the sample as in the population, accounting for 47 percent of the Rimbe households of the sample (48 percent in the population) and 32 percent of all households in the sample (36 percent in the population). The pastoral Fulbe and the Maccube are the second largest single groups, each accounting for more than 21 percent of sample households (as opposed to 20 percent Fulbe households and 17 percent Maccube for the population). Households with Nyeenybe (artisan) heads are 10 percent of the

sample, 7 percent of the population. As in the population, the Sebbe and Jaawambe, who constitute 3 and 2 percent of sample households, respectively, and 5 and 4 percent of the population households, are numerically the smallest groups.

Table 3.16. Number of Households, Population, and Average Household Size in Sample by Caste

Caste	Number of Households*	Sample Population	Average Household Size	Number of Households as Percent of All Sample Households
Fulbe	71	691	9.73	21.45
Toorobbe	106	1,150	10.85	32.02
Jaawambe	7	137	19.57	2.11
Sebbe	10	79	7.90	3.02
Subalbe	30	284	9.47	9.06
Nyeenybe	32	366	11.44	9.67
Maccube	71	718	10.11	21.45
Other	4	51	12.75	1.21
Total	331	3,476	10.50	100

* The caste of the household head was used to classify the eight households that reported members belonging to more than one caste.

The distribution of the sample population by caste is, of course, related to the distribution of households (Tables 3.16 and 3.17). The total number of people in Rimbe households is 67 percent of the sample; Toorobbe comprise 49 percent of the Rimbe group and 33 percent of the whole sample. The sample populations in Fulbe- and Maccube-headed households are again similar (about 20 percent each in the sample); Nyeenybe are about 10 percent of the sample population as well as of the households; Subalbe are about 8 percent of the sample population and 9 percent of sample households. Differences between percentages of households and percentages of people are attributable to differences in household size. As indicated in Table 3.16, these vary quite widely, especially in the groups with few households: from a low of 7.9 for the Sebbe-headed households in our sample to 19.6 for Jaawambe households. The groups that dominate the population, however, have household sizes that cluster around the overall average for the sample, 10.5 persons per household.

Wide variations by caste are seen also in the percent of the sample population who were absent during the survey period (Table 3.17). The range is from about 14 percent of Sebbe absent to nearly 33 percent of Jaawambe. A high proportion of Nyeenybe are absent as well (30 percent).

Table 3.17. Sample Population by Caste and Present/Absent

Caste	Present	Absent	Total	Percent of Sample Population	Percent Absent
Fulbe	558	133	691	19.88	19.25
Toorobbe	898	252	1,150	33.08	21.91
Jaawambe	92	45	137	3.94	32.85
Sebbe	68	11	79	2.27	13.92
Subalbe	241	43	284	8.17	15.14
Nyeenybe	255	111	366	10.53	30.33
Maccube	592	126	718	20.66	17.55
Other	35	16	51	1.47	31.37
Total	2,739	737	3,476	100.00	21.20

Looking at caste representation in the sample by PS (Table 3.18), the Toorobbe remain the largest group in five of the nine PSs (as opposed to six in the population; see Table 3.8): PS 1, PS 2, PS 4, PS 6, and PS 9. In PS 8, where the Toorobbe form the largest group in the population, they are the second largest group in the sample, outnumbered by Maccube. Toorobbe, Maccube, and Fulbe are the only castes represented in the sample in every PS. (In the population, one Nyeenybe household, with 10 members, appears in PS 5.) Despite their small total numbers, Subalbe, Jaawambe, and Sebbe are among the largest groups in the samples of several PSs. In PS 6, for example, the Jaawambe are exceeded only by the Toorobbe; in PS 7, the number of people in Subalbe-headed sample households is about as large as the number of Fulbe, and larger than the number of Toorobbe; and Sebbe comprise the third largest group, after Maccube and Toorobbe, in PS 8.

Table 3.18. Population in Sample by Caste and PS

PS	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	Total
1	80	158	0	0	18	41	17	1	315
2	36	114	0	6	64	4	19	0	243
3	68	88	0	0	72	53	102	13	396
4	26	242	0	0	0	9	27	22	326
5	213	16	0	0	0	0	62	0	291
6	18	177	128	13	11	75	63	15	500
7	128	102	9	0	119	8	187	0	553
8	50	65	0	53	0	47	97	0	312
9	72	188	0	7	0	129	144	0	540
Total	691	1,150	137	79	284	366	718	51	3,476

5. Caste and Access to Land

As measured by percentage of plots, access to the different types of land available for cultivation varies among the castes. Table 3.19 presents an overall view of access to "traditional" land (as opposed to irrigated perimeters) by caste, further subdivided as to whether the household has (1) general access, including those with access as sharecroppers or renters as well as owner/cultivators and co-cultivators (land held and farmed collectively in joowre), or (2) direct access, including only owner/cultivators and cultivators in joowre.

Table 3.19. Access to Traditional Land: Percentage of Plots by Caste Controlled by:
(1) Owner/cultivator, sharecropper, renter (general access)
(2) Owner/cultivator, cultivator in joowre (direct access)

Caste	Percent of Sample[a]	Waalo		Falo		Foonde		Jeeri	
		(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Fulbe	19.88	16.15	19.19	8.0	6.52	5.88	5.88	23.0	23.0
Toorobbe	33.08	33.08	40.4	40.0	41.3	64.71	64.71	31.5	31.5
Jaawambe	3.94	3.85	4.04	0.0	0.0	0.0	0.0	1.0	1.0
Sebbe	2.27	5.38	6.06	0.0	0.0	0.0	0.0	1.5	1.5
Subalbe	8.17	8.46	10.1	44.0	47.83	14.71	14.71	8.0	8.0
Nyeenybe	10.53	6.15	7.07	0.0	0.0	2.94	2.94	9.0	9.0
Maccube	20.66	25.38	12.12	6.0	2.17	8.82	8.82	25.0	25.0

[a] Columns do not add to 100 percent due to rounding error and omission of the category "others."

a. Toorobbe

Except for foonde land, where Toorobbe have access to 65 percent of the plots in the sample, Toorobbe access to traditional land—whether they cultivate directly, sharecrop, or rent—corresponds rather closely to their representation in the community (33 percent): waalo 33 percent, jeeri 31.5 percent, and falo 40 percent. These percentages change somewhat if we consider only owner/renter and cultivator in joowre (in association with one or more persons): waalo 40.4, jeeri 31.5, foonde 64.7, and falo 41.3.

For irrigation, considered by some as the most egalitarian among the systems, since, ideally, the state distributes irrigated plots without regard to a person's ethnic or caste origin, the picture we see is somewhat different (Table 3.20).

Table 3.20. Toorobbe Access to Irrigation: Owner/Cultivator, Sharecropper, or Renter

Irrigation System	Percent of Total Plots in Sample
Private Perimeters	66.67
Village Perimeters	46.43
Middle-size Perimeters	52.38
Large-scale Perimeters	5.26
Vegetable Gardens	37.34

In all but large-scale perimeters, the Toorobbe have access to land that is much greater than is their one-third representation in the sample (Table 3.20). The situation with large-scale perimeters is somewhat misleading, however, because the research area includes only one large perimeter, Nianga, located in PS 5. If we look at the caste composition of this PS (Table 3.18), we see that the Toorobbe account for only 5.5 percent of the sample population, not substantially different from their degree of access (5.26 percent). The picture does not change much if we count only owner/cultivators and those who cultivate in joowre (Table 3.21).

Table 3.21. Toorobbe Access to Irrigation: Owner/Cultivator and in Joowre

Irrigation System	Percent of Plots
Private Perimeters	60.00
Village Perimeters	51.58
Middle-size Perimeters	50.00
Large-scale Perimeters	5.56
Vegetable Gardens	37.34

b. All Castes

Table 3.19 shows the relationship between caste and degree of access to waalo, falo, foonde, and jeeri land for all castes including the Toorobbe. Understandably, the Subalbe fishermen are overrepresented in their access to falo: 8 percent of the sample population directly controls nearly 48 percent of the available falo land. They are also somewhat disproportionately represented in foonde.

In all but jeeri cultivation, the Fulbe control a smaller proportion of land than their proportion of the sample. As Fulbe wealth is centered around livestock and not land, this, too, is expected. The Nyeenybe are underrepresented in all systems: as artisans, they are not as land dependent for their livelihoods as are other castes. The Sebbe, on the other hand, control almost three times a. many waalo plots as their numbers in the sample would suggest.

Only for the Maccube are there significant differences between general and direct access to land. These differences are related to the types of land. On jeeri and foonde (cultivated as jeeri in most years), general access is the same as direct access, though Maccube access to foonde is less than half their representation in the sample. With waalo and falo lands, however, the differences are dramatic. The Maccube, comprising over 20 percent of the sample, have general access to 25 percent of waalo and 6 percent of falo lands. When we consider the tenure system, however, these percentages dwindle to 12 percent for direct access—as owners or joowre cultivators—in the case of waalo and 2 percent for falo. This finding is not surprising, as the former slave status of the Maccube prevented them from acquiring direct rights to land, and the inhabitants of the area attach great importance to waalo and falo lands.

6. Caste, Production Space, and the Production System

The four tables that follow show sample household participation in the production system by caste (Tables 3.22 and 3.23) and PS (Tables 3.24 and 3.25). As expected, Subalbe are the most active in falo cultivation, which engages over 73 percent of the sample's Subalbe households. The relatively moderate number of households engaged in jeeri cultivation (60 percent), ranging from about 29 percent among the Jaawambe to 70 percent for the Maccube, reflects the poor rainfall conditions that prevailed in 1991 and 1992. Waalo cultivation occupies 71 percent of Jaawambe and 70 percent of Sebbe households, declining to 50 percent or less for other castes: 46 percent for the Maccube and 41 percent for the Toorobbe. Altogether, fewer than 40 percent of the sample households engaged in waalo—a result of the inadequate flooding situation in recent years. The tables do indicate, however, the importance that all groups, irrespective of caste affiliation, place on agriculture: nearly 92 percent of all households engaged in some form of agricultural production during the study period. Even among Nyeenybe households, 78 percent farmed.

Looking at the distribution of agricultural systems by production space, we notice the strong effect of geography on what people do. While 88 percent of households in PS 2 and 81 percent of households in PS 4 engage in irrigation, this percentage drops to less than 21 percent for PS 6, 2 percent for PS 9, and 0 for PS 8. Middle-scale (CIN) perimeters, available only in PS 2, and large-scale (GPI) perimeters available only in PS 5, engage 84 percent of the population in the first and 54 percent in the second PS, but elsewhere, of course, none. Participation is discussed in more detail in Chapter V.

Table 3.22. Number of Sample Households Participating in Various Components of the Agricultural System, by Caste[a]

Caste	Subtotal	PIP	PIV	CIN	GPI	WLO	JRI	FLO	FND	MJF	IRR	AGR
Fulbe	71	0	11	0	14	21	46	4	2	7	25	68
Toorobbe	106	4	52	11	1	43	63	20	22	20	55	97
Jaawambe	7	0	1	0	0	5	2	0	0	0	1	6
Sebbe	10	0	1	1	0	7	3	0	0	1	2	9
Subalbe	30	1	17	6	0	11	16	22	5	16	23	29
Nyeenybe	32	0	9	1	0	8	18	0	1	3	9	25
Maccube	71	1	18	2	4	33	50	3	3	6	22	66
Other	4	0	3	0	0	2	2	1	1	0	3	4
Total[b]	331	6	112	21	19	130	200	50	34	53	140	304

[a] Participation is defined in terms of access to land irrespective of the particular land tenure system, whether farmed directly, sharecropped, or received under a rental agreement. Lands rented out or loaned out are not included.

[b] Totals do not add across because households usually participate in more than one production system.

Definitions of column heads:

Subtotal	Number of households sampled in each PS
PIP	Private irrigated perimeter
PIV	Village irrigated perimeter
CIN	Medium-size irrigated perimeter
GPI	Large-scale irrigated perimeter
WLO	Waalo
JRI	Jeeri
FLO	Falo
FND	Foonde
MJF	Vegetable gardens
IRR	Number of households engaged in irrigation
AGR	Number of households engaged in agriculture

Table 3.23. Percentages of Sample Households Participating in Various Components of the Agricultural System, by Caste

Caste	PIP	PIV	CIN	GPI	WLO	JRI	FLO	FND	MJF	IRR	AGR
Fulbe	0.0	15.5	0.0	19.7	29.6	64.8	5.6	2.8	9.9	35.2	95.8
Toorobbe	3.8	49.1	10.4	0.9	40.6	59.4	18.9	20.8	18.9	51.9	91.5
Jaawambe	0.0	14.3	0.0	0.0	71.4	28.6	0.0	0.0	0.0	14.3	85.7
Sebbe	0.0	10.0	10.0	0.0	70.0	30.0	0.0	0.0	10.0	20.0	90.0
Subalbe	3.3	56.7	20.0	0.0	36.7	53.3	73.3	16.7	53.3	76.7	96.7
Nyeenybe	0.0	28.1	3.1	0.0	25.0	56.3	0.0	3.1	9.4	28.1	78.1
Maccube	1.4	25.4	2.8	5.6	46.5	70.4	4.2	4.2	8.5	31.0	93.0
Other	0.0	75.0	0.0	0.0	50.0	50.0	25.0	25.0	0.0	75.0	100.0
Total	1.8	33.8	6.3	5.7	39.3	60.4	15.1	10.3	16.0	42.3	91.8

Table 3.24. Sample Households' Participation in Various Components of the Agricultural System, by PS

PS	Subtotal	PIP	PIV	CIN	GPI	WLO	JRI	FLO	FND	MJF	IRR	AGR
1	32	0	20	0	0	0	21	5	0	19	20	29
2	25	4	13	21	0	2	16	13	1	19	22	25
3	37	0	21	0	0	27	28	5	2	0	21	36
4	32	2	26	0	0	25	0	14	27	0	26	31
5	35	0	0	0	19	2	28	0	0	0	19	35
6	34	0	7	0	0	15	25	0	0	0	7	32
7	53	0	24	0	0	24	36	11	3	15	24	48
8	38	0	0	0	0	28	13	1	0	0	0	32
9	45	0	1	0	0	7	33	1	1	0	1	36
Total	331	6	112	21	19	130	200	50	34	53	140	304

Table 3.25. Percentage of Sample Households Engaged in Various Components of the Production System by PS

PS	PIP	PIV	CIN	GPI	WLO	JRI	FLO	FND	MJF	IRR	AGR
1	0.0	62.5	0.0	0.0	0.0	65.6	15.6	0.0	59.4	62.5	90.6
2	16.0	52.0	84.0	0.0	8.0	64.0	52.0	4.0	76.0	88.0	100.0
3	0.0	56.8	0.0	0.0	73.0	75.7	13.5	5.4	0.0	56.8	97.3
4	6.3	81.3	0.0	0.0	78.1	0.0	43.8	84.4	0.0	81.3	96.9
5	0.0	0.0	0.0	54.3	5.7	80.0	0.0	0.0	0.0	54.3	100.0
6	0.0	20.6	0.0	0.0	44.1	73.5	0.0	0.0	0.0	20.6	94.1
7	0.0	45.3	0.0	0.0	45.3	67.9	20.8	5.7	28.3	45.3	90.6
8	0.0	0.0	0.0	0.0	73.7	34.2	2.6	0.0	0.0	0.0	84.2
9	0.0	2.2	0.0	0.0	15.6	73.3	2.2	2.2	0.0	2.2	80.0
Total	1.8	33.8	6.3	5.7	39.3	60.4	15.1	10.3	16.0	42.3	91.8

IV. AGROHALIOPASTORAL SYSTEMS (FARMING, FISHING, HERDING)

A. Introduction

The floodplain ecosystem supports the production activities of farmers, herders, and fishers who occupy and exploit the floodplain successively throughout the year. The grain, dairy products, and fish produced circulate among the groups through market and other exchange relationships. Although particular activities may be the domain of certain groups (Fulbe herd and Subalbe fish, for example), this does not preclude most groups from engaging in more than one agrohaliopastoral activity. Halpulaar farmers keep livestock. Subalbe fishers farm the riverbanks. And Fulbe herders hold vast tracts of floodplain land. The combination of activities and the forms they take vary throughout the river basin and over time as flood patterns, topography, climate, social organization, and political economy change.

Before examining each component of the agrohaliopastoral complex separately, we briefly review the geographic and social characteristics of the nine production spaces. Geographic and social differences help to determine the productive schemes that individuals and households employ to survive.

The Podor region features rainfall levels generally below 300 mm per annum, considerably lower than in the Department of Matam. The hot, arid climate of this region and sandy dunal upland soils are not conducive to rainfed agriculture. Recession cultivation, irrigation, and herding thus predominate in this zone. Villages and households within the arrondissements of Salde, Cascas, and Gamadji in the central and eastern parts of the Podor Department are characterized by relatively high access to both flood recession and irrigated lands. This area corresponds to Production Spaces 1, 2, 3, and 4. Several permanent defluents, notably the Doue and the Gayo, run parallel to the Senegal River for hundreds of miles. The overflowing of these channels creates large flood recession areas, while the permanent flow of water makes irrigation possible year round. PS 1, corresponding to the Subalbe village of Ngouye, the Fulbe village of Pete, and the Toorobbe village of Boke Dialloube, has had the longest experience with irrigation. Still, parcels are not large enough to cover household food needs. In this PS, falo agriculture remains an important source of food and income (Salem-Murdock et al. 1991 [August]:61).

In PS 2, corresponding to the Toorobbe and Subalbe village of Wassatake, the Toorobbe village of Barobe, and the small Fulbe village of Ngarane, more people have access to irrigation than to waalo agriculture thanks to the middle-sized scheme of Salde-Walla. Following the Senegal-Mauritania conflict in 1989, Wassatake lost access to most of its flood recession lands, which are located on the Mauritanian side of the river. PS 3, which includes the villages of Doumga Lao, Doumga Diawambe, Ida, Tourguenol, and Wande, exhibits the socioecological niches of the agrohaliopastoral complex described by Schmitz (1986): Fulbe villages in the jeeri, a Toorobbe village in the jeejegol, and a Subalbe village in the riverine zone utilizing common land and water resources in a complementary fashion (Salem-Murdock et al. 1991 [August]:63). PS 4 boasts particularly large flood basins between the Doue and Senegal River, and two

villages, Pate Galo and Marda, participate heavily in irrigation. Pate Galo maintains three PIVs, two private perimeters, and numerous GIEs. Marda maintains two PIVs.

In the Arrondissement of Thille Boubacar, where PS 5 is located, the river valley narrows; as a result, the flood basins are much smaller in size and number. Flood recession agriculture is for the most part limited to the riverbanks, where villagers plant maize and vegetables. Here, large irrigation perimeters make up for the paucity of flood lands and precarious rainfall conditions. In the case of the large Nianga scheme, perimeter construction has permanently blocked the flow of water into adjacent flood basins, making flood recession agriculture impossible even where there is no perimeter. Five Fulbe villages—Nguendar Waalo, Nguendar Jeeri, Kawe, Tekinguel, and Ouro Boune—make up PS 5.

In the Department of Matam, rainfall increases to between 300 and 600 mm per annum as one moves east, making rainfed agriculture possible alongside floodplain farming. The arrondissements of Kanel, Ogo, and Thilogne in the Department of Matam, where PSs 6, 7, and 8 are found, contain large flood basins, but little opportunity for irrigation, at least not year-round, because of the absence of permanent water flows throughout the year. It is this region that has the highest rate of out-migration. The village of Kanel in PS 6 is well-known for its vast waalo tracts. Twenty-nine different flood basins, all of which were inundated in 1988 and 1989, were identified in this PS. Kanel has no irrigated perimeters, but does farm in the jeeri and on the foonde. Thiemping is a riverine village whose residents engage in flood recession farming on the floodplains (waalo) and riverbanks (falo), irrigated cultivation of rice and vegetables, fishing, and small-animal husbandry. Among these activities, waalo agriculture predominates, both in terms of the number of people it employs and the contribution it makes to household food stocks. Thiemping villagers cultivate fields in ten waalo basins, not all of them flooded regularly. Generally, flood recession agriculture is more important than irrigation in PS 7, although the particular combination of these two activities varies quite a bit among the villages of Doumga Rindiaw, Kaawel Dialloube, Kaawel Cangal, and Mbakhna Less. While the two Kaawels have no irrigation, Doumga Rindiaw and Mbakhna Less have been irrigating since 1978. PS 8 is representative of the region along the national highway which, except for Orefonde, does not practice irrigation, but has access to large flood basins. This very populous region has high rates of out-migration. The villages of Agnam Godo, Agnam Civol, Mberla, and Belle in PS 8 jointly hold and exploit numerous flood basins (Salem-Murdock et al. 1991 [August]:60). In the eastern portion of Matam Department, in the Arrondissement of Semme, is an area where rainfall has remained relatively abundant. Herders from farther downstream have moved here to graze their animals and engage in rainfed farming. Flood recession areas are generally small, and irrigation is limited to village perimeters. Rainfed agriculture and herding are the principal activities in the villages of Haoure, Sadatou, and Gourel Dara in PS 9. The small Toorobbe village of Gourel Dara, however, controls one of the largest falo stretches in the zone. An inventory of flood basins in PS 9 revealed that only six were inundated in 1988 and 1989. The only irrigated perimeter in the production space, located in Gourel Dara, has not been operational since 1988.

In most areas, the successive exploitation of different agricultural systems over the course of a year acts as a relay cropping system that yields vegetables and cereals for the local population and fodder for livestock (Adams 1985:295). The Halpulaar distinguish among five discrete seasons, although the actual seasonal calendar varies from year to year depending on the timing of rainfall and floods.

Ndungu: The rainy season extends from July to September, during which time farmers plant rainfed millets and sorghum in the jeeri, jeejegol, and foonde. It is at this time as well that herds browse the wet-season pasture in the jeeri, jeejegol, and foonde. From August to October wet-season fishing takes place in low-lying waalo ponds.

Kawle: This short, hot and humid period lasts approximately six weeks, from the end of the rains in October through mid-November. The sowing of falo and waalo fields begins at this time.

Dabbunde: The cool dry season, from mid-November to late February corresponds to the growth period of flood-recession vegetables and cereals. Also during this time, dry-season herding takes place on the jeeri, jeejegol, and foonde.

Ceedu: The hot dry season sets in around March and continues until May. It is at this time that northerly harmattan winds blow in from the Sahara. March marks the period when cattle and small livestock enter the floodplains to browse crop stubble, while May brings an end to dry-season irrigated vegetable production.

Deminaare or *seetto*: This short, hot and humid season occurs during the month of June, just before the arrival of the rain.

B. Flood Recession Lands

1. General Description

Waalo and falo agriculture on the floodplains and riverbanks yield a wide variety of cereals, vegetables, and legumes that help support a relatively dense population during the dry season. River garden vegetable crops are harvested over a two-to-three month period from January to March, while sorghum and cowpeas on the floodplains reach maturity in March and April. These two harvests, in certain cases combined with irrigated vegetable crops, provide food at a time when rainfed cereal stocks have been depleted. Both systems are economically sustainable because of their limited use of labor and capital. This makes them attractive to smallholders who experience recurrent shortages of these inputs.

The alluvial plains and riverbanks also sustain a range of local flora and fauna. *Acacia nilotica* forests, which are important to the local population as a source of firewood and building materials, depend on the periodic flooding of the basins. In certain places in the waalo bottomlands, marshlike ponds exist year-round. There, local flora, fauna, fish, birds, and

waterfowl thrive (van Lavieren and van Wetten 1990:18, 21). Many of the grasses and herbaceous plants growing in the area are of value as graze for livestock, as food for households, and as materials for such uses as thatching.

2. Waalo

a. Percent of Labor Time in Waalo by Age and Gender

Table 4.1 presents the percent of total hours worked in waalo production, sorted by gender and age group, by a subsample of 15 households from each production space, thus 135 households in total. The figures represent the labor effort of various gender and age groups. Men contributed slightly more labor time to waalo production (59 percent) than did women (41 percent). This is most evident in age groups 8 to 14, 46 to 60, and 60 and over, where labor time for men was about twice as great as for women. In the 15 to 45 age group, however, labor time was almost as great for women as for men.

Table 4.1. Percent of All Labor Time on Waalo, by Age and Gender (135 households)

Sex	Age	Percent Labor Time
Men	0-7	1
	8-14	17
	15-45	29
	46-60	8
	60+	4
Women	0-7	2
	8-14	9
	15-45	24
	46-60	4
	60+	2
Total		100

b. Soils

Hollalde soils predominate in the waalo basins monitored by the SRBMA II study. These soils are found in the bottomland portion of the flood basins and generally fall into three groups: *hollalde baleere*, *hollalde raneere*, and *hollalde waka*. Hollalde baleere soils are located in the

lowest portion of flood-basin bottomlands. They are high in clay content (between 40 and 70 percent) and contain little sand (about 15 percent). Flooding causes hollalde baleere soils to swell quickly and become impermeable. Productivity is lowest on these soils, probably because of waterlogging and the late planting season, which means that crops have not reached full maturity before the arrival of the hot harmattan winds (Tabor and Ba 1987:7). Without the periodic disposition of organic matter that occurs during flooding, these soils undergo compaction (Mitsch and Gosselink 1986:366). Hollalde raneere soils are situated in the middle portion of alluvial bottomlands. They contain alluvium, silt, and clay (approximately 35 percent). Their lower clay content makes these soils considerably more productive than the hollalde baleere soils. The risks associated with farming hollalde raneere soils are somewhat higher, however, because weak floods will not inundate these soils. Hollalde waka soils are highest in elevation. Their sand content approaches that of foonde soils. The productivity of these soils exceeds that of hollalde baleere, but not of hollalde raneere. These soils are the first to be planted when the floodwaters begin to recede.

Others soils identified during the research period are *jakre*, *wakajiju*, *kola waka*, *mella waka*, *wadere*, *wahe*, *waka*, *wallere*, and *wodere*. Some of these names refer to soils within the hollalde group. In most cases, the names are specific to a village or region. Wakajiju are loamy soils that produce small heads of grain (Tabor and Ba 1987:78). They are situated at elevations higher than those of hollalde soils. Kola waka soils are red and black soils located between wakajiju and hollalde soils. Wallere soils are positioned similarly to hollalde soils. They differ in that they have a layer of recently deposited sand (Tabor and Ba 1987:79).

c. Crops

On the flood basins, households harvested sorghum (*samme*) and its leaves and stalks (*naayko*), cowpeas (*niebe*) and their leaves (*haako*) and stalks (*goyyi*), maize, and melon, in decreasing order of importance. To protect against crop failure from pest infestation, poor flood conditions, irregular soil qualities, waterlogging, and heat and temperature stresses, some farmers plant different varieties of sorghum, with crop cycles ranging from 100 to 150 days. SRBMA I identified a number of frequently used varieties of sorghum including *samme bodeego* (red sorghum), *samme daneejo* (white sorghum), *samme baleejo* (black sorghum), *sewil* (smaller red or white grained sorghum), and *yaki* and *purdi jorngal* (large-grained black sorghum).

d. Agricultural Performance on Waalo Land

Yields on flood recession lands vary considerably, not only among sites and between years, but also within sites. In the latter case, irregular topography and soil composition are responsible for the large disparities. In the former cases, climate, particularly rainfall conditions in the Fuuta Jallon highlands of Guinea, and, more recently, changing dam-management strategies, alter the volume, duration, and velocity of the flood and, consequently, agronomic performance.

Table 4.2 presents flood conditions in 1988, 1989, 1990, and 1991 for the kolaade (cuvettes) in the rural communities studied during SRBMA II. The first year in which a controlled flood was released from Manantali was 1988. It was generally considered to be a good flood year. Flood levels in September reached 800 cm on the limnimetric scale at Matam. Multiple releases occurred in 1989, resulting in two flood peaks in early and mid-September. At approximately 710 and 650 cm, both peaks were weaker than the peak in 1988. In 1990, virtually a no-flood year, there were repeated, but very small releases from Manantali for dam-testing purposes. Flood levels at Matam barely exceeded 400 cm in early September. Multiple releases in 1991 also created smaller peaks (590 and 650 cm in September) than the 1988 flood and, again, washed out planted areas. This forced some farmers to plant twice and to extend the planting period late into the season. The flood in 1992 appears to have been much better. One release was effected from Manantali between August 28 and September 19. Although the flood peak in September did not exceed 650 cm at Matam, farmers reported good flood conditions. Mamoudou Athie, one of the field research assistants in PS 8 in the Department of Matam, wrote:[1]

> A la date de 3/9/92 la crue est revenue à une très grande vitesse dans les affluents qui inondent les kolladés (cuvettes); cependant son nouveau retour était porteur d'espoir d'après des informations que j'ai receuillis sur les pecheurs. Le 9/9/92 quand j'étais partis voir la crue qui était presque arrivé aux alentours de Agnam Godo, j'ai constatait qu'elle avançait à une très grande vitesse. Après trois semaines de stagnation dans les cuvettes, elle a effectué un retrait vers le 26/9/92. De ce fait les semis ont commencé à Agnam Godo le 29/9/92.
>
> . . . des propos que j'ai receuillis auprès des paysans me montrent que la crue de cette année à bien mouillé les cuvettes, les sols ont bien reçu l'eau de la crue et on note aussi que la retraite de la crue s'est fait sans lenteur, ce qui augure une bonne campagne du waalo.

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[1] On 3 September 1992, the flood entered the feeder channels leading to the flood basins with great rapidity. According to information I collected on fisherfolk, its return brought hope. On 9 September, when I went to take a look at the floodwaters which had almost reached the outskirts of Agnam Godo, I noticed that they were advancing rapidly. The retreat of waters began three weeks later on approximately 26 September. Planting in Agnam Godo began on the 29th.

. . . information I have collected from farmers indicates that this year the inundation of the flood basins has been good, the soil has been well watered, and the retreat of the water has taken place without delay. People expect a good waalo season.

Table 4.2. Flood Performance on Monitored Kolaade by PS and Year (number of kolaade)

PS/Year	Good	Average	Weak	Null	Total
1-88	7	1	0	1	9
1-89	0	5	2	2	9
1-90	-	-	-	-	-
1-91	0	0	0	8	8
2-88	5	0	0	0	5
2-89	2	1	1	1	5
2-90	-	-	-	-	-
2-91	0	0	0	5	5
3-88	1	1	0	0	2
3-89	0	0	2	0	2
3-90	-	-	-	-	-
3-91	2	10	1	0	13
4-88	5	12	5	2	24
4-89	5	12	4	3	24
4-90	-	-	-	-	-
4-91	13	1	2	10	26
5-88	0	1	2	4	7
5-89	0	0	1	6	7
5-90	-	-	-	-	-
5-91	0	0	3	10	13
6-88	28	1	0	0	29
6-89	15	1	0	13	29
6-90	-	-	-	-	-
6-91	11	4	1	7	23
7-88	4	4	0	0	8
7-89	4	3	1	0	8
7-90	-	-	-	-	-
7-91	7	2	2	4	15
8-88	15	2	0	0	17
8-89	9	7	1	0	17
8-90	-	-	-	-	-
8-91	14	0	0	0	14
9-88	0	1	5	0	6
9-89	0	0	6	0	6
9-90	-	-	-	-	-
9-91	0	0	6	4	10

In attempting to replant after each release in 1991, some farmers exhausted their seed reserves. The CER (Centre d'Expansion Rural) in Kanel estimates that 30 percent of seeds planted were lost (Salem-Murdock et al. 1992 [May]:120). Households that could afford to buy seeds in the market paid 1,000 FCFA per muud of sorghum seed and more. As one villager in Thiemping noted, "Le samme est devenu aussi rare qu'un Maure au Senegal." The tripling in the price of sorghum made it difficult to continue to replant, but at the same time it provided an opportunity for some women to earn a little money selling sorghum from their granaries.

The dual peaks created weak floods. Accordingly, some flood recession areas, especially the more elevated ones, received no water. In PS 6, farmers, expecting an eventual heavier flood in 1991, did not plant after the last release. When the heavier flood never came, they were obliged to hand-water fields to soften the soils they should have planted earlier. This work was carried out largely by women, who had to carry the water over distances as great as three km (ibid.:120). Some women lost access to sorghum as a result of the poor flood season, despite their important labor contributions during this period. In areas where waalo agriculture prevails, women customarily receive "gifts" of grain (*caatal*) from field owners with whom they maintain close social or family ties. These gifts are used to feed their families or are sold for cash. In 1992, because harvests on waalo lands were so poor, many women did not receive such gifts (Salem-Murdock et al. 1991 [December]:111). Labor time on the flood basins was especially high because of the need to remove weeds whose growth was facilitated by the multiple releases (Salem-Murdock et al. 1992 [November]:100).

Long-term effects also are associated with alteration of the flood's regime. Some farmers complained that floods in quick succession would leach nutrients from the soil (Salem-Murdock et al. 1992 [May]:109). Other research has shown that extended periods without a flood and the deposit of organic matter lead to soil compaction (Mitsch and Gosselink 1986:366).

The differing flood patterns did not affect all flood recession areas equally. Because of the great variation in location, elevation, and feeder-channel mechanisms of the flood basins, some areas did very poorly in 1988; others did quite well in 1989 and 1991. For example, inundation of flood basins in PS 5 was not satisfactory in any of the years monitored (Table 4.2). In 1988, 4 of 7 flood basins monitored in that PS were not flooded at all; in 1989, the proportion increased to 6 of 7 flood basins; and in 1991, 10 of 13 flood basins monitored did not receive floodwaters. Conversely, in PS 8, 1991 turned out to be a relatively good year: all 14 flood basins monitored experienced a good flood. Generally speaking, however, 1989 and 1991 greatly reduced the number of tillable flood basins. In PS 1, for example, 7 of 9 flood basins monitored had good floods in 1988; in 1989, 5 of 9 flood basins had average floods and none good; and in 1991, 8 of 8 flood basins were not flooded at all. In PS 6, 1988 saw 28 of 29 monitored flood basins experiencing good floods. This dropped to 15 of 29 flood basins in 1989, and 11 of 23 flood basins in 1991. Data for the 1991/92 season show that of 57 households (from a subsample of 135 households) that planted on the waalo, 50 actually brought in a harvest.

e. Agricultural Calendar

The agricultural calendar for waalo agriculture reflects differences in labor allocation strategies required by the repeated flood releases. Planting should be completed no later than the first half of November in the Department of Matam and the second half of November in the Department of Podor. Sorghum planted after these dates will not have a chance to mature properly because of the onset of the hot dry season. The agricultural calendars for the individual production spaces show that repeated releases in 1991 forced farmers to plant beyond the optimal time. In PS 4, in the Department of Podor, planting continued into December. In PS 6, in the Department of Matam, planting also continued into December. The delay in planting inhibited proper crop growth on the floodplains, and may have disrupted activities in the other systems by creating labor bottlenecks. Late maturation of crops may also have interfered with the seasonal movement of livestock onto the waalo after crop stubble on the jeeri was depleted.

In most of the PSs where a harvest was possible, it took place early. Sometimes farmers plant sorghum even after a late flood and harvest the crop as livestock forage for direct consumption or sale. It may also be that farmers harvested early fearing an invasion of their fields by desperate herders and their livestock. In PS 3 and PS 4, harvest activities began in early January and extended into March. Similarly, in PS 8 harvesting began early in January.

f. Types and Levels of Inputs

Farming tools are locally made and inexpensive. Presented here is a list of tools described by Lericollais and Schmitz (1984) and inventoried by John Magistro at his research site, Thiemping:

1. *Jambere*: axe
2. *Wafdu*: sickle
3. *Njinndaangu*: hoe
4. *Luugal*: post planter
5. *Horde*: calabash
6. *Worong*: hoe
7. *Lotundu*: sling
8. *Wafdu, ngoban*: razor-edge

An inventory of production inputs used in waalo production (for the entire sample), presented in Table 4.3, shows that only one household used fertilizers. The naturally occurring regeneration of soil fertility with each annual flood makes it unnecessary to apply fertilizer. Nor did any of the households surveyed use herbicides. Under normal conditions, weed growth is not a problem on waalo lands. Some, but relatively few households (13) did use pesticides.

Table 4.3. Number of Households Using Specific Production Inputs in Waalo: 1991/1992

Production Inputs in Waalo	No. of Households
Seeds	133
Fertilizers	1
Herbicides	0
Pesticides	13
Fuel	0
Motor-pump maintenance	0
Motor-pump repair	0
Irrigation	0
Tractor	0
Hired labor	5
Other	3

3. Falo

Traditionally, falo production has been the domain of Subalbe households. These are fisher caste households who take advantage of their close proximity to the river to farm falo land. Some Subalbe live in small fishing villages along the banks of the Senegal River. Others reside in fishing villages on the foonde levees of larger floodplain channels. Larger, less homogeneous farming villages also host fisher groups.

Flood recession cultivation takes place on riverbank plots and on the banks of smaller secondary channels and drainage ways or *caali* (sing. *caangol*). Planting generally takes place in September, as floodwaters recede. Small contiguous plots are sown with cereal and vegetable crops, including maize, tomatoes, and sweet potatoes, also yielding such residual products as corn stalks (*nyaayko*) and cowpea vines (*gooji*), used as livestock fodder. Falo crops are both subsistence and market oriented, and the revenues that households earn from marketing is substantial.

a. Labor Allocation in the Falo by Age and Gender

Older women, who do not participate in waalo and jeeri activities occurring at the same time, devote considerable time to this agricultural system. As Tables 4.1, 4.4, and subsequent data for other production systems will show, women over 45 contributed proportionately more of falo production time in 1991/1992 than of time worked at any other agricultural activity except for vegetable production on irrigated perimeters during the hot off-season and watermelon production on foonde plots. Falo gardening offers women an important economic niche.

Without this income, they are forced to ask their husbands for money to purchase necessary household items. In Ngouye, in the Arrondissement of Salde, several people interviewed offered this explanation:[2]

> Içi, la culture maraîchère dans les palle est exclusivement reservée aux femmes: elles en tirent un très grand profit. Les produits tels que le niébé, la tomate, les courges, et les pastèques qu'elles y cultivent servent à l'autoconsommation tandis que la patate est destinée à la commercialization (Salem-Murdock et al. 1992 [May]:45).
>
> Vendu à 2,000 ou 2,500 FCFA par sac la patate procure aux femmes d'importantes sommes d'argent. La vente de patate est leur principale source de revenue (ibid.).

Table 4.4. Percent of All Labor Time Worked in Falo by Sex and Age (135 households)

Sex	Age	Percent Labor Time
Men	0-7	0
	8-14	7
	15-45	28
	46-60	4
	60+	6
Women	0-7	4
	8-14	6
	15-45	27
	46-60	15
	60+	2
	Total	100

[2] Here, vegetable production on falo land is exclusively the domain of women; they profit greatly from this type of production. Products such as cowpeas, tomatoes, squash, and watermelon are principally for home consumption, while sweet potatoes are for the market.

Sacks of sweet potatoes are sold for 2,000 or 2,500 FCFA each, providing women with substantial sums of money. The sale of sweet potatoes is their main source of revenue.

b. Soils and Crops

Falo soils are classified by local inhabitants into *wallere baleere*, *wallere raneere*, and *wallere ceenyal*. Wallere baleere soils are located high up on the riverbanks. As the flood begins to recede, the upper portion of the riverbank receives deposits of light soil particles such as clay. High clay content does not render these soils very fertile. Wallere raneere soils are found midway down the riverbank. They are light-colored, loamy, silt soils, also not very fertile. Wallere ceenyal soils, on the lower portion of the riverbank, receive deposits of heavier silts and coarse sands as the flood recedes. They are thus high in alluvial content and are the most fertile soils for crop and fodder production.

Falo plots in 1991/1992 produced a wide range of foods including maize and maize stalks, sweet potatoes, tomatoes, cowpeas, hibiscus, sorghum, melon, and squash. Much of the harvest of these crops is destined for the market as either food or forage. Sometimes gourds and calabashes are produced and sold as baskets and watertight containers. In addition, the lower slopes of falo areas are used for grazing small ruminants at the height of the long dry season.

c. Agricultural Calendar and Performance of Falo Agriculture

Under normal conditions, farmers are able to complete farming tasks on the falo and waalo without creating labor bottlenecks (Horowitz et al. 1991 [May]:173). Households cultivating falo gardens fence their fields from October to December, when the jeeri harvests are coming in. They begin harvesting maize and cowpeas as early as the end of January, after the rainfed harvest, and continue into March, when the waalo harvest begins. Tomatoes are harvested daily in February and March and sweet potatoes in April (ibid.:179). When rainfed harvests are meager, falo crops serve as a critical food reserve. The multiple releases in 1991 took a heavy toll on riverbank gardens, however. Crops of sweet potatoes, maize, and beans were repeatedly washed out, forcing farmers to replant several times. In PSs 1, 2, and 9, planting was still going on in January. As a result, harvesting in PS 1 extended well beyond March into June. This probably caused some labor bottlenecks at the time of activities preparing for the 1992 jeeri season. In PS 2, on the other hand, the harvest took place very early, in February. In this case, farmers may have decided to harvest maize stalks as fodder to feed their animals and sell in the market. In PS 4, planting did not begin until February 1992, and harvesting continued as late as May. In PS 6, planting began more or less on schedule in October. In February, however, farmers were replanting. Here as well, harvesting was continuing into June. PS 7 and PS 8 seem to have had a more normal season. Planting was completed by December and crops harvested by April.

Faced with food shortages and the inability to feed their animals, some farmers closed their fields to herders so as to let their own animals graze on the post-harvest stubble. In the

village of Ngouye in PS 1, Moussa Kane, a field research assistant, wrote these notes in late June:[3]

> Aux *pale* [pl. de falo] se tiendra le *nyaayngal* [ouverture des champs au bétail]. Cette année, nous avons constaté que le nyaayngal ne s'est pas déroulé comme dans le passé. Comme à l'accoutoumée, les Peuls étaient là depuis plusieurs jours avec leurs troupeaux et attendaient autour des pale bien entourés par des haies vives et des branchages. Les Subalbe ont alors refusé d'évacuer les champs et ont préféré faire entrer leur bétail en premier lieu. Aux bergers qui tentaient de faire entrer leur bétail de force, ils les ont menacé de porter plainte à la Communauté Rurale, et même de tuer le berger qui se hasarderait à entrer dans les pale. Finalement, le nyaayngal proprement dit ne s'est déroulé que très tradivement et a été volontairement retardé par les propriétaires des pale (Salem-Murdock et al. 1992 [May]:45).

d. Types and Levels of Inputs

An inventory of production inputs used in falo production by the whole sample (Table 4.5) reveals infrequent use of fertilizers and no use of pesticides and herbicides. As with waalo soils, falo soils are naturally fertile, and weed growth is limited because of the single inundation of fields in normal years.

C. Jeeri

1. Introduction

Because of the unpredictability of rainfall and the constant threat from grain-eating birds and grasshoppers, rainfed jeeri production is one of the riskiest ventures in this sudano-sahelian zone. Combined with other agricultural systems, however, it helps support the population and its livestock. Millet and rainfed sorghum are the principal crops, usually intercropped with cowpeas (niebe), watermelon (*dende*), and sorrel (*follere*). These crops, particularly millet, are bartered or sold in local markets in exchange for fish, dairy products, and other grains.

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[3] The nyaayngal (opening of parcels to livestock) takes place on falo parcels. This year, we noticed that the nyaayngal did not occur as in past years. As is customary, for several days Peul [Fulbe] herders had been waiting with their animals just outside the fields, which were securely enclosed by hedges and branches. Subalbe farmers refused to leave their fields, choosing to let their own animals enter first. When the Peul tried to use force to enter the fields, the Subalbe threatened to notify the Rural Community and even to kill any shepherd who tried to enter the fields. In the end, the nyaayngal took place quite late and was voluntarily extended by holders of falo land.

Table 4.5. Number of Households Using Specific Production Inputs in Falo: 1991/1992

Production Inputs in Falo	No. of Households
Seeds	46
Fertilizers	4
Herbicides	0
Phyto-sanitary products	0
Fuel	0
Motor-pump maintenance	0
Motor-pump repair	0
Irrigation	0
Tractor	0
Hired labor	0
Other	1

In the rainy season, herds transhume north from the Ferlo into the upland jeeri where they graze on palatable perennials. The jeeri produces a variety of range grasses including *Panicum turgidum, Aristida longiflora, Borreria radiata, Blepharis linarifolia,* and *Zornia glochita* (Nuttall 1989:32). It also supports various species of thorn trees and shrubs that are of value to livestock as browse and to people for use in construction and medicine, and as fuel.

2. Percent of Labor Time on Jeeri by Age and Gender

Two jeeri seasons were followed, one in 1991 and the other in 1992. An average of labor hours for the two years was calculated and then translated into percentages for each age and gender group. As Table 4.6 shows, production on jeeri lands was carried out largely (three-quarters of all labor time) by boys and men between the ages of 8 and 60.

3. Soils and Crops

The most common soil in the jeeri is *seeno*, literally meaning sand. It is a sandy loam with poor water retention, fertility, and organic content. It is found on the plains and bottomlands. In lower drainage areas, one can find *naaruwal* or *salka* soils. These are dark clay, fine-textured soils that produce good pasture. In drainageways there are black clay soils known as *baljol*. They have a high water-retention capacity, and it is here that farmers sometimes practice water-harvesting techniques. Finally, there exist *seeno baleere* soils. These are black, sandy, clay soils intermediate between seeno and naaruwal (Nuttall 1989:21; Tabor and Ba 1987:13-15).

Rainfed sorghum, millet, and watermelon were the crops most frequently planted on the jeeri in 1991 and 1992. Also important were cowpeas and peanuts. A few farmers planted melon, hibiscus, and okra. During his field research in Thiemping in PS 6 in 1988 and 1989, John Magistro identified numerous varieties of short-, medium-, and long-cycle rainfed sorghum able to accommodate and withstand varying levels of humidity, types of soils, and attacks by birds and insects. These include: *nyubuko* or *nyendiko jawdo* and *hajankori* (short-cycle rainfed sorghum); *daddiri*, *fela daneejo*, and *fela bodeejo* (medium-cycle rainfed sorghum); and *ceerno cudido* (long-cycle rainfed sorghum). Short-cycle varieties are particularly critical in years of late rainfall.

Table 4.6. Percent of All Labor Time Worked on Jeeri by Sex and Age (135 households)

Sex	Age	Percent Labor Time
Men	0-7	4
	8-14	25
	15-45	40
	46-60	9
	60+	7
Women	0-7	1
	8-14	4
	15-45	8
	46-60	1
	60+	0
Total		100

4. Agricultural Calendar and Production Conditions in the Jeeri in 1991 and 1992

Tasks in the jeeri parallel those on the waalo. The one big difference is that weeding takes considerably more time in the jeeri, where three separate weedings are usually required within the course of a season. Included in weeding tasks are the construction of furrows and ridges (*fiil*, *casi*) to retain rainwater runoff.

For many farmers, 1991 and 1992 turned out to be very disappointing seasons for rainfed production. Out of the subsample of approximately 135 households, 59 planted in jeeri fields in 1991, but only 19 harvested. The situation was similar in 1992: 77 households from the same subsample planted, but only 38 harvested. This phenomenon was particularly pronounced in PSs

1, 3, and 8, where all subsample households surveyed planted, but none harvested. In late July 1991, a villager from Agnam Godo in PS 8 put it this way:[4]

> Les paysans qui avaient preparé leurs champs depuis le moi de mai, qui avaient fait le lori (brulis lors du debroussaillage), le dudial (action d'enlever les souches d'arbres), et même les clotures, ont attendu en vain la pluie qui ne sera pas au rendez-vous jusqu'à la fin du mois: c'est la periode de soudure à Agnam Godo.

As with falo agriculture, tardy and insufficient rains obliged farmers to plant late. In PS 6 and PS 7, for example, farmers were still planting in September. In September 1991, one of the field assistants, Nafissatou Sow, noted in her diary:[5]

> Les habitants de Kaawel Dialloube [PS 7] étaient très inquiets face au manque des pluies: à cette epoque l'année dernière, il ne restait que peu de temps avant la recolte, tandis que cette année, le semis n'avait même pas poussé.

Early harvests were frequent. In PS 5, planting took place in August and harvesting in October and January. In PS 7 and PS 9 planting occurred in August and September and harvesting was carried out in November. Most likely, farmers did not expect a good harvest and therefore preferred to reap part of the crop as fodder.

5. Types and Levels of Inputs

Although jeeri soils are less fertile than flood recession soils and are easily depleted if farmed too intensively, farmers do not apply fertilizers in jeeri fields, probably because of the precarious nature of jeeri production. They cannot afford to invest much in rainfed production because the risks of poor harvests are high. The very serious threat of locusts, however, did persuade certain farmers in the sample to use pesticides (Table 4.7). Some villagers also made use of hired labor.

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[4] Farmers who had begun preparing their fields in May, who had completed the *lori* (burning of brush that has been removed), the *dudial* (removal of tree stumps), and had even fenced in their fields, waited in vain for rain, which did not come until late July: it is a time of want in Agnam Godo.

[5] Inhabitants of Kaawel Dialloube [PS 7] were very anxious about the lack of rain. At this time last year, only a short time remained until the harvest. This year, the seeds planted have not yet sent up shoots.

Table 4.7. Number of Households Using Specific Production Inputs in Jeeri: 1991 and 1992

Production Inputs in Jeeri	No. of Households (1991)	No. of Households (1992)
Seeds	99	194
Fertilizers	0	0
Herbicides	0	0
Phyto-sanitary products	12	34
Fuel	1	1
Motor-pump maintenance	1	0
Motor-pump repair	1	0
Irrigation	0	1
Tractor	0	0
Hired labor	12	26
Other	3	2

D. Foonde Lands

1. General Introduction

Production on foonde land closely resembles that on jeeri, which is why this agricultural system frequently goes unnoticed by researchers. Foonde land is situated on the levees of riverbanks. Foonde microenvironments are dispersed; they are planted in rainfed sorghum and maize when rainfall conditions are good, and in watermelon when conditions are drier. Villagers distinguish between two types of foonde fields: *gese jeeri* and *gese pode*. The former refers to elevated foonde depressions farmed as dryland plots. The latter refers to lower-lying foonde depressions that receive substantial rainfall runoff. Farmers frequently use water-harvesting techniques to retain rainfall on the gese pode. When rains are strong, these depressions fill with water. Farmers wait for the waters to recede and then plant them much as they do the falo. In heavy flood years, moreover, when the gese pode are flooded, they host a variety of fish species that make for good fishing well into the dry season.

2. Percent of Labor Time on Foonde by Age and Gender

Production on foonde lands is carried out in a fashion similar to that on jeeri lands, yet the labor allocation pattern is quite different. Whereas on the jeeri young boys and men contribute the bulk of the labor hours, on the foonde women provide most of the labor. Table 4.8 presents the percentages of hours averaged for the two foonde seasons, 1991 and 1992, by age and gender group. Over 60 percent of labor on the foonde was contributed by women. The

high participation rate of women may have to do with the fact that foonde fields are relatively small and dispersed, making production on a large scale impossible. In this way they resemble falo plots. During the research period the principal foonde crop was watermelon, the seeds of which women use in sauces and sell in the market.

Table 4.8. Percentage of All Labor Time on Foonde by Age and Gender (135 households)

Sex	Age	Percent Labor Time
Men	0-7	0
	8-14	3
	15-45	26
	46-60	4
	60+	6
Women	0-7	3
	8-14	9
	15-45	33
	46-60	7
	60+	10
Total		100

3. Soils and Crops

Foonde soils fall into three groups: *foonde raneere*, *foonde baleere*, and *foonde wallere*. Foonde raneere soils are situated high up on the levees. They are sandy alluvial soils with 10 to 20 percent clay content. For much of the year, they produce pasture for small village livestock. Foonde baleere soils are similar to the raneere soils except that they contain less silt and more clay, approximately 20 to 30 percent. They are located in the lower sections of the levees. Finally, foonde wallere soils, also present in the lower portions of the foonde, are red sandy soils containing silt. They are sometimes referred to as *wakajiju*.

Watermelon was the crop most frequently planted on the foonde in 1991 and 1992, followed by cowpeas. A few farmers planted rainfed sorghum and maize.

4. Agricultural Calendar and Performance on Foonde Lands

Farmers cultivating foonde lands faced a set of constraints similar to those cultivating jeeri lands. In PS 1 and PS 3 farmers planted, but did not harvest. In PS 4 planting continued

into October, but poor crop prospects compelled farmers in this PS to harvest early in November. In PS 9 planting was completed in August and harvesting took place in November.

5. Types and Levels of Inputs

The use of fertilizers and other purchased inputs on foonde plots was almost nonexistent for the sample in the period studied. Only one farmer applied fertilizer and only one hired labor (Table 4.9). As with cultivation on jeeri land, production on foonde land is risky, and farmers cannot afford to invest much when the risks of a poor harvest are high.

Table 4.9. Number of Households Using Specific Production Inputs in Foonde: 1991 and 1992

Production Inputs in Foonde	Number of Households (1991)	Number of Households (1992)
Seeds	28	22
Fertilizers	1	0
Herbicides	0	0
Phyto-sanitary products	0	0
Fuel	0	0
Motor-pump maintenance	0	0
Motor-pump repair	0	0
Irrigation	0	0
Tractor	0	0
Hired labor	1	0
Other	0	0

E. Irrigation

1. Areas of Inquiry: Modes of Access and Tenure

The precarious conditions of life among Senegal Valley inhabitants and the somber perspective of future food security suggest that research is urgently needed to explore the optimal and sustainable attainment of local capacities. In this respect, irrigation, which already occupies an important place in the river valley, may play an even greater role. The highly touted achievements of irrigation have yet to be realized, however.

The present study attempts to further explore and build upon observations initially made on a smaller scale in SRBMA I. On the basis of recent analyses in Matam Department (Niasse 1990, 1991a, 1991c; Salem-Murdock 1990), several problems concerning the future of irrigated agriculture were raised. These areas of inquiry included:

- The organization of producers and the question of land tenure practice in the perimeters. The following conclusions were drawn: (a) access to irrigation is not as democratic as has been assumed; (b) peasant cooperatives, due to problems of land inheritance, progressively lose their cohesion and ability to mobilize labor; (c) perimeter size becomes increasingly difficult for producers to manage as the number of members forced to withdraw from production rises; (d) as members withdraw and group cohesion erodes, the costs of production become excessive for the remaining producers; (e) the final result is the dissolution and reorganization of producer groups and the creation of new perimeters.

- An analysis of production costs, from which the following conclusions emerged: (a) irrigation is financed primarily by migration, but that creates a scarcity of labor for production; (b) those producers without migratory remittances must finance production by selling off livestock, consequently reducing the level of inputs (such as fertilizer), and hence lowering crop yields.

- The tightening of the land tenure system, which touches on the following: (a) the absence of a legal commodity market in land, resulting in share-tenancy arrangements, which are contrary to the spirit of the National Domain Law, and the abandonment of parcels, which makes for low intensification ratios; and (b) the confiscation of land by a social stratum of gerontocratic elite, while individuals of inferior social strata, women, and children are excluded from organizational management and often from access to the perimeters.

Two recent studies of SAED (SAED-DG 1991 and SAED-DG-CSE 1991) demonstrate that the problems of irrigation are not limited to the Middle Valley. The performance of perimeters in the Delta, commonly cited as a model of success in the Senegal Valley, is quite disturbing. Among the numerous questions raised in the documents, several concern this study.

- The persistent low level of agricultural intensification: of the 48,200 hectares developed in the entire valley (left bank) in 1990-91, only 31,190 have been cultivated (including both wet and dry season production), or a rate of 0.65, far short of the PDRG (Plan Directeur de Développement Integré pour La Rive Gauche de la Vallée du Fleuve Sénégal) objective of 1.6 (GERSAR/CACG et al. 1991).

- The development of strategies of land occupation rather than agricultural intensification, referred to as "mining consumption" of land resources.

- The atomization of peasant organizations, resulting from the preference of producers for smaller groups.

• A disastrous credit situation, with very low recovery rates, posing a grave threat to the CNCA (Caisse Nationale de Crédit Agricole), the principal lender of credit in the valley.

• The status of land, because of the insecurity of land tenure, is perceived as one of the principal constraints to irrigation development in the valley.

In sum, the problems observed with irrigation in the Delta at present are not unique to that zone, but exist in the Middle Valley as well. The objective of this research is to study on a large scale the changes in tenure that are occurring on irrigated lands. While irrigated perimeters are still relatively new in the Middle Valley, some have an extensive record of evolving land tenure problems.

2. Methodology

Among the 32 villages followed under SRBMA II, 10 (Haoure, Kanel, Kaawel Dialloube, Kaawel Cangal, Ida, Wa-Wa, Agnam Godo, Agnam Civol, Mberla, and Belle) have no access to irrigation. A large number of villages that do have irrigated perimeters are unable to undertake a second cropping season during the hot dry period because of water shortages at this time. Several of the perimeters—such as Mbakhna and Doumga on the Diamel, and the intermediate-size perimeter at Hamady Ounare fed by the Dioulolare—are sustained by watercourses that evaporate during the dry season, so that even among villages with access to irrigation, water becomes unavailable at times. Moreover, in villages with access to irrigation in the (cool, dry) contra-season, a large number of households that regularly practice recession farming do not have access to irrigated parcels.

Initial study (prior to the wet season of 1991) involved preparing a list of all farmers (those considered landowners) with parcels in the irrigation perimeters studied (excluding private perimeters, which were studied separately). Each landholder was identified by name, age, sex, caste, and village of residence. Information was also collected on modes of access. These include the following:

- granting of parcels at the time of creation of the perimeter;
- reallocation of subdivided parcels by the producer group after initial organization of the perimeter: this internal fractioning of parcels is the result of the increased demand for irrigated land in some villages;
- reallocation of an original owner's parcel: this occurs in cases where, for example, the initial owner changes physical residence, gives up the parcel, loses the parcel by decision of the producers' group because he or she lacks means to cultivate effectively, etc.;
- inheritance;

- parcel received as a gift;

- purchase of a parcel.

This information, while important, constitutes only the initial phase of monitoring. During each production season, this information was used in order to carry out research on several topics:

- to ascertain the dynamics of production on the parcels of owner-cultivators; what are the timing and methods of change in production on these parcels?

- to investigate relationships between factors influencing production (absence or presence of owner, gender, age) and levels of agricultural intensification on each parcel;

- to identify modes of land tenure and their correlations to the identity of those exploiting the parcel.

The data were initially collected in the villages studied at the end of the wet season, between December 1991 and January 1992. A second survey, undertaken between March and May 1992, included information concerning the cool contra-season. A third survey—the last undertaken by SRBMA II—was conducted from June to July 1992 in order to take into account production data during the hot contra-season.

These surveys enabled the researchers to follow the annual production cycle in irrigation and to obtain correlations between the age of perimeters, the age of scheme participants, access to production by women and children, the residential location of participants, modes of land tenure, and levels of agricultural intensification.

3. Units of Study

The analysis presented here on land tenure in the perimeters is based on a survey of 2,435 parcels located in 28 irrigation units that include large schemes (Nguendar and Nianga), intermediate perimeters (Ngarane, Barobe, and Wassatake in the Salde-Walla perimeter), and other cooperative village perimeters (PIVs). These schemes were all exploited by villages studied in SRBMA II and are found within the various arrondissements in the departments of Podor and Matam (with the exception of the Arrondissement of Thilogne[6]).

Most of the parcels studied are found in the Department of Podor (83 percent); the remainder (17 percent) are located in Matam Department. This translates into a discrepancy between the two departments in terms of surface area developed for irrigation. Of 17,400

[6] In the Arrondissement of Thilogne, irrigation is a marginal activity and was not undertaken by the villages studied under SRBMA II in this region.

managed hectares in late 1990-early 1991, 10,800 were in Podor (62 percent) and 6,600 in Matam (38 percent) (SAED-DG 1991:6).

The irrigation units surveyed at the research sites involve 20 small village perimeters (PIVs) of which 6 are in Matam Department, 7 are autonomous units (Unités Autonomes d'Irrigation or UAI) belonging to the intermediate perimeter of Salde-Walla (Podor Department), and 1 is a Section d'Utilisation du Matérial Agricole (SUMA) belonging to the large perimeter (GPI—Grand Périmètre Irrigué) of Nianga (Podor Department). The PIVs represent 75 percent of all parcels studied, the intermediate schemes 21 percent, and 4 percent are found in the large perimeters. These irrigation units are relatively recent: in 1991, the average age of a unit was 8 years.

In assessing production changes, the units studied are grouped by their year of creation. A first group of perimeters was created between 1975 and 1978; 497 parcels of the 2,435 studied are in this group, representing 20 percent of the total studied. A second group of units was created in 1979; these comprise 564 parcels or 23 percent of the total in our sample. The next group includes units created between 1980 and 1986 and is composed of 561 parcels (23 percent of the total). The last group, created between 1988 and 1990, includes 813 parcels, or 33 percent of the total.

4. Access to Irrigated Land

The parcels of a new perimeter are issued to individuals who, in principle, are founding members of the producer group. Thus these participants access irrigated parcels through an initial stage of land allocation ("*première attribution*" or "*première affectation*"). At this stage, SAED often attempts to apply a certain number of norms: for example, the granting of parcel size in proportion to the number of active laborers in the household (e.g., at the perimeter of Salde-Walla). In turn, members of the producer groups attempt to negotiate for their own benefit within the scheme's cooperatives in obtaining parcels. This process is often determined by: (1) the reproduction of traditional hierarchies, which often implies the marginalization of those social groups without land; (2) the primacy of use rights by age, favoring lineage and compound (galle) elders; and (3) the priority of men over women, the latter being almost totally excluded from access to land.

The equity objectives of the state, then, are challenged by the internal social and political dynamics of the producer group. The prevalence of such shifts in access are indicated in Table 4.10, which supports the following conclusions:

- Regardless of the age of the perimeter, the original recipients of parcels ("*premiers attributaires*") today remain the large majority of landholders, comprising between 62 percent and 73 percent of all owners. In only eight years (the average age of the perimeters studied), approximately one-third of all parcels have changed hands: 68 percent remain with the initial landholder. Thus, in less than a decade, the jural principles of land registration by the state have been largely eroded by the producers at the village level.

• The redistribution of parcels occurring at the initiative of the producer group, through subdivision and replacement of landholders, varies between 15 and 20 percent of all parcels issued, depending on the period during which the perimeter was created. This proportion is highest (20 percent) in perimeters created between 1988 and 1990.

• Land access through inheritance involves 8 percent (194) of all parcels. This figure is influenced by the age of the perimeter, however. The number of parcels inherited averages 10 percent or more in irrigation groups that are over 12 years old (established in 1979 or earlier).

• Although the sale of parcels constitutes an illegal transaction, it does occur, involving 4 percent (104) of the parcels. This is not a function of the age of the irrigated perimeter. Only 1 percent of all parcels were sold in perimeters created in 1975-1978, while 9 percent were sold in those established in 1979 and 3 or 4 percent in perimeters created later.

Table 4.10. Access to Irrigated Land in Relation to Age of Perimeter

Year Created	Initial Landholder	Subdivision	Replacement	Inheritance	Gift/Other	Purchase	Total
1975-78	349	85	2	48	6	7	497
% 1975-78	70	17	0	10	1	1	100
1979	349	1	87	67	9	51	564
% 1979	62	0	15	12	2	9	100
1980-86	412	70	23	29	5	22	561
% 1980-86	73	12	4	5	1	4	100
1988-90	541	130	29	50	39	24	813
% 1988-90	67	16	4	6	5	3	100
Total	1,651	286	141	194	59	104	2,435
% Total	68	12	6	8	2	4	100

In sum, irrigation units in the Middle Valley have undergone important changes in land tenure from year to year in terms of the reduction in the number of original scheme participants. Those obtaining de facto ownership of perimeter parcels by other means, such as inheritance or sale in the informal market, are becoming more numerous. This phenomenon does not conform well, however, to the logic of irrigation developers and extension agents, nor to that of peasant society practicing irrigation at large. Because the history of irrigation in the Middle Valley is relatively brief, it is still too early to know just how land tenure strategies in the perimeters will be played out.

By means of both inheritance and an evolving commodity market in land, the reorganization of access to perimeter parcels may develop in an uncontrolled and undesirable

fashion. This is illustrated below in terms of the participation of women and youth in irrigation farming.

a. Women's Access to Irrigation

As shown in Table 4.11, women represent only 6 percent of all landholders (152 out of 2,435) in the irrigation units studied. They constitute barely 4 percent of all original owners of land. The fact that women are initial landowners of 66 out of 1,651 parcels is the result of: (1) a compromise arrived at between irrigation planners and village scheme participants; (2) an internal evolution of peasant society that increasingly recognizes the rights of women to access to land, or (3) a concession forced upon society by the demands of irrigated agriculture. In any case, it is internal mechanisms within the producer group (replacement or subdivision, inheritance, sale, gift, etc.) that enable women to obtain irrigated parcels.

Table 4.11. Modes of Land Access by Gender in Irrigated Perimeters

	Initial Landholder	Subdivision	Replacement	Inheritance	Gift/Other	Purchase	Total
Women	66	26	15	24	6	15	152
% Total W	43	17	10	16	4	10	100
Men	1,585	260	126	170	53	89	2,283
% Total M	69	11	6	7	2	4	100
Total	1,651	286	141	194	59	104	2,435
% Total	68	12	6	8	2	4	100

Among all women cultivators, 16 percent obtained their parcels through inheritance, compared to only 8 percent for all owner-cultivators (women and men included). It is through inheritance, then, that women have relatively easy access to irrigated land. Such is not the case for waalo lands, however: these are managed at the level of the extended family—by segmented lineage and by galle (compound)—where the transmission of men's property rights takes precedence over women's, and elders' over juniors'. In order for women to inherit land in this context, one of the following conditions must occur:

- The authoritative village body determines the extent to which lands belonging to a particular lineage will be divided. Women must make their claims explicitly known. According to the principles of Islamic Sharia law, women may inherit one-half the part of males.

- If a woman is the sole descendant of the deceased, she becomes the legal inheritor of land. This generally occurs when land is managed at a level below that of the lineage, such as the galle.

Thus the opportunity for women to obtain ownership of customary lands is practically nil, since inheritance is patrilateral and gerontocratic in nature. In large lineages, a male inheritor is almost always available to assume responsibility for the lineage patrimony. In contrast, irrigation parcels are managed on a smaller scale by autonomous households. At this level, even following traditional principles, women have a greater chance of obtaining land through inheritance.

Women occasionally obtain irrigated land through purchase: 10 percent of the parcels held by women were obtained in this manner, compared to only 4 percent for all scheme landholders, men and women included. This phenomenon may be interpreted not only as an indicator of an increase in the economic autonomy of women in the Middle Valley, but also as a mark of their interest in the irrigated sector, since access to customary recession lands remains largely closed to them.

The actual level of access by women to irrigated land remains modest and falls far short of their labor contribution in production and their economic role in the region. The enlargement of this role is the consequence of migration of adult males in recent years.

b. Age of Landholders and Access to Irrigation

While the disposition of land occurs at the level of the household, such family units do not have equal access to irrigated parcels. They are part of a much larger social structure of extended family compounds (galle) and administrative domestic units (*carré*). The galle may include one household (fooyre) or it may group several households linked by brothers or their married sons. The carré is a political-administrative unit created for tax purposes and other governmental concerns such as the distribution of food aid. Related to the customary social structure of lineage organization, the carré is under the authority of the eldest male of the patri-segment and may comprise several households located within several different galle.

Producer groups follow the structural logic of the carré as the principal social unit of organization in the perimeters.[7] Successive producer groups established in the village are composed of the different carré heads according to seniority, followed by household heads in descending order of age.

While this organizational system is more individualized than that found in customary recession agriculture, it is nonetheless marked by the gerontocratic organization of production. This is well illustrated among the irrigation units studied here. Although the population in the Middle Valley engaged in irrigated production is relatively young, the average age of landholders in the schemes is much older, 54 years (Table 4.12). The average age of those

[7] This domestic unit is the most logical one for organizational purposes since irrigation was developed and promoted through state intervention by public authorities familiar with the carré as an administrative unit.

owners obtaining parcels as original scheme participants is 56, while those subsequently receiving land by replacement of the original landowner or by inheritance is relatively young: 46 years for the former and 42 years for the latter. It is through inheritance, then, that rejuvenation of membership within the producer group takes place.

Table 4.12. Average Age of Landholders in Irrigation by Mode of Access and Age of Perimeter

Age of Perimeter	Mode of Access						Total
	Initial Landholder	Subdivision	Replacement	Inheritance	Gift/Other	Purchase	
1975-78	60	45	36	39	63	59	55
1979	57	62	45	39	58	55	53
1980-86	49	55	52	41	51	38	49
1988-90	59	54	46	50	51	52	57
Total	56	52	46	42	54	51	54

The figures show that youth do not obtain access to parcels by means of purchase.[8] The average age of those purchasing land is 51 years, closely approaching the average age of 54 for all landholders. Only buyers of parcels in the perimeters created in 1980-1986 are relatively youthful.

c. Access to Irrigation and Caste Hierarchy

The carré is also a political structure whose power depends on its numeric representation —an important consideration at the time of local government elections. The most influential village elders head the largest carrés. These include not only the households of their own lineage but also those who have historically been their dependents, most often the former slave caste of Maccube.

Certain heads of dependent households are often used by their "masters" in order to obtain more parcels than is officially permitted. Heads of households permanently residing outside the village are often registered as members of a producer group. Their parcels then become accessible to the carré heads.

The allocation of perimeter sites to village producer groups by the Rural Council is often determined by social relations of collegiality. The traditional landowner who cedes land for perimeter development may receive in return more irrigation parcels than he would normally be

[8] Women, as noted earlier, are able to purchase parcels.

allowed. If he is not from the village where the new perimeter is being constructed, he may still be registered as a member of the village producer group and obtain parcels in the scheme. This illustrates how attempts by public authorities to promote democratic principles of equal access to irrigated lands can be undermined at the local level.

In order to determine more rigorously the degree of democratization of access to land in irrigation, it is necessary to distinguish among groups traditionally without land and a landed aristocracy. The concept of caste, which does not correspond strictly to a political-economic hierarchy, is not applicable here. This sort of analysis, however, requires a more profound examination than can be undertaken on such a large scale as this study.

Nevertheless, analysis concerning access to land by caste suggests several generalizations. The largest owners of customary lands are members of the freeborn noble castes—Fulbe, Toorobbe, and Sebbe. Jaawambe and Subalbe, also of freeborn status, are generally less well endowed in land. The Subalbe, for example, often own only falo lands, whereas irrigated lands are located on the foonde and in the waalo cuvettes. The Nyeenybe artisan caste and the former slave Maccube are generally subordinate groups with no freehold rights to land.

Access to irrigated lands, however, shows little evidence of differences among the castes. Changes in land tenure are most notable among the Fulbe. Of all Fulbe landholders, 59 percent were granted parcels as original scheme members (Table 4.13). This compares with an average of 67 percent for all other castes. The larger proportion of Fulbe obtaining land after initial allocation (such as subdivision) is probably because participation of this social group in irrigation occurred relatively late, their engagement in herding being primary. But the persistent crisis—originating in severe drought—affecting livestock production in northern Senegal and lasting more than 15 years forced many Fulbe families who have lost their herds to engage in irrigation in order to survive. Fulbe families participating in irrigation have had to subdivide their parcels to provide access to other family members newly forced to abandon livestock management. This has been the case at Nguendar, where the number of herders requesting access to parcels because they were unable to feed their herds has increased from year to year.

Table 4.13. Modes of Access to Irrigated Land by Caste (in percent)

	Caste								Total
	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	
Initial Landholder	59	66	81	67	80	67	66	67	68
Subdivision	30	10	0	12	3	15	11	8	12
Replacement	1	9	0	0	1	4	6	25	6
Inheritance	5	8	15	9	8	9	9	0	8
Gift/Other	1	3	0	4	1	2	2	0	3
Purchase	4	3	4	0	7	2	5	0	4
Total %	100	100	100	100	100	100	100	100	100
Total	291	1,119	26	93	396	123	375	12	2,435

5. Consequences of Access to Land in Irrigation

Besides the desire for equity of access to resources, studies of land tenure in irrigation have possible implications for agricultural development, an activity that is very costly for the national economy. The organization of land tenure, involving all its modalities of use rights and access, may be seen as either a catalyst or an impediment to development in the rural sector.

The National Domain Law of Senegal, elaborated at independence—when government preoccupations were oriented toward economic prosperity—has yet to achieve its goals. Attempts at jural land reform, such as the National Domain Law and the Territorial Administrative Reform, have been undermined and restructured in accordance with customary land use practice, which remains strong at the local level.

Information on land tenure and the future development of irrigation in this study is preliminary because of the limited, static nature of the data available. The information thus far presented is important for a number of reasons:

- The objective of the National Domain Law is to redistribute land to those with the capacity to exploit it effectively. In order to achieve this goal, it is necessary for the recipients of land to be at the site where production will take place.

- Certain patterns of migration, notably seasonal movements, are not incompatible with the direct exploitation of parcels. In the context of the Fuuta, however, seasonal migration is only one type of migration, however, so that knowing the destinations of migrants who own irrigated land is important for determining whether they are directly involved in exploitation of their parcels.

- The management of irrigated parcels is relatively complex. A sizable and specialized labor force must be deployed at precise times in order to carry out such tasks as transplanting, irrigating parcels, and harvesting. The mobilization of factors of production must be carried out on specific dates, requiring the presence of scheme participants to obtain credit or collect funds promptly. For this reason, absentee management of an irrigated parcel is not easy, particularly where two or three production seasons occur during a year.

- Remittances from migrants are important for irrigation at present because locally generated revenues are small. Remittances enable scheme participants to cover production costs that exceed the capital allotments provided by borrowing. In this respect, extensive migration among scheme members may be seen as an advantage.

- The emergence and growth of forms of usufruct access to parcels (such as loans, leases, and share contracts) may be happening as a way of allowing migrants who are unable to mobilize the necessary labor to cover costs of production.

• If, in order to avoid obstacles to democratization, no more land were to be granted to absentee landholders, migrants would return, possibly requiring the creation of new perimeters. Access for returning migrants would be made easier if jural mechanisms were present prohibiting the commercial sale of land.

The data indicate that the absentee rate among landholders is relatively high, involving 19 percent (466 of 2,435) of all scheme members (Table 4.14). This rate is low compared to absentee rates of the active population as a whole, which are high throughout the Fuuta. The absence of migrant landholders may be viewed both as a potential constraint because of the problems of absentee management, and as an advantage, in terms of generating revenue for purchasing production inputs.

The available data do not enable one to establish a clear relation between perimeter age and rates of absenteeism among landholders (Table 4.14). Preliminary observation suggests a higher absentee rate in the more recent perimeters, but an explanation for this finding is premature.

Table 4.14. Presence of Scheme Members by Perimeter Age

Year Created	Number of Members			Percent		
	Absent	Present	Total	Absent	Present	Total
1975-1978	94	403	497	19	81	100
1979	56	508	564	10	90	100
1980-1986	145	416	561	26	74	100
1988-1990	171	642	813	21	79	100
Total	466	1,969	2,435	19	81	100

Table 4.15 shows a higher absentee rate among those obtaining land through inheritance (29 percent) than through other means. This suggests that if absenteeism is interpreted as an impediment to irrigation development, inheritance as a means of obtaining land might be reconsidered, or the parcels of absentee owners might be made more easily available to the larger community.

Landholders who were absent during the survey period of this study were unable to supervise directly the exploitation of their parcels, even during one production season a year because of their extended periods of migration. Seasonal migration generally occurs to small towns and rural zones of the peanut basin while longer-term migrants often live in Dakar (Table 4.16). Those involved in international migration (40 percent of the migrants), who return to Senegal only once every three or four years, presumably have more difficulty in managing their parcels.

Table 4.15. Presence of Scheme Members by Mode of Access

Mode of Access	Present		Absent		Total	
	Number	Percent	Number	Percent	Number	Percent
Initial Landholder	1,352	82	299	18	1,651	100
Subdivision	229	80	57	20	286	100
Replacement	127	90	14	10	141	100
Inheritance	137	71	57	29	194	100
Gift/Other	45	76	14	24	59	100
Purchase	79	76	25	24	104	100
Total	1,969	81	466	19	2,435	100

Table 4.16. Destination of Absentee Landholders in Irrigation

Destination	Number of Migrants	Percent of Total
Total Fuuta	14	3
Other Senegal	267	57
(to Dakar)	(201)	(43)
Total Senegal	281	60
Total Other Africa	148	32
(to Mauritania)	(18)	(4)
Total to Europe, America, Other Non-Africa	37	8
(to France)	(30)	(6)
Total	466	100

6. Conclusion

The future of irrigation in the Senegal Valley remains uncertain. Land tenure is a critical factor among the forces that will shape the future of this agricultural system. The region, particularly the Middle Valley, maintains a customary system of land management that remains tenacious in resisting land and administrative reforms initiated by the state. These reforms have not closely followed the political and economic orientation of the government: conceived during a period when state intervention in agriculture was promoted, the reforms should logically have

been adapted to the New Agricultural Policy, which favors private initiative and disengagement of the state.

Any alteration of the institutional and jural environment, to have a chance of success, should be preceded by a critical appraisal of existing practices. Irrigated perimeters in the Senegal Valley are still too new to determine accurately the nature of land use patterns. However, irrigation in the region has existed long enough for some observations to be made. One finding that needs further exploration is the marginalization of certain social groups that play a critical economic role in the region, including women, youth, migrants, and castes of lower social standing. The traditional gerontocratic and aristocratic social structure has dominated irrigation and the control of land. Notwithstanding ideological concerns for equity and democratization, the actual process of gaining control of irrigated land may turn out to be a major constraint on agricultural development in the region.

F. Vegetable Gardens

Gardens, the household or communal plots close to (or in) villages where vegetables are grown, are predominantly the domain of women. A subsample of the SRBMA II household sample indicates that just over 75 percent of those who reported working in the gardens were female, less than a quarter male. The study of Thiemping in SRBMA I found:

> . . . a mixed pattern of cropping among the sexes, in which a majority of fields are under the care of either a man or woman, while a small number are cultivated simultaneously by both sexes. Garden plots are usually held by men while their wives or other close female family members most often farm them. In 65 percent of the plots women were solely in charge of cultivation, while men farmed 23.8 percent of the plots alone. In the remaining 11.2 percent, both men and women cultivated the field together, each one usually responsible for a different crop (Horowitz et al. 1991:176).

In two production spaces (PS 5 and PS 7) of the present study, women research assistants surveyed all the women working in the gardens—some 577 women in 9 gardens—not just the women in the household sample. Ethnically, two-thirds of these gardeners are Halpulaar, nearly a third are Fulbe, and a few are Maure in origin. Their castes are largely Sebbe and Fulbe (about 30 percent each), with nearly 20 percent Maccube, 15 percent Toorobbe, 3 percent Nyeenybe, and the rest scattered among other ethnic backgrounds.

The average age of the women is approximately 30: almost 87 percent are in the 15-to-45-year age bracket, and 8 percent are between 46 and 60. Only 2 percent are under 15, fewer than 3 percent over 60. The overwhelming proportion (80 percent) are married; only 15 percent are single, the others divorced or widowed. An even higher proportion (82 percent) are illiterate, having had no schooling. About one in eight (12 percent) have had from one to three years of school and can read and write, while the remaining 6 percent have had somewhat more formal French or Koranic schooling: 3 percent attended school for six years, and only 1 percent have more schooling than that.

Gardens often are found in the falo, where flooding is crucial to success, but they are sometimes cultivated in the irrigated perimeters during the cool dry season and frequently in or close to villages where water from a well or a nearby stream is accessible. In SRBMA II, field staff collected general information on the establishment, financing, size, crops, and gardening calendar of 24 gardens associated with the villages surveyed in the production spaces of the household sample. No gardens were located in the villages sampled in three of the production spaces (PSs 1, 2, and 3). In the other areas: PS 4 villages in the sample had six gardens, PS 5 had five, PS 7 had four, and each of the other production spaces (PSs 6, 8, and 9) had three (Table 4.17). Two-thirds of the gardens had been established between 1987 and 1990, six of these in 1988, the peak year. The earliest garden dates back to 1982.

Table 4.17. Vegetable Gardens: Number of Gardens, Members, and Parcels, and Distance from Village, by Production Space

PS	Number of Gardens	Number of Members		Number of Parcels		Distance from Village (m)	
		Total	Average	Total	Average	Total	Average
4	6	656	109	808[a]	162[a]	1,020	170
5	5	145	29	236	47	350	70
6	3	206[b]	103[a]	1,796	599	1,090	363
7	4	434	109	404	101	780	195
8	3	789[a]	394[a]	492[a]	246[a]	210	70
9	3	440[c]	133[c]	27[a]	27[a]	30[a]	15[a]
Total	24	2,670[a]	--	3,763	--	3,480	--
Average	4	445[a] per PS	121[a] per Garden	627 per PS	188 per Garden	580 per PS	145 per Garden

[a] Excludes not reported (nr) or not applicable (na).
[b] Not reported for one garden.
[c] Approximate.

Note: Totals and averages refer only to gardens of villages in the sample, and not to the entire production spaces.

A third of the gardens were financed locally, by the users (members) or by a village association; one garden was created by a village chief for the exclusive use of his family. Five (four of them in PS 5) were financed by the Projet Integré de Podor—which is run by a Senegalese NGO, the Centre de BOPP N'Dioum. Of the three gardens in PS 9, PADEC (Association Panafricaine pour le Développement Communautaire) funded two, and UNICEF (United Nations Children's Fund) the other. In the other production spaces, CRS (Catholic

Relief Services), the UN High Commissioner for Refugees, and the Netherlands each helped fund one garden. Financing information was not available for six of the gardens.

Ongoing costs are covered by membership fees, which average about 500 FCFA. The amounts of these fees vary considerably, ranging from less than 100 FCFA to as high as 3,000 FCFA. The time period that these sums represent is not always clear, however. The amount may be an initial or monthly fee. Other levies are indicated in some responses: the questionnaire for one garden notes that after the harvest members pay 500 FCFA each; the money is pooled to reimburse the loan that helped establish the garden. At another site, the women gardeners were investing in reforestation activities during the survey year (1991), planting eucalyptus trees along the fence of the garden area in collaboration with the water and forest service of N'Dioum. The same service is supplying fruit trees (mangoes, guavas, lemons), which will allow the women to keep busy throughout the year. This garden, which was very small at the beginning, has had two extensions. One extension required a contribution of 750 FCFA per member; 1,000 FCFA per member was assessed for the other. The members of this garden are collaborating with the Projet Integré de Podor, which has been supplying seeds and equipment such as sprinklers, hoes, shovels, and rakes. If seed is in short supply, however, members are expected to pay 100 FCFA.

Several gardens are actually in or adjacent to their villages; the most distant in the sample is only 1 kilometer away, while on average the gardens are located 145 meters (160 yards) from their villages (Table 4.17). Areas are quite small, ranging from a fraction of 1 hectare to a maximum of 5 hectares, with an average of 1.35 ha per garden.

Individual parcels are also very small, measured in square meters. If the total area of the gardens is divided by the total number of parcels, the average parcel size comes to 78 m^2, but parts of the garden areas may be unplanted—in common paths, wells, and canals, for example—making the usable plots even smaller. Some parcels extend only a square meter or less: in one instance the interviewer's estimated measure (1 m x 50 cm) would mean a plot the size of a small desktop. The gardens average 188 parcels and 121 members each, with an average of approximately 1.5 parcels per member. The maximum number of parcels held by a single member is seven. A few gardens reported more members than parcels, however, implying that some members either share parcels or have none.

Gardens are watered from wells or with water brought from the river or streams (*marigots*). Sixteen wells serve slightly more than half of the 24 gardens: 3 gardens have two wells each, 10 have a single well each, and 11 have none. Some clustering among production spaces appears. Each of the five gardens in PS 5 has a well, while none of the gardens in PS 9 have wells. All but three of the wells had been in existence before the gardens were established. Well depth averages 18.7 meters, and the mean distance of these wells from the gardens is 20 meters. One garden was not planted at all in 1990-1991 partly because the well had frequently been inoperable, and the members could not agree on how to proceed. In two instances, water is piped to gardens from deep wells that are not within the gardens themselves.

Where wells are absent, water is pumped or carried from natural watercourses. Eight of the 11 gardens without wells reported distances from their water sources: three of these distances are short—under 10 m; two more are under 100 m; and the other three range from 100 m to 300 m. The average is about 89 m, four and one-half times as far to transport water as in the gardens with wells. All but two of these eight gardens had pumps to bring the water up to the garden, but one of those without a pump was 100 m from water.

As with establishment of the gardens themselves, information about financing of the wells and pumps is incomplete. In each of the three gardens of PS 4 that report having a well, the well was drilled and financed by the Direction Hydraulique. FAFD (La Fédération des Associations du Fuuta pour le Développement, a regional Senegalese NGO) financed a well in PS 7, and CRS funded well repairs there. The village chief who operates a garden for his family also financed a well from his own resources. Pumps to bring water from streams to the gardens were funded in several ways: aid from tne Netherlands in one case; the Projet Integré de Podor financed two others; UNICEF also funded two; and SAED one.

The gardeners grow at least two dozen different vegetables and fruits (Table 4.18). Cabbage, produced in all but one garden, is the most frequent product; onions and eggplant (aubergine) are also common. (In addition to Western-style aubergine, six gardens grow local varieties of eggplant—*diakhatou*, *jaxatu*, or *batassé*—also known as *aubergine amère*.) Lettuce (*salade* as well as *laitue*) is the fourth most popular vegetable, followed by tomatoes (including three gardens that specified cherry tomatoes), carrots, and hot peppers. The number of gardens growing other produce falls off: seven grow potatoes and turnips; six grow cowpeas (niebe); five yams or sweet potatoes (*igname, patate*); four corn (*maïs*) and okra (*gombo*, *kanje*); three beets, parsley, and mint (*nana*); two each named beans (haricots), guava trees, lemon trees, and hibiscus (from which a drink is made). Only one garden mentioned each of the following: bananas, mangoes, and melons.

In 1990-1991, the gardeners reported planting only once a year. Ground was usually prepared for planting in October or November, though this task ranged from August through January; seeding took place between September and February, with the largest frequency in November and half between November and December. A first weeding most often occurred in November or December, with the timing extending from September through March. Two gardens began harvesting in December and four in January, but the bulk of the harvesting (12 of 20 gardens reporting) was in March through May.

G. Fishing

The socioeconomy of fishing has changed considerably in the past 20 years. Prior to the drought of the 1970s, fishing caste families (Subalbe) made their living by fishing and farming falo land. Today fewer than 10,000 full-time fishermen are reported to operate in the Senegal River Basin (van Lavieren and van Wetten 1990:42; Dunn 1990:6; Grosenick et al. 1990:110). Traditionally, the Subalbe served an important function in Halpulaar society, using their intimate knowledge of the river, its channels, and the floodplains to guide livestock herds across the river

and floodplain channels, and to direct herders and their animals to water points. Their navigation skills made them particularly useful during the flood season when villagers had to travel. During the past two decades, however, many fishing families have taken up other activities, principally farming, petty trade, and wage labor migration. Some migrate seasonally to fishing grounds in the southern Casamance region.

Table 4.18. Number of Gardens Producing Particular Fruits and Vegetables (24 gardens)

Vegetable or Fruit	Number of Gardens
Cabbage (choux)	23
Onions (oignons)	20
Eggplants (aubergines)	18
Lettuce (salade, laitue)	15
Tomatoes, cherry tomatoes (tomates, tomate/cerise)	14
Carrots (carottes)	10
Hot peppers (piments)	9
Potatoes (pommes de terre)	7
Turnips (navets)	7
Cowpeas (niebe)	6
Local eggplant (diakhatou, jaxatu, batassé; aubergine amère)	6
Yams, sweet potatoes (igname; patate)	5
Corn (maïs)	4
Okra (gombo, kanje)	4
Beets (betteraves)	3
Mint (nana)	3
Parsley (persil)	3
Beans (haricots)	2
Guava trees (goyaves, goyaviers)	2
Hibiscus (bissap)	2
Lemon trees (citron, citronniers)	2
Bananas (bananes)	1
Mango trees (manguiers)	1
Melon (melon)	1

The alteration of river flows has been shown to be detrimental to downstream fisheries. Fish reproduction depends on the flooding of waalo bottomlands, where sediment is deposited and plant and animal refuse decays. The relationship of the waalo floodplain to the successful reproduction of freshwater fish in the Senegal Valley has been explored at length by Reizer (e.g., Reizer et al. 1972). Adams's study (1985:297) on the ecological and socioeconomic impact of the Bakolori Dam in northwest Nigeria reports a substantial decline in fishing, both in the floodplain and in drying pools and channels. Some villages surveyed had no fish harvests at all following a reduction in the extent, depth, and duration of flooding in the Sokoto Valley. All villages spoke of reduced catches, smaller fish, and the absence of certain species. A study by Lelek and El Zarka in 1973 (in Davies 1979:130) on the Kainji Dam in Nigeria reports declines in fish landings from 19.6 tons to 12.2 tons between 1967 and 1969, when the Kainji Dam was closed. Fishing incomes in three villages in the region fell between 47 and 73 percent (Adeniyi 1973, in Scudder 1980:395). In the Senegal River Basin, a nine-month study by Dorfman (1980:5, 6) forecast total annual fish losses in the post-dam era at 22,000 tons, 7,700 tons of it freshwater fish from the Senegal Valley.

The fishing calendar can be broken down into the wet and dry fishing seasons. The wet fishing season begins in mid-to-late June at the outset of the rainy season. Within a few weeks, the river begins its rise and the channels start to fill. Schools of fish start their migration into the floodplain toward the end of July and early August, when the lowest portions of the floodplain have flooded. There, they find sheltered niches and rich feeding grounds for nesting their young. This period, known as *uddude* (to close the door), is one of the most active fishing periods of the flood season. Just prior to the movement of fish into the waalo basins, fishermen establish themselves at the mouths of the channels and sieve for fish that are entering the floodplain. Sometimes they set up gill nets, known as *sakite*, at the mouths of channels in the evening and retrieve them in the morning. They may also employ a dam technique, known as *mbargu*. Large tree branches are placed in the channel bed before flooding occurs. When the flood has arrived, men fish near the tree dams where fish are trapped. Following the fish migration into the floodplain, fishers move up the river channels into the floodplains in small dugout canoes. If fishing conditions are good, some fishers remain for as long as several weeks in small camps located on elevated foonde land that has not been flooded. As the waters begin to recede, the fishermen move back to the mouths of the channels to catch fish in their return migration to the river.

Dry season fishing begins with the drop in river water levels and the drying up of inland plains. Fish feeding grounds are then reduced to deep pools in the river and small-standing residual streams, ponds, and marshes that do not dry up immediately (Welcomme 1986:18, 19). In these isolated bodies of water, small fish feed on phytoplankton. Fishing continues here until the end of the cool dry season, usually in January or February, when many communities prohibit fishing in order to protect fish populations during the dry season. This period may last several months. Fishing in the shallow dry season ponds and floodplain streams is carried out with handheld nets, known as *anja-njaara*, *duyru*, and *jawli kofe*, or with bunding and bailing techniques, known as *parka*. Small dams are constructed several meters apart in the stream. Water is then bailed out of an enclosed area containing fish moving downstream. In ponds,

fishing is also carried out by bunding and bailing, or *wecu beli*. Around March, the fish season is once again opened and is marked by an important period of communal fishing of deep pools. It is during the dry fishing season that small groups of fisherfolk set up camp on the falo to fish the deep pools of the main river channel. Also at this time, many families farm falo gardens.

Fishing in both the wet and dry seasons requires low-cost equipment such as wooden, hand-dug canoes, nylon fishing lines, and simple gill nets of varying size. Fishing techniques differ according to location (river, channels, floodplain, and ponds), species of fish desired, and time of year.

SRBMA II collected information from four fishermen in the villages of Ngouye, Wassatake, Wande, and Mbakhna Less in PSs 1, 2, 3, and 7. These four full-time fishers were provided with scales and asked to record on a daily basis the quantity of fish harvested, the location of harvests, the quantity of fish sold, and the price received. Collection of fishing data began in August 1991. Table 4.19 presents the number of days per month in which these four fishermen harvested fish. In both 1991 and 1992, October appears to be the month with the most activity. October is also the month with the largest total fish catches, as shown in Table 4.20, which presents the minimum and maximum figures for average daily fish harvests of the four fishermen, their average daily catches, and their total fish harvests by month and year. Fish were harvested during 90 man-days for a total harvest of 244.66 kg in October 1991 and in 94 man-days for a total harvest of 275.50 kg in October 1992.

The importance of normal flooding conditions for fish harvests is apparent in a comparison of the figures for the two years. Table 4.20 suggests that 1992 was a somewhat better year for fishing than 1991. The average per fisher of total fish harvested in the five months covered in both years (August through December) was higher in 1992 than in 1991 except in November. Minimum average daily catches from August to December were from 1.5 to 5 times higher in 1992 than in 1991. Except for September and October, months when maximum daily fish harvests were slightly higher in 1991, maximum harvests were considerably greater in 1992.

In 1991, the repeated release of waters at Manantali washed fish populations downstream toward Richard Toll, making it difficult for fishers to bring in good catches. Moussa Kane, a field research assistant in PS 1, noted in his diary:[9]

> Il faudrait ajouter que les lachures d'eau répétées ont empêché les poissons de se fixer sur place car à chaque que les poissons commençaient à creuser leur logis, le courant très fort du fleuve les entrainées plus en aval vers Richard Toll. On

[9] The repeated release of waters has prevented fish from nesting. Each time the fish began to make their nests, the strong river current swept them further downstream towards Richard Toll. One could spend the whole day fishing on the river and not catch more than two fish.

pouvait passer la journée à pecher dans le fleuve, on n'attrapait pas plus de deux poissons (Salem-Murdock et al. 1991b [December]:89).

Table 4.19. Number of Days Fish were Harvested by Month, 1991 and 1992: Total for Four Fishermen

Month	1991[a]	1992
January	-	73
February	-	62
March	-	24
April	-	10
May	-	12
June	-	10
July	-	55
August	4	79
September	60	49
October	90	94
November	82	50
December	74	48

[a] Data collection began in August 1991.

The 1992 flood was much improved. One large release was effected from 8 August to 19 September to coincide with the natural flow from the Faleme and Bakoye rivers. A smaller release was effected in October to maintain a minimum river level for irrigation. This second release did not inundate flood basins, although it may have destroyed some falo crops.

H. Herding

Completing the triad of farming and fishing activities in the Senegal Valley is the rearing of livestock by both seminomadic Fulbe groups and sedentarized farming communities that invest in small livestock production as a measure of security against crop losses and environmental instability. Herding is a primary source of livelihood among the Fulbe who reside on the sandy dunes of the upland jeeri plateau bordering the southern fringe of the valley. It plays a secondary role in the production configuration of farming settlements of the jeejegol, waalo, and falo zones. Despite serious herd losses and consequent economic decline among livestock owners during the Sahelian drought years of the 1970s, animal husbandry continues to be a key source of capital investment and economic security for smallholders in the region.

Table 4.20. Minimum, Maximum, Average, and Total Daily Fish Harvests by Month: Averages for Four Fishermen

Month	Average per Fisherman Daily Fish Harvests (kilograms)							
	1991				1992			
	Min.	Max.	Avg.	Tot.	Min.	Max.	Avg.	Tot.
January	-	-	-	-	1.05	3.90	2.54	185.30
February	-	-	-	-	2.09	3.90	3.02	187.20
March	-	-	-	-	2.08	5.10	2.71	64.95
April	-	-	-	-	1.42	1.42	1.42	14.20
May	-	-	-	-	1.47	1.47	1.47	17.60
June	-	-	-	-	0.92	0.92	0.92	9.15
July	-	-	-	-	2.37	5.22	3.55	195.40
August	0.81	0.81	0.81	3.25	2.07	4.53	3.22	254.40
September	0.53	3.48	2.30	137.95	3.02	3.44	3.18	155.80
October	0.47	3.95	2.72	244.66	2.42	3.34	2.93	275.50
November	1.13	5.46	2.89	237.11	2.52	6.17	3.98	199.20
December	1.33	4.46	2.23	164.85	1.96	9.71	4.70	225.75

Access to dry-season pasture in the waalo bottomlands is essential to the survival and well-being of Fulbe herds and ruminants from nearby farming communities. Fulbe have been making annual treks into the floodplain with their herds in search of green pasture for centuries. The arrival of rains in early June signals a northern movement of thousands of cattle, sheep, and goats from dry-season pastures in the southeast, in Senegal, Guinea, and Mali. While floodplain farmers begin harvesting their waalo bottomlands, herds from the jeeri move slowly northward toward the plains as the dry season progresses and southern pasture is depleted. The herds graze along transhumant routes, following a corridor from the uplands to the river. Small pond and marsh areas (*beeli*) serve as critical water points in the floodplain corridor.

Both area and herds from the south manage to graze the northern grasslands for several months of the year, well into the dry season, as a result of extensive flooding of the low-lying plains. In Matam Department, fodder production from the basin is estimated at between 20,000 and 25,000 tons of crop residue or 200 to 400 kg/ha of dry biomass (GERSAR/CACG et al. 1988:28). Much of this organic matter exists as palatable grasses, trees, and shrubs located on the upper knolls and uncultivated margins of the floodplain. The most critical forage source, however, is the nutrient-rich stubble that remains in the harvested sorghum fields. A complementary system of farm and range management has evolved in the region among farmers and herders, whereby animals enter sorghum fields to graze the crop residues on the final day of completed harvests. The nyaayngal, or opening of the floodplain as communal pasture, is

crucial to the overall welfare of area herds. Smallholders benefit in return, as their fields are well manured by large numbers of livestock. This high concentration of organic nutrients proves to be particularly beneficial as a mineral-rich source of food for freshwater fish that spawn and feed in the plains at the height of the flood cycle. Access to fields for neighboring herds also solidifies socioeconomic ties among farming, fishing, and herding communities in the region, enabling a local economy to flourish in which grains, fish, and dairy products circulate in an interdependent fashion among these groups.

Under SRBMA II, an inventory of herd size was conducted to assess the relative importance of livestock holdings in the overall economic portfolio of farming and herding households. Analyses here explore the degree to which mean size of family herds is influenced by geographical location (PS or production space) and by caste status.

As anticipated, ownership of herds by caste reveals substantially larger holdings among the Fulbe than among the other groups (Table 4.21).[10] Fulbe own nearly twice as many cattle and small ruminants (sheep and goats)—6.9 cattle and 19.5 small ruminants per household—as the average for all castes—3.5 cattle and 11.0 small ruminants. Only in the category "other" does herd size exceed that of the Fulbe.[11] This group includes a number of civil servants who have purchased herds as an investment strategy. The Sebbe have the smallest number of animals, 4.9 per household, considerably below that of the other groups. This may be seen as a rough indicator of impoverished economic status, but it could reflect the orientation toward farming of this group as well.

Table 4.21. Livestock Holdings per Household by Caste

Caste	Cattle	Small Ruminants	Total
Fulbe	6.9	19.5	26.4
Toorobbe	3.2	8.5	11.7
Jaawambe	4.4	4.6	9.0
Sebbe	0.4	4.5	4.9
Subalbe	2.1	8.9	11.0
Nyeenybe	3.2	6.1	9.3
Maccube	1.3	9.9	11.2
Other	7.5	22.0	29.5
Total	3.5	11.0	14.4

[10] Livestock holdings reported here constitute all animals owned and kept by the household surveyed as well as animals owned but entrusted to another individual outside the household.

[11] "Other" constitutes all households in the survey of ethnic identity other than Halpulaar; this largely means Wolof.

With respect to production space, access to animals was determined in the same manner as access to land. Access refers to all animals managed by a household in the survey, whether owned by that household or not. Levels of livestock holdings vary across production spaces. As Table 4.22 indicates:

- In areas with a substantial amount of irrigation (PSs 3-5), access to animals is relatively high, averaging 22.6 head per household compared to the overall average of 14.4. These PSs are located in the central and western portions of Podor Department. PS 5 has the greatest number of animals per household, including by far the most cattle.

- In three of the PSs (PSs 2-4), small ruminants dominate, averaging 16.0 head per household compared to 11.0 for the overall sample.

- In areas dominated by recession farming (PSs 6-8), herd size is relatively small (averaging 9.2 head) compared to the overall average (14.4). These PSs are located in the central and western portions of Matam Department.

- In PS 9 (Arrondissement of Semme in eastern Matam), where both irrigation and recession cultivation are weak, cattle holdings are quite high, averaging 5.8 head per household compared to 3.5 for all production spaces. Cattle herding is important to this area partly because agricultural activity is risky and agricultural revenues low.

The smallholders of the Middle Valley engage in a herding strategy of mixed species, with small ruminants an increasing component. Large animals, cattle in particular, were especially ravaged by the drought. In reconstituting herds, many farmers and herders increased their numbers of small ruminants, as they more easily survive severe drought conditions.

Herding small ruminants, especially sheep, which are easily sold for ceremonial occasions such as *Tabaski*, seems to be especially suited to a situation of diversified agriculture. Even where animals are stalled, households can find adequate forage throughout the year: green forage in the rainy season, crop residues from the jeeri harvest in October, canal herbs and grasses and the residual harvest of irrigated perimeters between November and January, and waalo and falo harvest residues between the February-April period and the start of the rainy season. It is for these reasons that herding small ruminants is a prominent activity in the PSs that engage in diversified production systems.

Table 4.22. Livestock Holdings per Household by PS

PS	Cattle	Small Ruminants	Total
1	3.3	8.7	11.9
2	1.7	12.1	13.8
3	3.1	15.2	18.2
4	2.1	20.9	23.0
5	7.8	18.8	26.6
6	1.9	6.1	8.0
7	3.2	9.2	12.5
8	1.4	5.8	7.2
9	5.8	5.3	11.0
Average	3.5	11.0	14.4

V. HOUSEHOLD DYNAMICS AND THE ORGANIZATION OF PRODUCTION

The organization of production in the Middle Senegal Valley is determined by many forces: floodplain ecology, geography, history (precolonial, colonial, and postcolonial), political economy, and sociology. It is expressed in the mix of economic activities, the differential access to resources among groups, and the inter- and intra-household division of labor.

Before the modern introduction of irrigation in the early 1970s, the agricultural system in Halpulaar society had two major components: dryland farming and recession cultivation. Each involves different types of land, crops, land tenure, and land use.

A. Dryland Farming

Dryland farming is practiced on the sandy (seeno) soils of the upland fields known as jeeri, and on the sandy clay soils (foonde raneere, foonde baleere, and foonde walleere) that are found in the elevated areas of the waalo—the foonde. On seeno soils farmers grow low-humidity adapted sorghum, usually fela and nyendiko, and millet, often intercropped with cowpeas and watermelons. Although the sorghum varieties fela and nyendiko are normally the most common crops on the foonde, the most frequently planted crop in 1991-1992 was watermelon, followed by cowpeas. A few farmers planted rainfed sorghum and maize.

Because precipitation in the area is scarce, and variable in both quantity and distribution, and predators such as locusts, grasshoppers, and birds frequently attack the crops, rainfed farming is the riskiest and least rewarding of all activities. Nevertheless, it is also the most widely practiced type of farming since jeeri lands are the most numerous and most readily available to all groups irrespective of social standing, as jeeri tenure rights are widely distributed across caste groups.

Tables 5.1 and 5.2 reflect the tenure rights of jeeri farming—which, as we shall see later, differ from tenure rights in the other production systems found in the area (waalo, falo, and irrigation)—in the agricultural years 1991 and 1992. The second column in both tables presents the total number of sample households by caste, including those that do not have access to jeeri land. The last column gives the number (or percent) of households in the sample that have no access to land. Except for the category "other" (strangers), which consists of four households, all groups contain some households that cultivated as owner/cultivator and/or rented out land. In each group other than the Sebbe, more households cultivated their own land than rented out to others. Average plot size for owner/cultivators ranged between 0.7 ha for the Sebbe to 2.26 ha for the Nyeenybe, with an average size of 2.59 ha for the 200 households in this category. Again excepting the Sebbe, who rented out more and larger fields than they farmed themselves (1.64 ha as opposed to 0.7 ha), the area rented out is small compared to that farmed by the owners (with a range of 0.10 to 0.95, averaging—excluding the Sebbe—0.33 ha). None of the groups "rented in" any jeeri fields.

Table 5.1. Number of Households That Own, Farm, and Rent Jeeri Fields, and Average Plot Sizes by Caste: 1991-1992*

Caste	No. of Households	FLH		SCO/RLO		SCR/RLR (no. of households)	No Access (no. of hhs.)
		No. of Households	Ave. Plot Size (ha)	No. of Households	Ave. Plot Size (ha)		
Fulbe	71	46	1.40	4	0.10	0	22
Toorobbe	106	63	1.77	11	0.35	0	36
Jaawambe	7	2	1.07	1	0.95	0	4
Sebbe	10	3	0.70	4	1.64	0	4
Subalbe	30	16	1.06	4	0.25	0	11
Nyeenybe	32	18	2.26	2	0.11	0	13
Maccube	71	50	1.53	14	0.47	0	10
Other	4	2	0.83	0	0	0	2
Total or Average	331	200	2.59	40	0.49	0	102

* Tables 5.1 and 5.2 present averages for the agricultural years 1991 and 1992. Some households appear in more than one category.

FLH: owner/cultivator
SCO: rented out for a fraction of harvest
RLO: rented out for cash or loaned free of charge

SCR: rented in for a fraction of harvest
RLR: rented in for cash or free of charge
["rented in" means rents land owned by other(s)]

Table 5.2. Percentage of Households Owning, Farming, and Renting Jeeri Fields by Caste: 1991-1992

Caste	No. of Households	FLH	SCO/RLO	SCR/RLR	No Access
Fulbe	71	64.79	5.63	0	30.99
Toorobbe	106	59.43	10.38	0	33.96
Jaawambe	7	28.57	14.29	0	57.14
Sebbe	10	30.00	40.00	0	40.00
Subalbe	30	53.33	13.33	0	36.67
Nyeenybe	32	56.25	6.25	0	40.63
Maccube	71	70.42	19.72	0	14.08
Other	4	50.00	0	0	50.00
Total or Average	331	60.42	12.08	0	30.82

With the exception of the Maccube, each group has a large percentage of households with no access to land (from 31 to 57 percent). These figures should be regarded with caution, however, since the agricultural years 1991 and 1992 as we have seen earlier, were characterized by very low rainfall. Measurements taken at five stations in each of the departments of Matam and Podor give average rainfall for the period May-September 1991 as 186 mm for Matam and 44 mm for Podor, excluding September. Consequently, many farmers were unable to cultivate, or they planted but did not harvest.

1. Jeeri Farming Production Cycle and Labor Inputs[1]

The high degree of risk associated with dryland farming in the Middle Senegal Valley is augmented when we consider labor expenditure balanced against potential crop returns. The season starts with field preparation, before the advent of the first rains in June-July, an arduous task that requires many labor hours (see Table 5.3). Field preparation involves land clearing, fence construction, and burning to remove weeds and stubble from the preceding season. Planting, using a long-handled hoe, takes place directly after the first rains. Seed germination is accompanied by a rapid growth of weeds that continues throughout the season and requires several weedings. Thinning and transplanting usually take place along with the first weeding: young plants that have grown too close to each other are separated and replanted in holes made for seeds that did not germinate. Guarding of fields starts as soon as the young plants begin to mature and continues until harvest and threshing of fields.

2. Labor Time by Age, Gender, and Production Space

Of the households in the subsample for which labor hours were collected, 88 cultivated jeeri plots in the 1991 and/or 1992 agricultural seasons. Tables 5.3 and 5.4 show total and average (per household) jeeri labor hours by agricultural operation, age, and gender for these 88 households. The category weeding and irrigation refers to very small portions of jeeri fields that occasionally are planted with vegetable crops under irrigation. The data do not reveal a strict division of labor by gender. Nevertheless, certain activities are associated more with certain age and/or gender groups than with others. Men are in general much more active in jeeri cultivation than women. Men tend to be responsible for the more arduous tasks such as land preparation, fence construction, and hoeing. The only activity that did not engage women at all, however, is weeding the very small areas that were cultivated under irrigation, a minor activity that engaged an average of 2.97 labor hours among men aged 15-45, and 1.63 labor hours for men 61 and over. Contrary to expectation, women, especially the age group 15-45 are considerably involved in planting, harvesting, and even transport, activities usually associated with men. Women between the ages of 15 and 45 spent, respectively, 61, 93, and 41 percent of the time spent by men of this age group in the three activities.

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[1] As farm labor data were collected on a biweekly basis, only a subsample of 15 households from each PS, chosen from the larger sample, was interviewed.

Table 5.3. Total Hours of Household Labor in Jeeri Fields by Task, Age, and Gender: 1991-1992 (88 households)[a]

Agricultural Operation	Male					Female				
	0-7	8-14	15-45	46-60	61+	0-7	8-14	15-45	46-60	61+
Unknown	0	4	4	4	0	0	0	0	0	0
Field Preparation	0	869	1,110	435	289	0	9	52	12	0
Planting	201	2,143	3,492	587	584	240	672	2,128	265	84
Replanting	17	60	63	17	0	0	0	12	0	0
Fence Construct.	8	1,369	2,397	570	491	20	30	42	12	0
Weeding/hoeing	870	7,770	12,214	2,564	1,668	28	102	308	106	20
Irrigation	0	0	4	10	16	0	0	5	0	0
Transplant./thin.	7	13	27	26	0	0	26	26	0	0
Weeding/irrig.	0	0	261	0	143	0	0	0	0	0
Guarding	936	1,468	2,121	908	603	343	1,067	1,122	100	150
Harvesting	52	494	993	106	212	7	163	919	65	11
Threshing	0	0	0	0	0	0	6	6	0	0
Transporting	0	109	375	58	0	5	31	153	6	8
Other	0	0	16	0	0	0	0	0	0	0
Total	2,091	14,299	23,077	5,285	4,006	643	2,106	4,773	566	273

[a] The figures are based on averages for two seasons, 1991 and 1992.

Table 5.4. Average Labor Hours per Household in Jeeri Fields by Task, Age, and Gender: 1991-1992 (88 households)

Agricultural Operation	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total Task	0-7	8-14	15-45	46-60	61+	Total Task
Unknown	0	0.05	0.05	0.05	0	0.14	0	0	0	0	0	0
Field Preparation	0	9.88	12.61	4.94	3.28	30.72	0	0.10	0.60	0.14	0	0.83
Planting	2.28	24.36	39.68	6.68	6.64	79.62	2.73	7.63	24.18	3.01	0.96	38.50
Replanting	0.20	0.69	0.72	0.20	0	1.78	0	0	0.14	0	0	0.14
Fence Construct.	0.10	15.56	27.24	6.48	5.58	54.94	0.22	0.34	0.48	0.14	0	1.18
Weeding/hoeing	9.89	88.30	138.80	29.14	18.96	285.07	0.32	1.16	3.50	1.20	0.23	6.41
Irrigation	0	0	0.05	0.11	0.19	0.34	0	0	0.06	0	0	0.06
Transplant./thin.	0.08	0.15	0.31	0.30	0	0.83	0	0.30	0.30	0	0	0.59
Weeding/irrig.	0	0	2.97	0	1.63	4.59	0	0	0	0	0	0
Guarding	10.64	16.69	24.10	10.32	6.85	68.59	3.90	12.13	12.75	1.14	1.70	31.62
Harvesting	0.60	5.61	11.29	1.21	2.41	21.11	0.08	1.85	10.44	0.74	0.13	13.24
Threshing	0	0	0	0	0	0	0	0.07	0.07	0	0	0.14
Transporting	0	1.24	4.26	0.66	0	6.16	0.06	0.36	1.74	0.07	0.09	2.31
Other	0	0	0.18	0	0	0.18	0	0	0	0	0	0
Total	23.76	162.49	262.24	60.06	45.52	554.07	7.31	23.93	54.23	6.43	3.10	94.86

Irrespective of age or gender group, the most demanding tasks in terms of labor hours are weeding, field preparation (including fence construction), planting, and guarding. Men in the 15-45 age group spend an average of 138.8 labor hours weeding, followed by men of the age groups 8-14 and 46-60 who respectively spend 88.3 and 29.1 labor hours per household. Women spend 6.4 hours per household weeding, ranging from a low of 0.23 hours for the age group 61 and above to a high of 3.5 for the 15-45 group.

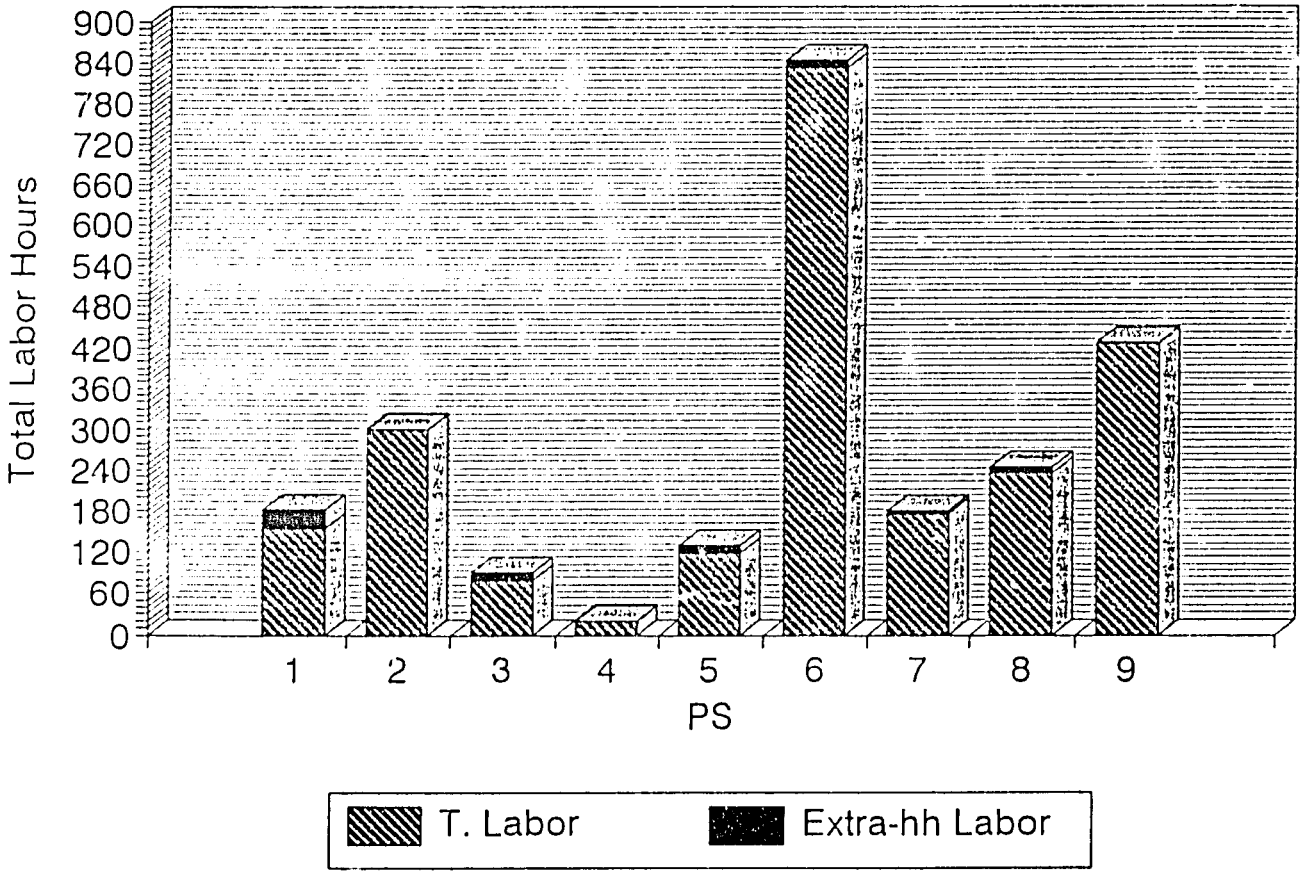
There is also great variability in average labor hours by PS and in the percentage of work provided by extrafamilial labor, as evidenced in Table 5.5 and Figure 5.1. In this table and figure, except for guarding—where the mere presence of a person is usually sufficient—a weighting system is applied to the age groups to calculate labor hours with the following weights: 0-7 = 0.25; 8-14 = 0.5; 15-60 = 1; 61+ = 0.5. The variation in the average labor per household by PS is partly due to differential rainfall distribution. Unlike waalo cultivation, as we shall see later in this chapter, where there is some relationship between the total amount of labor expended and that provided by extrafamilial labor, this correlation is not evident in jeeri cultivation. PS 6 shows the highest number of hours of labor per household, but the proportion provided by extrafamilial labor is only 1.5 percent. In PS 3, on the other hand, which reports per-household labor of 80 hours, outside labor constitutes 17 percent.

Table 5.5. Labor Hours per Household vs. Extrafamilial Labor on Jeeri, by PS: 1991-1992

PS	Number of Households	Total Labor Hours per Household	Labor Hours per Household Provided by Others	Percent Provided by Others
1	11	154	29.08	18.88
2	4	302	0	0
3	15	80	13.60	17.00
4	1	22	0	0
5	9	119	12.67	10.65
6	10	833	12.83	1.54
7	15	175	5.08	2.90
8	12	236	10.67	4.52
9	11	427	2.70	0.63

In general, households rely mainly on family labor in rainfed production. This is more evident in the Department of Matam (PSs 6-9), where extrahousehold labor ranges from 0.6 to 4.5 percent, than in Podor (PSs 1-5), where extrahousehold labor ranges between 10.6 and 18.9 percent. The very poor rainfall conditions in PS 2 and PS 4 that drove many farmers to abandon their fields precluded the need for much labor, let alone extrafamilial. The larger proportion

Fig.5.1. Jeeri Household Labor Hours
Total vs. Extrahousehold Labor



of extrafamilial labor in Podor can be explained partly by the prominence of irrigation in the department: this system has a high demand for labor, increasing, consequently, the need for extrahousehold labor in all agricultural systems.

3. Jeeri Farm Income

Table 5.6 shows the relationship between labor hours and farm income from jeeri farming, for the combined years 1991 and 1992. The second column represents the number of sample households that farmed on the jeeri, the third, average labor hours per household. The fourth column is the number of households that harvested. As harvest data were collected from the entire sample while labor data were collected from the subsample only, the number of households that harvested is larger than the number who worked on jeeri plots for all PSs except 2 and 4.

Table 5.6. Net Farm Income per Household from Jeeri Fields Compared to Labor Expended, by PS[a]

PS	Number of Households Farming on Jeeri	Labor Hours per Household	Number of Households Harvesting	Net Income per Household (FCFA)	Net Income per Labor Hour
1	11	154	24	-1,253	-8.14
2	4	302	4	29,504	97.70
3	15	80	25	656	8.20
4	1	22	0	0	0
5	9	119	22	-514	-4.32
6	10	833	26	31,073	37.30
7	15	175	46	10,957	62.61
8	12	236	27	1,999	8.47
9	11	427	38	9,731	22.79
All	88	269	212	8,131	30.22

[a] Only those households that participated in jeeri farming were counted to calculate average. Even though farm labor involved only a subsample, the number of those involved in labor is sometimes larger than those who harvest, reflecting the very poor rainfall conditions of 1991-1992, when many households planted and expended labor at the beginning of the season but never harvested.

Looking at jeeri labor expenditure against the value of the harvest reinforces the evidence of riskiness entailed in dryland farming in the Middle Senegal Valley. An average negative income of 514 FCFA (about $2.00) for PS 5 might not seem dramatic, even in the context of the Middle Valley, but to end up $2.00 short after having expended an average of 119 labor hours (nearly 15 8-hour days) is to suffer a substantial loss. Despite the risks involved, however, dryland farming remains a very important component of the production system in the

area because when the rains are good, returns can be worthwhile, as evidenced in PSs 2, 6, and 7. Moreover, jeeri crop residues constitute an important component of animal feed.

The risk associated with jeeri cultivation is even more in evidence if we regard each of the agricultural seasons (1991 and 1992) separately, as in Tables 5.7, 5.8, and 5.9, since the previous tables smooth out differences between the two seasons.

Table 5.7. Number of Households Practicing Jeeri Farming: 1991 vs. 1992

PS	Watermelons (podde)		Millet		Sorghum	
	1991	1992	1991	1992	1991	1992
1	0	9	0	5	0	0
2	0	0	0	0	0	4
3	7	3	0	1	0	0
4	0	0	0	0	0	0
5	2	1	0	0	0	0
6	0	0	6	8	10	22
7	0	3	0	26	1	14
8	2	0	2	0	0	0
9	0	0	11	3	15	13
All	11	16	19	43	26	53

Table 5.7 compares the number of households that engaged in jeeri farming in 1991 and in 1992 of the three most frequently grown crops: watermelons, rainfed sorghum (fela), and millet (souna). The total number of households that cultivated in 1992 is always larger than in 1991: 53 to 26 for sorghum, 43 to 19 for millet, and 16 to 11 for watermelons. As we have remarked earlier, because of severe rainfall conditions few farmers were able to cultivate in 1991, and many of those who cultivated were unable to see their crops through to harvest. There was virtually no successful cultivation in PSs 1, 2, and 4, and cultivation was restricted to watermelons in PSs 3 and 5. While PS 8 endured a poor season in 1991, the fact that 1992 was even worse confirms the unevenness of the distribution of rainfall even in a relatively more generous year.

Tables 5.8 and 5.9 show total and average quantities of harvest in kilograms for these three crops. Watermelon is a supplementary crop, grown mostly for its seeds. In 1991, watermelon was harvested in only 3 of the 9 PSs; for these, the average harvest per household was 100 kg. In 1992 it was grown in 4 PSs, but the average harvest per household, 32 kg, was

Table 5.8. Quantity of Harvest by PS and Product: 1991 vs. 1992 (in kg)

PS	Watermelon		Millet		Sorghum	
	1991	1992	1991	1992	1991	1992
1	0	162	0	256	0	0
2	0	0	0	0	0	4,048
3	973	261	0	1	0	0
4	0	0	0	0	0	0
5	4	12	0	0	0	0
6	0	0	3,445	2,951	3,493	10,993
7	0	73	0	4,352	16	4,997
8	124	0	2,070	0	0	0
9	0	0	2,316	1,270	3,255	4,150
All	1,101	508	7,831	8,830	6,764	24,188

Table 5.9. Quantity of Harvest per Household by PS and Product: 1991 vs. 1992 (in kg)

PS	Watermelon		Millet		Sorghum	
	1991	1992	1991	1992	1991	1992
1	0	18	0	51	0	0
2	0	0	0	0	0	1,012
3	139	87	0	1	0	0
4	0	0	0	0	0	0
5	2	12	0	0	0	0
6	0	0	574	369	349	500
7	0	24	0	167	16	357
8	62	0	1,035	0	0	0
9	0	0	211	423	217	319
All	100	32	412	205	260	456

much smaller. Although the number of households cultivating sorghum and millet in 1992 were considerably larger than in 1991, total and average production do not always reflect this substantial increase. In PS 6, for example, the number of households cultivating millet increased from 6 to 8 and those cultivating sorghum from 10 to 22. Total production for millet in this PS, however, went down from 3,445 to 2,951, while the average dropped by almost one-third (from 574 kg to 369). Overall, millet harvested per household fell from 412 kg to 205 kg, the failure of production in PS 8 contributing a substantial share of the decline. The sorghum harvest

showed marked improvement on the whole (from an average of 260 kg to 456 kg per household), but five PSs harvested no sorghum at all in 1992. Although the total number of sample households increased in 1992, this does not apply to all PSs. In PS 9, for example, the number of households harvesting millet dropped from 11 to 3, and the number harvesting sorghum from 15 to 13.

B. Recession Cultivation

1. Waalo

A view held widely among social scientists who have worked in the Middle Valley is that a household's relationship to land is the most visible manifestation of its social status, expressed in its caste affiliation. Nowhere is this clearer than in the differential control that different castes exercise over waalo land (Boutillier et al. 1962; Minveille 1976, 1985; Schmitz 1980, 1986). Our data show that, while ownership and/or direct control over the very valuable bottomland used in waalo cultivation tends to be vested in the Rimbe (Fulbe, Toorobbe, Subalbe, Jaawambe, and Sebbe), mechanisms exist that allow for a more equal distribution. These include *rem peccen didabal* and *rem peccen tatabal,* where one-half (didabal) or one-third (tatabal) of the harvest is paid to the *jom ngesa* (master of the land); *coggu* or renting for cash; and *rem bamaa* or *lubal,* where the land is loaned without charge.

Tables 5.10 and 5.11 present the number and percentage of households that own, farm, or rent waalo fields, by caste and type of tenure. The second column in both tables shows the number of households by caste, including those that do not have access to waalo. Table 5.12 shows what percentage of the households in each caste, excluding households with no access to waalo, have access through which type of tenure. In each table, households appear more than once if they enjoy access through more than one type of tenure.

More than half the sample households have no access to waalo land, but some members of every caste group do have access. The nature of this access varies, however. If we look at the category "no access" (Table 5.11) we see that 66 percent of the Fulbe households and 54 percent of the Toorobbe report no access to waalo. Among those who do have some type of access to waalo (Table 5.12), 82 percent of the Toorobbe, 75 percent of the Sebbe, 71 percent of the Subalbe, 80 percent of the Jaawambe, and 79 percent of the Fulbe cultivate as owner/cultivator (FLH), while only 27 percent of the Maccube have that type of access. Moreover, except for the Sebbe, very small percentages of the higher castes are in the renter category (SCR): 17 percent of the Fulbe, 20 percent of the Jaawambe, 29 percent of the Subalbe, and 12 percent of the Toorobbe. Although a smaller percentage of the Nyeenybe artisans than any other group have access to land (31 percent—Table 5.11), among those, a large proportion is reported as owner/cultivator (70 percent—Table 5.12). A plausible explanation is that, as clients of the Toorobbe in the past, they could have received lands as recompense for services rendered.

The Sebbe warrior caste, 80 percent of whom have some access to waalo (Table 5.11), seem to be active as both owners (75 percent) and landlords (25 percent), and on the renters'

end as well (62.5 percent rent "in" as sharecroppers—for a fraction of the harvest) (Table 5.12). Also interesting is that all groups, including the Maccube, have some households engaged in loaning or renting out.

Table 5.10. Number of Households That Own, Farm, or Rent Waalo Fields and Average Plot Size (in ha), by Caste: 1991-1992*

Caste	Number of HHs	FLH	Average Size (ha)	RLO	Average Size (ha)	SCR	Average Size (ha)	SCO	Average Size (ha)	No Access
Fulbe	71	19	1.54	5	0.18	4	0.35	0	0	47
Toorobbe	106	40	1.92	12	0.30	6	0.37	1	0.04	57
Jaawambe	7	4	0.98	1	4.88	1	0.53	0	0	2
Sebbe	10	6	3.16	2	0.07	5	0.93	0	0	2
Subalbe	30	10	0.72	3	0.21	4	0.79	0	0	16
Nyeenybe	32	7	1.27	2	0.22	3	0.95	0	0	22
Maccube	71	12	0.71	16	0.40	25	1.27	0	0	27
Other	4	1	1.2	0	0	1	2.00	0	0	2
All	331	99	1.56	41	0.43	49	0.99	1	0.04	175

* FLH: owner/cultivator
SCO: rented out for a fraction of harvest
RLO: rented out for cash or loaned free of charge
SCR: rented in for a fraction of harvest
RLR: rented in for cash or free of charge (none)
["rented in" means rents land owned by other(s)]

Table 5.11. Percentage of Households That Own, Farm, or Rent Waalo Fields by Caste: 1991-1992

Caste	Number of Households	FLH	RLO	SCR	SCO	Access	No Access
Fulbe	71	26.76	7.04	5.63	0	33.80	66.20
Toorobbe	106	37.74	11.32	5.66	0.94	46.23	53.77
Jaawambe	7	57.14	14.29	14.29	0	71.43	28.57
Sebbe	10	60.00	20.00	50.00	0	80.00	20.00
Subalbe	30	33.33	10.00	13.33	0	46.67	53.33
Nyeenybe	32	21.88	6.25	9.38	0	31.25	68.75
Maccube	71	16.90	22.54	35.21	0	61.97	38.03
Other	4	25.00	0	25.00	0	50.00	50.00
All	331	29.91	12.39	14.80	0.30	47.13	52.87

Table 5.12. Types of Tenure among Households with Access to Waalo, by Caste: 1991-1992 (in percent)

Caste	No. with Access	FLH	RLO	SCR	SCO
Fulbe	24	79.17	20.83	16.67	0
Toorobbe	49	81.63	24.49	12.24	2.04
Jaawambe	5	80.00	20.00	20.00	0
Sebbe	8	75.00	25.00	62.50	0
Subalbe	14	71.43	21.43	28.57	0
Nyeenybe	10	70.00	20.00	30.00	0
Maccube	44	27.27	36.37	56.82	0
Other	2	50.00	0	50.00	0
All	156	63.46	26.28	31.41	0.64

Most remarkable is that, irrespective of caste affiliation, a large number of households are reported as having no access to waalo (Table 5.11). We should remind ourselves that access refers to a cultivable piece of waalo land in a particular year, in this instance, the year 1991-1992. A look at flood coverage in 1991-1992 reveals why large numbers of households were not able to participate in waalo cultivation (Table 5.13). In addition to the poor release from Manantali, production was not possible in many instances because of plugged flood channels, a longer-term phenomenon that is not necessarily linked to recent dam releases.

Table 5.13. Flood Coverage in 1991-1992 by PS[a]

PS	Kolangal	V/G	G	F	W	N	Reason
	Allaga					X	land too high
	Baarol Jombo					X	plugged channel
	Bonni Bey					X	land too high
	Ciifi Fresbe					X	land too high
	Cooya Alluki					X	land too high
	Daakooke					X	land too high
	Jam Bahe					X	land too high
	Jonnukol					X	land too high
	Jonnukol Kurunaabe					X	land too high
	Kaayel					X	land too high

PS	Kolangal	V/G	G	F	W	N	Reason
	Kolangal					X	plugged channel
	Koyle Buubel					X	land too high
	Kumba Aali					X	land too high
	Maas					X	land too high
	Manga Aw-Awbe					X	land too high
	Manga Boubou Koumba					X	land too high
	Manga Damougal					X	land too high
	Nadda					X	land too high
	Ndonco					X	land too high
	Ngaaraan					X	plugged channel
	Reedu Mbabba					X	plugged channel
1	Allata					X	land too high
1	Baari					X	land too high
1	Baarol-Jombo					X	plugged channel
1	Dounde					X	land too high
1	Goddol					X	plugged channel
1	Jooroodji					X	land too high
1	Manga Koyli					X	land too high
1	WoDos					X	plugged channel
2[b]	Baarol					X	plugged channel
2	Dounde					X	land too high
2	Kolangal					X	land too high
2	Manga Koyli					X	land too high
2	WoDos					X	plugged channel
3	Adiout			X			
3	Arlouwa			X			
3	Diawalel			X			
3	Foulkourou			X			
3	Hada			X			
3	Jayngal		X				
3	Lade			X			
3	Lobaade		X				
3	Maka Njam				X		
3	Mayel			X			

PS	Kolangal	V/G	G	F	W	N	Reason
3	Sappen			X			
3	Tethiane			X			
3	Thiaski Bolol			X			
4	Aasde					X	see footnote[c]
4	Baafe	X					
4	Baari Marda			X			
4	Beeci				X		
4	Beela		X				
4	Budala					X	kolangal too high[d]
4	Caalaba					X	kolangal too high & plugged channel
4	Ceeecan				X		
4	Ciffi Joobe	X					
4	Danala		X				
4	Jaha	X					
4	Jaha Marda		X				
4	Jalbwaa					X	kolangal too high
4	Joon		X				
4	Laan		X				
4	Labbudonguel	X					
4	Lewre Jaalo					X	plugged channel
4	Mangay	X					See footnote[e]
4	Mbabba	X					
4	Mbadeewa					X	kolangal too high
4	Mbarllaba					X	kolangal too high
4	Nguendi		X				
4	Samba Allo					X	kolangal too high & plugged channel
4	Sombilde					X	kolangal too high
4	Winaan	X					
5	Alla Tinde					X	plugged channel[f]
5	Baara Lelli					X	land too high
5	Baawaara					X	land too high
5	Barrol					X	plugged channel
5	Beeli Naayde					X	land too high
5	Bille				X		

PS	Kolangal	V/G	G	F	W	N	Reason
5	Boubou Yere					X	plugged channel[g]
5	Dougouli					X	plugged channel[h]
5	Dougue					X	plugged channel[i]
5	Gouma					X	land too high
5	Kine Baali				X		
5	Labou-Guel					X	land too high
5	Wallere				X		
6	Allah Lewi Sire Idy			X			insufficient duration
6	Allah Lewisire			X			kolangal too high
6	Barol Balol Yondol				X		kolangal too high
6	Bing-Bing		X				insufficient duration
6	Coofinaale		X				
6	Coome		X				
6	Danawel		X				
6	Fetere		X				
6	Hiwal			X			insufficient duration
6	Kanel Lowal		X				
6	Koole Ndoyron			X			insufficient duration
6	Leone		X				insufficient duration
6	Lewe Badi		X				
6	Lewre Gide Allah		X				
6	Lotoke		X				
6	Tumbere		X				
7	Barry Diallo			X			insufficient duration
7	Barry Gamby				X		kolangal too high
7	Barry Goudji				X		insufficient duration
7	Barry Guidjile			X			insufficient duration
7	Barry Pathe		X				
7	Barry Sally		X				
7	Cangay Bonabe		X				
7	Cangay Dow Seydi		X				
7	Cangay Freybe		X				
7	Cangay Sally		X				
7	Cokkobel		X				

PS	Kolangal	V/G	G	F	W	N	Reason
8	Belel	X					
8	Berthiengue	X					
8	Biilaambe	X					
8	Ceenel	X					
8	Dibiribi	X					
8	Djeme	X					
8	Dounguel	X					
8	Gnoudou	X					
8	Jorne	X					
8	Komane	X					
8	Laladji	X					
8	Nogondy	X					
8	Toulal	X					
8	Ubodji	X					
9	Belal				X		plugged channel
9	Haari - Lewa				X		plugged channel
9	Koli - Ndiougue				X		plugged channel
9	Maabakke				X		plugged channel
9	Samaldou				X		plugged channel
9	Sammeji				X		plugged channel

[a] The information about flood intensity and coverage was collected by each research assistant in his/her area. The first 21 kolaade are between PS 1 and PS 2. V/G = Very Good, G = Good, F = Fair, W = Weak, N = None.

[b] Most of the kolaade in this PS have been swallowed up by the perimeter of Salde-Walla and therefore eliminated.

[c] Because of its proximity to the Senegal River, the kolangal has been transformed into a private irrigated perimeter (PIP) of 9 households.

[d] Because of its high location the kolangal has been transformed since 1990 to a PIP by a number of families who are related to each other through kinship ties.

[e] Poor returns attributed primarily to water level fluctuation.

[f] The channel was plugged by the inhabitants themselves for the construction of a village irrigated perimeter (PIV).

[g] The channel was plugged by the inhabitants themselves for the construction of a PIV.

[h] The channel was plugged by the inhabitants themselves for the construction of a PIV.

[i] The channel was plugged by the inhabitants themselves for the construction of a PIV.

a. Waalo Cultivation Production Cycle and Labor Inputs

With an extremely poor jeeri season in 1991, farmers' attention and hope were directed toward their waalo fields, in other words, the flood. Remembering the lack of flood the previous year, the question on everyone's mind was whether there would be a flood, of what magnitude and duration, when, and with what frequency.

Farmers began to inspect their fields as soon as the riverbed—which had reached its annual minimal flow during the month of May—began to fill, in June and July. The river started overflowing into its lateral channels onto the floodplain by mid-August. Although better than no flood at all, as had happened in 1990, the 1991 flood was far less than what the farmers were hoping for in intensity, coverage, and duration. Not only did it not reach the level of 1988, which had been considered a very good year, it was even inferior to the flood of 1989 and was, in addition, plagued with multiple peaks (Figure 5.2). As shown in Table 5.13, many kolaade were either not flooded at all (e.g., in PS 1 and PS 2) or were flooded for only a very short time.

Although our data for Matam stop at 21 September, the 1 September - 21 October information that we have for Bakel and Manantali shows that this multipeak phenomenon continued throughout October (Table 5.14 and Figure 5.3). During this entire period the flow at Bakel reached 2,500 m^3/second (the minimum flow required to reach hydrograph A, which would produce a flood that would inundate 50,000 hectares after a minimum duration of 10 days) on two days only: 5 September (2,627) and 6 September (2,531). As a result of a decreased release from Manantali, the flow diminished almost without interruption, reaching 1,502 m^3/s on 15 September and 608 m^3/s on the 22nd. From 23 September to 11 October the flow fluctuated between a low of 624 and a high of 2,176. On 12 October it started declining again, reaching 408 on 20 October.

Water at Matam started rising toward the middle of July, reaching an average of 247 cm on 18 July. On the following day it started to fall, reaching a low of 163 cm on 27 July. It climbed again to 233 cm by 29 July and then rose, more or less steadily, reaching 579 cm on 29 August, 647 cm on 5 September, and 660 cm on 7 September, a level that it did not surpass in 1991. From that date on, the water level began to dwindle, reaching 601 cm by 12 September, 579 by the 16th, 487 by the 19th, and 420 by the 21st.

As soon as the floodwaters start receding, farmers arrive to inspect their fields, test the softness of the soil, clear the fields of brush and debris brought by flood waters, and burn small shrubs and trees in preparation for planting. Soils have to be sufficiently hardened before planting begins, but with enough surface moisture to encourage germination. Relying on low-cost, locally manufactured, rudimentary farm implements, no fallow period—as soils are replenished by the sediments deposited during the flood (Lericollais and Schmitz 1984)—and little capital investment, waalo cultivation is among the most attractive agricultural activities in the area for those who have access to inundated waalo fields.

Fig. 5.2. Water Level at Matam: 1988-1992

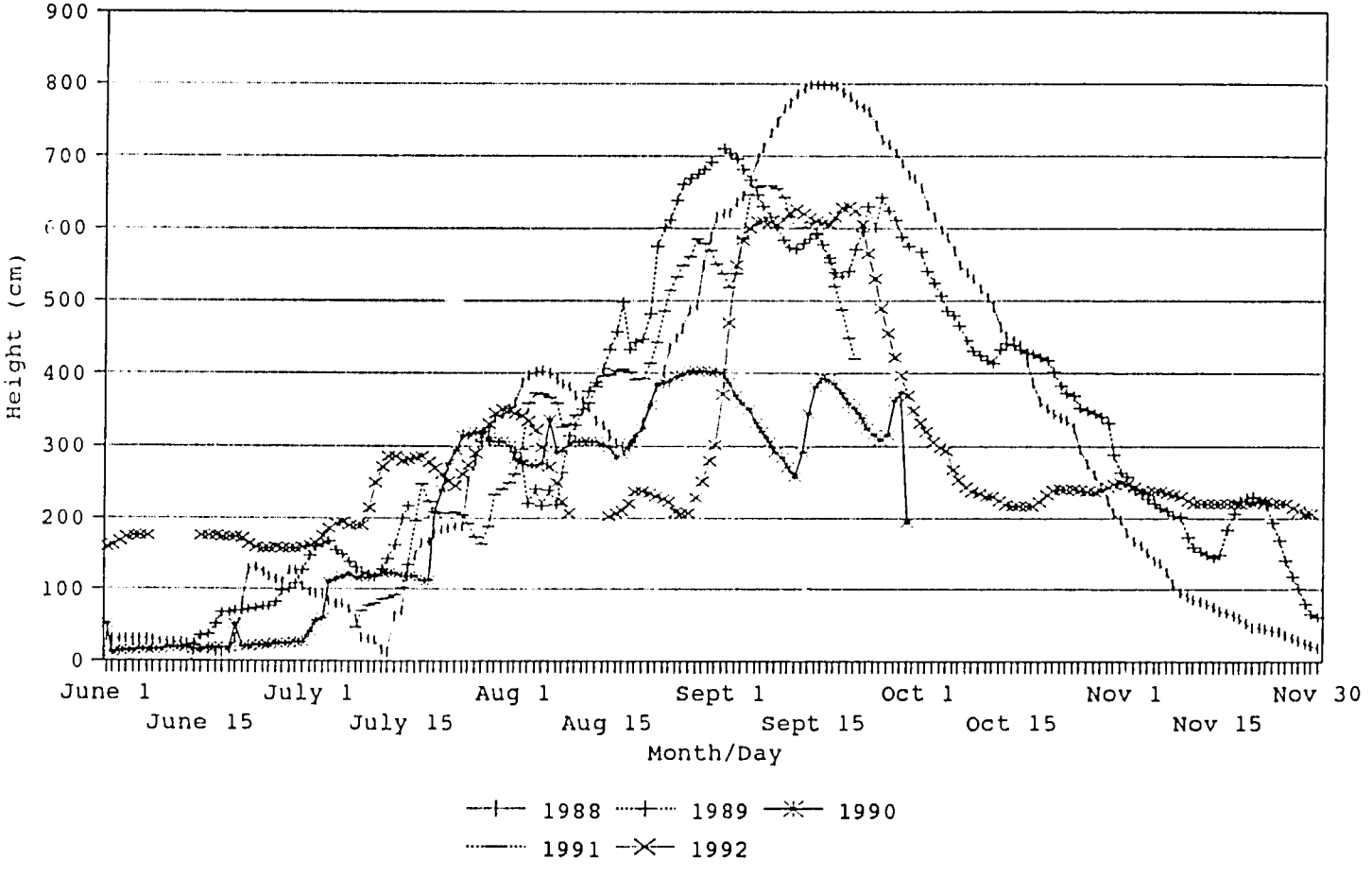


Table 5.14. Water Level/Flow at Bakel and Release from Manantali

Date	Level at Bakel (cm)	Flow at Bakel (m^3)	Release at Manantali (m^3)
09/01/91	428	1,127	918.50
09/02/91	556	1,478	1,053.00
09/03/91	657	1,990	474.60
09/04/91	745	2,484	588.10
09/05/91	769	2,627	648.98
09/06/91	753	2,531	380.09
09/07/91	742	2,467	244.77
09/08/91	723	2,356	342.61
09/09/91	670	2,061	397.40
09/10/91	606	1,721	242.70
09/11/91	595	1,668	146.24
09/12/91	648	1,943	104.00
09/13/91	633	1,863	13.99
09/14/91	598	1,682	8.66
09/15/91	561	1,502	8.79
09/16/91	522	1,318	8.29
09/17/91	478	1,107	8.46
09/18/91	440	937	7.84
09/19/91	395	760	7.93
09/20/91	373	671	5.95
09/21/91	366	647	5.92
09/22/91	354	608	5.37
09/23/91	559	624	6.33
09/24/91	378	688	45.42
09/25/91	399	777	466.55
09/26/91	406	804	1,147.00
09/27/91	398	772	353.74
09/28/91	425	879	460.50
09/29/91	519	1,304	461.12
09/30/91	515	1,286	367.47
10/01/91	494	1,186	403.66
10/02/91	478	1,107	928.76
10/03/91	455	1,003	467.98

Date	Level at Bakel (cm)	Flow at Bakel (m^3)	Release at Manantali (m^3)
10/04/91	440	937	1,634.14
10/05/91	505	1,240	1,504.43
10/06/91	600	1,692	1,398.09
10/07/91	660	2,006	827.50
10/08/91	691	2,176	12.42
10/09/91	682	2,127	11.14
10/10/91	606	1,721	58.00
10/11/91	510	1,263	58.00
10/12/91	433	910	58.00
10/13/91	373	671	58.00
10/14/91	335	549	58.00
10/15/91	318	493	58.00
10/16/91	310	467	58.00
10/17/91	304	450	155.00
10/18/91	300	440	300.00
10/19/91	296	428	462.42
10/20/91	289	408	639.34
10/21/91	289	408	n.a.

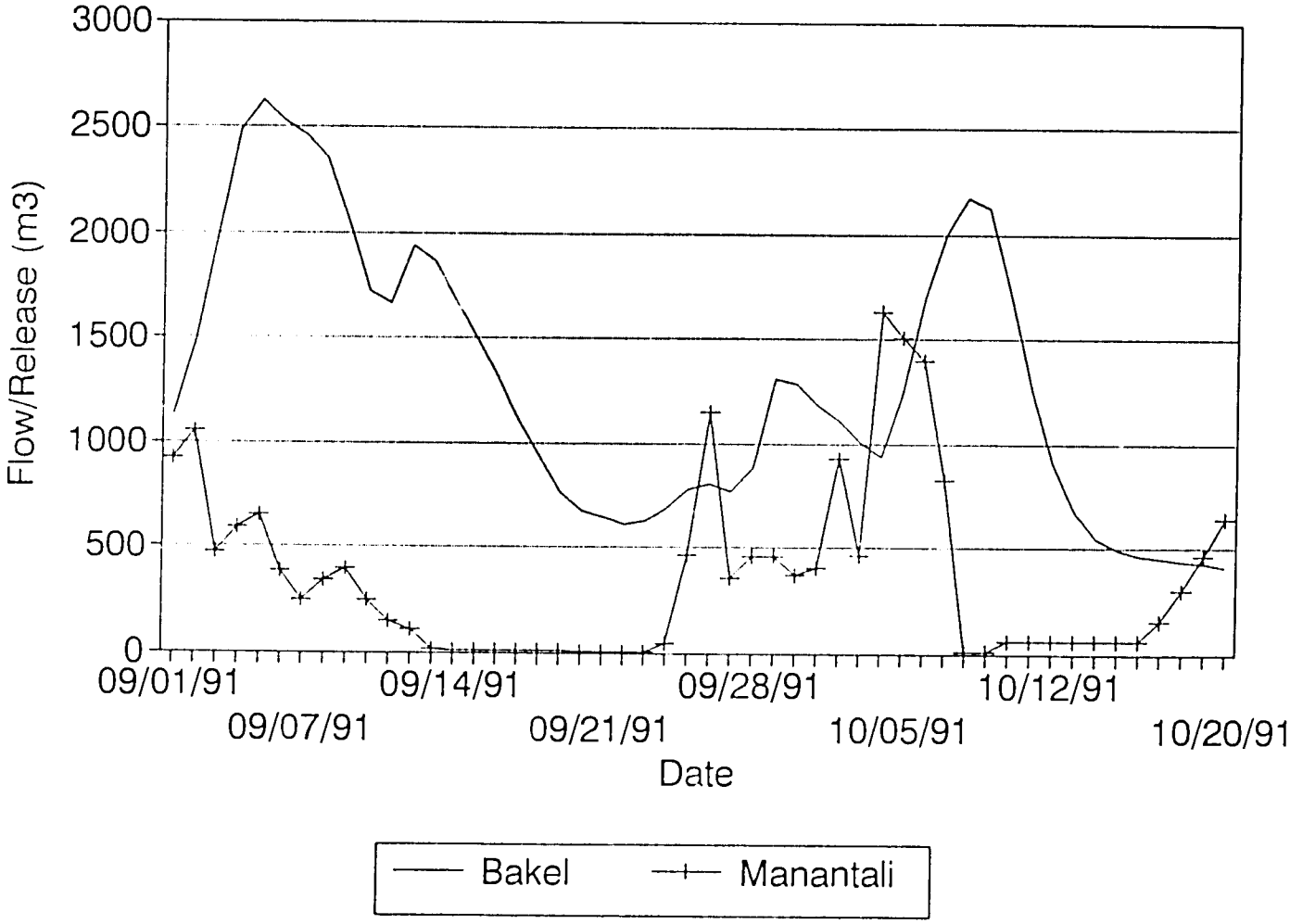
The agricultural season lasts for about five months, starting with field clearing and culminating in harvesting. Planting starts about two weeks after the retreat of water, usually with sorghum intercropped with cowpeas, in late September/early October. Because the beginning of the waalo season overlaps the end of jeeri cultivation skillful management of time and farm resources is required. In the absence of repeated flooding, which would require reseeding, and natural disasters, such as locust or grasshopper invasions, there is little to do in the waalo fields until harvest time in late February to early March other than weeding and guarding.

b. Labor Time by Age, Gender, and Production Space

Tables 5.15 and 5.16 show total and average waalo labor hours[2] by agricultural operation, age, and gender for 54 households that formed part of our farm labor subsample. As with jeeri cultivation, waalo data do not reveal a strict division of labor by age and gender,

[2] Here, labor hours are not weighted.

Fig. 5.3. Water Flow at Bakel and Release at Manantali 1991 (m3)



although women were much more active in waalo cultivation than in jeeri. Normally, jeeri is more labor demanding than waalo, especially in terms of field preparation and weeding activities. Even in years as bad as 1991 and 1992, when many people were forced to abandon their jeeri fields in mid-season and others were unable to cultivate at all, men spent an average of 285 hours per household on weeding/hoeing (Table 5.4). In the 1991-1992 waalo season, however, average household labor for all age and gender groups was 739 hours (Table 5.16: 443 + 296), as against 649 on jeeri (Table 5.4, average for 1991 and 1992). Yet per-household labor hours for men for all tasks was 443 on waalo as opposed to 554 hours per household for men on jeeri. The additional household labor hours on waalo came from a larger share of women's labor. Women provided 40 percent of all waalo labor but only 15 percent of jeeri labor. While women of all age groups spent an average of 95 hours on jeeri, their labor input on waalo fields was over three times that, averaging 296 hours per household.

Table 5.15. Total Hours of Household Labor in Waalo Fields by Age and Gender: 1991-1992 (54 households)

Agricultural Operation	Male					Female				
	0-7	8-14	15-45	46-60	61+	0-7	8-14	15-45	46-60	61+
Field Preparation	0	20	289	65	57	0	8	49	9	3
Planting	221	1,937	3,533	796	495	271	1,507	4,655	195	79
Replanting	0	28	135	21	8	0	70	99	0	0
Fence Construct.	0	240	96	92	22	0	0	0	4	15
Weeding/hoeing	77	2,464	4,670	1,290	609	0	17	349	81	0
Fertilizing	0	10	10	0	0	0	10	5	0	0
Transplant./thin.	0	0	14	0	11	0	0	22	0	0
Guarding	169	1,591	1,554	783	423	251	1,505	2,914	935	567
Harvesting	16	233	760	148	92	100	332	1,059	169	60
Threshing	0	0	393	32	8	0	28	413	19	48
Transporting	7	105	308	60	16	14	27	107	7	0
Other	0	0	10	0	0	0	0	0	0	0
All	490	6,628	11,772	3,287	1,741	636	3,504	9,672	1,419	772

A likely explanation is that, many adult men, faced with a disastrous jeeri season, and fearing that 1991 might be a repeat of the no-flood situation of the previous year, left on seasonal migration earlier in the year than usual, forcing those who stayed behind to absorb an additional burden of waalo labor. Men and women spent similar amounts of time on waalo planting (129 per household for men; 124 for women), whereas women spent only 39 hours per household for jeeri planting against 80 for men. Women also spent more hours than men on harvesting (32 vs. 23) and threshing (9 vs. 8) of waalo fields, activities normally associated with men.

Table 5.16. Average Hours of Labor per Household in Waalo Fields, by Age and Gender: 1991-1992 (54 households)

Agricultural Operation	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total	0-7	8-14	15-45	46-60	61+	Total
Field Preparation	0	0.37	5.35	1.20	1.06	7.98	0	0.15	0.91	0.17	0.06	1.28
Planting	4.09	35.87	65.43	14.74	9.17	129.30	5.02	27.91	86.20	3.61	1.46	124.20
Replanting	0	0.52	2.50	0.39	0.15	3.56	0	1.30	1.83	0	0	3.13
Fence Construct.	0	4.44	1.78	1.70	0.41	8.33	0	0	0	0.07	0.28	0.35
Weeding/hoeing	1.43	45.63	86.48	23.89	11.28	168.70	0	0.31	6.46	1.50	0	8.28
Fertilizing	0	0.19	0.19	0	0	0.37	0	0.19	0.09	0	0	0.28
Transplant./thin.	0	0	0.26	0	0.20	0.46	0	0	0.41	0	0	0.41
Guarding	3.13	29.46	28.78	14.50	7.83	83.70	4.65	27.87	53.96	17.31	10.50	114.30
Harvesting	0.30	4.31	14.07	2.74	1.70	23.13	1.85	6.15	19.61	3.13	1.11	31.85
Threshing	0	0	7.28	0.59	0.15	8.02	0	0.52	7.65	0.35	0.89	9.41
Transporting	0.13	1.94	5.70	1.11	0.30	9.18	0.26	0.50	1.98	0.13	0	2.87
Other	0	0	0.19	0	0	0.19	0	0	0	0	0	0
All	9.07	122.74	218.00	60.87	32.24	442.92	11.78	64.89	179.11	26.28	14.30	296.35

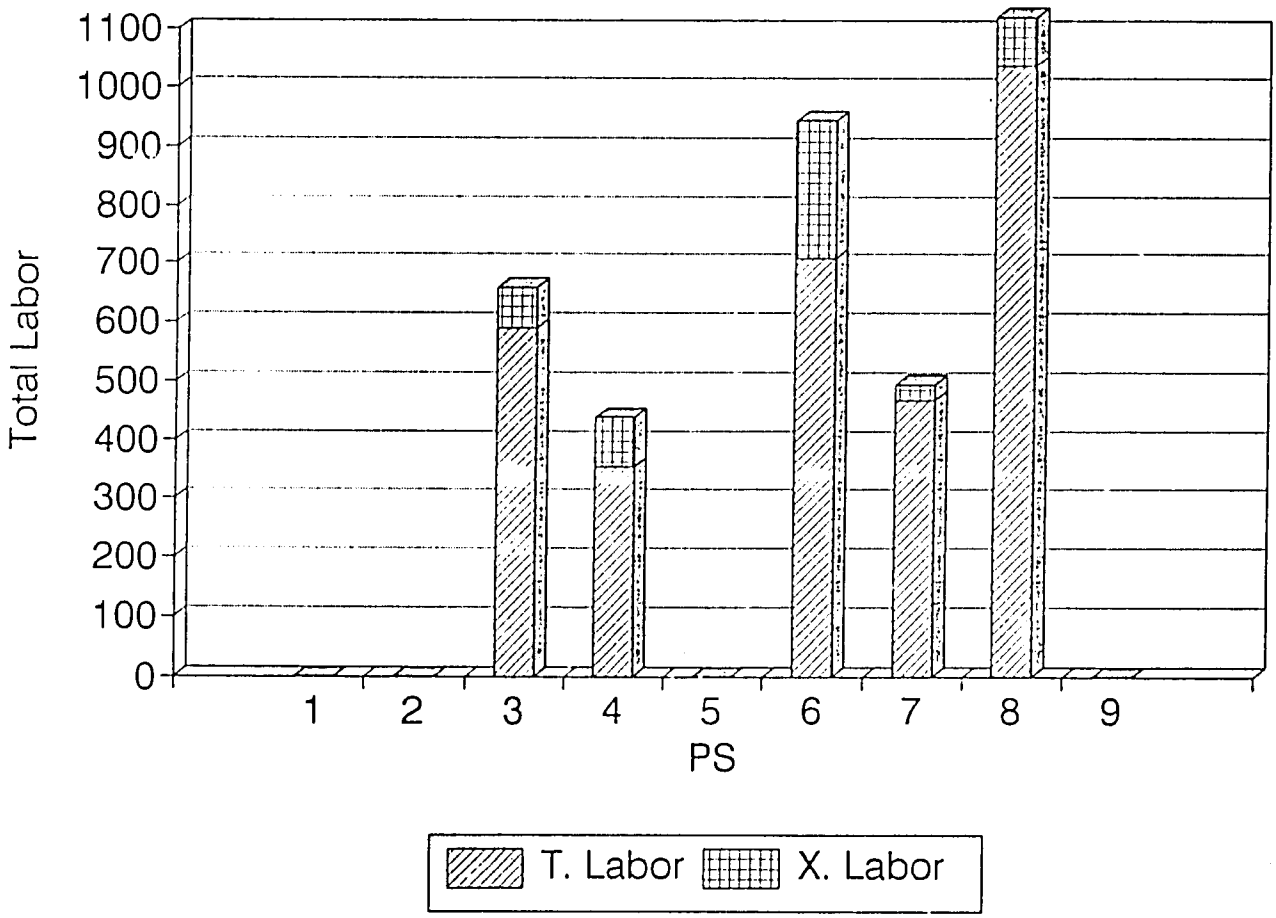
c. Household vs. Extrafamilial Labor

Table 5.17 and Figure 5.4 compare labor provided by household members to that of extrafamilial labor hours by PS. Column two of the table presents the number of households within the subsample who participated in waalo cultivation, the following two columns show average household and extrafamilial labor, and the last column shows what percentage of total labor has been provided by extrafamilial labor.

Table 5.17. Waalo Labor Hours per Household vs. Labor Provided by Others, by PS: 1991-1992

PS	Number of Households	Total Hours of Labor per Household	Extrafamilial Hours of Labor per Household	Extrafamilial as Percent of Total
1	0	0	0	0
2	0	0	0	0
3	12	590	69.39	11.76
4	13	353	86.10	24.39
5	0	0	0	0
6	8	708	237.11	33.49
7	9	467	27.23	5.83
8	13	1,038	132.76	12.79
9	0	0	0	0

Fig. 5.4. Household Waalo Labor Hours
Total vs. Extra-Household Labor



The variation that we see in average household labor by PS corresponds rather closely to the conditions of flood coverage for the year. PS 1 and PS 2, which had no flood,[3] show zero labor input. In PS 9, where there was minimal flood coverage, only a few households attempted to cultivate, including seven households from the overall sample but none from the subsample. PSs 6 and 8, on the other hand, which reported "very good" and "good" floods (Table 5.13), show the highest per-household total labor inputs and relatively high inputs of extrafamilial labor. PS 3, with largely "fair" floods, and PS 4, which had mixed experience (almost equal numbers of "very good," "good," and "no" floods in the kolaade), also used sizable quantities of extrafamilial labor—unlike PS 7, which encountered largely "good" but also some "fair" and "weak" waalo flooding, and used relatively little outside labor.

Describing the low capital and labor input generally used in waalo cultivation, Lericollais and Schmitz (1984) portray the system as stagnant and resistant to innovations. While we do not dispute the assertion concerning low inputs, one can argue that the level of farmer effort is a rational strategy, adapted to the built-in limitations of the system: the irregularity of the flood and the danger of predators. It makes little sense to invest more than is necessary in a system that is highly vulnerable. Although total production might increase (at least temporarily) with investments in fertilizers, herbicides, pesticides, and the like, the next section points out that our data do not show that higher labor input in waalo cultivation necessarily leads to increased output.

d. Waalo Farm Income

Table 5.18 presents the relationship between labor and farm income from waalo cultivation. The second column lists the number of sample households in each PS that farmed on the waalo. The third gives the average labor hours per household; the fourth is the number of households that actually harvested. As with the jeeri data, harvest information was collected from the entire sample, while labor data were collected from the subsample only.

In the areas where waalo cultivation was practiced, average returns per hour of labor ranged between a low 29 FCFA (PS 7) and a high of 344 FCFA (PS 6). At an exchange rate of 250 FCFA to the U.S. dollar, the latter seems not a bad rate of return.

2. Falo Farming

While farming the waalo is the most important component of recession cultivation, horticultural gardening on the riverbanks—falo—is an important supplement. Falo usually has the additional advantage of being located close to the villages, thus providing access to markets and an important source of revenue for older women.

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[3] Certain kolaade bottomlands flooded long enough to permit a few households to cultivate some sorghum (samme). In our sample one household was able to cultivate in this fashion, reporting a harvest of 75 kilograms of samme.

Table 5.18. Net Farm Income per Household from Waalo Fields Compared to Labor Expended, by PS[a]

PS	Number of Households Farming Waalo	Average Labor Hours per Household	Number of Households Harvesting	Net Income per Household (FCFA)	Net Income per Labor Hour (FCFA)[b]
1	0	0	0	0	0
2[c]	0[c]	0[c]	1[c]	61,875[c]	[c]
3	12	590	31	42,419	71.90
4	13	353	29	58,095	166.87
5	0	0	0	0	0
6	8	708	20	243,206	343.51
7	9	467	28	13,546	29.0
8	13	1,038	34	60,004	57.81
9	0	0	7	-2,889	0

[a] Only those households that participated in waalo cultivation were counted to calculate average.

[b] Labor hours are calculated from a subsample, cost of production and value of harvest from the full sample. Income per labor hour is thus approximate.

[c] Although there was "no flood" in PS 2, a few bottomlands were submerged long enough to allow some households, like this one, to attempt to cultivate. Only one household in the full sample actually harvested waalo fields in this PS, however. As it was not in the subsample, the number of labor hours and net income per labor hour are not available (n.a.).

Tables 5.19 and 5.20 show numbers and percentages of households that own, farm, or rent falo land, and average plot sizes. The second column in each table displays the number of sample households by caste, including those who do not have access to falo. The following columns in Table 5.19 show differential land tenure by caste and average plot size. Table 5.21 shows, among those with access to falo land, how falo fields are distributed, in terms of land tenure and caste affiliation.

Access to falo fields is quite restricted because they tend to be very small and because of their location on riverbanks, which constrains their number. Naturally, the Subalbe fishermen, masters of the water and by extension its banks, have the best access to falo lands. Only 17 percent of Subalbe households reported no access to falo fields, as opposed to 100 percent among the Jaawambe, Nyeenybe, and Sebbe, 94 percent of the Fulbe, 86 percent of the Maccube, and 75 percent of the Toorobbe (Table 5.20).

Table 5.21 shows falo land distribution among those with access to this type of land, by caste. Except for the Maccube, who are mainly in a "landlord" position, either renting for cash or lending free of charge (RLO) or for a portion of the harvest (SCR), most people with such access cultivate their own plots: 88 percent of the Subalbe, 75 percent of the Fulbe, and 73 percent of the Toorobbe. Why such a relatively large number of Maccube households, a slave

caste by tradition, control falo fields, and why the majority rent them out needs further exploration.

Table 5.19. Number of Households That Own, Farm, or Rent Falo Fields and Average Size, by Caste: 1991-1992

Caste	Number of Households	FLH		RLO		SCR		No Access
		No. of Households	Average Size (ha)	No. of Households	Average Size (ha)	No. of Households	Average Size (ha)	
Fulbe	71	3	0.19	0	0	1	0.07	67
Toorobbe	106	19	0.19	8	0.05	2	0	80
Jaawambe	7	0	0	0	0	0	0	7
Sebbe	10	0	0	0	0	0	0	10
Subalbe	30	22	0.35	8	0.05	1	0.02	5
Nyeen, e	32	0	0	0	0	0	0	32
Maccube	71	1	0	8	0.15	2	0.04	61
Other	4	1	.05	0	0	0	0	3

[a] FLH: owner/cultivator RLO: rented out for cash or loaned free of charge
SCR: rented in for a fraction of harvest ["rented in" means rents land owned by other(s)].

Table 5.20. Percentage of Households That Own, Farm, or Rent Falo Fields by Caste: 1991-1992

Caste	Number of Households	FLH	RLO	SCR	Access	No Access
Fulbe	71	4.23	0	1.41	5.63	94.37
Toorobbe	106	17.92	7.55	1.89	24.53	75.47
Jaawambe	7	0	0	0	0	100.00
Sebbe	10	0	0	0	0	100.00
Subalbe	30	73.33	26.67	3.33	83.33	16.67
Nyeenybe	32	0	0	0	0	100.00
Maccube	71	1.41	11.27	2.82	14.08	85.92
Other	4	25.00	0	0	25.00	75.00

Table 5.21. Types of Tenure among Households with Access to Falo, by Caste: 1991-1992 (in percent)

Caste	No. with Access	FLH	RLO	SCR
Fulbe	4	75	0	25
Toorobbe	26	73	31	8
Jaawambe	0	0	0	0
Sebbe	0	0	0	0
Subalbe	25	88	32	4
Nyeenybe	0	0	0	0
Maccube	10	10	80	20
Other	1	100	0	0

a. Falo Production Cycle and Labor Inputs

Falo farming is an important component of the production system, not only because of its proximity to the villages, which permits the active participation of women, but also because of the great variety of crops grown there: maize, eggplants, squash, tomatoes, hibiscus (bissap), gourds, okra, sorghum, rice, watermelons, etc., which contribute nutritional variety. Crop residues, including maize stalks and bean vines, provide a valuable source of feed for small ruminants.

Planting in falo fields is staggered, in coordination with the drawdown of floodwaters—which leave behind useful deposits of sediment—and in accordance with the varieties planted. Both the nature of the crops, mainly vegetables that allow for ongoing harvest during a certain period of time, and the staggering of planting itself lead to staggered harvests, providing households with a constant supply of food throughout a season but greatly complicating the process of calculating output. As a result, people tend to report considerably less than they actually harvest, so that our data probably underestimate output and farm income from falo. As the next section indicates, falo farming is extremely labor intensive, particularly planting, weeding, guarding, and harvesting.

b. Labor Time by Age, Gender, and Production Space

Tables 5.22 and 5.23 show total and average labor hours expended by those households in our subsample that participated in falo farming, by activity, age, and gender. We see that women are much more involved in falo gardening than in jeeri, and more active than men. Looking at total (unweighted) labor hours for men and women, we see that, while men worked

8,916 hours, women worked 10,584, with a per-household average of 194 hours for men and 230 hours for women.

Table 5.22. Total Household Labor in Falo Fields by Activity, Age, and Gender: 1991-1992 (46 households)

Agricultural Activity	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total	0-7	8-14	15-45	46-60	61+	Total
Land Preparation	0	30	138	73	26	267	0	6	69	96	3	174
Nursery Preparation	0	0	0	0	0	0	0	0	30	0	0	30
Planting	10	137	565	208	109	1,029	16	161	1,762	482	38	2,459
Replanting	0	2	64	0	0	66	0	6	53	243	0	302
Fence Constr.	7	72	260	86	16	441	36	47	95	29	2	209
Weeding	12	189	1,363	208	228	2,000	79	94	293	68	31	565
Irrigating	0	0	0	12	0	12	0	0	0	0	0	0
Fertilizing	0	0	0	1	0	1	0	0	0	0	0	0
Transplanting	0	228	485	16	5	734	133	157	387	91	78	846
Guarding	0	472	2,015	167	639	3,293	299	412	1,243	1,454	95	3,503
Harvesting	0	189	359	17	71	636	126	191	957	234	141	1,649
Transporting	0	88	260	3	20	371	46	80	404	39	24	593
Other	0	18	48	0	0	66	0	43	55	156	0	254
Total	29	1,425	5,557	791	1,114	8,916	735	1,197	5,348	2,892	412	10,584

Because of their close proximity to villages, falo gardens are much more accommodating to older women who would find it difficult to walk long distances or spend the night in the field as they would have to do in jeeri and waalo farming. While women of age 46 and older (the two oldest groups) spend an average of 9.5 hours in jeeri cultivation (Table 5.4) and 40.6 in waalo (Table 5.16), they spend an average of 71.8 hours in falo (Table 5.23). The proximity factor does not affect older men in the same fashion, however. For the same age groups, 46 and older, men spend an average of 105.6 in jeeri, and 93.1 hours in waalo, as compared to only 41.4 hours on falo gardening. This may be because, unlike waalo and jeeri fields, which can be left pretty much alone after planting, falo gardens need constant attention on an almost daily basis during their season. The older women do a lot of their socializing in the field, while working. Older men tend to do their socializing in the village, in the village chief's courtyard, in the market, or near the mosque.

Table 5.23. Average Labor Hours per Household in Falo Fields, by Activity, Age, and Gender: 1991-1992 (46 households)

Agricultural Activity	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total	0-7	8-14	15-45	46-60	61+	Total
Field Preparation	0	0.65	3.00	1.59	0.57	5.80	0	0.13	1.50	2.09	0.07	3.78
Nursery Preparation	0	0	0	0	0	0	0	0	0.65	0	0	0.65
Planting	0.22	2.98	12.28	4.52	2.37	22.37	0.35	3.50	38.30	10.48	0.83	53.46
Replanting	0	0.04	1.39	0	0	1.43	0	0.13	1.15	5.28	0	6.57
Fence Constr.	0.15	1.57	5.65	1.87	0.35	9.59	0.78	1.02	2.07	0.63	0.04	4.54
Weeding	0.26	4.11	29.63	4.52	4.96	43.48	1.72	2.04	6.37	1.48	0.67	12.28
Irrigating	0	0	0	0.26	0	0.26	0	0	0	0	0	0
Fertilizing	0	0	0	0.02	0	0.02	0	0	0	0	0	0
Transplanting	0	4.96	10.54	0.35	0.11	15.96	2.89	3.41	8.41	1.98	1.70	18.39
Guarding	0	10.26	43.80	3.63	13.89	71.59	6.50	8.96	27.02	31.61	2.07	76.52
Harvesting	0	4.11	7.80	0.37	1.54	13.83	2.74	4.15	20.80	5.09	3.07	35.85
Transporting	0	1.91	5.65	0.07	0.43	8.07	1.00	1.74	8.78	0.85	0.52	12.89
Other	0	0.39	1.04	0	0	1.43	0	0.93	1.20	3.39	0	5.52
Total	0.63	30.98	120.80	17.20	24.22	193.83	15.98	26.02	116.26	62.87	8.96	230.09

c. Falo Farm Income

As we remarked earlier, trying to estimate total harvest in falo gardens is difficult because people tend to underestimate the amount harvested, especially if it has been done in small quantities over several weeks: falo harvesting is done almost daily during the season, while we collected harvest data once a month. Despite this often gross underestimation, yields per hectare from falo gardens, as we shall see later (Table 5.34), are much higher than the other systems (waalo, foonde, and jeeri) combined. Table 5.24 compares average hours of labor and net returns (in FCFA) for falo among PSs. PS 5 is excluded because of absence of falo cultivation. Columns two and three show the number of households in our subsample that participated in cultivation, and average number of labor hours per household. The next column gives the number of households in the whole sample that had falo harvests. As harvest data were collected from the entire sample and labor data only from the subsample, the number of households that harvested is larger (or equal, in the case of PS 6) than the number that worked on falo plots except in PS 9, where we have two households laboring but only one harvesting. Our data on access to land reveal that only one of these households reported access to falo land.

The other performed labor on someone else's falo field but did not report any harvest, since it did not have specific rights to a portion of harvest.

Table 5.24. Net Farm Income per Household from Falo Fields Compared to Labor Expended, by PS

PS	No. of Households Farming Falo	Average Labor Hours	No. of Households Harvesting	Net Value of Harvest (FCFA)	Ave. Net Income per Labor Hour (FCFA)
1	7	867	9	63,783	73.57
2	8	111	14	18,842	169.75
3	2	375	6	21,145	56.39
4	13	75	20	6,216	82.88
6	4	897	4	142,779	159.17
7	6	693	13	122,238	17.66
8	3	302	7	18,083	59.88
9	2	226	1	49,616	219.54

As we look at these figures we should remember that the returns we have are net returns: cost of production has been deducted. Later in this chapter, as we compare the different systems, we will see gross return figures for the research area in general.

C. Irrigation

Irrigation in the delta of the Senegal River dates back to 1824, when the French experimented with irrigated rice, cotton, sugarcane, and vegetables, but it has a much more recent history in the Middle Valley. As late as 1965, when the Organization Autonome du Delta (OAD) was replaced, the mandate of the new organization, the Societé d'Aménagement et Exploitation des Terres du Delta (SAED), was, as suggested by its name, the region of the Delta. The Middle Valley of the Senegal was brought into focus when the Sahelian drought of 1967-1974 and the consequent stress on food production brought about attempts to introduce village-level irrigated perimeters. The first such perimeters, financed by FAO, were introduced in Mauritania in 1973 and in Senegal in 1974, near the towns of Matam (Department of Matam), Aere-Lao (Department of Podor), and Bakel (Department of Bakel) (GERSAR 1980). The spread of village perimeters in the area has been spectacular. From 3 perimeters in 1974-1975, the number had increased to between 522 (Diemer and Van der Laan 1987:47) and 750 (Boutillier and Schmitz 1987:534) perimeters on both sides of the river by 1985.

Around the same time the Government also experimented with large-scale irrigation (managed by SAED), which was the model for irrigation development in the Delta and later in Dagana. The Nianga scheme—on the Doue, in the Department of Podor—with a surface area of 1,340 hectares, was introduced in 1975 as a pilot project financed by the FED (Fonds Européen de Developpement) at a cost of 4,500,000 FCFA per hectare (GERSAR/CACG 1981:30-31). The scheme has been extended twice, in 1980 and 1988, both times with the financial support of KfW (Kreditanstalt für Wiederaufbau), at, respectively, 4,000,000 and 4,500,000 French francs per hectare (ibid.). Production is organized through 16 units, each referred to as a SUMA (Section d'Utilisation du Matériel Agricole) and responsible for an average of 60 ha, cultivated by from four to six farmer groups (*groupements de producteurs*) (ibid.).

Faced with the very high cost of production of large schemes and the small size of village perimeters that consequently are accessible only to a fraction of the population, the government combined various features of small and large schemes and introduced intermediate size perimeters (Casiers Intermédiares—CIN), promoting them as the future model for irrigated agriculture in the Senegal River Valley. Two examples of such schemes are Amadi Ounare in Matam and Salde Wala in Podor.

To replicate what were considered the advantages of PIVs—a small number of farmers tied to each other by kinship or other links—the CINs were organized in the form of Unités Autonomes d'Irrigation (UAI), each in charge of the cultivation of from 17 to 30 ha, and equipped with its own motor-pump. Each UAI is organized also as a GIE (Groupement d'Intérêt Economique), the legal entity that was created in 1984 under the Nouvelle Politique Agricole to allow producer groups to qualify for credit.

Other modes of irrigation in the Middle Valley are private perimeters, usually composed of two to three households organized into a family GIE, and village vegetable gardens, cultivated largely by women. Since in this section we are concerned with inter- and intra-household dynamics and the organization of production, we shall deal mainly with Village Irrigated Perimeters (PIVs), as, along with women's gardens, they are the most widespread forms of irrigation.

1. Village Irrigated Perimeters (PIVs): Production Cycle and Labor Inputs

The arrival of PIVs in the Senegal Valley was greeted with a great deal of enthusiasm, not only for their anticipated important role in food production but also because they were regarded as a force of democratization that would pave the way toward a more equal access to land. As land was traditionally controlled by the rural high-caste elites, at least one scholar referred to PIVs as "a small-scale social revolution" (Schmitz 1986:52). One of the conclusions of SRBMA I was that "the democratization of land is somewhat illusory, being dictated more by the laws of supply and demand than by a system of equitable land allocation to all members of the community" (Horowitz et al. 1991:211). We have remarked earlier (Chapter III) that on all but large-scale perimeters, the Toorobbe have access to land that is much greater than their

representation in the sample. While the Toorobbe and other elites are granted first consideration in irrigated plot allocation, other groups, as we see in the following tables, do not seem to face obvious discrimination.

Table 5.25 shows the number of sample households that owned, cultivated, or rented (from or to others) PIV parcels in the rainy season of 1991-1992. The first three columns show the total number of households in the sample by caste and PS. The other columns give the number of households with each type of access, and the average size of the plots they work. Two PSs, PS 5 and PS 8, have no village perimeters. In another, PS 9, village perimeters are not yet common, and only one household in our sample participated in PIV irrigation. Even in some PSs where village irrigation is relatively widespread, a large number of households from all caste groups do not have access to a PIV. For example, out of 32 households in PS 1, only 6 have access to PIVs; in PS 3, the ratio is 37 households to 15 with access; in PS 7, 53 households to 25 with access. In PS 6, near Matam, only 7 households out of 34 used PIV land in 1991-1992. Plot sizes are quite small: in only one instance is average size about 1 ha, and that was a single Sebbe household in PS 6.

Table 5.25. Number of Households that Own, Cultivate, or Rent PIVs, by PS and Caste: 1991-1992 Rainy Season[a]

PS	Caste	No. of Households	FLH (ha)	Average Size	SCR (ha)	Average Size	RLO (ha)	Average Size	SCO (ha)	Average Size	RLR (ha)	Average Size	No Access
1	Fulbe	8	0	0	2	0.28	0	0	0	0	0	0	6
1	Toorobbe	14	1	0.22	0	0	0	0	0	0	0	0	13
1	Subalbe	3	1	0.39	0	0	0	0	0	0	0	0	2
1	Nyeenybe	4	1	0.16	0	0	0	0	0	0	0	0	3
1	Maccube	3	1	0.16	0	0	0	0	0	0	0	0	2
2	Fulbe	3	1	0.40	0	0	0	0	0	0	0	0	2
2	Toorobbe	12	9	0.41	0	0	0	0	0	0	0	0	3
2	Sebbe	1	0	0	0	0	0	0	0	0	0	0	1
2	Subalbe	6	0	0	0	0	0	0	0	0	0	0	6
2	Nyeenybe	1	1	0.28	0	0	0	0	0	0	0	0	0
2	Maccube	2	2	0.45	0	0	0	0	0	0	0	0	0
3	Fulbe	6	0	0	0	0	0	0	0	0	0	0	6
3	Toorobbe	7	2	0.09	1	0.09	2	0.08	0	0	1	0.02	4
3	Subalbe	6	1	0.05	1	0.19	0	0	0	0	0	0	4
3	Nyeenybe	6	1	0.09	2	0.05	0	0	4	0.11	0	0	1
3	Maccube	11	4	0.25	2	0.05	2	0.06	0	0	0	0	6
3	Other	1	0	0	0	0	0	0	0	0	0	0	1
4	Fulbe	2	1	0.19	1	0.10	0	0	0	0	0	0	0
4	Toorobbe	23	19	0.30	0	0	0	0.06	0	0	0	0	3
4	Nyeenybe	2	0	0	0	0	0	0	0	0	0	0	2

PS	Caste	No. of Households	FLH (ha)	Average Size	SCR (ha)	Average Size	RLO (ha)	Average Size	SCO (ha)	Average Size	RLR (ha)	Average Size	No Access
4	Maccube	3	2	0.49	0	0	1	0.10	0	0	0	0	1
4	Other	2	2	0.68	1	0.16	0	0	0	0	0	0	0
5	Fulbe	26	0	0	0	0	0	0	0	0	0	0	26
5	Toorobbe	2	0	0	0	0	0	0	0	0	0	0	2
5	Maccube	7	0	0	0	0	0	0	0	0	0	0	7
6	Fulbe	2	0	0	1	0.30	0	0	0	0	0	0	1
6	Toorobbe	12	0	0	0	0	0	0	0	0	0	0	12
6	Jaawambe	6	0	0	0	0	0	0	0	0	0	0	6
6	Sebbe	1	1	1.60	0	0	0	0	0	0	0	0	0
6	Subalbe	1	1	0.18	1	0.20	0	0	0	0	0	0	0
6	Nyeenybe	4	0	0	1	0.22	0	0	0	0	0	0	3
6	Maccube	7	3	0.2[illegible]	1	0.10	0	0	0	0	0	0	4
6	Other	1	0	0	0	0	0	0	0	0	0	0	1
7	Fulbe	10	1	0.23	1	0.19	0	0	0	0	0	0	9
7	Toorobbe	10	7	0.30	5	0.17	0	0	0	0	0	0	2
7	Jaawambe	1	0	0	1	0.28	1	0.34	0	0	0	0	0
7	Subalbe	14	8	0.22	5	0.13	2	0.03	0	0	0	0	4
7	Nyeenybe	1	0	0	0	0	0	0	0	0	0	0	1
7	Maccube	17	4	0.21	0	0	1	0.05	0	0	0	0	12
8	Fulbe	6	0	0	0	0	0	0	0	0	0	0	6
8	Toorobbe	10	0	0	0	0	0	0	0	0	0	0	10
8	Sebbe	7	0	0	0	0	0	0	0	0	0	0	7
8	Nyeenybe	4	0	0	0	0	0	0	0	0	0	0	4
8	Maccube	11	0	0	0	0	0	0	0	0	0	0	11
9	Fulbe	8	0	0	0	0	0	0	0	0	0	0	8
9	Toorobbe	16	0	0	1	0.57	0	0	0	0	0	0	15
9	Sebbe	1	0	0	0	0	0	0	0	0	0	0	1
9	Nyeenybe	10	0	0	0	0	0	0	0	0	0	0	10
9	Maccube	10	0	0	0	0	0	0	0	0	0	0	10

FLH: owner/cultivator
SCO: rented out for a fraction of harvest
RLO: rented out for cash or loaned free of charge
SCR: rented in for a fraction of harvest
RLR: rented in for cash or free of charge
["rented in" means rents land owned by other(s)]

Table 5.26 shows the relationship between caste affiliation and access to PIVs irrespective of PS, but including all nine. Column two shows the number of sample households in each caste group, including those with no access to PIVs. The next five columns give the distribution by type of land tenure. A large proportion of households of all castes—72 percent—do not have access to PIV cultivation whether as owner, sharecropper, or renter. Among the Fulbe and Sebbe, two high-status castes, 90 percent are without access.

Table 5.26. Number of Households and Distribution by Type of Tenure on PIV Fields and Caste: 1991-1992

Caste	Number of Households							Percent with No Access
	Total	FLH	SCR	RLO	SCO	RLR	No Access	
Fulbe	71	3	5	0	0	0	64	90
Toorobbe	106	38	7	7	0	1	64	60
Jaawambe	7	0	1	1	0	0	6	86
Sebbe	10	1	0	0	0	0	9	90
Subalbe	30	3	7	2	0	0	16	53
Nyeenybe	32	3	3	0	4	0	24	75
Maccube	71	16	3	4	0	0	53	75
Other	4	2	1	0	0	0	2	50
All	331	66	27	14	4	1	238	72

If we exclude households in PS 5 and PS 8 because of the lack of PIVs in those areas, and PS 9 as only 1 (a Toorobbe) out of 45 households has access to PIV cultivation, the results are somewhat different, but the number of households from all caste groups that have no access to PIV fields is still more than half—57 percent (Table 5.27). Tables 5.27 and 5.28 show the number and percentage of households that own, cultivate, or rent PIV fields in the six remaining PSs.

Looking at these six PSs together, all groups, irrespective of caste affiliation, show some access to PIV fields, although variation exists as to the degree of that access. While fewer than half (47 percent) of the Toorobbe households have no access, among the Jaawambe and Fulbe the percentages are 86 and 77, respectively. This does not seem to be a function of a household's caste origin, however, since the Maccube and the Nyeenybe, "lower" castes, show a higher degree of access than such higher castes as the Fulbe and Jaawambe. The Fulbe's low access to PIV plots may be because agriculture, including irrigated cultivation, is not their primary occupation. As noted, many Fulbe remain pastoralists.

The same seems to be true when we examine the types of tenure among those who do have access to PIV land. As indicated in Table 5.29, which shows the percentage distribution of PIV land tenure according to caste affiliation among those with access, the Toorobbe and Sebbe elite castes are prominent in the owner/cultivator category (FLH), with 93 percent and 100 percent of their households, respectively, farming their own PIV plots (we are disregarding the two households in the category "other"). The lower-caste Maccube, however, do not fall far behind, with 89 percent. The Subalbe fishers appear to be the most disadvantaged in terms of direct access: only 21 percent operate as owner/cultivators, while 50 percent are share-

croppers. Nevertheless, 14 percent of the Subalbe also operate as PIV landlords or lenders of PIV land.

Table 5.27. Number of Households That Own, Cultivate, and Rent PIV Fields Excluding PS 5, PS 8, and PS 9: by Caste, 1991-1992[a]

Caste	Number of Households						
	Total	FLH	SCR	RLO	SCO	RLR	Households with No Access
Fulbe	31	3	5	0	0	0	24
Toorobbe	78	38	6	7	0	1	37
Jaawambe	7	0	1	1	0	0	6
Sebbe	2	1	0	0	0	0	1
Subalbe	30	3	7	2	0	0	16
Nyeenybe	18	3	3	0	4	0	10
Maccube	43	16	3	4	0	0	25
Other	4	2	1	0	0	0	2
All	213	66	26	4	4	1	121

[a] FLH: owner/cultivator
RLO: rented out for cash or loaned free of charge
RLR: rented in for cash or loaned free of charge
SCR: rented in for a fraction of harvest
SCO: rented out for a fraction of harvest

Table 5.28. Percentage of Households That Own, Cultivate, and Rent PIV Fields Excluding PS 5, PS 8, and PS 9: by Caste, 1991-1992

Caste	Number of Households	Percent					
		FLH	SCR	RLO	SCO	RLR	With No Access
Fulbe	31	9.7	16.1	0	0	0	77.4
Toorobbe	78	48.7	7.7	9.0	0	1.3	47.4
Jaawambe	7	0	14.3	14.3	0	0	85.7
Sebbe	2	50.0	0	0	0	0	50.0
Subalbe	30	10.0	23.3	6.7	0	0	53.3
Nyeenybe	18	16.7	16.7	0	22.2	0	55.6
Maccube	43	37.2	7.0	9.3	0	0	58.1
Other	4	50.0	25.0	0	0	0	50.0
All	213	31.0	12.2	6.6	1.9	0.5	56.8

Table 5.29. Type of Tenure among Households with Access to PIV Land, by Caste: 1991-1992 (in percent)

Caste	No. with Access	FLH	SCR	RLO	SCO	RLR
Fulbe	7	42.9	71.4	0	0	0
Toorobbe	41	92.7	14.6	17.1	0	2.4
Jaawambe	1	0	100.0	100.0	0	0
Sebbe	1	100.0	0	0	0	0
Subalbe	14	21.4	50.0	14.3	0	0
Nyeenybe	8	37.5	37.5	0	50.0	0
Maccube	18	88.9	16.7	22.2	0	0
Other	2	100.0	50.0	0	0	0

2. PIVs: Production Cycle and the Division of Labor

Despite its high labor and capital demands and its recent emergence in the area, irrigation has become an important component of the agricultural production system in the Middle Senegal Valley. Theoretically, irrigated parcels are cultivated three times a year: in the rainy season, off-cold season, and the hot season, but the reality is otherwise. While 48 of our subsample households cultivated PIV plots in the rainy season, only 18 households cultivated in the off-cold season and 10 in the hot season. There are substantial seasonal differences in labor hours as well (see Table 5.30). While a household in PS 6, for example, expended 2,549 labor hours in the rainy season, the off-season average labor hours amounted to only 217, or 8.5 percent. When the difference between energy expended in the rainy and cold seasons is small it is not because farmers are putting more energy into the off-season crop, but because farmers could not or would not put in many hours in the rainy season crop, as in PS 1.

Table 5.30. Average Hours of Labor per Household in PIV Fields in Three Seasons, by PS: 1991-1992[a]

PS	Rainy Season	Cold Season	Hot Season
1	189	168	0
2	670	0	0
3	581	283	0
4	586	46	160
6	2,549	217	0
7	621	0	238
9	125	125	0

[a] PS 5 and PS 8 have been excluded because they had no PIVs.

Irrigated rice farming is very labor intensive, easily surpassing the labor demands of jeeri farming and recession cultivation, especially when we consider labor per hectare, as we shall see later in this chapter. Yet the net returns per unit of labor are low, ranging from a negative 5.97 FCFA for PS 1 to (positive) 150 for PS 4 (see Table 5.31).

Table 5.31. Net Farm Income per Household from PIV Fields Compared to Labor Expended, by PS

PS	No. of Households Farming PIVs	Average Labor Hours	No. of Households Harvesting	Net Value of Harvest (FCFA)	Ave. Net Income per Labor hour (FCFA)
1	8	189	7	-1,128	-5.97
2	3	670	11	70,311	104.94
3	11	581	19	6,054	10.42
4	12	586	26	87,902	150.00
5	0	0	3	-37,350	--
6	6	2,549	7	49,670	19.49
7	14	621	24	19,817	31.91
8	0	0	0	0	0
9	1	125	0	0	0

The season starts with preparation of fields and nurseries in mid-to-late June, including repairing canals, fencing nurseries, and preparing beds for planting. Nursery beds are seeded in mid-to-late July, and the first hoeing takes place in August. Young plants are transplanted in August, and the fields are irrigated and fertilized. Irrigation starts soon after planting, first in the nurseries, later in the fields, and continues throughout the season. Weeding starts late in August and continues through November. Guarding begins as soon as the young plants start to mature and continue throughout the season. If all operations are more or less on time, harvesting, threshing, and transport of the harvest are usually over by mid-to-late December.

3. PIVs: Age and Gender Factors in the Division of Labor

Tables 5.32 and 5.33 show total and average household labor by activity, age, and gender. Although some activities are associated more with one gender or age group than with others, all activities except for fence construction, which is carried out by men, involve both men and women. The most demanding activities, in terms of unweighted labor hours, are harvesting (8,425 hours), weeding (7,823), field preparation, nursery preparation, and fence

construction (7,131), threshing (6,618), and transplanting (5,706), all activities with substantial female participation.

Table 5.32. Total Household Labor Hours in PIV Fields by Activity, Age, and Gender: 1991-1992 (48 households)

Activity	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total	0-7	8-14	15-45	46-60	61+	Total
Field Preparation	0	754	2,320	873	350	4,297	42	423	1,099	47	0	1,611
Nursery Preparation	0	280	414	264	91	1,049	0	12	74	16	0	102
Planting	0	76	230	52	126	484	13	100	275	22	0	410
Replanting	0	0	12	0	0	12	0	0	12	6	0	18
Fence Constr.	0	16	40	0	16	72	0	0	0	0	0	0
Irrigating	0	418	1,666	491	245	2,820	4	136	111	8	4	263
Fertilizing	0	78	309	85	33	505	24	17	113	4	0	158
Transplanting	0	414	1,737	222	125	2,498	128	799	2,176	88	17	3,208
Weeding	0	850	2,539	993	338	4,720	80	845	2,015	154	9	3,103
Guarding	0	70	109	6	36	221	0	22	20	56	0	98
Harvesting	44	779	2,082	527	264	3,696	408	1,120	2,941	258	2	4,729
Threshing	43	629	1,888	300	229	3,089	388	740	2,222	160	19	3,529
Transporting	0	25	200	72	1	298	12	47	128	4	0	191
Other	0	66	320	30	197	613	0	0	0	2	0	2
Total	87	4,455	13,866	3,915	2,051	24,374	1,099	4,261	11,186	825	51	17,422

The most active groups in PIV rice cultivation are men and women in the age group 15-45 (men: 13,866; women: 11,186), followed by boys and girls ages 8-14 (boys: 4,455; girls: 4,261). Girls in the age group 0-7 show more activity in PIV farming than boys of the same age (1,099 hours vs. 87). Male presence on the PIVs considerably surpasses that of females in the groups 46 and older, where men spend a total of 5,966 hours, while women spend 876 hours. This could be attributed to the active involvement of women of these age groups in falo and irrigated garden cultivation.

Table 5.33. Average Hours of Labor per Household in PIV Fields, by Age and Gender: 1991-1992 (48 house holds)

Activity	Male						Female					
	0-7	8-14	15-45	46-60	61+	Total	0-7	8-14	15-45	46-60	61+	Total
Field Preparation	0	15.72	48.34	18.19	7.28	89.53	0.88	8.81	22.90	0.98	0	33.57
Nursery Preparation	0	5.83	8.64	5.50	1.90	21.87	0	0.25	1.54	0.33	0	2.12
Planting	0	1.58	4.79	1.08	2.63	10.08	0.27	2.08	5.73	0.46	0	8.54
Replanting	0	0	0.25	0	0	0.25	0	0	0.25	0.13	0	0.38
Fence Constr.	0	0.33	0.83	0	0.33	1.49	0	0	0	0	0	0
Irrigating	0	8.71	34.71	10.23	5.10	58.75	0.08	2.83	2.31	0.17	0.08	5.47
Fertilizing	0	1.63	6.44	1.77	0.69	10.53	0.50	0.35	2.35	0.08	0	3.28
Transplanting	0	8.61	36.19	4.63	2.60	52.03	2.67	16.65	45.33	1.83	0.35	66.83
Weeding	0	17.71	52.89	20.69	7.04	98.33	1.67	17.60	41.98	3.21	0.19	64.65
Guarding	0	1.46	2.27	0.13	0.75	4.61	0	0.46	0.42	1.17	0	2.05
Harvesting	0.92	16.23	43.38	10.98	5.50	77.01	8.50	23.33	61.27	5.38	0.04	98.52
Threshing	0.90	13.10	39.33	6.25	4.77	64.35	8.08	15.42	46.29	3.33	0.40	73.52
Transporting	0	0.52	4.17	1.50	0.02	6.21	0.25	0.98	2.67	0.08	0	3.98
Other	0	1.38	6.67	0.63	4.10	12.78	0	0	0	0.04	0	0.04
Total	1.82	92.81	288.88	81.56	42.73	507.79	22.90	88.77	233.04	17.19	1.06	362.96

D. Productivity in the Various Agricultural Systems per Units of Land, Labor, and Capital

Tables 5.34 and 5.35 compare average yield per hour of labor, average yield per hectare, average expenditure per hectare, and average labor hours per hectare for irrigation—distinguishing among large-scale perimeters (GPI), middle-scale perimeters (CIN), private irrigated perimeters (PIP), village irrigated perimeters (PIV), and irrigated vegetable gardens (MJF); waalo (WLO); falo (FLO); jeeri (JRI); and foonde (FND). Table 5.34 includes a total of 405 parcels: all parcels for which we had parcel size and labor information, including those reporting no harvest. Table 5.35 excludes parcels that did not report any harvest, leaving a balance of 274 parcels.

The differences between Table 5.34, which summarizes data on all parcels, including those that reported zero harvest, and Table 5.35, which excludes those that reported zero harvest, are revealing, especially with respect to jeeri cultivation. First, among the 405 parcels cultivated by the subsample from which we gathered extensive farm labor data, one third (131 of the 405) yielded no harvest—a clear example of the risks associated with agriculture, especially dryland farming, in the Senegal River Valley. Excluding parcels that reported no

Table 5.34. Land, Labor, and Capital Productivity: 1991-1992 (405 parcels)[a]

Agricultural System	Average Yield per Hour (FCFA)	Average Yield per Ha (FCFA)	Average Expenditure per Ha (FCFA)	Average Hours of Labor per Ha
Irrigation: Mid-Scale Perimeters (CIN)	252	385,436	80,336	1,531
Falo (FLO)	160	220,939	4,512	1,381
Foonde (FND)	24	13,207	1,410	557
Irrigation: Large-Scale Perimeters (GPI)	275	209,508	52,630	761
Jeeri (JRI)	27	5,562	869	209
Irrigated Vegetable Gardens (MJF)	17	27,358	17,656	1,589
Irrigation: Private Irrigated Perimeters (PIP)	5	13,644	37,520	2,849
Irrigation: Village Irrigated Perimeters (PIV)	135	196,581	35,040	1,454
Waalo (WLO)	140	37,772	1,836	271

[a] All parcels with information on size of parcel and labor, including those with zero harvest.

Table 5.35. Land, Labor, and Capital Productivity: 1991-1992 (274 parcels)[a]

Agricultural System	Average Yield per Hour (FCFA)	Average Yield per Ha (FCFA)	Average Expenditure per Ha (FCFA)	Average Hours of Labor per Ha
Irrigation: Mid-Scale Perimeters (CIN)	280	447,239	86,384	1,598
Falo (FLO)	181	260,444	4,765	1,439
Foonde (FND)	34	19,903	1,747	581
Irrigation: Large-Scale Perimeters (GPI)	297	212,707	53,434	717
Jeeri (JRI)	57	22,773	961	396
Irrigated Vegetable Gardens (MJF)	51	31,267	18,671	611
Irrigation: Private Irrigated Perimeters (PIP)	5	13,644	37,520	2,849
Irrigation: Village Irrigated Perimeters (PIV)	165	251,981	38,461	1,523
Waalo (WLO)	177	45,455	1,644	257

[a] All parcels with information on land size and labor, excluding those with zero harvest.

harvest (Table 5.35) increases average yields (per hour and per hectare) in all systems, of course (except for private irrigated perimeters, where no change is indicated—no subsample PIP plots failed completely—but where average yield per hour of labor is already quite low—5 FCFA). For some systems, yields per hour of labor are up sharply: in irrigated vegetable gardens, by 200 percent; in jeeri, by 111 percent; and in foonde, by 42 percent (Table 5.36). We note similar but not parallel types of changes in average yields estimated in FCFA per hectare. For example, while yield per hour of labor in irrigated vegetable gardens is up 200 percent when parcels with no harvests are excluded, per-hectare yield increases by only 14 percent. On jeeri parcels, the percent increase measuring the ratio of yield per hectare omitting zero-harvest plots, to yield per hectare including them, is 309 percent.

Table 5.36. Percentage Increases in Productivity When Parcels with Zero Harvest Are Excluded

Agricultural System	Average Yield per Hour (FCFA)	Average Yield per Ha (FCFA)	Average Expenditure per Ha (FCFA)	Average Hours of Labor per Ha
Irrigation: Mid-Scale Perimeters (CIN)	11	16	8	4
Falo (FLO)	13	18	6	4
Foonde (FND)	42	51	24	4
Irrigation: Large-Scale Perimeters (GPI)	8	2	2	-6
Jeeri (JRI)	111	309	11	89
Irrigated Vegetable Gardens (MJF)	200	14	6	-62
Irrigation: Private Irrigated Perimeters (PIP)	0	0	0	0
Irrigation: Village Irrigated Perimeters (PIV)	22	28	10	5
Waalo (WLO)	26	20	-10	-7

Average expenditure per hectare and average labor per hectare generally show little change when zero-harvest parcels are omitted (Table 5.36). The decreases in average expenditure per hectare for waalo, and in labor per hectare for large irrigated perimeters, irrigated vegetable gardens, and waalo, result from two factors: a decrease in inputs when people realize there will be no harvest, and the likelihood that some of the parcels excluded because of zero harvest had inputs at the beginning of the season that were higher than inputs for some of the successful parcels. The decreases are quite small, however, except for the total labor hours per hectare in irrigated vegetable gardens. The only substantial higher value is for labor per hectare for jeeri cultivation, and the largest increase in expenditure per hectare when zero-harvest plots are excluded is for foonde.

Since the potential for zero harvest in all agricultural systems in the Middle Valley is a fact of life it is more revealing to use the data of Table 5.34 (which includes parcels that reported zero harvest) in our calculation of productivity by units of labor, land, and capital. Because of the different values of various crops, we converted the physical weights (in kilograms) into monetary values, using average prices received by farmers or average market prices for a given season.[4]

In terms of yields per labor hour in FCFA (Table 5.34 and Figure 5.5), the larger irrigated parcels, whether large-scale irrigated perimeters (GPI) or middle-scale perimeters (CIN), appear the most rewarding. This is predominantly a function of the much heavier use of machinery in irrigated agriculture, especially in large-scale, middle-scale, private, and village irrigated perimeters, a variable that was not factored in when we calculated labor. This resulted in overvaluing the labor hour of a man on a tractor, given its heavy cost. In an attempt to resolve this problem, we started by calculating the number of animal and machine hours recorded on the various parcels, as presented in Tables 5.37 and 5.38.

Table 5.37 and Figure 5.6 reveal that among irrigated parcels, only village irrigated perimeters reported using animals (mostly donkeys or animal-drawn carts), in large part to move harvests. Examining the use of machinery (Table 5.38), we notice that only two types of parcels, private irrigated perimeters and village perimeters, reported employing heavy machinery (namely harvester/threshers and tractors), with PIPs reporting 18 hours of harvester/thresher use, and PIVs reporting 21 hours of tractor use.

As we know that both tractors and harvester/threshers are used in at least two other types of irrigated parcels, large-scale (GPI) and medium-scale (CIN) perimeters, we looked at production charges to discover the amounts of money that farmers reported having paid for

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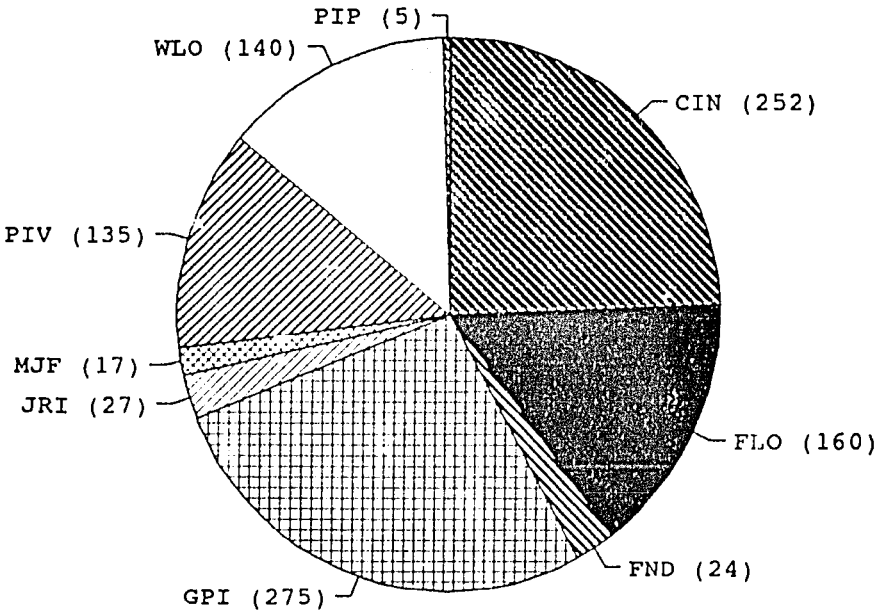
[4] Crop values were calculated on the basis of the average prices that farmers reported having received for a kilo of crop. Accordingly, our calculations differentiate among sorghum, felo, and nyendiko, for example—all rainfed sorghum varieties—depending on farmers' differentiations among these crops. Where prices were not provided, we used the following average market prices (in FCFA): paddy rice, 62.69; millet, 92.39; souna (millet variety), 100; sorghum, 61.01; fela (a rainfed sorghum variety), 98.64; nyendiko (a rainfed sorghum variety), 98.64; samme (a recession cultivation sorghum variety), 82.5; maize, 78.45; gombo, 97.37; niebe (cowpeas), 150.71; gourds, 15.54; haako (sauce leaves), 57.07; potatoes, 54.79; tomatoes, 42.45; bissap, 121.67; watermelon, 333.33; onions, 82.73; salad greens, 218.03; podde (watermelon seeds), 44.75; goyyi (stalks and leaves of cowpeas), 10.62; cabbage, 76.29; sorrel, 218.03; carrots, 218.03; diakatou (a vegetable similar to eggplants but bitter), 218.03; peanuts, 161.59; naayko (sorghum stalks and leaves), 51.02.

Fig. 5.5. Average Yield per Labor Hour: 1991-1992 (in FCFA)



PIP	Private irrigated perimeter
CIN	Middle-sized irrigated perimeter
FLO	Falo
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
PIV	Village irrigated perimeter
WLO	Waalo

Table 5.37. Number of Animal Hours by Type and Agricultural System: 1991-1992

Agricultural System	Donkey	Horse	Plough	Animal-Drawn Cart
Falo (FLO)	41	0	0	38
Foonde (FND)	0	0	0	16
Jeeri (JRI)	0	266	543	124
Village Irrigated Perimeter (PIV)	40	8	0	21
Waalo (WLO)	14	22	27	102

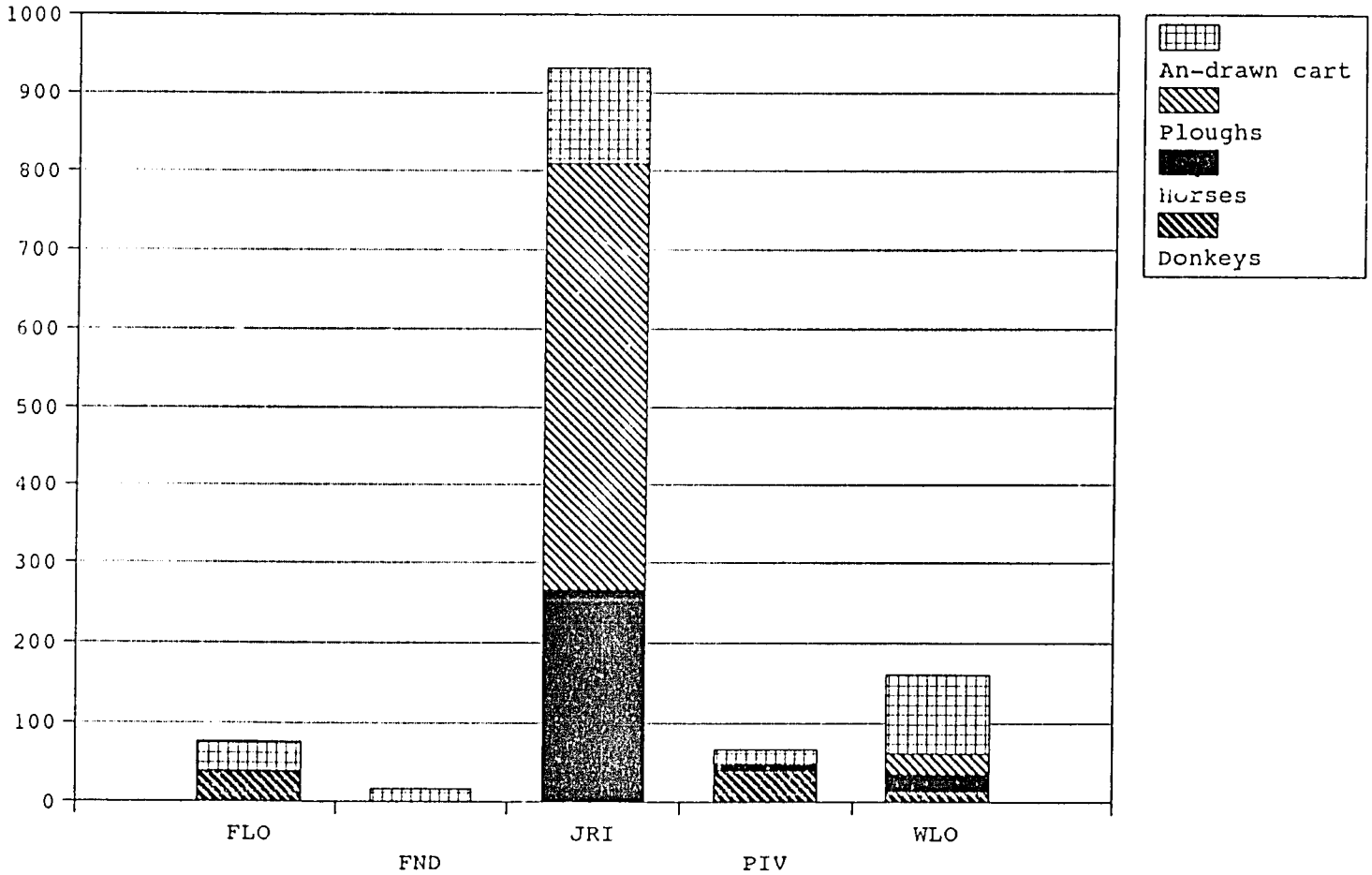
Table 5.38. Number of Machine Hours by Agricultural System: 1991-1992

Agricultural System	Harvester/Thresher	Tractor
Private Irrigated Perimeter (PIP)	18	0
Village Irrigated Perimeter (PIV)	0	21

machine services (Table 5.39).[5] For hiring tractors, farmers spent FCFA 107,400 on large-scale perimeters (9 instances of use), 105,000 on private perimeters (3 instances of use), 86,000 on middle-scale perimeters (18 instances of use), and 78,000 on village-irrigated perimeters (14 instances of use) (Figure 5.7). Average cost per use varies widely among systems, from the high reported for the three private irrigated perimeter instances to the considerably lower costs per use of the mid-scale and village perimeters.

[5] Farm labor and cost data were collected in the fields, cost data on a monthly basis, and labor data every two weeks. Many of the heavier agricultural operations, such as plowing and harvesting on government-operated irrigated schemes, be they large-, medium-, or village-level, are coordinated and operated by the government or a designated agency. Fees for such services are recorded as part of the credit that each farmer/parcel owes and are charged against harvest, if there is any, at the end of the season. Accordingly, farmers (and therefore research assistants) often do not know what these charges are until some time after the season is over and gains and losses are calculated.

Fig. 5.6. Number of Animal Hours by Agricultural System: 1991-1992



FLO Falo
FND Foonde
JRI Jeeri
PIV Village irrigated perimeter
WLO Waalo

Table 5.39. Tractor Use by Agricultural System, Number of Uses Reported, and Cost: 1991-1992

Agricultural System	Number of Uses Reported	Total Cost (FCFA)	Cost per Use (FCFA)
Large-Scale Perimeters (GPI)	9	107,400	11,933
Mid-Scale Perimeters (CIN)	18	86,000	4,778
Private Irrigated Perimeters (PIP)	3	105,000	35,000
Village Irrigated Perimeters (PIV)	14	78,000	5,571
All	44	376,400	8,555

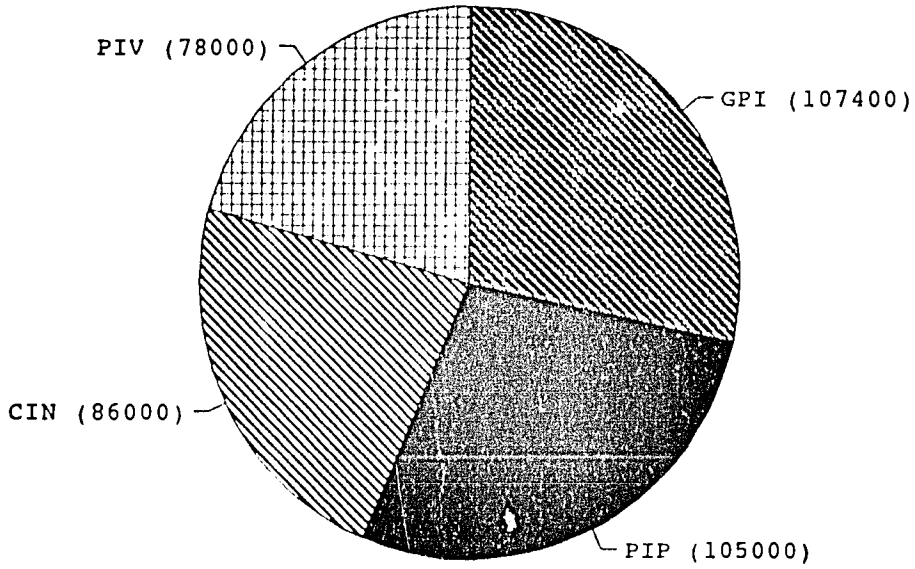
Leaving aside the complications of returns to labor because of mechanization in the irrigated systems for the moment, yield per labor hour among the unirrigated systems shows falo and waalo farming to be the most rewarding, with per-hour yields of, respectively, 160 FCFA and 140 FCFA (Table 5.34). The generally low labor returns are a result of the disastrous agricultural year, with—as noted above—out of 405 parcels cultivated, 131 or 32 percent reporting no harvest. The most affected by natural conditions, in terms of labor returns, were irrigated vegetable gardens and jeeri farms (Table 5.36).

In yield per hectare, falo exceeds waalo by almost sixfold, 220,939 FCFA as opposed to 37,772 FCFA (Table 5.34). Village irrigated perimeters, at 196,581 FCFA, are closer to falo than to waalo in per-hectare yield. As expected, on irrigated parcels that rely on heavy machinery, whether large- or middle-scale, yield per hectare is quite high: 385,436 FCFA on middle-scale perimeters and 209,508 FCFA on large perimeters, though falo returns per hectare in our sample exceeded those of the large-scale perimeters (Table 5.34 and Figure 5.8).

Largely because of the use of heavy machinery, fuel, insecticides, and herbicides, the cost of production per unit of irrigated land, for middle-scale perimeters (80,336 FCFA), large-scale perimeters (52,630 FCFA), private irrigated perimeters (37,520 FCFA), and village irrigated perimeters (35,040 FCFA) are high (see Table 5.34 and Figure 5.9). Cost of production for falo cultivation, 4,512 FCFA, exceeds those of waalo (1,836 FCFA), foonde (1,410 FCFA), and jeeri (869 FCFA). Compared to the cost of production on irrigated gardens (17,656 per hectare)—the least costly among irrigated parcels—however, falo production costs seem quite modest. As we calculate cost, it is worth noting that farmers did not report seeds that were saved from the previous year's harvest as cost.

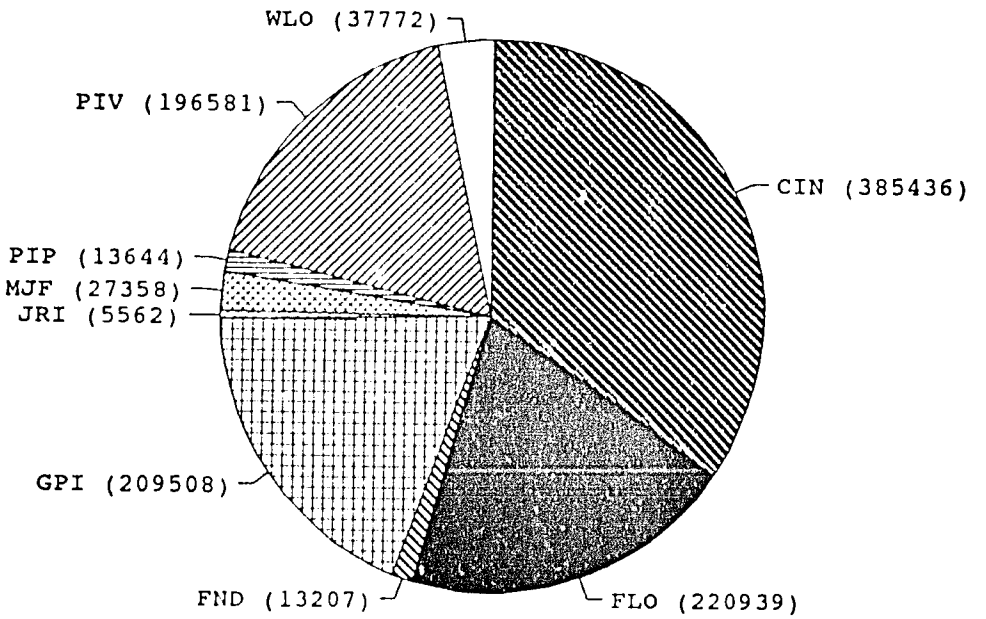
Despite the use of heavy machinery, which increases the value of labor as we have seen above, larger-scale irrigated farming is still very demanding of labor. Private perimeters reported 2,849 labor hours per hectare, middle-scale perimeters 1,531 hours, village irrigated perimeters 1,454, and large-scale perimeters 761 (Table 5.34 and Figure 5.10). As we mentioned earlier, falo gardening is very labor intensive (1,381 hours), justified by higher

Fig. 5.7. Use of Tractors by Agricultural System 1991-1992 (in FCFA)



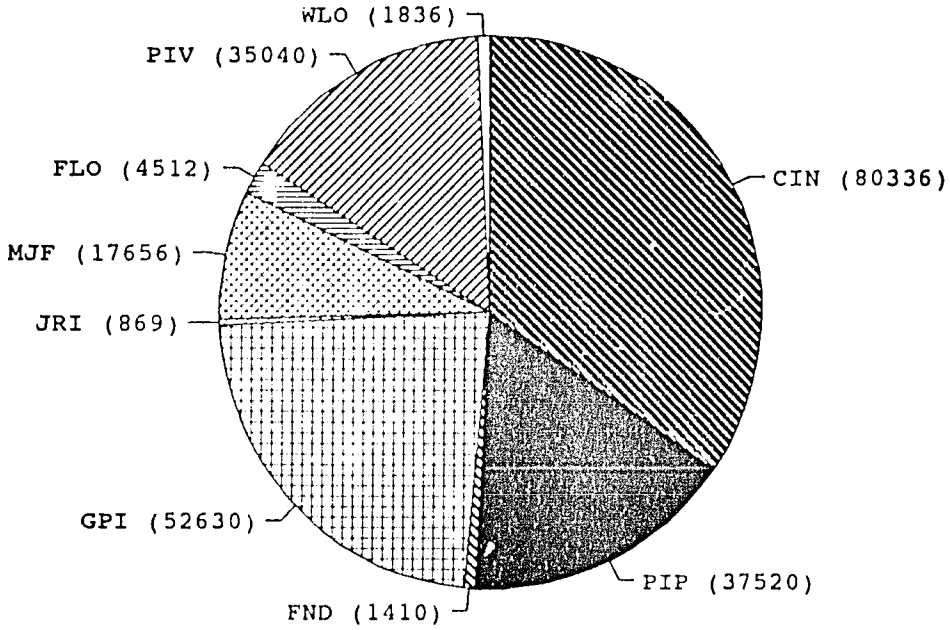
PIV	Village irrigated perimeter
GPI	Large-scale irrigated perimeter
PIP	Private irrigated perimeter
CIN	Middle-sized irrigated perimeter

Fig. 5.8. Average Yield per Hectare: 1991-1992 (in FCFA)



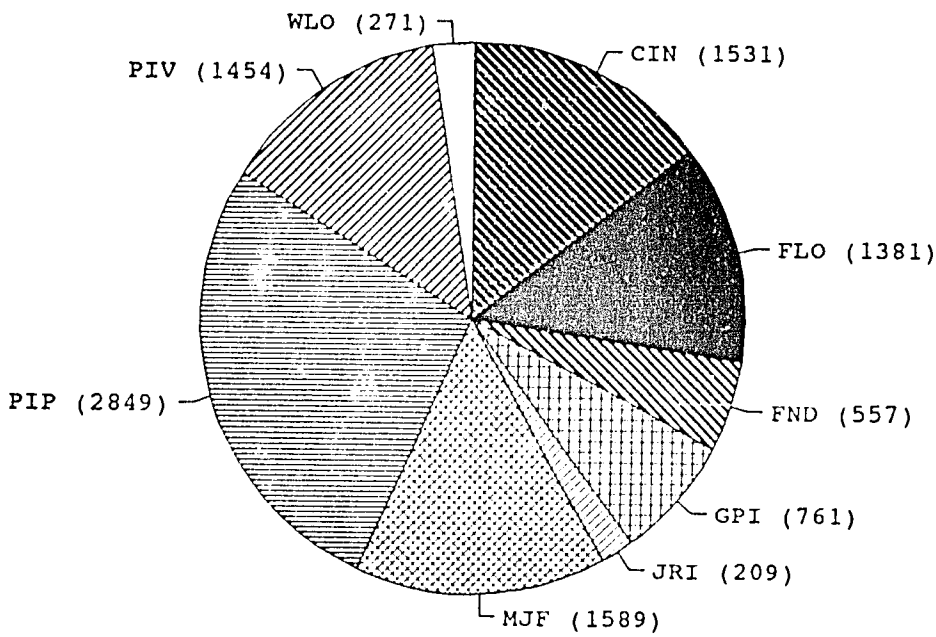
WLO	Waalo
CIN	Middle-sized irrigated perimeter
FLO	Falo
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
PIP	Private irrigated perimeter
PIV	Village irrigated perimeter

Fig.5.9. Average Expediture per Hectare
1991-1992 (in FCFA)



WLO	Waalo
CIN	Middle-sized irrigated perimeter
PIP	Private irrigated perimeter
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
FLO	Falo
PIV	Village irrigated perimeter

Fig. 5.10. Average Total Labor Hours per Hectare: 1991-1992



WLO	Waalo
CIN	Middle-sized irrigated perimeter
FLO	Falo
FND	Foonde
GPI	Large-scale irrigated perimeter
JRI	Jeeri
MJF	Irrigated vegetable garden
PIP	Private irrigated perimeter
PIV	Village irrigated perimeter

returns, especially in terms of units of land and labor. While falo gardening demands an average of 173 person/days on the basis of 8 hours per day per hectare, a little less than what is required on PIVs (182 person/days), waalo farming, among the least demanding of the systems, requires 34 person days. (Labor hours as used here are not weighted. Accordingly, 14 hours of labor, for example, is evaluated the same irrespective of age or gender.)

E. Farm Productivity: Regression Analysis

1. Methodology

a. Regression Model

A regression model was used to estimate jointly the effects of various inputs on the outputs of the farm production systems—that is, the productivity of the factors of production. The model used for this analysis is basically a Cobb-Douglas production function of the form:

$$Y = f(L^{b1}E^{b2}X^{ai})$$

where Y is output, L is labor, E is expenditure, and X is a matrix of other variables that are believed to affect productivity. In particular, our model, in logarithmic form, is:

$$\ln Y = a_1D_1 + a_2D_2 + a_3D_3 + a_4D_4 + a_5D_5 + a_6D_6 + a_7D_7 + a_8D_8 + a_9D_9 + b_1\ln L + b_2\ln E,$$

where:

- Y is the value of the harvest per hectare, in FCFA;
- D_i is a dummy variable representing production space i (i = 1,2,...,9);
- L is the number of labor hours per hectare;
- E is the value of expenditures per hectare, in FCFA; and
- a_i, b_1, and b_2 are coefficients to be estimated statistically.

As this equation is in log form, the coefficients of labor and expenditure (b_1 and b_2) are usually interpreted as the elasticities of their respective inputs with respect to the outputs, that is, the relative impact on production of increasing the particular input by a small amount.

b. The Sample

The basic sample consists of observations from individual parcels of land, as reported on the survey questionnaires. For each plot, the output, Y_i, is the sum of all crops harvested on that plot, with each crop valued at the average FCFA price per kilogram for farm sales of that crop as reported in the sample survey. Labor is measured by the number of hours of labor, weighted by age/sex group, worked on that parcel to produce that crop. Expenditures are payments reported for any other inputs (seed, chemicals, traction rental, etc.) for that crop on that parcel.

Separate regressions were run for three production systems: irrigation, falo, and waalo, with irrigation including large, intermediate, and village irrigated perimeters. We used only parcels for which we had information on size of the parcel and hours of labor input. In the first case, output information cannot be compared without adjusting for parcel size. (Quality of the parcels' land, which also affects output, is to some extent captured in the PS, where location affects soil quality, and the type of system, whether floodplain, riverbank, or irrigation perimeter.)

As for labor, the absence of information on labor input implies errors in the data collection. Even if it is possible to imagine an agricultural crop growing from seeds dropped or blown onto the land without human labor, gathering the harvest requires some human activity, which should have been reported.

Expenditures, too, were not greater than zero in all instances: 19 falo, 23 waalo, and 11 irrigated parcels were listed with zero expenditure. Although this might occasionally be caused by nonreporting error, cash expenditures are not always required. Seed from the household's stocks, tools owned by the household, and labor can be combined with land to provide a harvest without cash expenditure in the reporting period. We did not have enough information to adjust for the opportunity cost of seed (using it for consumption or sale, for example, instead of for planting) or the value of depreciation of agricultural implements. Expenditure thus is a proxy for a better measure of (non-land) capital, but zero expenditure is not considered sufficient grounds for excluding the parcel in the regressions.[6]

Parcels that had zero harvests in the research period were excluded from the samples, however. Largely because of the unfavorable conditions of rainfall and flood, or, in the case of irrigation, insufficient labor, water, and/or capital to continue working the plot, a substantial number of parcels fell into this category and thus are not part of the samples analyzed here.[7] The dependent variable, Y, therefore contains only positive values.

The resulting sample sizes for the three systems are: irrigation, 65; falo, 47; and waalo, 82. We ran the regression equations with ordinary least squares.

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[6] We did run regressions on the three production systems excluding parcels with zero expenditure with results, discussed below, that produced higher R^2s (coefficients of determination) than the selected set of regressions.

[7] These included 49 of the 243 parcels from which usable reports were filed: 16 irrigation, 8 falo, and 25 waalo. A value of zero is not theoretically allowable for the dependent variable in this form of the production function. Time did not allow us to work with different forms of the equations, but future analysis may be able to utilize some of the data omitted from these samples. (For the independent variables, because our resources precluded trying other transformations of the equations, the problem of getting the logarithms of observations with zero expenditure was resolved by using very small numbers.)

2. Results

Results of the three regressions are given in Table 5.40. With only one exception (PS 7 for waalo), in each system, the coefficient for each production space in the sample for that system is significantly different from zero: location matters in explaining how good or poor the harvest will be. In this study, not only does location (PS) capture some of the variations in soil quality, it also reflects noticeably different experiences with weather and flood conditions. Chapter III presents some qualitative evidence of this.

Table 5.40. Regression Output: Irrigation, Falo, and Waalo

Irrigation

Constant:	0
Standard Error of Y Estimate:	0.866
R Squared:	0.438
Number of Observations:	65
Degrees of Freedom:	56

	Ps1	Ps2	Ps3	Ps4	Ps5	Ps6	Ps7	Exp/ha	Lb/ha
X Coefficients	5.19	7.19	5.84	7.57	7.04	6.43	6.05	0.00	0.75
Std Err. of Coef.	1.71	1.46	1.51	1.44	1.35	1.65	1.50	0.01	0.20

Falo

Constant:	0
Standard Error of Y Estimate:	1.236
R Squared:	0.540
Number of Observations:	47
Degrees of Freedom:	39

	Ps1	Ps2	Ps3	Ps4	Ps6	Ps7	Exp/ha	Lb/ha
X Coefficients	9.14	8.35	7.66	8.73	9.87	6.11	-0.03	0.49
Std Err. of Coef.	1.28	1.06	1.69	1.25	1.61	1.30	0.03	0.17

Waalo

Constant:	0
Standard Error of Y Estimate:	1.419
R Squared:	0.298
Number of Observations:	82
Degrees of Freedom:	75

	Ps3	Ps4	Ps6	Ps7	Ps8	Exp/ha	Lb/ha
X Coefficients	6.64	7.31	7.98	2.50	7.43	-0.03	0.55
Std Err. of Coef.	0.85	0.66	0.81	1.63	0.78	0.02	0.13

For each of the three production systems, the coefficient for labor hours is significantly greater than zero. In none of the three equations is the coefficient for expenditure per hectare significantly different from zero. The explanation for this is not obvious. Nonreporting, and our inability to include opportunity costs for noncash expenditures (other than labor) may help to account for it. As indicated in footnote 6, when we exclude the parcels that reported no expenditures, the regressions fit the data better. The coefficient for expenditure per hectare for plots in irrigated perimeters remains positive and becomes significantly nonzero. The coefficient for expenditure for waalo becomes positive but is still not significantly different from zero. The expenditure coefficient for falo does not improve, remaining negative and not significantly different from zero.

The three R^2s give some idea of how much of the variation among parcels is explained by the independent variables we used. For irrigation, this is about 44 percent; for falo, 54 percent; and for waalo, 30 percent. What is unexplained (56 percent for irrigation, 46 percent for falo, 70 percent for waalo) must be attributed to other factors that we have been unable to quantify. The large value of unexplained variation for waalo might, in this period, mark the particularly serious uncertainty about whether, when, and how much the flood would be, which had consequential effects on farmers' decisions about when and where to plant in the floodplain. The outcomes of their activities often depended on what seemed like arbitrary decisions about the "controlled" flood: different waalos received the right amount of water at the right time, no water or too little water, repeated floods that washed away seeds, or water that arrived after the planting season (see Table 5.13).

In summary, the samples provide strong evidence that the amount of labor available for work in all three agricultural systems is important for yield per hectare. A parcel's location is also a key determinant of its productiveness. And finally, the ability to rely on a reasonable flood at a reliable time might reduce the wide variation in waalo harvest.

VI. HOUSEHOLD DIVISION OF LABOR, LABOR ALLOCATION STRATEGIES, AND IMPLICATIONS FOR FUTURE DEVELOPMENT

A. Introduction

Irrigation remains the centerpiece of development thinking in the Senegal River Valley as expressed in the master document for the region, the PDRG (Plan Directeur de Développement Integré pour La Rive Gauche de la Vallée du Fleuve Sénégal). Irrigation is intended not only to assure food self-sufficiency in the area, but also to contribute to food security in the country as a whole (GERSAR-CACG 1991:8-9). Accordingly, the PDRG calls for the expansion of irrigation to 98,500 ha by the year 2015: 88,000 ha for "des exploitation familiales" and 10,500 ha for "entreprises agricoles, essentiellement céréales et polyculture, et l'agrobusiness (canne à sucre et tomate)" (ibid.:219-220). Although it acknowledges the high rate of migration from the area, the PDRG does not anticipate difficulty in generating the required labor for such an expansion as it assumes the presence of high labor potential: "malgré l'importance de l'émigration des actifs, le potentiel de main d'oeuvre est élevée, et les agriculteurs locaux sont demandeurs d'attributions de terres irriguées" (ibid.:9).

In this chapter, labor allocation and the division of labor are examined at the household level. The data pertain to the sample of 331 households followed over a 12-month period, from August 1991 to July 1992. In this context, the various types of households are not differentiated by overall income, but the division of labor is examined with respect to age, gender, and caste. Field data reveal that, of the factors of agricultural production, labor and capital are the scarcest resources in the Middle Valley. Furthermore, among the agricultural systems practiced in the area (dryland farming, recession cultivation, and irrigation), irrigation is the most demanding of both labor and capital. Age and gender division of labor is explored here in terms of the amount of time households spend on daily chores, with the results presented as average labor hours per day and per year. Agricultural work is seasonal, however. A lull in productive activities in some periods of the year should not mask the intensity of labor during peak times, as seen in Chapter V. The questions raised are: (1) how realistic is the PDRG's assumption that labor is widely available in the region? (2) if it is not, how are the extra labor demands likely to be met by the society?

Data on the household division of labor by age and gender were collected and analyzed in three sectors of activity: agricultural, nonagricultural, and domestic. In addition, a fourth category, "diverse," subsumes social and ceremonial activities such as visits, weddings and baptisms, and travel, as well as time spent away from the village for other personal reasons such as illness or schooling.

B. Agricultural Activities

Two different sets of data on agricultural activities were collected. Farm-level data, referring specifically to agricultural field tasks, were gathered on a subsample of households on a biweekly basis during the course of each production cycle. A second data set on household

agricultural labor was collected throughout the year on a monthly basis, and it is these data that are summarized below. This information was solicited in a 24-hour recall period and involved the entire sample of 331 households. The labor data presented below involve all agricultural production systems in the study zones (recession, rainfed, irrigation).

1. Age and Gender in Agriculture

Table 6.1 shows total labor hours by activity, age group, and gender. Figure 6.1 summarizes this information, illustrating differential levels of labor input by gender and age group. In all age groups, men spend more hours in agricultural activities than women. For both men and women, the most active age group is that between 15 and 45. While men in this age group spend a total of 199,978 labor hours, women spend 154,737 or about 77.4 percent of the hours spent by men. These are followed by children aged 8-14: boys of that age group spend 134,209 hours on agricultural activities, while girls spend 59,459, or slightly less than one-half (44.3 percent) the time spent by boys. The greatest difference in terms of total agricultural labor hours between men and women is in the age group 61 and above. While men in this age group spend 52,117 total hours, women spend 7,581, or 14.5 percent those of the men. In terms of total labor time invested by both females and males, the largest number of hours were spent in guarding, planting, and weeding and hoeing, with harvesting and land preparation following.

Table 6.2 shows the percentage of total time that each age and gender group spends on the various agricultural activities. Among males of all age groups, the largest proportion of time was spent in weeding and hoeing, guarding, and planting. Among women, labor was allotted primarily for planting, guarding, and harvesting. Among children of age 0-7, boys spend 32.1 percent of their total labor time on guarding, while girls of the same age spend 54.3 percent; the difference between boys and girls in the proportion of guarding time is compensated for by boys' spending a larger proportion of their time in weeding/hoeing (33.5 percent) than girls (4.8 percent). Both boys and girls are active in planting (20.4 and 15.9 percent). The proportion of time children spend in planting is a reflection of the communal nature of this task, which is carried out simultaneously by several household members. After adult men and women dig and plant the seed in jeeri and waalo fields, children complete the task by covering the planted holes with sand.

Table 6.1. Total Agricultural Activities by Age and Gender: 1991-1992 (number of hours)

Activity	Male						Female						Total
	0-7	8-14	15-45	46-60	61+	Total Male	0-7	8-14	15-45	46-60	61+	Total Female	
Land Preparation	1,059	12,238	21,611	5,167	6,778	46,853	140	2,072	6,400	1,992	517	11,121	57,974
Nursery Preparation	0	337	2,319	168	702	3,526	0	87	187	253	168	695	4,221
Planting	4,052	26,975	30,526	10,240	7,416	79,209	1,675	16,707	34,862	5,984	999	60,227	139,436
Replanting	0	197	147	372	0	716	0	173	478	557	0	1,208	1,924
Fence Constr.	441	5,262	7,435	2,476	2,318	17,932	122	166	1,100	1,390	84	2,862	20,794
Weeding/hoeing	6,644	35,148	59,970	12,599	9,656	124,017	505	1,448	5,381	611	399	8,344	132,361
Irrigation	56	2,377	9,675	4,279	4,338	20,725	388	3,447	24,058	1,500	168	29,561	50,286
Fertilization	0	197	756	239	0	1,192	0	0	0	0	0	0	1,192
Transplanting	0	4,015	3,407	856	241	8,519	281	3,326	7,626	736	28	11,997	20,516
Weeding	533	5,718	8,352	1,941	2,218	18,762	253	6,189	11,853	983	337	19,615	38,377
Guarding	6,362	27,351	30,218	8,714	11,977	84,622	5,710	14,093	30,090	8,337	1,824	60,054	144,676
Harvesting	262	10,676	15,298	4,153	4,661	35,050	1,334	8,673	22,368	4,347	2,720	39,442	74,492
Threshing	91	1,717	3,815	1,048	421	7,092	0	1,516	4,127	1,376	253	7,272	14,364
Transport	183	744	1,026	722	0	2,675	112	709	2,858	942	0	4,621	7,296
Other	140	1,257	5,423	1,274	1,391	9,485	0	853	3,349	1,151	84	5,437	14,922
Subtotal	19,823	134,209	199,978	54,248	52,117	460,375	10,520	59,459	154,737	30,159	7,581	262,456	722,831
Percent	2.7	18.6	27.7	7.5	7.2	63.7	1.5	8.2	21.4	4.2	1.0	36.3	100

Fig. 6.1. Agricultural Labor Input
By Gender and Age

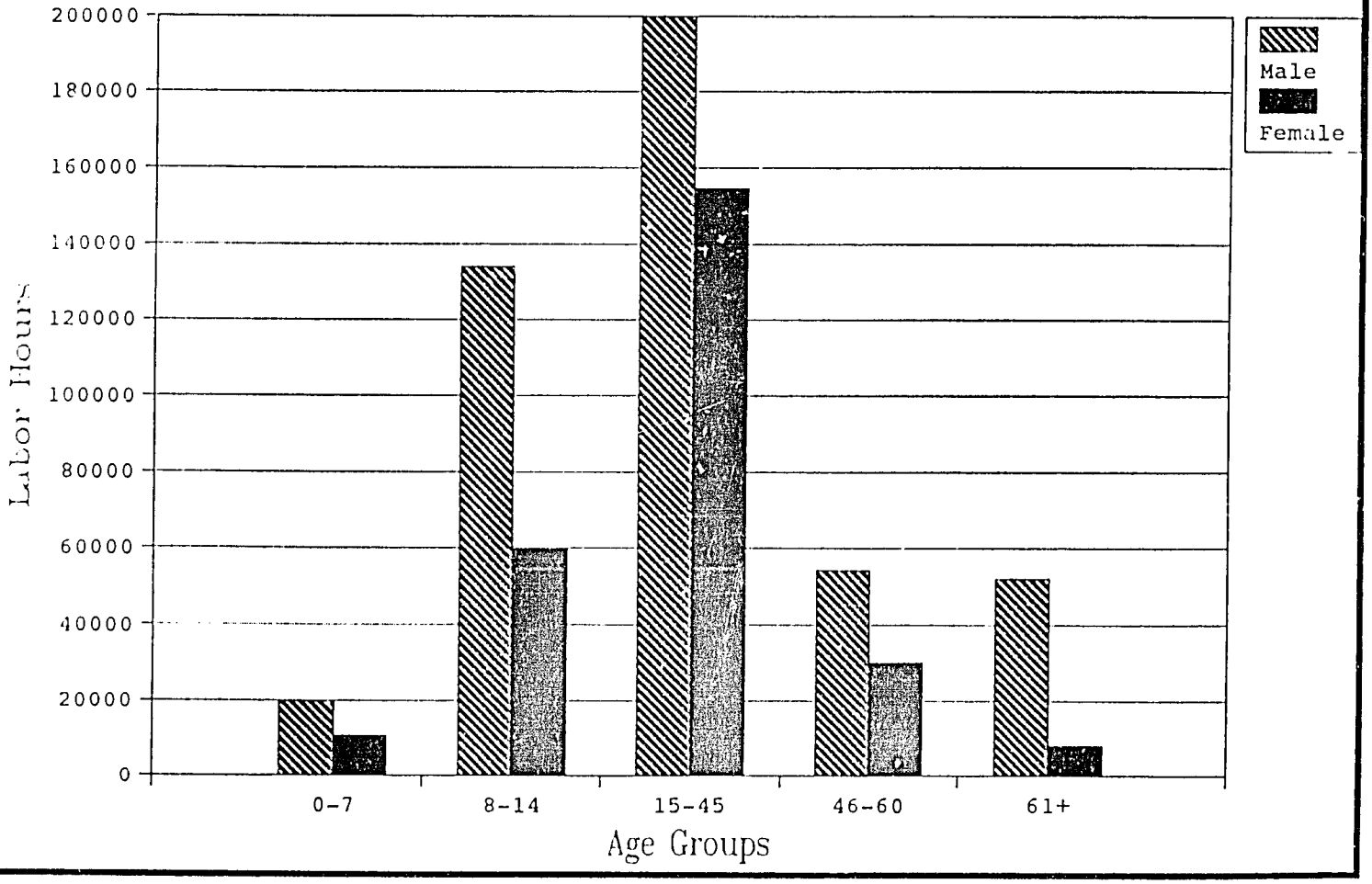


Table 6.2. Percentage of Agricultural Labor Hours by Age and Gender: 1991-1992

Activity	Male					Female				
	0-7	8-14	15-45	46-60	61+	0-7	8-14	15-45	46-60	61+
Land Preparation	5.3	9.1	10.8	9.5	13.0	1.3	3.5	4.1	6.6	6.8
Nursery Preparation	0.0	0.3	1.2	0.3	1.3	0.0	0.1	0.1	0.8	2.2
Planting	20.4	20.1	15.3	18.9	14.2	15.9	28.1	22.5	19.8	13.2
Replanting	0.0	0.1	0.1	0.7	0.0	0.0	0.3	0.3	1.8	0.0
Fence Constr.	2.2	3.9	3.7	4.6	4.4	1.2	0.3	0.7	4.6	1.1
Weeding/hoeing	33.5	26.2	30.0	23.2	18.5	4.8	2.4	3.5	2.0	5.3
Irrigation	0.3	1.8	4.8	7.9	8.3	3.7	5.8	15.5	5.0	2.2
Fertilization	0.0	0.1	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Transplanting	0.0	3.0	1.7	1.6	0.5	2.7	5.6	4.9	2.4	0.4
Weeding	2.7	4.3	4.2	3.6	4.3	2.4	10.4	7.7	3.3	4.4
Guarding	32.1	20.4	15.1	16.1	23.0	54.3	23.7	19.4	27.6	24.1
Harvesting	1.3	8.0	7.6	7.7	8.9	12.7	14.6	14.5	14.4	35.9
Threshing	0.5	1.3	1.9	1.9	0.8	0.0	2.5	2.7	4.6	3.3
Transport	0.9	0.6	0.5	1.3	0.0	1.1	1.2	1.8	3.1	0.0
Other	0.7	0.9	2.7	2.3	2.7	0.0	1.4	2.2	3.8	1.1
Subtotal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

2. Caste and Agriculture

Are there any correlations between involvement in agriculture and caste affiliation? Table 6.3 shows the total number of hours that people of different caste groups devote to agricultural activities, by age and gender.

The first column shows the different age groups by gender. We see, for example, that the Toorobbe spend the most hours on agricultural activities (253,265), followed by the Maccube (163,637), Subalbe (112,262), and Fulbe (96,615). These figures depend in large part on the potential labor available within each caste, however, and we know that the castes are not represented equally in our sample (or in the population as a whole). Tables 6.4 and 6.5 show the number of people recorded during our household survey. Table 6.4 shows the total number, both present and absent, who were reported as household members at the time of the household survey. Table 6.5 counts only those individuals who were reported as present—in other words, the potential labor available.

Table 6.3. Total Agricultural Labor Hours by Age, Gender, and Caste

Age/Gender	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	Total
Male: 0-7	2,756	6,193	225	0	983	2,826	6,308	533	19,823
8-14	11,862	55,512	4,265	8,980	15,143	6,570	29,964	1,913	134,209
15-45	27,902	69,787	11,348	11,032	30,241	5,692	41,532	2,445	199,978
46-60	12,236	13,924	1,795	5,435	3,861	2,424	14,095	477	54,248
61+	7,839	23,097	1,263	1,095	6,809	2,598	9,415	0	52,117
Female: 0-7	274	2,465	321	0	3,847	459	2,370	784	10,520
8-14	8,625	16,568	990	2,770	9,677	3,315	15,800	1,713	59,459
15-45	21,031	53,881	281	4,093	30,369	7,214	37,092	774	154,737
46-60	3,663	9,032	0	183	9,720	2,843	4,634	84	30,159
61+	428	2,806	0	0	1,614	309	2,425	0	7,581
Total	96,615	253,265	20,487	33,588	112,262	34,250	163,637	8,724	722,831
Percent	13.4	35.0	2.8	4.6	15.5	4.7	22.6	1.2	100

Table 6.4. Number of People in Household Sample by Age, Gender, and Caste (Present and Absent): 1991

Age/Gender	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Male: 0-7	90	137	9	10	30	53	100	7
8-14	50	91	10	10	21	29	61	10
15-45	149	269	41	16	68	84	155	11
46-60	22	29	5	5	7	18	34	2
61+	26	47	5	2	9	11	22	1
Female: 0-7	109	145	20	8	35	27	81	7
8-14	51	88	11	11	24	32	67	1
15-45	148	262	24	13	71	89	155	9
46-60	23	49	10	4	15	14	21	1
61+	23	33	2	0	4	9	22	2
Total	691	1,150	137	79	284	366	718	51

Table 6.5. Number of People in Household Sample by Age, Gender, and Caste (Present): 1991

[Potential Labor Availability]

Age/Gender	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Male: 0-7	81	113	6	10	30	45	95	5
8-14	40	80	8	9	21	23	53	8
15-45	78	137	17	7	33	22	81	7
46-60	19	22	3	5	7	9	23	1
61+	24	38	4	2	7	10	17	1
Female: 0-7	96	131	16	8	32	25	78	6
8-14	48	78	9	10	24	27	66	1
15-45	129	222	17	13	68	71	138	4
46-60	22	45	10	4	15	14	19	1
61+	21	32	2	0	4	9	22	1
Total	558	898	92	68	241	255	592	35
Percent	20.3	32.8	3.4	2.5	8.8	9.3	21.6	1.3

Because the Toorobbe and Maccube are the most numerous in both the overall sample (Table 6.4) and among those present (Table 6.5), it is not surprising that they spend the most number of hours on agricultural activities. To make the figures comparable we calculated the average labor expended per person by age, gender, and caste for the potential labor available (Table 6.6).

Table 6.6 and Figure 6.2 show average annual agricultural labor per person by caste affiliation. The average per person is highest among the Sebbe (494 hours per person), with the Subalbe (466 hours) second. The next two groups with high hours of agricultural activity are the Toorobbe (282) and the Maccube (276 hours). Least active in terms of agricultural labor per person are the Nyeenybe (134 hours), who invest in agriculture only half the hours of the average for all castes (264).

Gender variation exists among castes in the degree of involvement in agricultural activities. Figure 6.3 shows the variation among the four caste groups most actively engaged in agricultural activities: the Sebbe, Subalbe, Toorobbe, and Maccube. While Sebbe men in the 15-45 age group are the most intensively engaged in agriculture among the four groups, Sebbe women in this age group are only slightly more active than the two least active of the four, the Maccube and Toorobbe, and considerably less active than the Subalbe. Among the smaller castes, cell numbers are quite low, and the variations might not be significant. We cannot say what the situation might be like for Sebbe women over 60, for example, since there are none

Table 6.6. Average Agricultural Labor Hours Per Person Present, by Age, Gender, and Caste

Age/Gender	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	Total
Male: 0-7	34	55	37	0	33	63	66	107	51
8-14	297	694	533	998	721	286	565	239	555
15-45	358	509	668	1,576	916	259	513	349	524
46-60	644	633	598	1,087	552	269	613	477	610
61+	327	608	316	548	973	260	554	0	506
Female: 0-7	3	19	20	0	120	18	30	131	27
8-14	180	212	110	277	403	123	239	1,713*	226
15-45	163	243	17	315	447	102	269	194	234
46-60	166	201	0	46	648	203	244	84	232
61+	20	88	0	0	404	34	110	0	83
Subtotal	173	282	223	494	466	134	276	249	264

* In the category "other," one girl is reported to work 1,713 hours, as opposed to 239 hours on average for eight boys. This may be a statistical aberration involving either an unusual individual or a reporting or recording error.

in the sample. We are able only to speculate, at this point, about the causes of such gender differentiation. One possible explanation is that Subalbe women work on falo plots which are, as we have seen earlier, very labor intensive.

Figure 6.4 compares average annual agricultural labor input among females aged eight and over, by age group and caste. Subalbe women are the most active, irrespective of age group. The most striking difference that we see is between Sebbe and Subalbe women of the age group 46 to 60. While a Subalbe woman of this age group works an average of 648 hours, a Sebbe woman works an average of 46 hours. We might speculate that this could be a function of the elite status of Sebbe women which might prevent older women from being as involved in field activities as the lower-status Subalbe women. However, Toorobbe women, who are of at least equally high status as the Sebbe, spend four times as many hours as the Sebbe and only slightly less time (201 vs. 244) than the Maccube, a low-status group.

Figure 6.5 compares average annual agricultural labor input among men from age eight on. Except for the age group 61 and older, Sebbe men spend, on average, the most hours on agricultural activities, especially the age group 15-45. The small difference that we see between Maccube and Toorobbe men is similar to that found among women of the two castes, except that here it is the Toorobbe men who work almost as long (ages 15-45) or longer (ages 8-14 and 46 and over). This could be explained by the characteristics of the agricultural year 1991-1992, when the jeeri season was a disaster and flood coverage uneven. With less usable land available, owners—more likely to be Toorobbe than Maccube—would have had an incentive to cultivate their available land themselves, rather than assigning it to others. If this is the case,

Fig.6.2. Average Agricultural Labor
Hours per Person by Caste

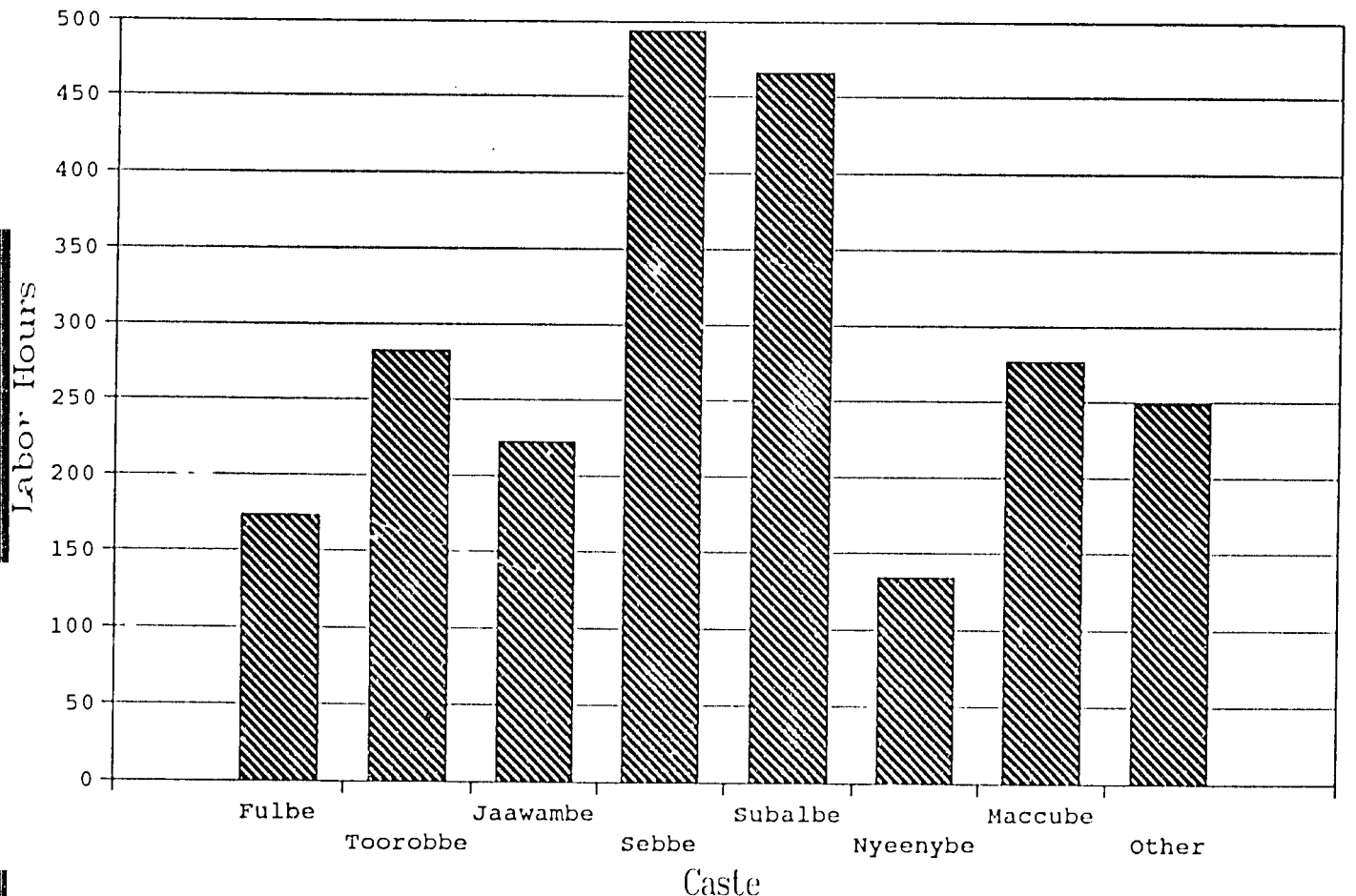


Fig. 6.3. Average Annual Agricultural Labor for Four Groups by Age and Gender

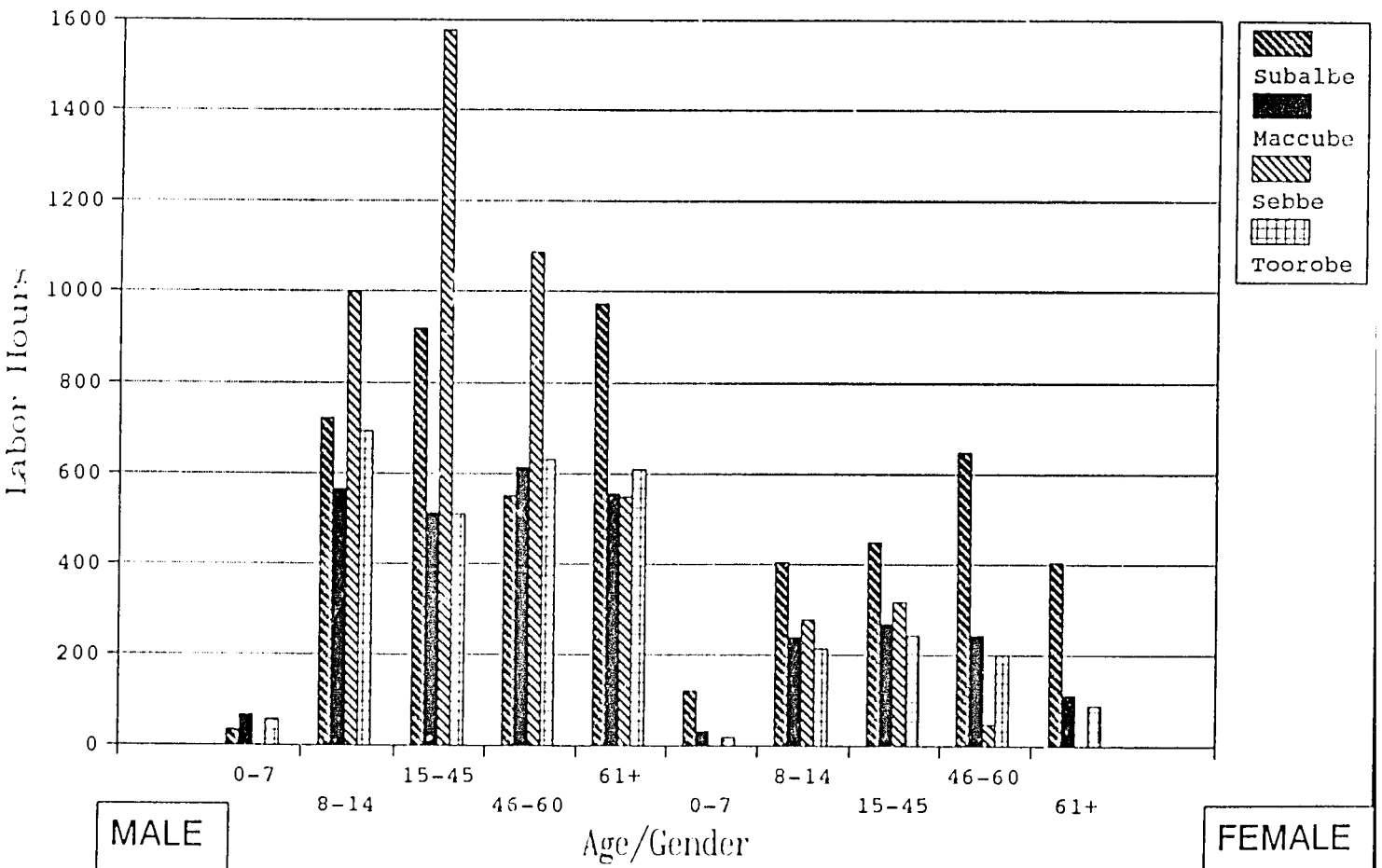


Fig. 6.4. Average Female Annual
Agricultural Labor by Caste

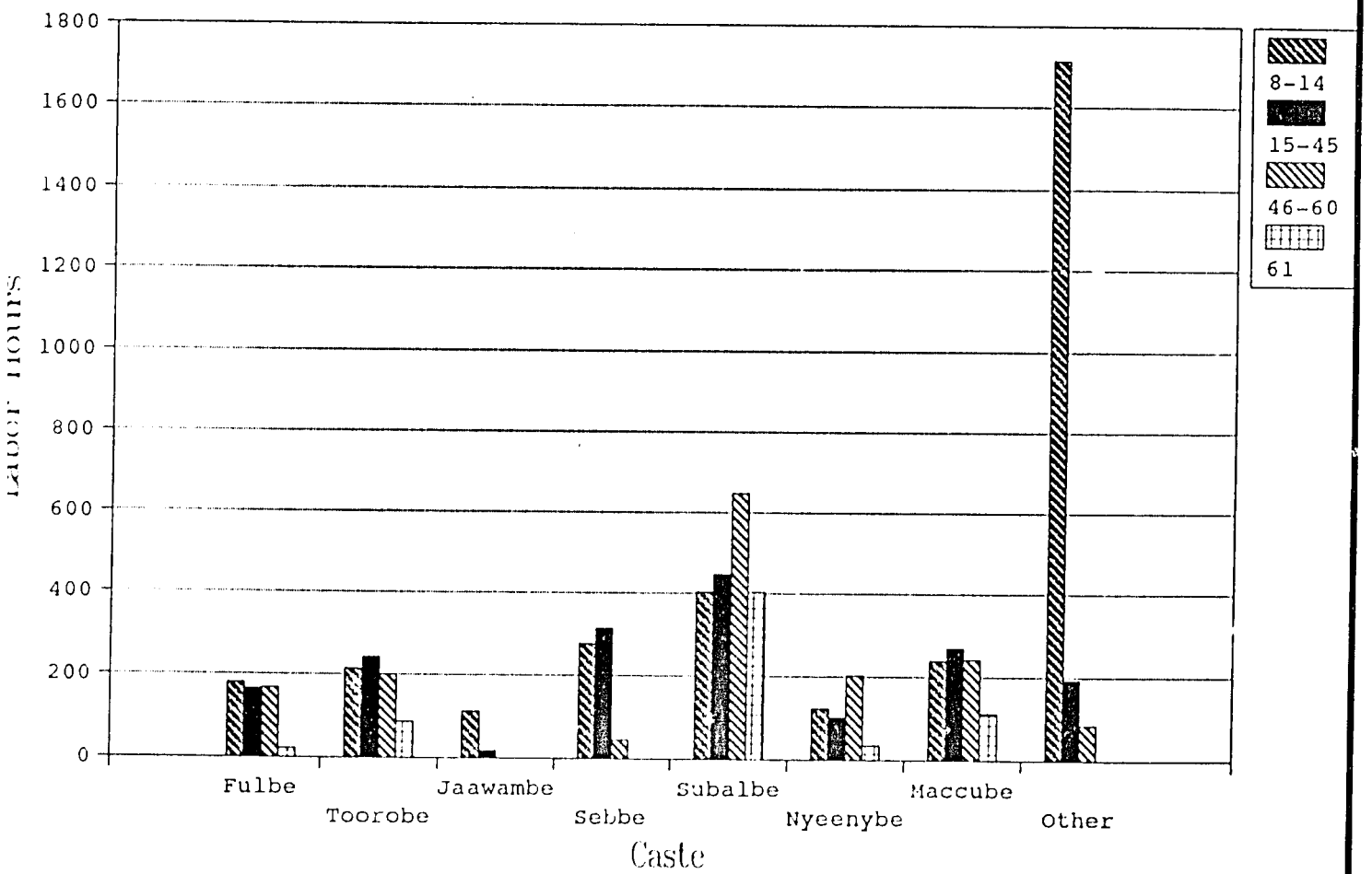
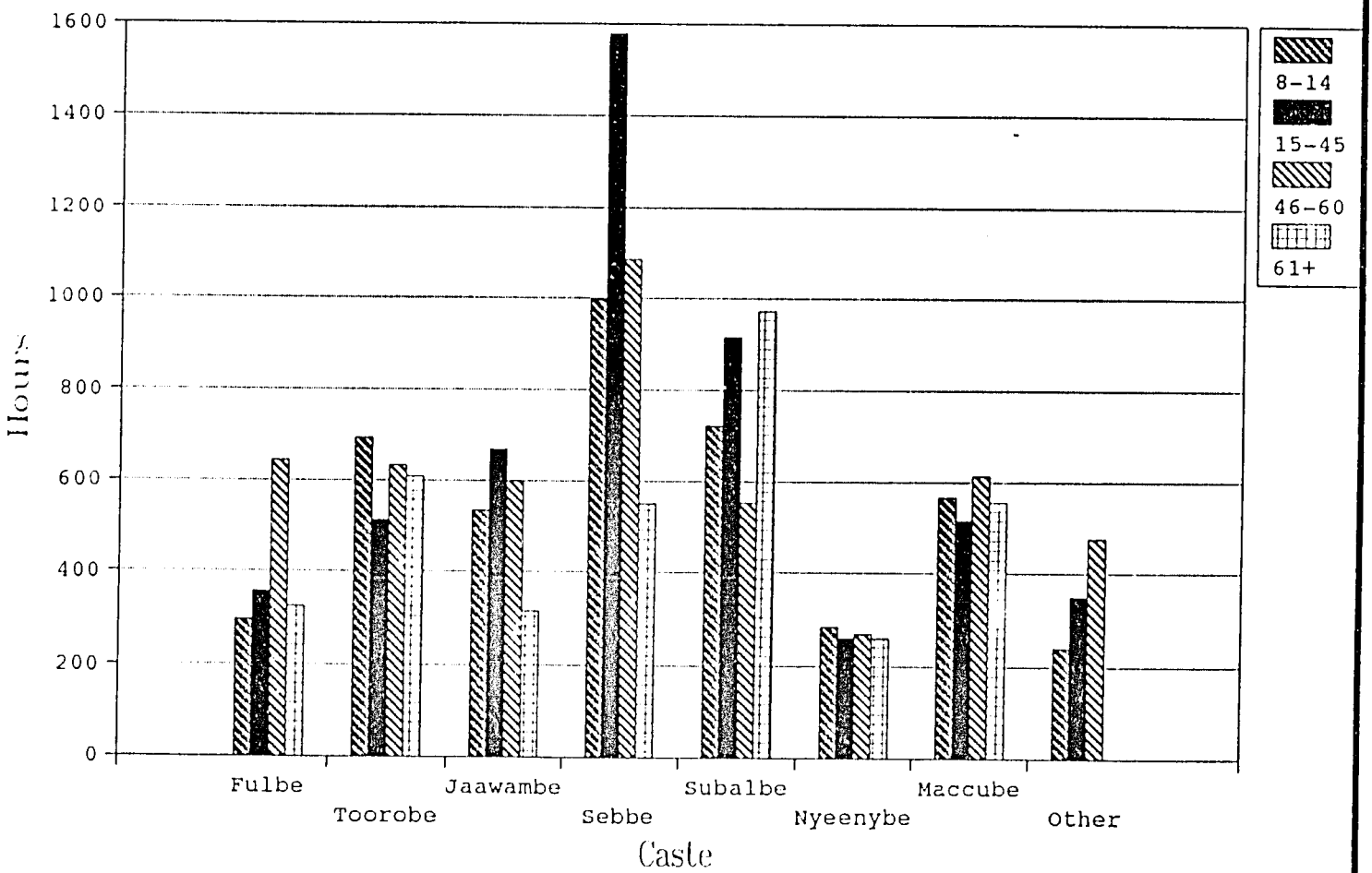


Fig. 6.5. Average Male Annual
Agricultural Labor by Caste



in normal years, Maccube men and women would be expected to be more heavily engaged in agricultural activities, increasing the gap that we see among women of the two groups and perhaps reducing the proportion of time that Toorobbe men spend in the field as compared to Maccube men.

Figure 6.6 compares average annual agricultural labor hours for men and women in the age groups 15-45 and 46-60, by caste. A most striking observation within the 15-45 age group is the big gender variation between Sebbe (1,576 vs. 315) and Jaawambe (668 vs. 17) men and women. For Subalbe, Fulbe, Maccube, Nyeenybe, and Toorobbe men and women of this age group the gaps are smaller. For the 46-60 age group, as in the younger group, the most striking differences are between Sebbe (1,087 vs. 46) and Jaawambe (598 vs. 0) men and women. Subalbe women of this age group spend more time in agricultural activities than their men, but only slightly (648 vs. 552 hours).

Figure 6.7 compares average annual agricultural labor for children from birth to 14. Except for the category "other," which consists of 20 children (Table 6.5), boys of the age group 8 to 14 spend the most hours on agricultural activities, followed by girls of the same age group.[1] As among the men, Sebbe boys (8-14) are the most active among the castes. The very youngest boys and girls (0-7) do not perform much agricultural labor in any caste, and among the Sebbe in the sample they do not participate at all. This might explain, at least partially, the heavy involvement of Sebbe males 8-60, since entire age/gender categories do not participate at all in the agricultural sector (boys and girls from 0 to 7) or participate very little (women 46-60).

3. Seasonal Agricultural Activities

Spread over a twelve-month period, the hours dedicated to agricultural work (as collected once a month on the basis of a 24-hour recall) can give a false impression of a leisurely pace of work, with an implication of more than an adequate supply of labor at hand for labor-intensive activities. Agricultural activities are exceedingly seasonal, however, and a labor force that might seem to have little to do in one season is likely to be stretched to its limits in another.

To be sure that misunderstandings are not generated, we follow the preceding discussion of hours spent on agricultural activities with a summary presentation of the 1991-1992 farm labor data. Table 6.7 and Figures 6.8 and 6.9 present total and average labor hours per household, from data collected on a bimonthly basis, for a particular season and from a subsample only.

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[1] In the category "other," one girl is reported to work 1,713 hours, as opposed to 239 hours on average for eight boys. This may be a statistical aberration involving either an unusual individual or a reporting or recording error.

Fig. 6.6. Average Annual Agricultural Labor by Caste: Men and Women 15-60

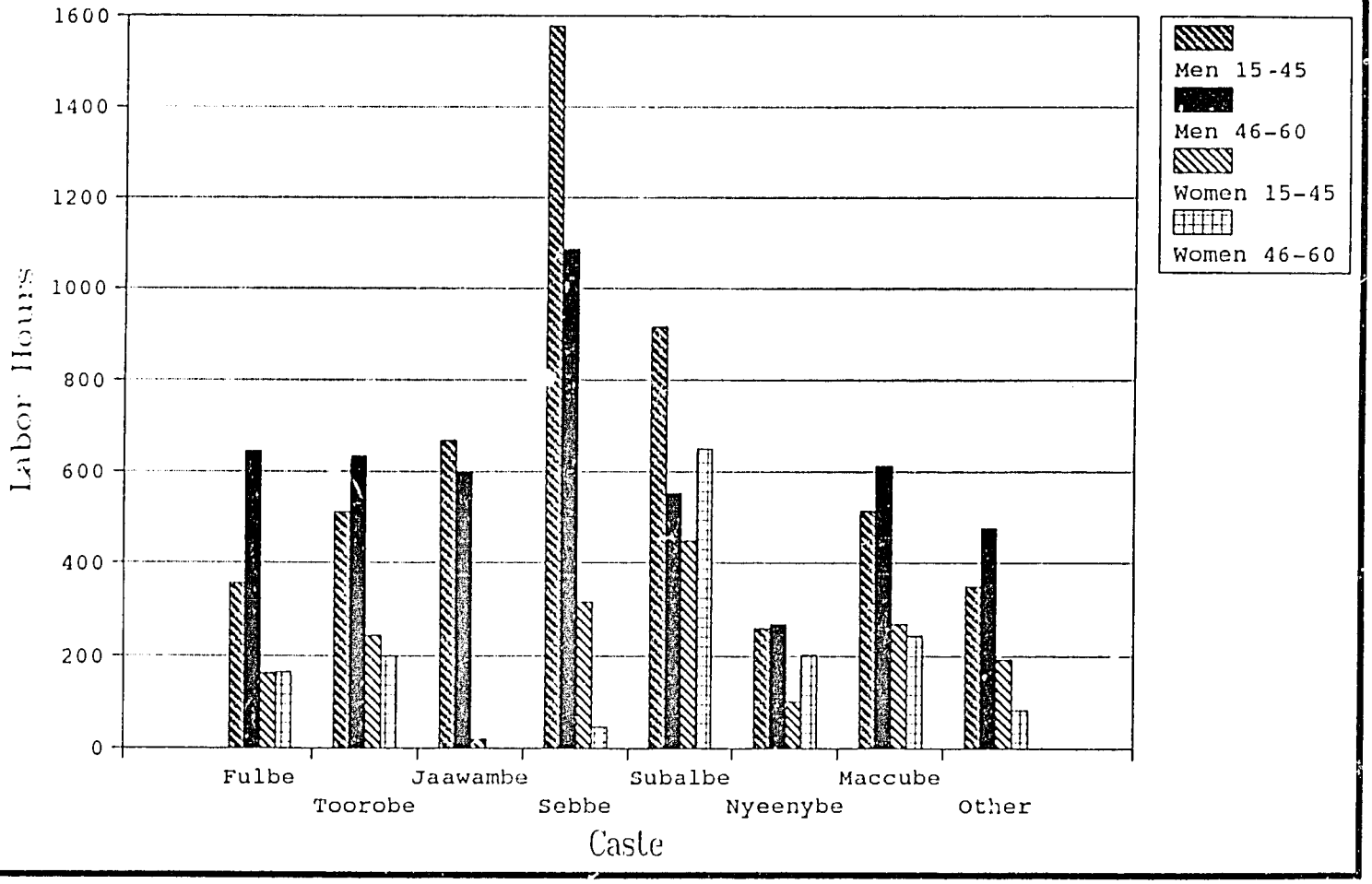


Fig. 6.7. Average Boys and Girls Annual Agricultural Labor by Caste

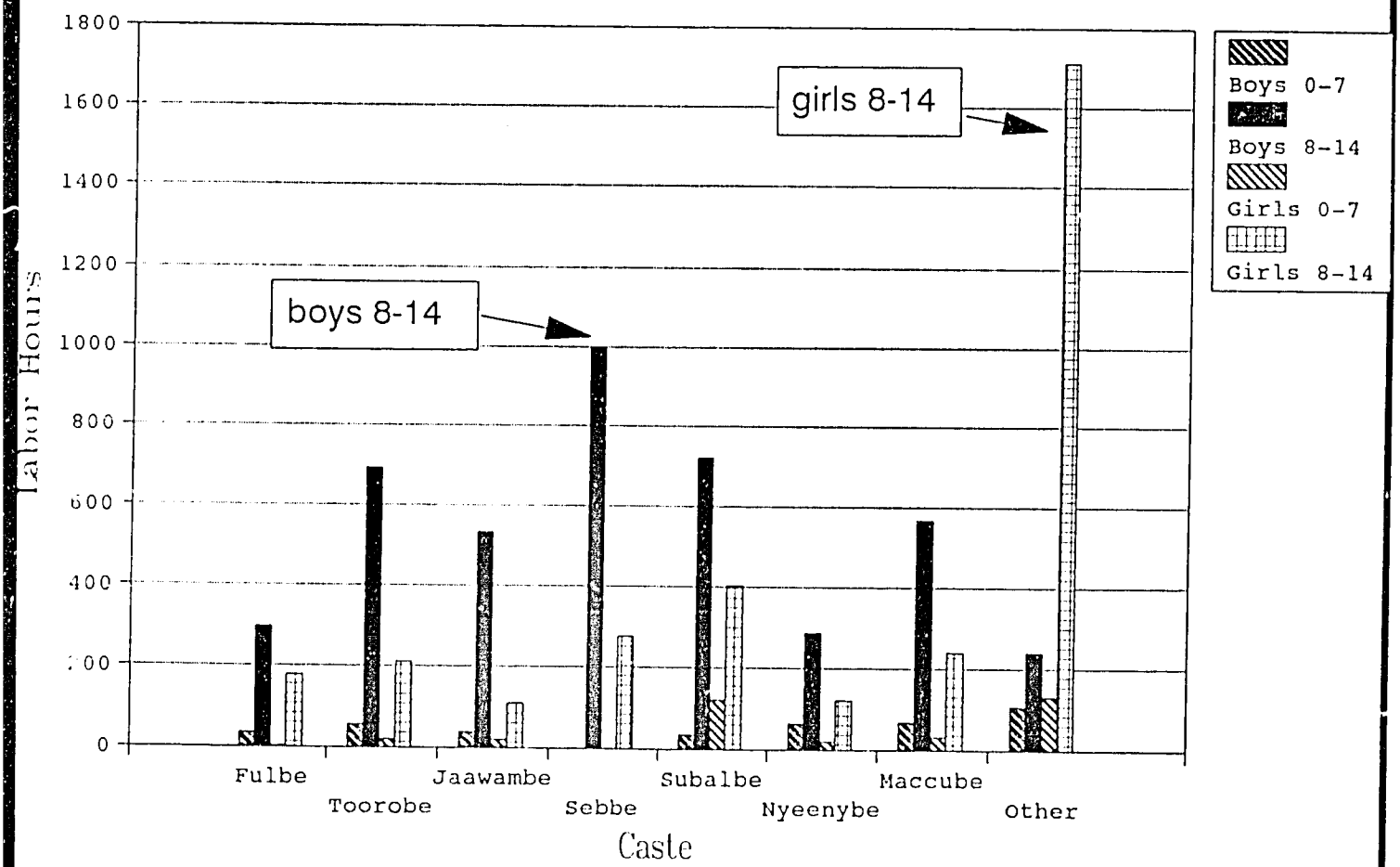


Table 6.7. Total and Average Labor per Household for Farming Households: 1991-1992

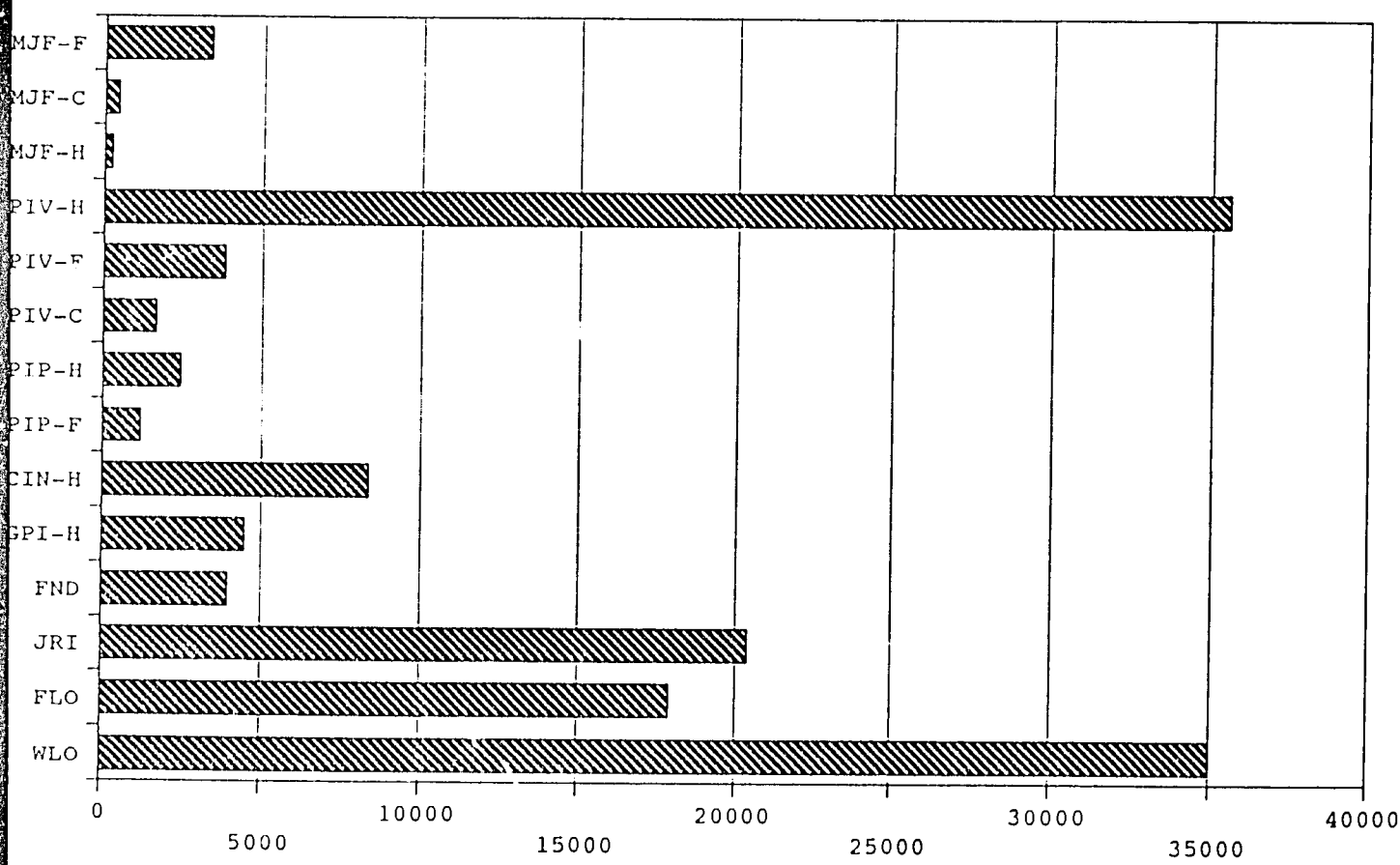
Agricultural System[a]	Season	Number of Households	Total Labor Hours (weighted)[b]	Labor Hours per Household (weighted)[b]
Waalo	Rainy	55	35,029	637
Falo	Rainy	46	17,894	389
Jeeri	Rainy	88	20,385	232
Foonde	Rainy	19	3,962	209
GPI	Rainy	8	4,455	557
CIN	Rainy	14	8,358	597
PIP	Dry-cold	3	1,204	401
PIP	Rainy	3	2,450	817
PIV	Dry-hot	10	1,677	168
PIV	Dry-cold	18	3,823	212
PIV	Rainy	48	35,562	741
MJF	Rainy	1	272	272
MJF	Dry-hot	7	461	66
MJF	Dry-cold	27	3,340	124

[a] GPI = large-scale irrigated perimeters; CIN = middle-sized irrigated perimeters; PIP = private irrigated perimeters; PIV = village irrigated perimeters; and MJF = irrigated vegetable gardens.
[b] Except for guarding, where all laborers were treated equally irrespective of age, the following weights were used: 0-7 years of age = 0.25; 8-14 and 61+ years = 0.5; 15-60 years = 1.

The first column of Table 6.7 presents the various systems: GPI (large-scale irrigated perimeters), CIN (middle-sized irrigated perimeters), PIP (private irrigated perimeters), PIV (village irrigated perimeters), and MJF (irrigated vegetable gardens, cultivated mostly by women), in addition to jeeri, foonde, waalo, and falo. Column two refers to the particular season: rainy season, dry-cold season, and dry-hot season. Irrigated farming does not take place at the height of the rainy season. Column three gives the number of households that cultivated in these seasons. Column four lists total weighted labor hours,[2] and column five the average labor hours per household for each agricultural system and season. Figures 6.10 and 6.11 present the same information but demarcated by age and gender.

[2] Except for guarding, where all laborers were treated equally irrespective of age, the following weights were used: 0-7 years of age = 0.25; 8-14 and 61+ = 0.5; 15-60 = 1.

Fig. 6.8. Total Labor Hours for Participating Households: 1991-1992



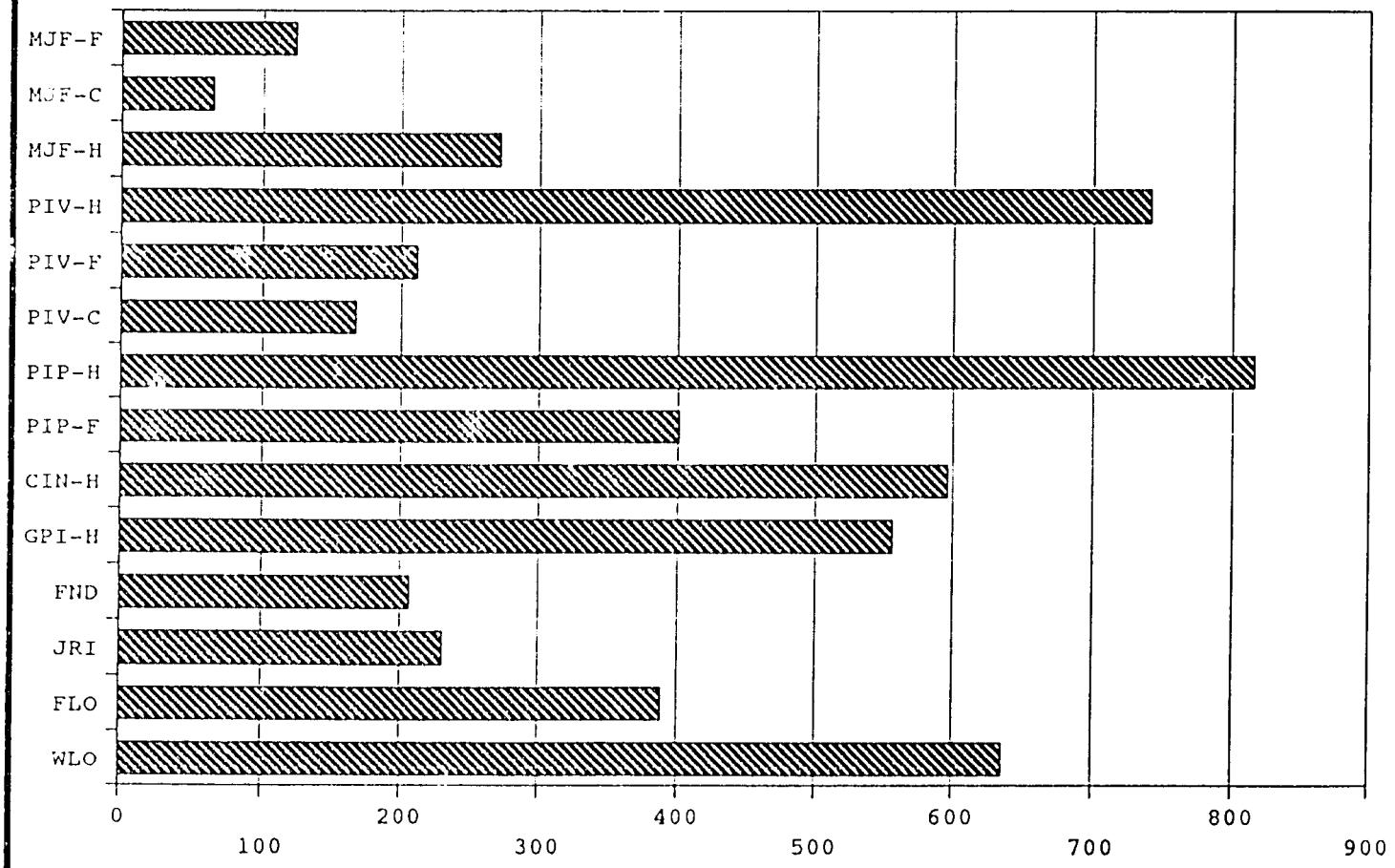
Agricultural System

MJF	Irrigated vegetable garden
PIV	Village irrigated perimeter
PIP	Private irrigated perimeter
CIN	Middle-sized irrigated perimeter
GPI	Large-scale irrigated perimeter
FND	Foonde
JRI	Jeeri
FLO	Falo
WLO	Waalo

Season

F	Dry-cold
C	Dry-hot
H	Rainy

Fig. 6.9. Average Labor Hours for Participating Households: 1991-1992



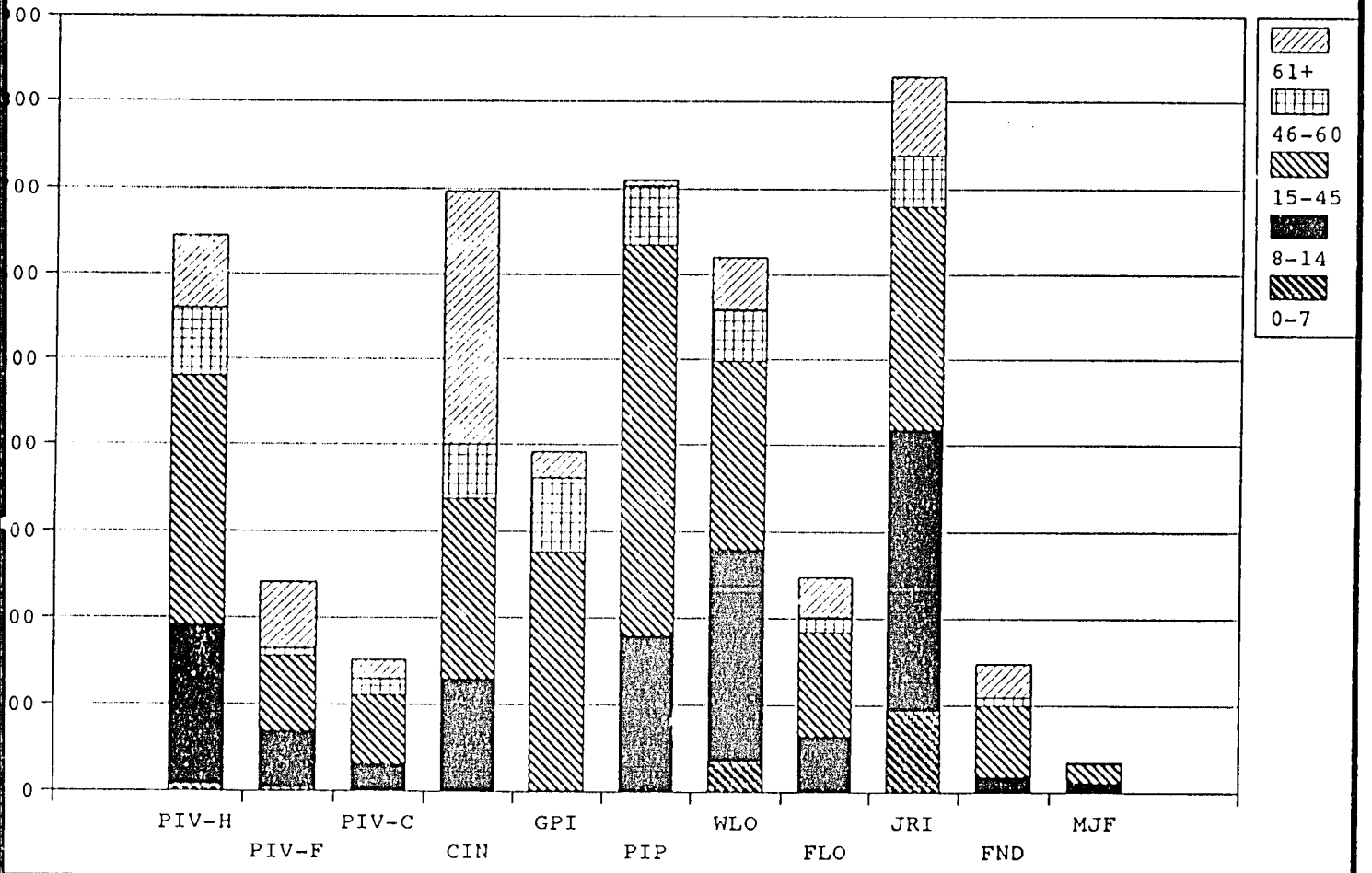
Agricultural System

MJF	Irrigated vegetable garden
PIV	Village irrigated perimeter
PIP	Private irrigated perimeter
CIN	Middle-sized irrigated perimeter
GPI	Large-scale irrigated perimeter
FND	Foonde
JRI	Jeeri
FLO	Falo
WLO	Waalo

Season

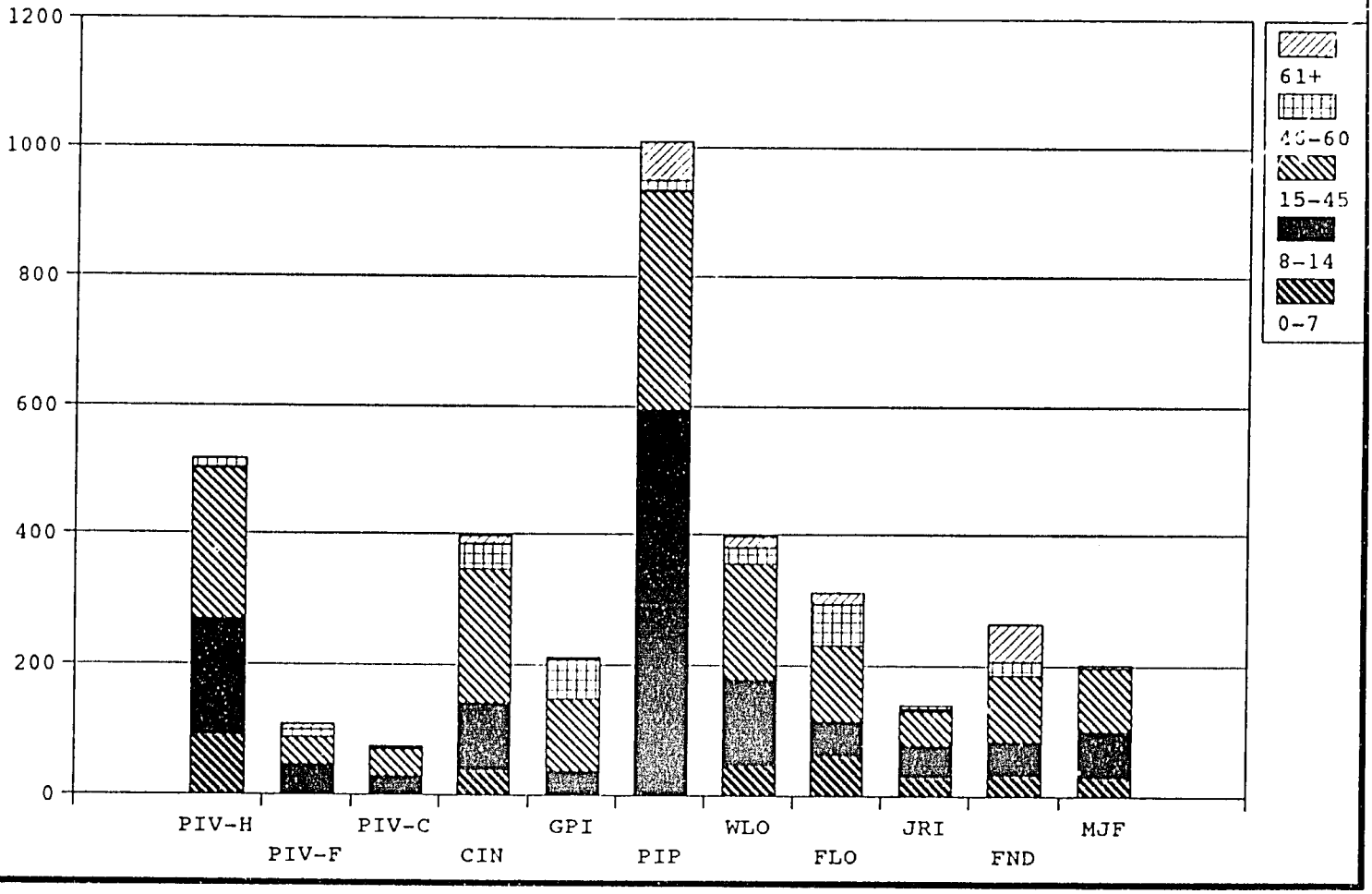
F	Dry-cold
C	Dry-hot
H	Rainy

Fig. 6.10. Average Male Labor Hours per Household by Age Group: 1991-1992



PIV-H	Village irrigated perimeter, rainy season
PIV-F	Village irrigated perimeter, dry-cold season
PIV-C	Village irrigated perimeter, dry-hot season
CIN	Middle-sized irrigated perimeter
GPI	Large-scale irrigated perimeter
PIP	Private irrigated perimeter
WLO	Waalo
FLO	Falo
JRI	Jeeri
FND	Foonde
MJF	Irrigated vegetable garden

Fig. 6.11. Average Female Labor Hours
per Household by Age Group: 1991-1992



PIV-H	Village irrigated perimeter, rainy season
PIV-F	Village irrigated perimeter, dry-cold season
PIV-C	Village irrigated perimeter, dry-hot season
CIN	Middle-sized irrigated perimeter
GPI	Large-scale irrigated perimeter
PIP	Private irrigated perimeter
WLO	Waalo
FLO	Falo
JRI	Jeeri
FND	Foonde
MJF	Irrigated vegetable garden

The sample population consists of 331 households, comprising 3,476 persons (present and absent), with an average sample household size of 10.5 persons. When we count only those who are present, average household size decreases to 8.27 (Table 6.8).

Table 6.8. Sample Population Absent and Present, by Gender and Age

Gender	Age (years)	Number		
		Absent	Present	Total
Male	0-7	51	385	436
	8-14	40	242	282
	15-45	411	382	793
	46-60	33	89	122
	61+	20	103	123
Subtotal		555	1,201	1,756
Female	0-7	40	392	432
	8-14	22	263	285
	15-45	109	662	771
	46-60	7	130	137
	61+	4	91	95
Subtotal		182	1,538	1,720
Total		737	2,739	3,476

Weighting household labor to arrive at what is termed adult equivalents (AE), average household size is further reduced to 5.46 persons—dividing the 1,808 adult equivalent units by the sample size of 331 households (Table 6.9).

Table 6.10 examines adult equivalent labor hours for each of the production systems and seasons considered above. The weighted hours of labor per household (from Table 6.7) are adjusted for a household averaging 5.46 adult equivalents to give average labor hours per AE. The last column adjusts these hours to present agricultural workdays per AE (for an eight-hour workday). For example, waalo cultivation requires 117 hours or 14.58 days of adult equivalent labor per household. Within a season, agriculture is characterized by peak labor demand at certain times, particularly early and late in the production cycle, with slack periods in between. The assumption that two-thirds of household members are able to perform agricultural labor would reduce the effective household adult equivalent labor available from 5.46 to 3.64, and increase the duties of each of the remaining 3.6 adult equivalents by 50 percent. Accordingly, for instance, average adult equivalent labor days for waalo cultivation would rise from approximately 14.6 days to 21.9 days. If most of the agricultural activities are squeezed within

Table 6.9. Sample Population Present, by Gender, Age, and Adult Equivalents

Gender	Age (years)	Present	Adult Equivalents
Male	0-7	385	96
	8-14	242	121
	15-45	382	382
	46-60	89	89
	61+	103	52
Subtotal		1,201	740
Female	0-7	392	98
	8-14	263	132
	15-45	662	662
	46-60	130	130
	61+	91	46
Subtotal		1,538	1,068
Total		2,739	1,808

Table 6.10. Average Adult Equivalent Labor for Farming Households: 1991-1992

Agricultural System	Season	Weighted Hours of Agricultural Labor per Household	Average Hours of Labor per Adult Equivalent	Average Days of Labor per Adult Equivalent
Waalo	Rainy	637	117	14.58
Falo	Rainy	389	71	8.91
Jeeri	Rainy	232	42	5.31
Foonde	Rainy	209	38	4.78
GPI	Rainy	557	102	12.75
CIN	Rainy	597	109	13.67
PIP	Dry-cold	401	73	9.18
PIP	Rainy	817	150	18.70
PIV	Dry-hot	168	31	3.85
PIV	Dry-cold	212	39	4.85
PIV	Rainy	741	136	16.96
MJF	Rainy	272	50	6.23
MJF	Dry-hot	66	12	1.51
MJF	Dry-cold	124	23	2.84

one-third of the season, the required work must be performed in one-third of the supposedly allotted time (for example, in 30 rather than 90 days). It is clear that farmers spending 22 days on waalo, for example, would be unable to perform much additional work during that period.

C. Nonagricultural Activities

Information on nonagricultural activities was also collected monthly on a 24-hour recall basis during a 12-month period.

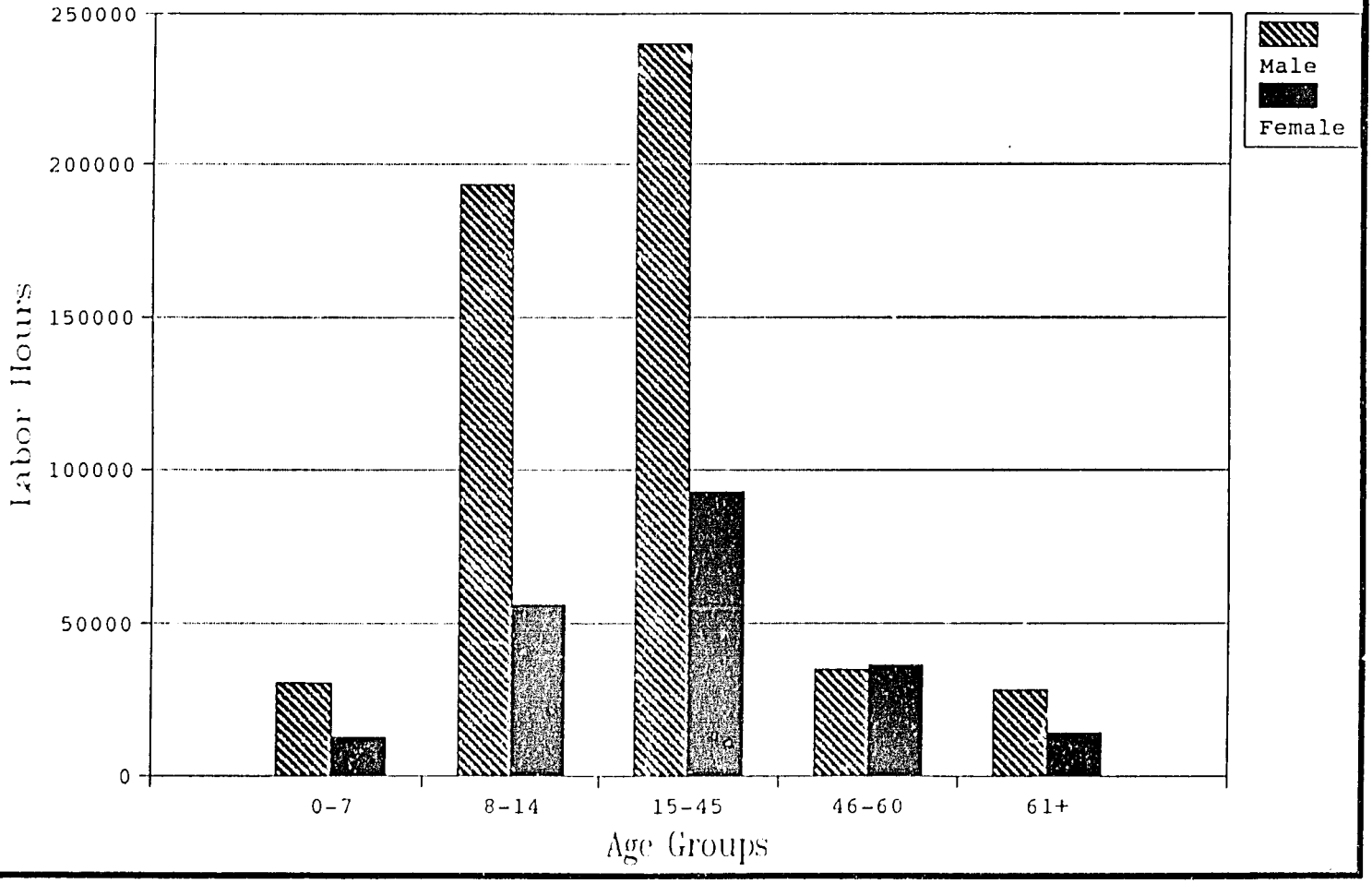
Table 6.11 shows total labor hours by activity and age and gender groups. Figure 6.12 presents some of this information to illustrate the prevalent variations in nonagricultural labor among gender and age groups. Some gender differentiations in nonagricultural activities are more obvious than are those in agricultural work. Except for the age group 46-60, where women spend slightly more total hours on nonagricultural activities than men (36,377 vs. 34,887), men, especially in the age groups 8-14 and 15-45, commit more time to nonagricultural activities than do women. This is particularly significant in light of the fact that the list of nonagricultural activities does not include labor migration, which is much more a male than a female endeavor.

Table 6.11. Total Nonagricultural Labor Hours by Age, Gender, and Activity

Activity	Male					Female				
	0-7	8-14	15-45	46-60	61+	0-7	8-14	15-45	46-60	61+
Commerce	0	826	20,019	4,901	1,249	84	852	11,233	2,895	836
Fishing	0	777	7,078	2,897	84	0	122	835	42	262
Artisanal	260	3,095	10,079	5,494	4,358	140	1,315	20,206	8,475	3,650
Service-oriented Activities[a]	425	3,881	37,214	3,990	2,387	0	1,544	2,252	196	0
Salaried (functionary, retired, etc.)	0	0	3,229	2,068	618	0	0	0	0	0
Herding	9,741	75,160	81,985	4,130	6,280	3,740	23,100	23,659	9,936	3,416
Hunting and Gathering	288	1,301	1,341	505	449	533	4,135	5,333	2,113	538
Other[b]	19,787	108,319	78,799	10,903	12,507	8,027	25,139	29,119	12,719	5,421
Total	30,501	193,358	239,744	34,887	27,733	12,525	56,206	92,637	36,377	14,123

[a] For example, tailoring, baking, butchery, marabout.
[b] Includes schooling, talibe (disciple of a religious leader or order), student.

Fig. 6.12. Male and Female Differential
Nonagricultural Labor Input



1. Gender Differences in Education

Figure 6.13, which weights the hours by age groups of the participants in the activity, reveals that the category "other" that subsumes all schooling activities (including French, Arabic, Koranic, and Pulaar literacy classes) is the single most time-consuming nonagricultural activity. As education in all its forms is geared much more toward males than toward females, especially for the age groups 8-14 and 15-45, the inclusion of schooling skews the data on nonagricultural activities toward males. While males in these two age groups spend 108,319 and 78,799 hours respectively on schooling, female cohorts spend only 25,139 and 29,119 hours (Table 6.11 and Figure 6.14).[3] In the age group 46-60, however, men and women are almost equally likely to be involved in schooling—in this case largely literacy training—with women exceeding men by a small margin.

The largest gap in schooling activities is in the age groups 8-14 and 15-45. For the youngest group, children 7 and under, almost half as many girls attend school as boys. The proportion of boys to girls increases as they get older (8-14), as girls are pulled out of school at an earlier age than boys. Girls in the age group 15-45 spend more hours on schooling activities, on average, than those between 8-14, however. The gender gap in the age group 15-45 narrows because some boys also leave school as they get older and some attend school elsewhere. The upper end of this age group includes adults attending literacy training classes, in which the number of women sometimes exceeds the number of men.

Thus, the narrowing of the schooling gap between women and men aged 46-60 may be a function of the dramatic increase of literacy in Pulaar in the Senegal River Valley. Literacy teachers say that women frequently are far more enthusiastic about literacy than men and attend classes more regularly. The proportion of women declines after the age of 61.

A quite different portrait emerges when we examine involvement in nonagricultural activities by gender but exclude schooling (Figure 6.15). While the male/female gap in nonagricultural activities remains, the magnitude is far less. Gender differences in age groups 0-7, 46-60, and 61 and older are almost unchanged, but the gaps between the male and female age groups 8-14 and to a lesser extent 15-45 are substantially reduced: in the school-age groups, girls attend school with far less frequency than boys, and the gap between boys and girls increases as the age goes up.

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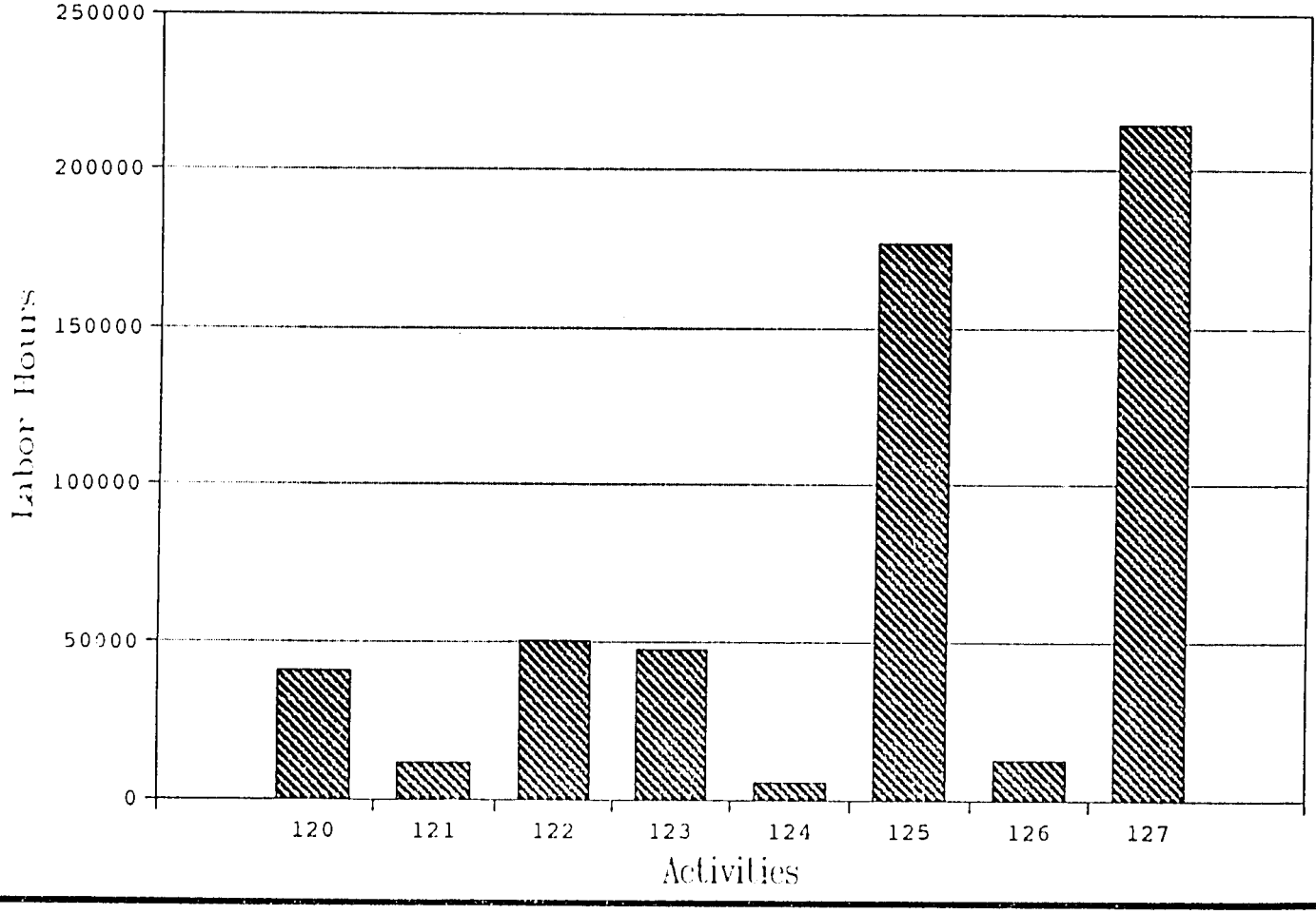
[3] Schooling as a nonagricultural activity covers only what occurs in the village. Boys and girls who attend school outside the village are included in a miscellaneous category, although they are coded as being absent from the village for schooling purposes.

Fig. 6.13. Total Nonagricultural
Labor Hours by Activity



120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig. 6.14. Male and Female Engagement
in Schooling Activities by Age Group

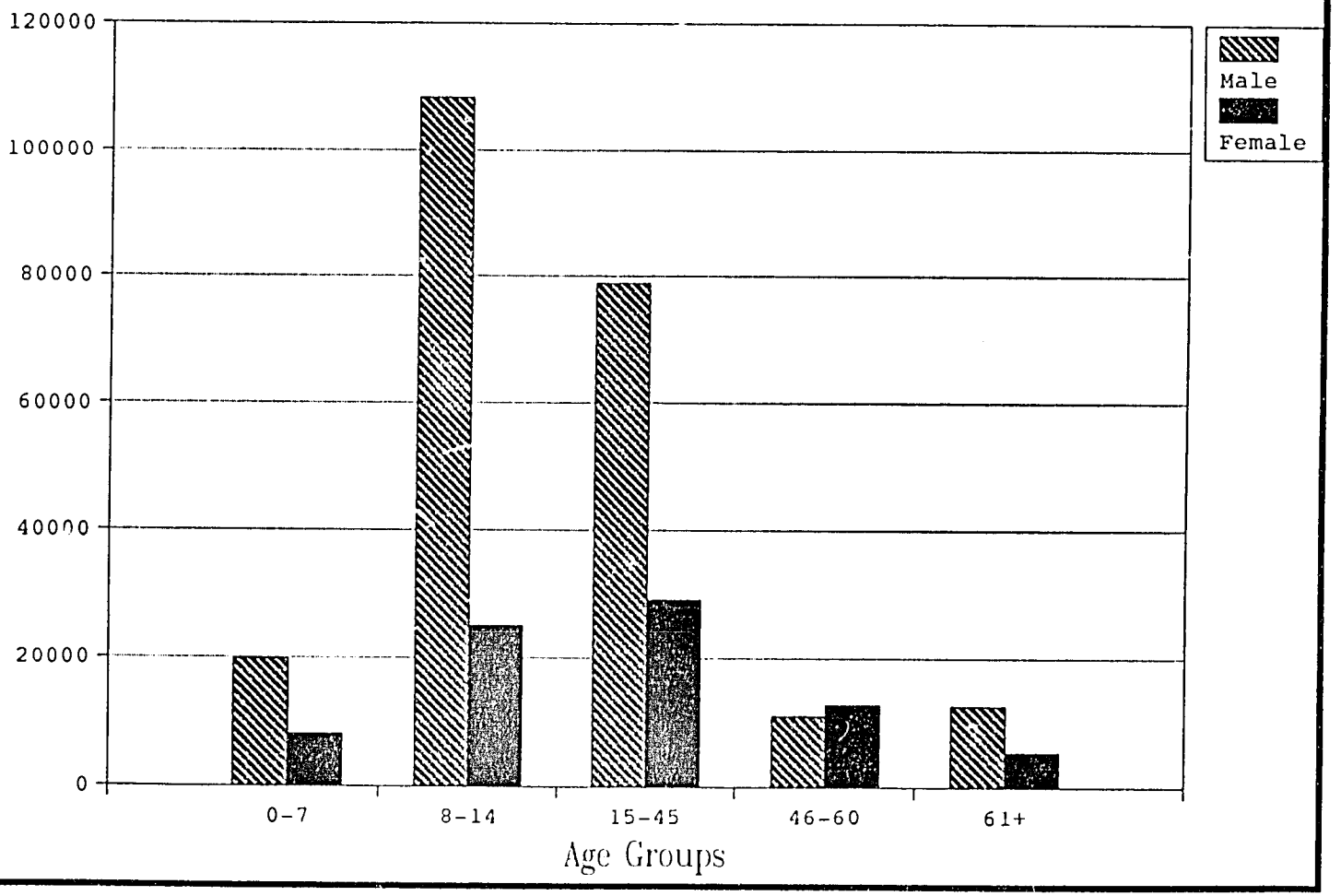
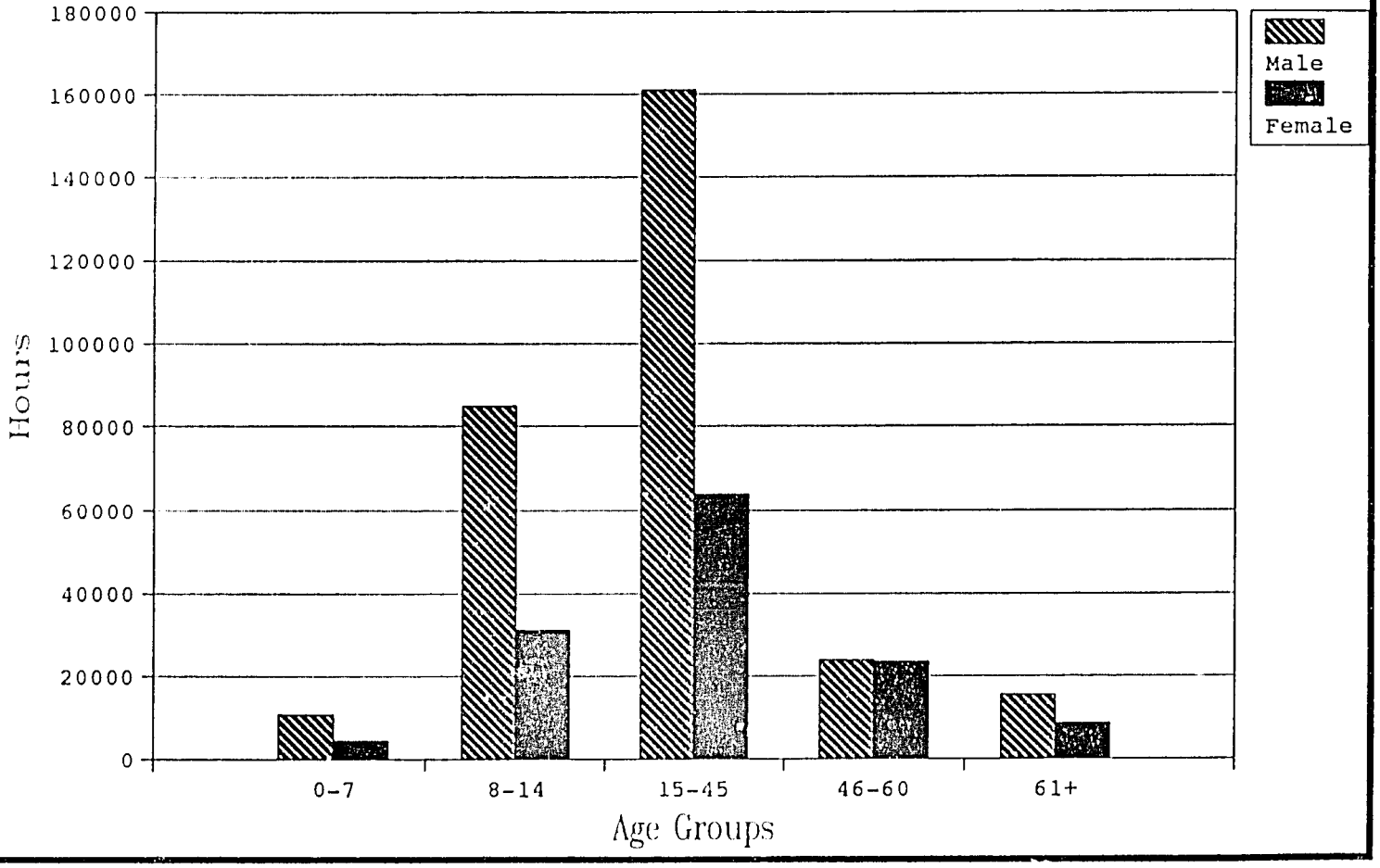


Fig. 6.15. Male and Female Engagement in Nonagricultural Activities Excluding Schooling



2. Caste Differences in Nonagricultural Activities

Figure 6.16 compares average annual nonagricultural labor by caste. The category "other" records the highest number of hours on nonagricultural activities, with four other castes —Jaawambe, Fulbe, Sebbe, and Toorobbe—close together but averaging fewer than half the hours of the "other" group. Later we will see the distribution of this labor across activities. Figures 6.17 and 6.18 show the distribution of overall nonagricultural labor by age and caste group for females and for males, respectively. In general, men are more active in non-agricultural activities than women, across age and caste groups. Among the Jaawambe (aged 0-7), Fulbe (46-60 and 61+), Maccube (46-60 and 61+), "other" (0-7, 8-14, and 15-45), Nyeenybe (46-60 and 61+), Toorobbe (61+), and Sebbe (0-7 and 46-60), women put in slightly more hours on average than men.

3. Age, Gender, and Caste Correlations by Activity

For a more detailed view of age, gender, and caste relationships in nonagricultural activities we look at the average hours that each caste spends on each activity by age group and gender, as seen in Figures 6.19 to 6.34.[4]

In general, with the exception of education, herding, and hunting and gathering, children age 0-7 understandably have little involvement in nonagricultural activities, irrespective of caste affiliation. The participation in nonagricultural activities of boys and girls in the age group 8-14 is much greater. As with the youngest age group, the three activities in which children of 8-to-14 years are most engaged are schooling, herding, and hunting and gathering. As expected, the boys in this age group most active in herding are Fulbe boys, who spend an average of almost 1,000 hours a year at this task. Fulbe girls, although they belong to the same herding society, do not spend much time in herding activities. Boys of the age group 8-14 spend many more hours on schooling than girls, notwithstanding caste.

Among men and women in the age group 15-60, men are clearly more involved in schooling and herding activities than women. Naturally, the most active group in herding are Fulbe men. Hours reported in herding for Fulbe women were much lower.[5]

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[4] Each figure is limited to four caste groups and one gender; the scales for each age group are usually the same for comparability. The activity codes are explained on the figures.

[5] We note that in reporting herding activities, research assistants did not report taking care of animals around the camp or herding-related activities such as milking or milk processing in the "herding" category. Including these would increase the average hours of Fulbe women dramatically.

Fig. 6.16. Annual Nonagricultural Labor
per Person, by Caste (Hours)

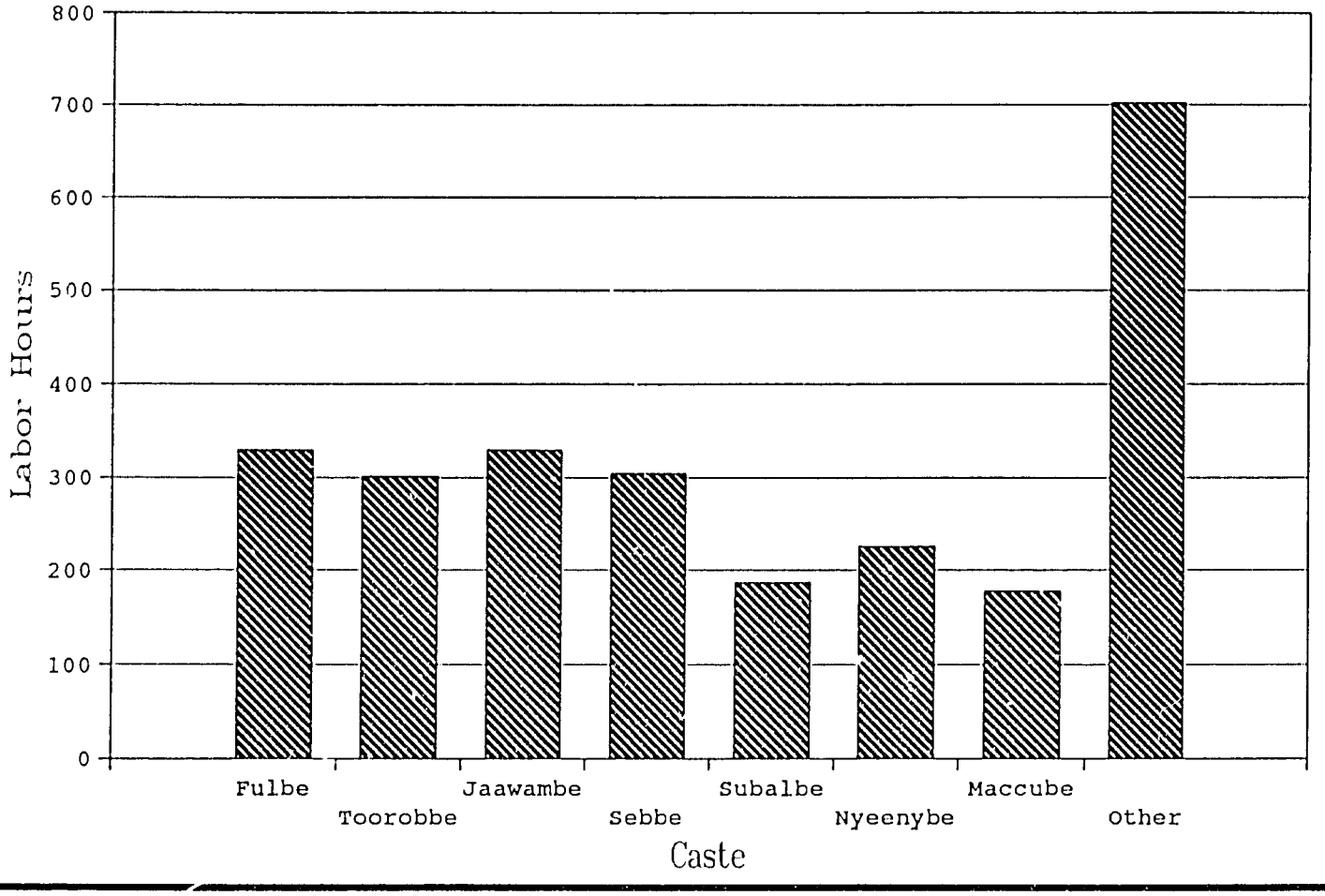


Fig.6.17. Average Annual Female Nonag. Labor by Caste

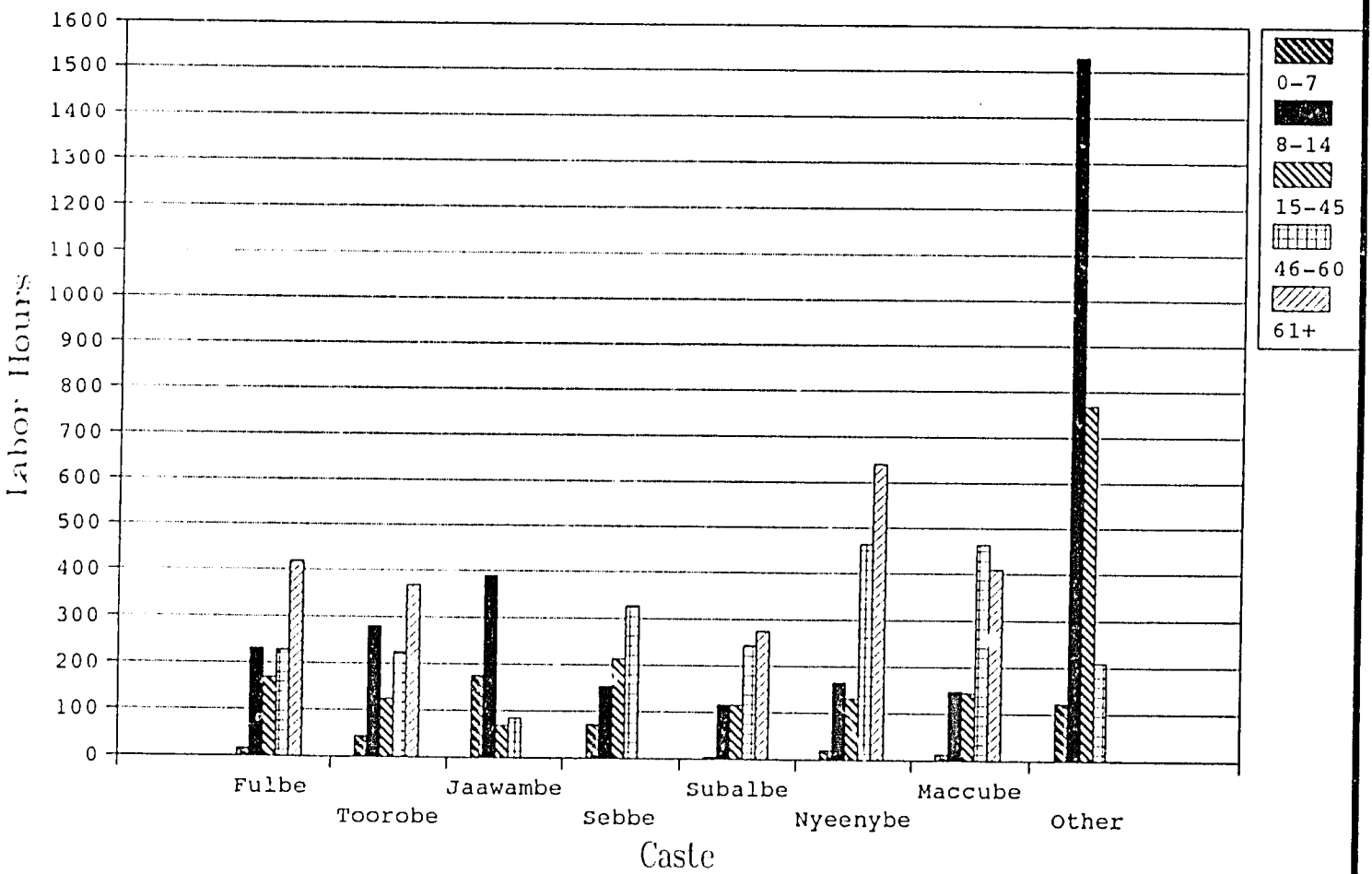
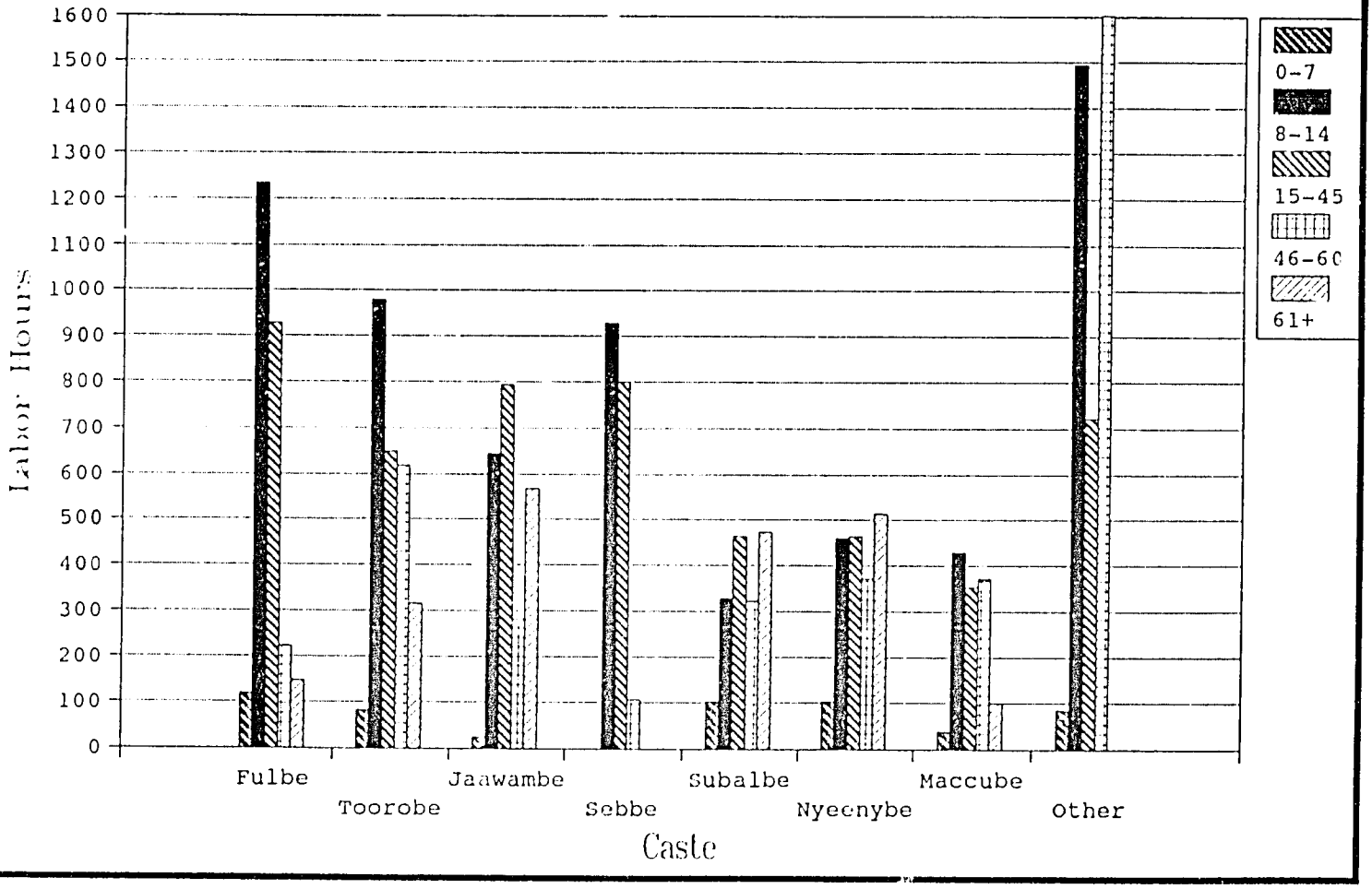


Fig. 6.18. Average Annual Male
Nonagricultural Labor by Caste



Among people over 60, men are more active than women. Differences between the two groups are not substantial, however. Service-oriented activities seem to be restricted to men, with the Subalbe, Jaawambe, and Nyeenybe being the most active.

a. Children 0-7

Figures 6.19, 6.20, 6.21, and 6.22 show the average hours that children of ages 0-7 spend on nonagricultural activities. As noted earlier, except for education, herding, and hunting and gathering, these children, irrespective of caste, have little involvement in nonagricultural activities. Only Subalbe girls—but not boys—spend a small amount of time (an average of less than two hours) on commercial activities such as shopkeeping. Nyeenybe, and to a lesser extent Fulbe, boys and Jaawambe girls spend some time, but also negligible amounts, on artisanal activities; this is almost entirely hair braiding for girls.

Contrary to our expectations, for these youngest children, the most active group in herding is not Fulbe but Subalbe boys. While the Subalbe spend an average of almost 100 hours per year, the Fulbe boys spend a little over 60 hours. Subalbe girls do not seem to be involved at all in herding, while Fulbe girls spend less time at it than the boys, a little less than 10 hours. Toorobbe girls, however, average more time a year than Toorobbe boys in herding.

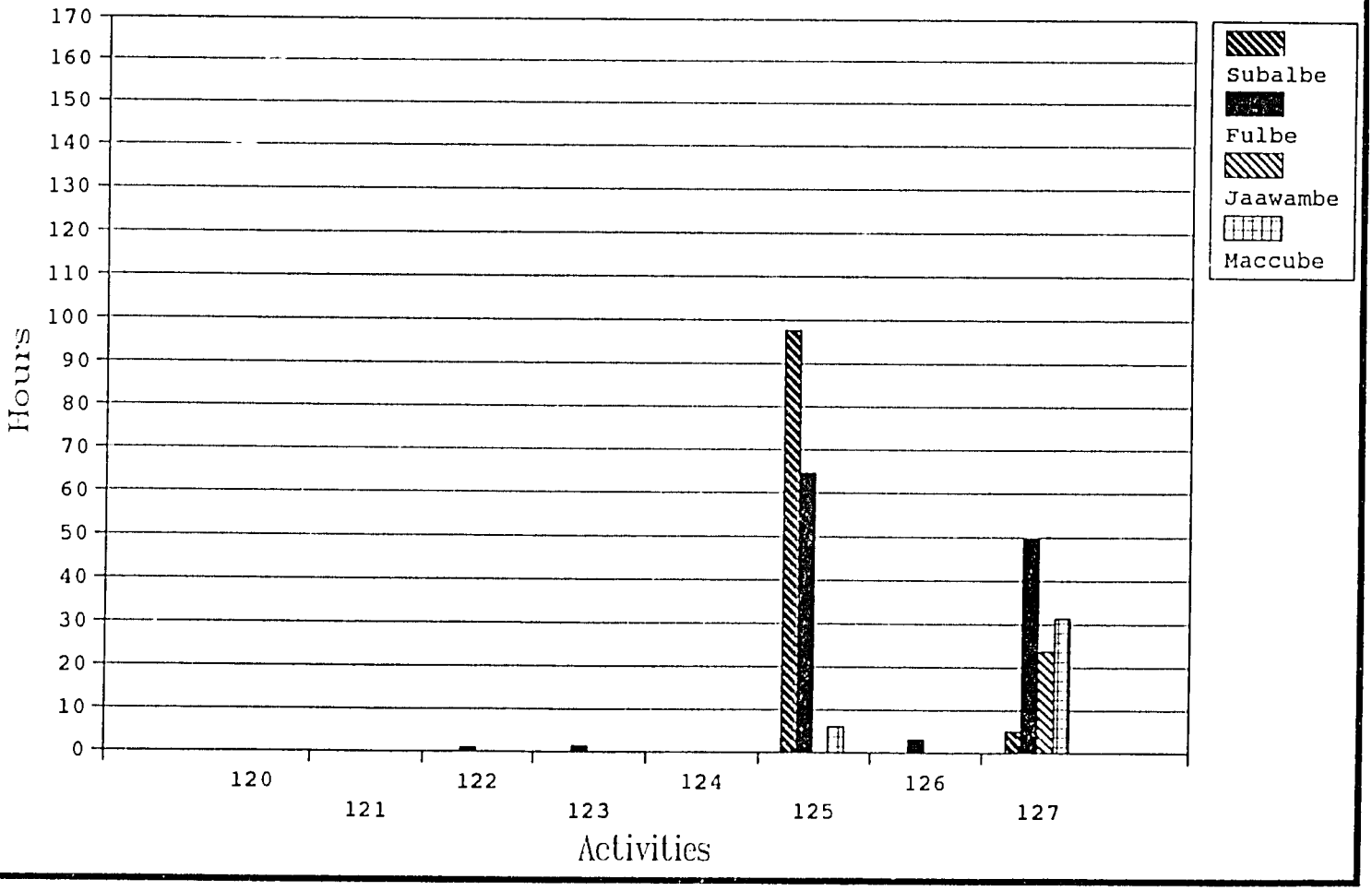
We have seen earlier that boys in general spend much more time than girls on schooling. This is not true for all caste groups, however, at least not for this youngest age group. Their schooling is largely in Koranic classes, since formal schooling does not start until age seven. Jaawambe girls in this age group spend the most hours on schooling activities, an average of almost 165. Jaawambe boys, on the other hand, average only a little over 20. The same is true for the Sebbe: while the girls report an average of almost 50 hours, boys in the sample report none. A plausible explanation for the difference among Sebbe children is that the Sebbe seem to be less inclined to impose work on very young and very old people, and less on boys than girls. As Figure 6.20 shows, Sebbe boys are not involved in any of the nonagricultural activities, including schooling. The only activity other than schooling that occupies the youngest Sebbe girls is as mothers' helpers in gathering (Figure 6.22).

The next most active group in education among these children are the Nyeenybe boys (about 90 hours), followed by Toorobbe and "other" boys (over 70 hours).

b. Children 8-14

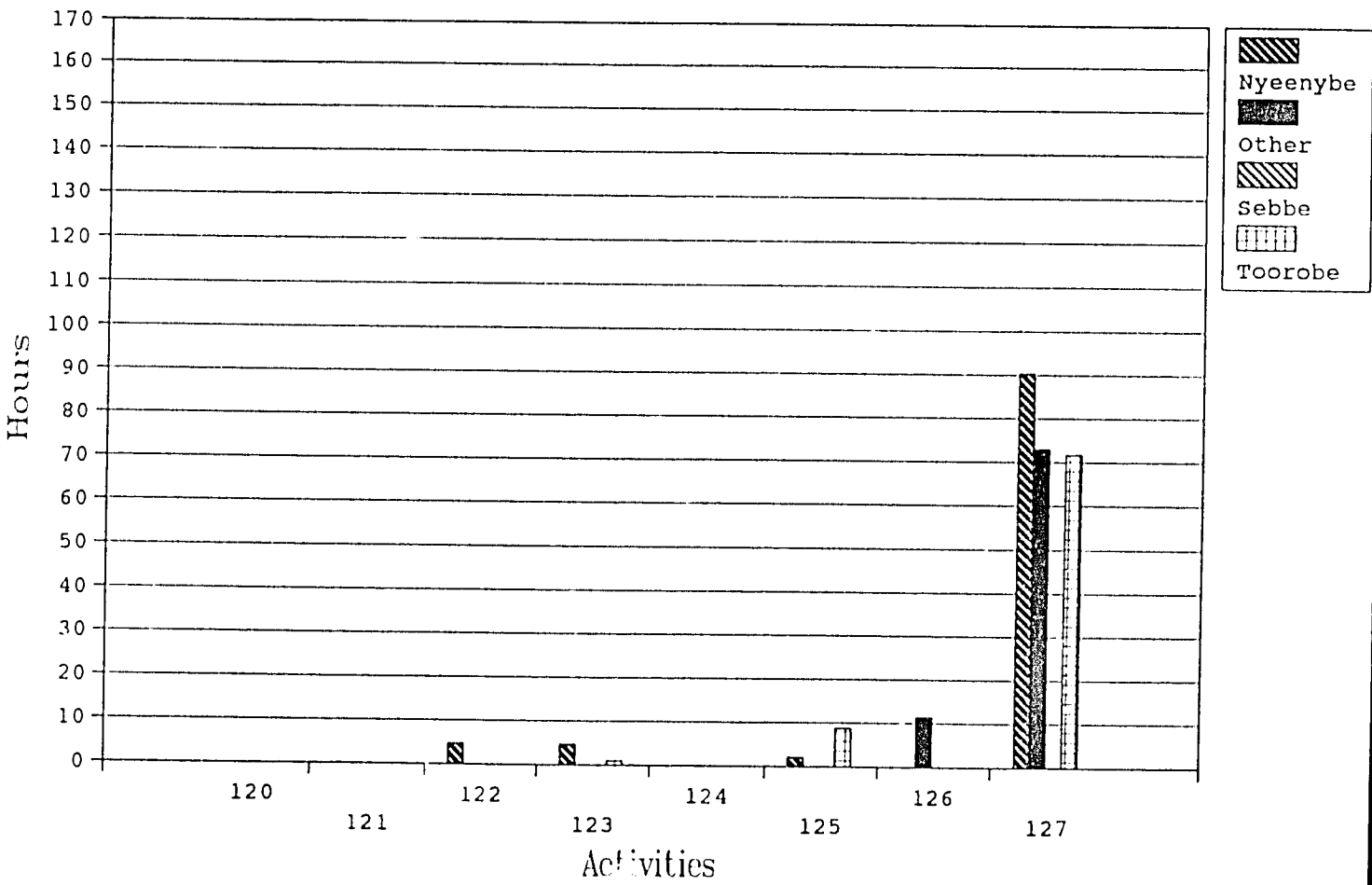
Figures 6.23, 6.24, 6.25, and 6.26 show the extent of the involvement of boys and girls between the ages 8 and 14 in nonagricultural activities by caste. This age group works considerably longer in nonagricultural activities than the younger one. While the highest number of average hours for children between 0-7 is under 170, the maximum for the 8-to-14 year-olds is almost 1,000. As with the youngest group, the three most important nonagricultural activities for this group are schooling, herding, and hunting and gathering.

Fig. 6.19. Average Hours per Boy for Nonagricultural Activities: 0-7 (1)



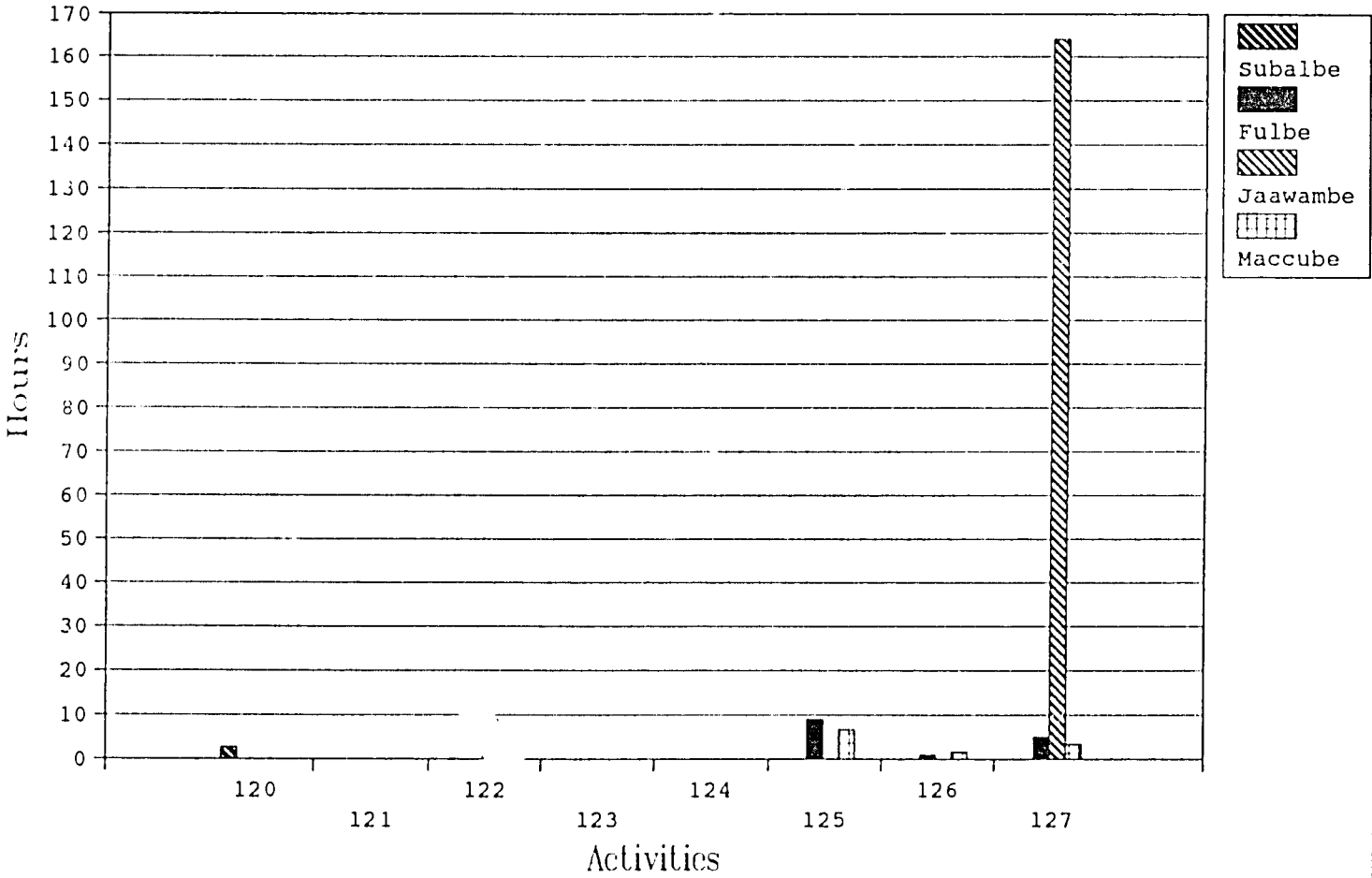
120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig. 6.20. Average Hours per Boy for Nonagricultural Activities: 0-7 (2)



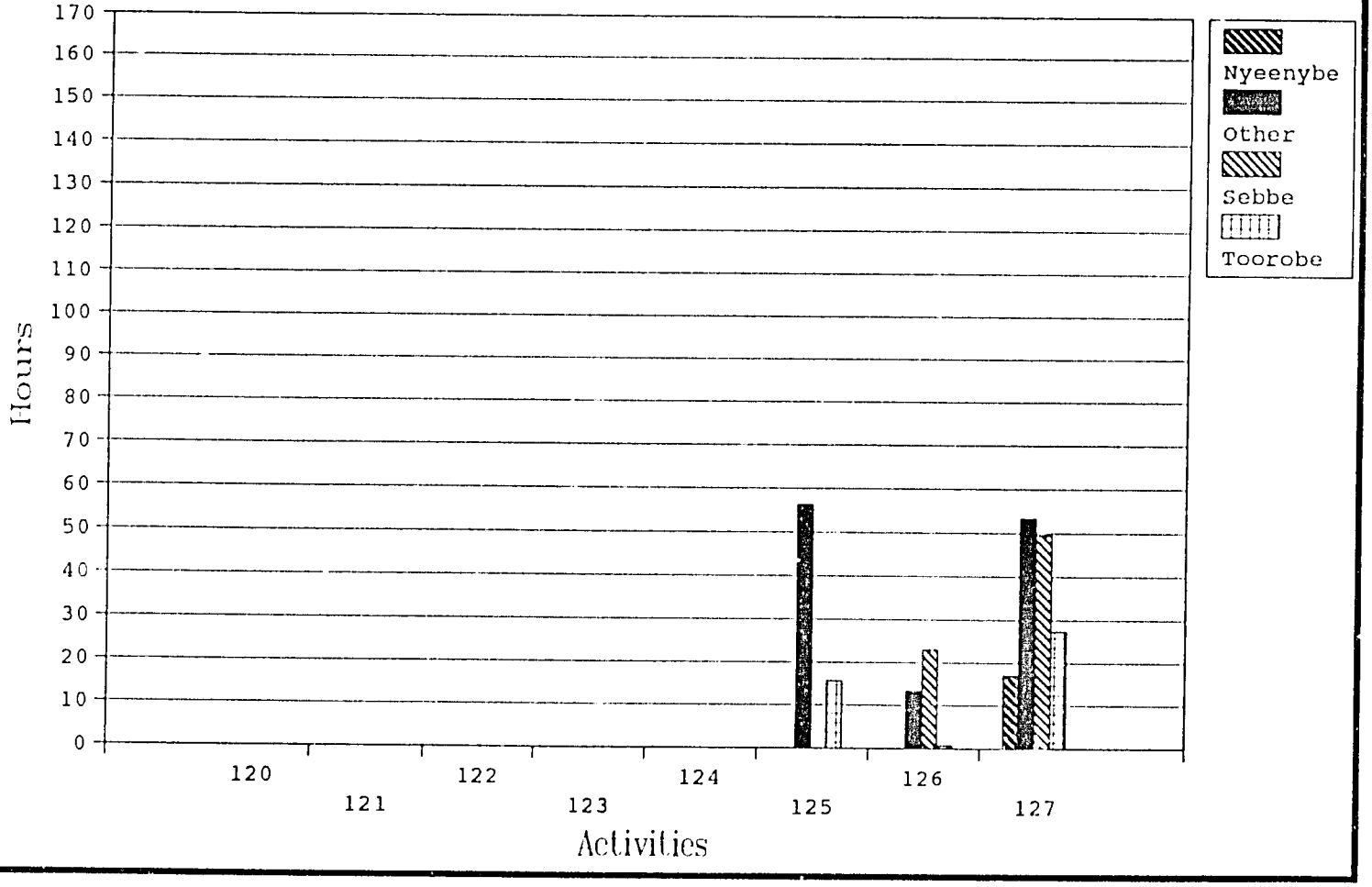
120	Commerce (shopkeeper, etc.)
121	Fishing
122	Artisanal (metalwork, wood-carving, hair braiding, etc.)
123	Service oriented (tailor, baker, butcher, marabout)
124	Salaried (functionary, retired, etc.)
125	Herding
126	Hunting and gathering
127	Other (talibe, student, etc.)

Fig. 6.21. Average Hours per Girl for Nonagricultural Activities: 0-7 (1)



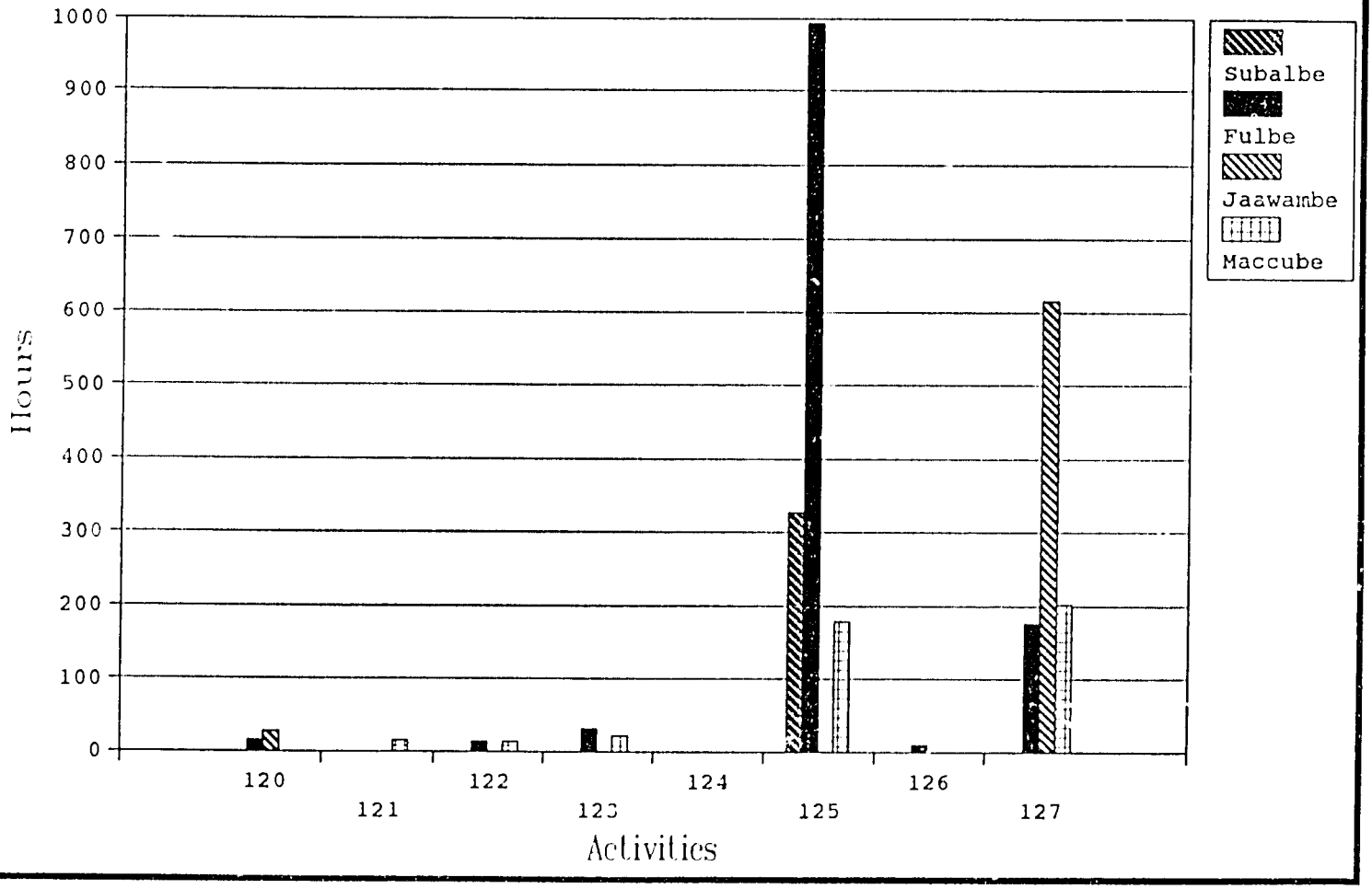
120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig. 6.22. Average Hours per Girl for Nonagricultural Activities:0-7 (2)



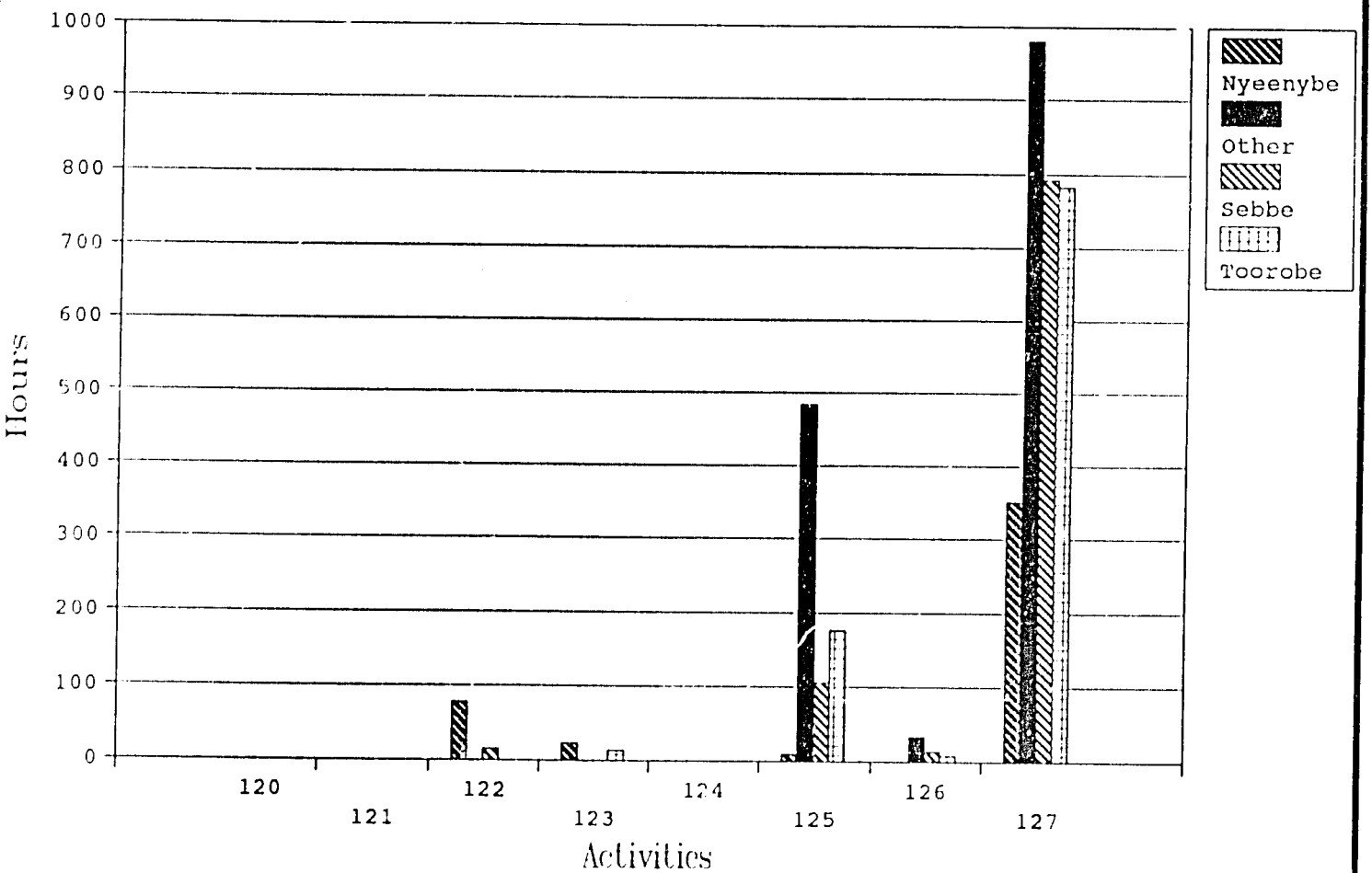
120	Commerce (shopkeeper, etc.)
121	Fishing
122	Artisanal (metalwork, wood-carving, hair braiding, etc.)
123	Service oriented (tailor, baker, butcher, marabout)
124	Salaried (functionary, retired, etc.)
125	Herding
126	Hunting and gathering
127	Other (talibe, student, etc.)

Fig. 6.23. Average Hours per Boy for Nonagricultural Activities: 8-14 (1)



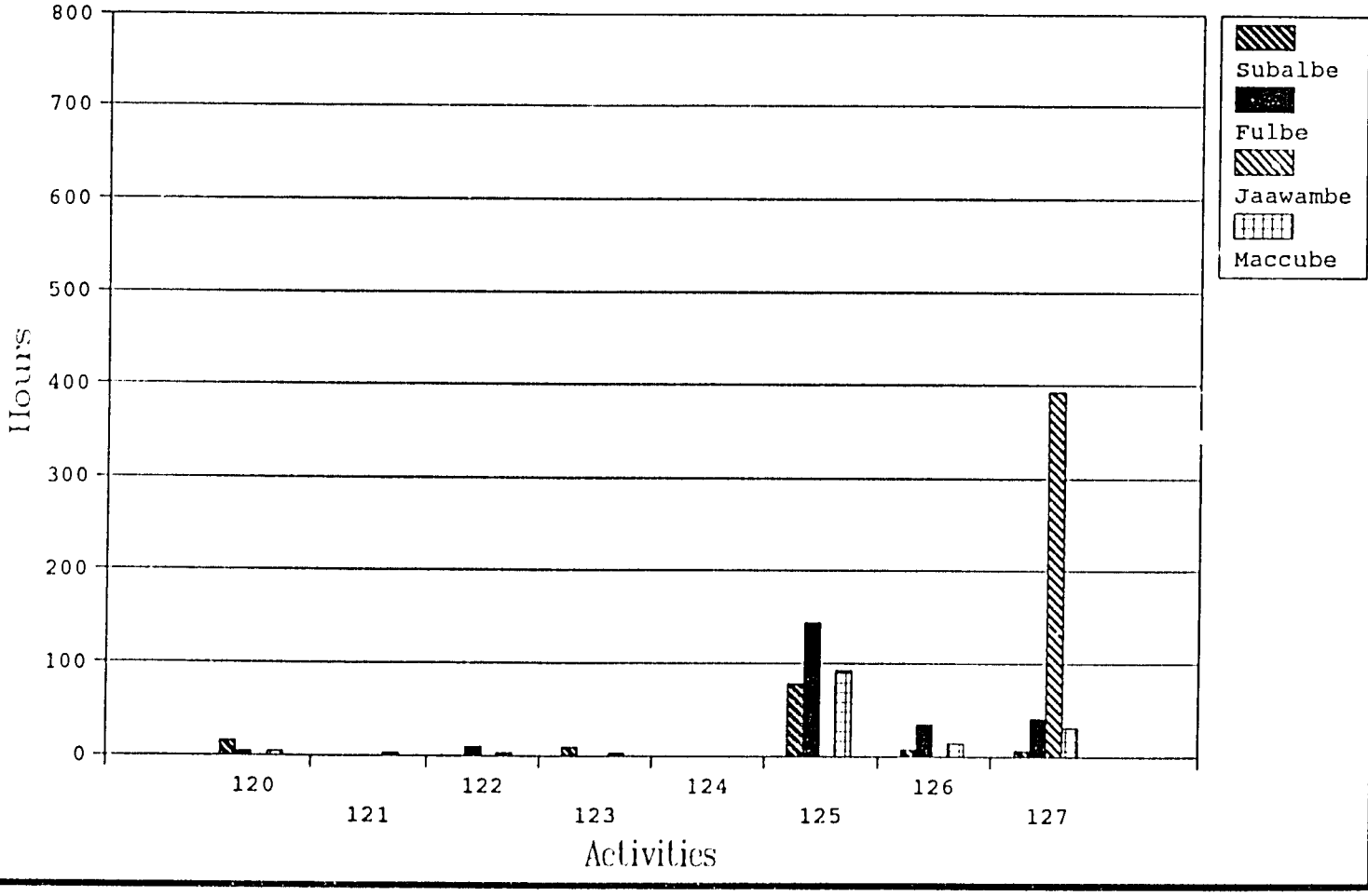
120	Commerce (shopkeeper, etc.)
121	Fishing
122	Artisanal (metalwork, wood-carving, hair braiding, etc.)
123	Service oriented (tailor, baker, butcher, marabout)
124	Salaried (functionary, retired, etc.)
125	Herding
126	Hunting and gathering
127	Other (talibe, student, etc.)

Fig. 6.24. Average Hours per Boy for Nonagricultural Activities: 8-14 (2)



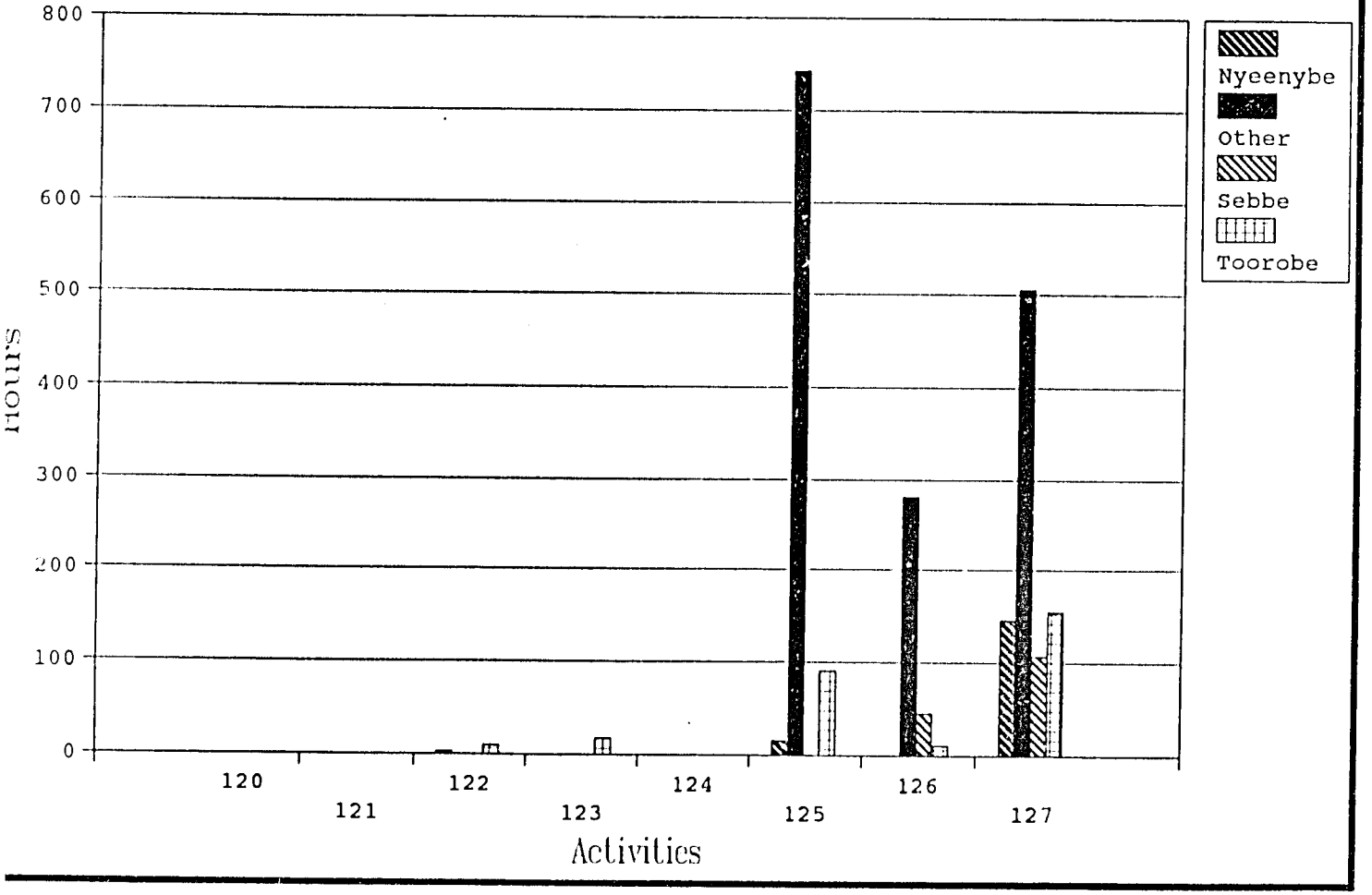
120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig. 6.25. Average Hours per Girl for Nonagricultural Activities:8-14 (1)



120	Commerce (shopkeeper, etc.)
121	Fishing
122	Artisanal (metalwork, wood-carving, hair braiding, etc.)
123	Service oriented (tailor, baker, butcher, marabout)
124	Salaried (functionary, retired, etc.)
125	Herding
126	Hunting and gathering
127	Other (t ibe, student, etc.)

Fig. 6.26. Average Hours per Girl for Nonagricultural Activities:8-14 (2)



120	Commerce (shopkeeper, etc.)
121	Fishing
122	Artisanal (metalwork, wood-carving, hair braiding, etc.)
123	Service oriented (tailor, baker, butcher, marabout)
124	Salaried (functionary, retired, etc.)
125	Herding
126	Hunting and gathering
127	Other (talibe, student, etc.)

As expected, those spending the most time in herding activities in this age group are Fulbe boys, with an average of almost 1,000 hours (Figure 6.23). They are followed by "other" girls (almost 750 hours) and boys (nearly 500 hours). Fulbe girls are not as involved in herding activities (about 150 hours). The most active group in hunting and gathering in this age bracket is "other" girls, who are thus occupied on average about 300 hours per year (Figure 6.26).

In all caste groups except the Subalbe, boys of this age spend many more hours on schooling activities than girls. The most active groups are the category "other" (almost 1,000 hours), followed by the Sebbe and the Toorobbe (almost 800 hours) (Figure 6.24). The difference in the number of hours that Sebbe and Toorobbe boys and girls spend on schooling activities is rather dramatic. Sebbe boys spend almost 800 hours in school as compared to only 100 for girls. Similarly, Toorobbe boys spend nearly 800 hours and girls about 155 (Figures 6.24 and 6.26).

c. Men and Women 15-60

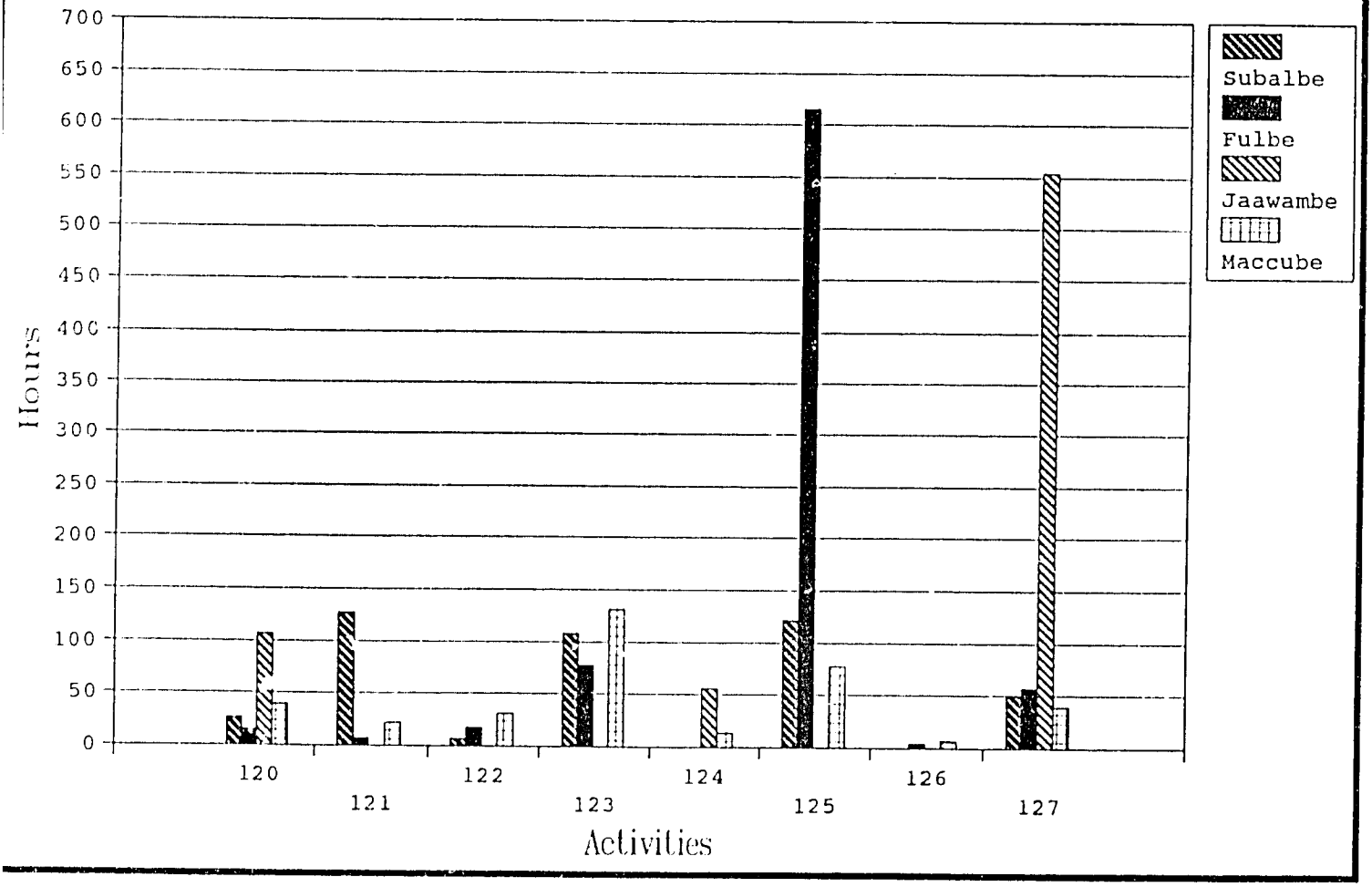
Figures 6.27, 6.28, 6.29, and 6.30 show the differential involvement of men and women between 15 and 60 years old in nonagricultural activities, by caste. Men and women in this age bracket comprise the bulk of the potentially available full-time labor force, and in this section the subgroups of ages 15-45 and 46-60 are combined to discover the major nonagricultural occupations of this whole middle range. If labor-intensive irrigation development is being considered, it is men and women between 15 and 60 who will have to staff it; their availability is thus a critical issue.

Men are clearly far more involved in schooling and herding activities than women. With the other activities, however, the situation is much less straightforward. Naturally, the most active group in herding are the Fulbe, but not Fulbe women. As we have indicated (in footnote 5) herding activities reported do not include taking care of animals around the camp or such associated activities as milking and milk processing, which substantially add to the average hours spent by Fulbe women on animal-related activities.

Jaawambe, Toorobbe and "other" men 15-60 are the most involved in schooling activities, followed by "other" women.

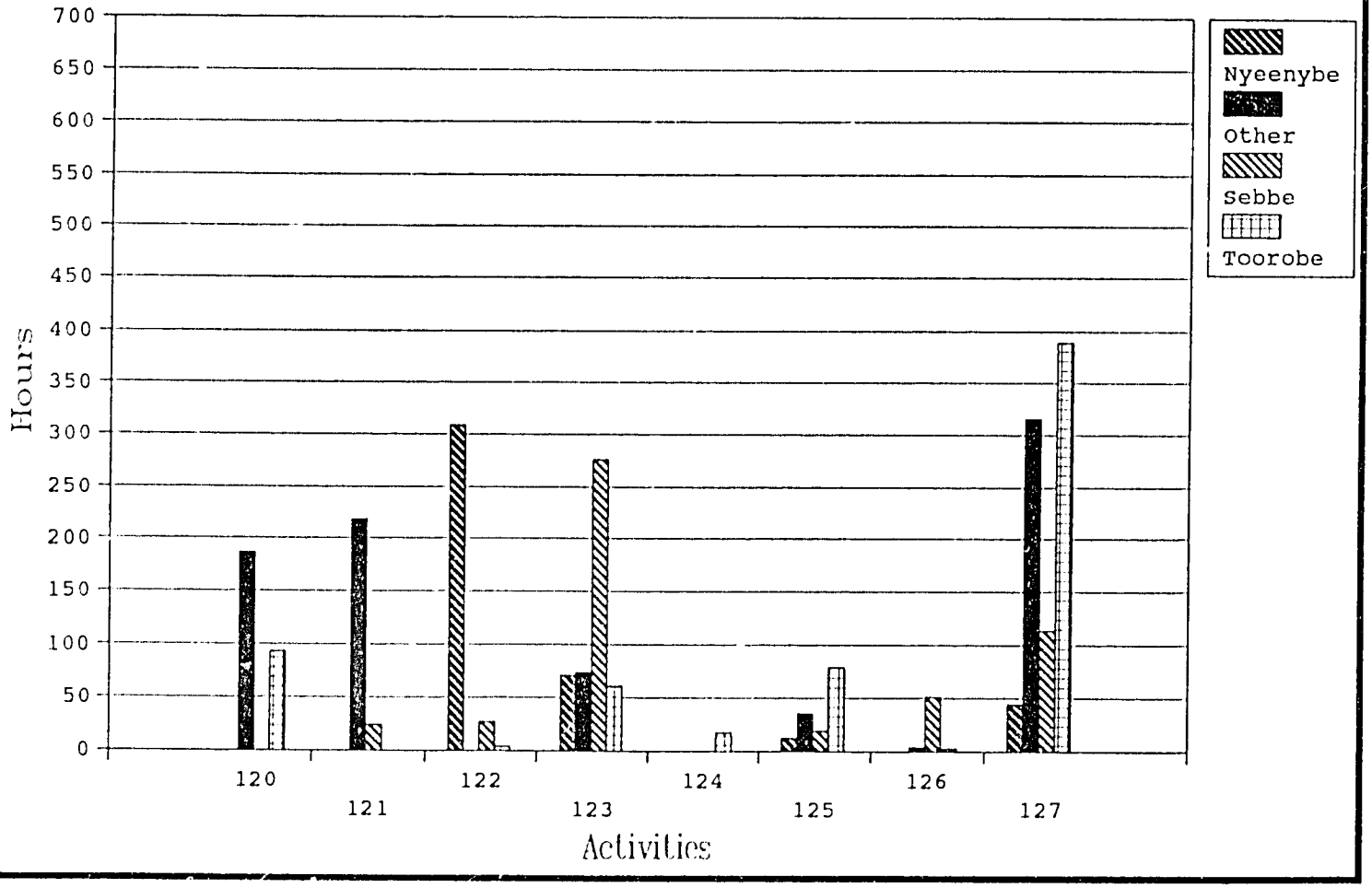
Men and women without recorded caste designation (the category "other") average the most hours on commercial activities such as shopkeeping; Sebbe women are highest among the identified castes. Surprisingly, "other" men surpass Subalbe fishermen in the average number of hours spent on fishing activities. Two possible explanations are suggested. The total number of Subalbe men in this age group is much larger than that of "other": 75 as opposed to 13. Since not all Subalbe men engage in fishing, averaging might grossly underestimate the involvement of those men who are very active (see the section on fishing in Chapter IV). The second possibility is that insofar as Subalbe are more skillful fishermen than other groups, they may need to spend fewer hours fishing for an equivalent catch. Women, including Subalbe women, average relatively few hours on fishing, supporting the observation that there is a clear

Fig. 6.27. Average Nonagricultural Hours for Men 15-60 (1)



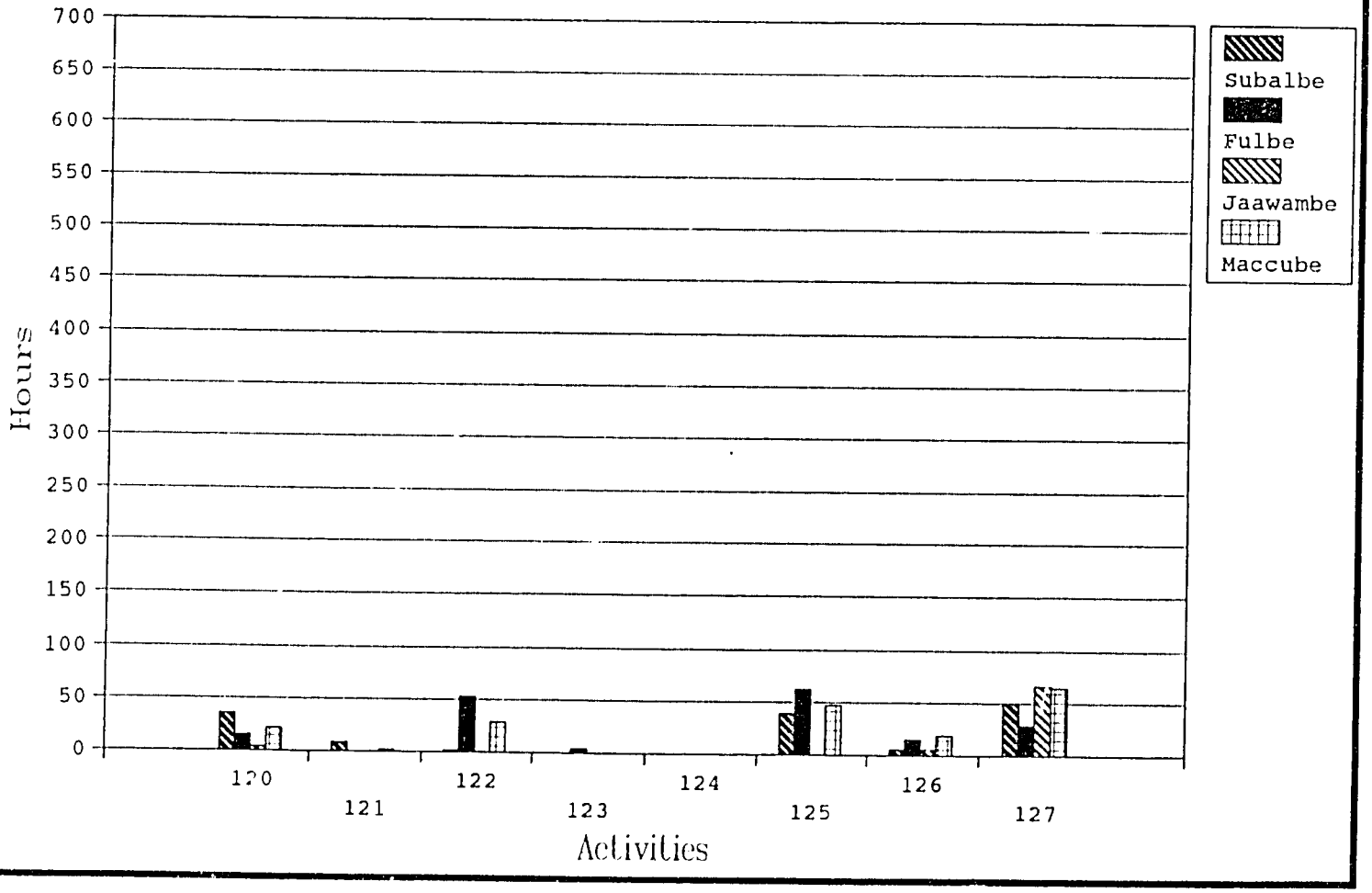
120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig. 6.28. Average Nonagricultural Hours for Men 15-60 (2)



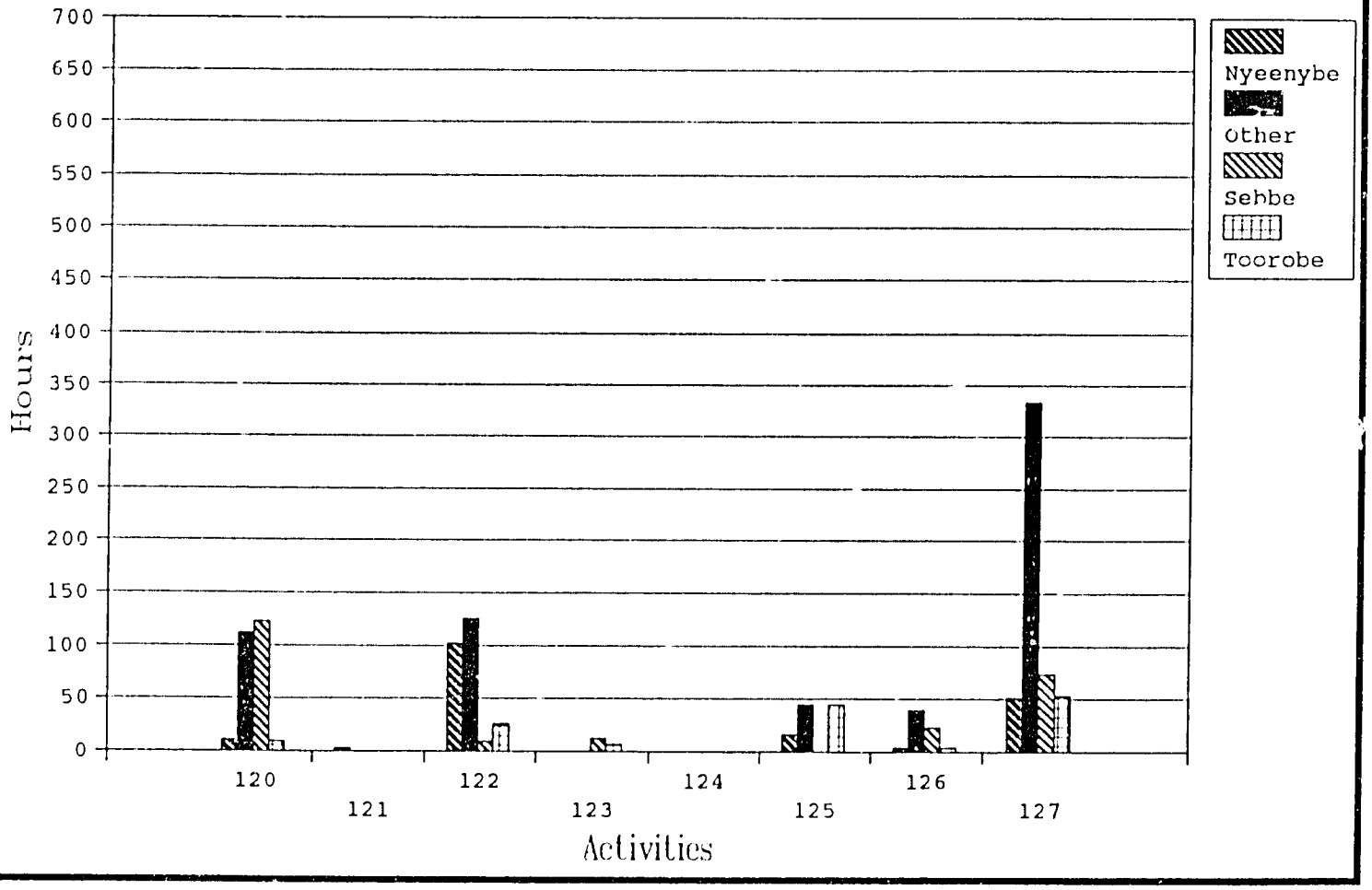
120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig. 6.29. Average Nonagricultural Hours for Women 15-60 (1)



120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig. 6.30. Average Nonagricultural Hours for Women 15-60 (2)



120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor. baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

gender division of labor among the Subalbe regarding fishing activities: men fish and women process and market the catch.

As expected, both men and women of the Nyeenybe artisanal caste are very involved in artisanal activities, as are "other" women. They are followed by Fulbe women, who are highly regarded for the quality of the straw mats and baskets they weave. In service-oriented activities such as tailoring, baking, and butchery, the most active group are Sebbe men (about 275 hours a year), followed by Maccube and Subalbe men. Only Fulbe, Sebbe, and Toorobbe women are involved in service-oriented activities, and their time is minimal. Only Jaawambe, Toorobbe, and Maccube men reported time spent on salaried activities such as being a government functionary or retiree.

d. Men and Women 61 and Older

Figures 6.31, 6.32, 6.33, and 6.34 show the distribution of nonagricultural activities among men and women over 60, by caste. In most of the nonagricultural activities that were observed, men's hours average higher than women's. Other than in schooling activities, where Jaawambe men show active engagement (an average of over 450 hours), however, differences between the genders are not large. As the number of Jaawambe men over 60 is small (four), the high average might be because one or two of these men are very old and spend many hours at the mosque learning the Koran and listening to the marabout, thereby exaggerating the group's involvement in schooling activities. Next in hours of schooling come Toorobbe and Nyeenybe men. Interestingly, Fulbe women in this age group show more involvement (over 100 hours) in schooling activities than Fulbe men (about 65 hours).

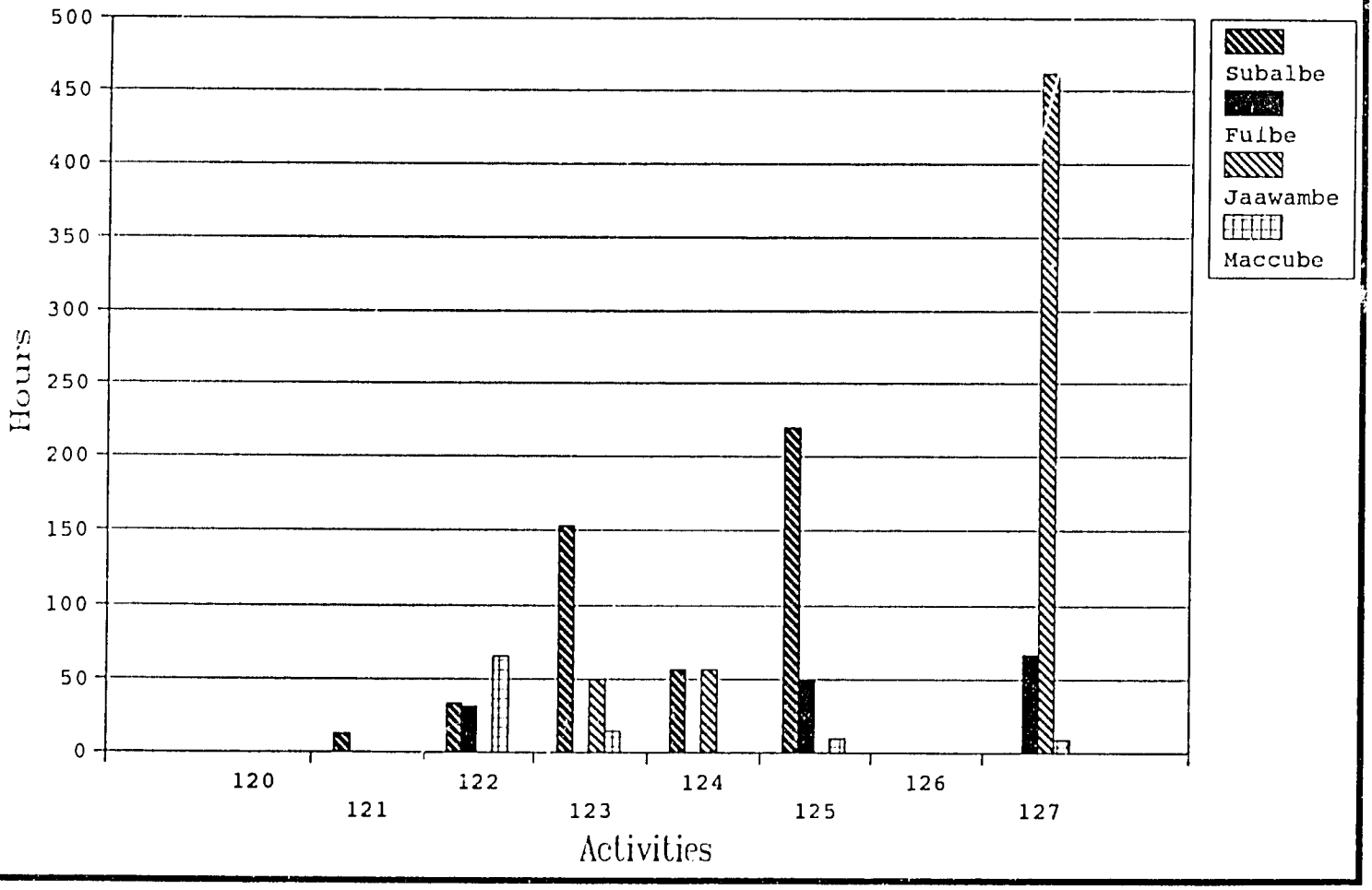
While the Fulbe generally spend the most time in herding activities, in this age group they are surpassed by the Subalbe and the Nyeenybe, especially Nyeenybe women, by a rather large margin. As with the 15-60 age group, Nyeenybe men are the most active in artisanal activities; Fulbe women are second.

Service-oriented activities seem to be restricted to men, with Subalbe, Jaawambe, and Nyeenybe the most active. We notice the total absence of Sebbe men and women, but that is because no Sebbe men and only two Sebbe women over the age of 60 are among our sample group, and, as a group, the Sebbe seem to be less demanding of their children and elderly than the other castes.

D. Domestic Activities

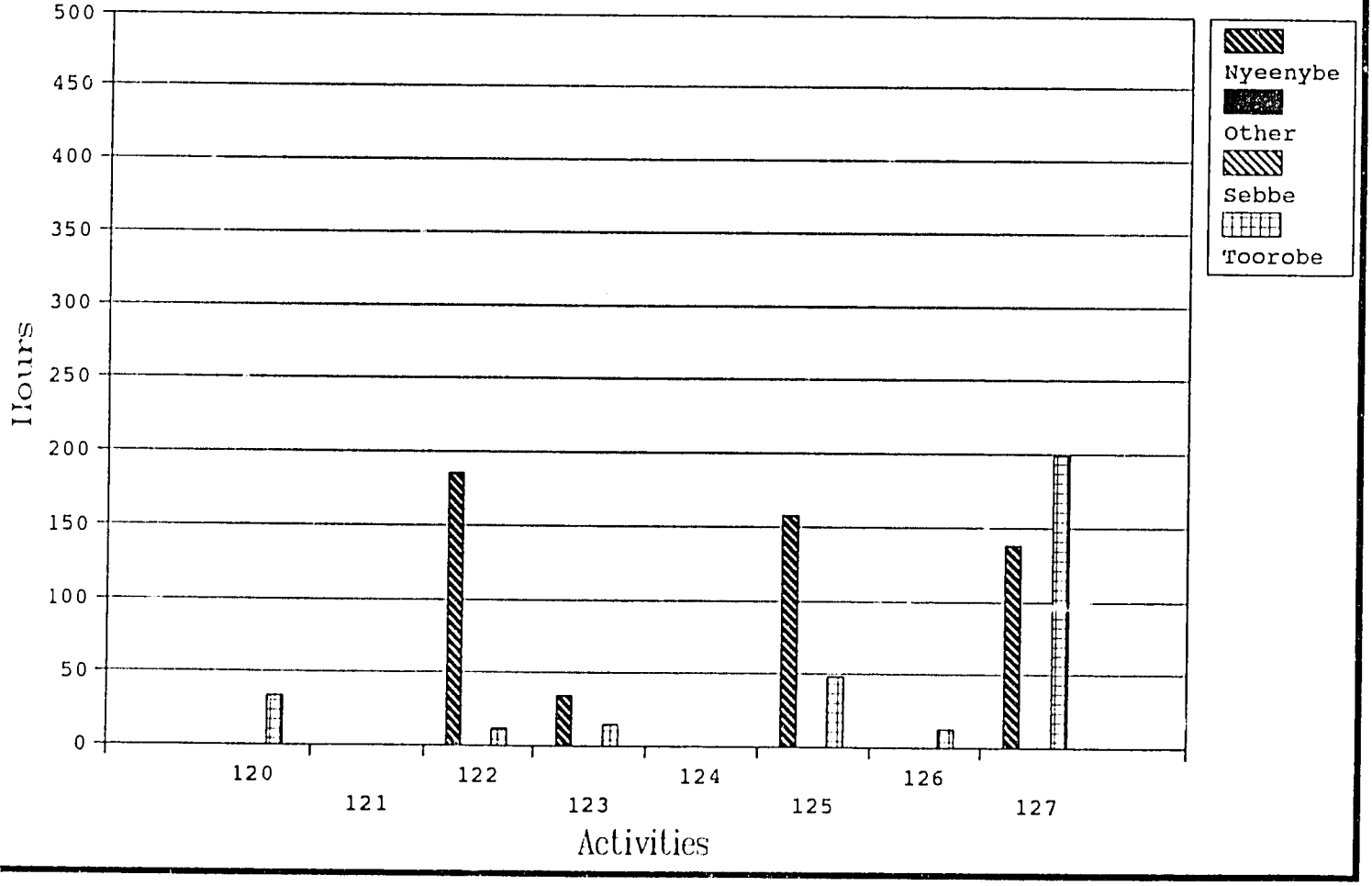
It is in the domain of domestic activities, especially for the age group 15-45, that the difference in the amount of time expended by males and females is most dramatic. Table 6.12 shows total annual labor hours that males and females of different age groups expend, by activity. The last row shows the total amount of domestic labor by gender and age group. Except for house construction/maintenance, where men over 60 expend slightly more total hours

Fig.6.31. Average Nonagricultural Hours
for Men:61+ (1)



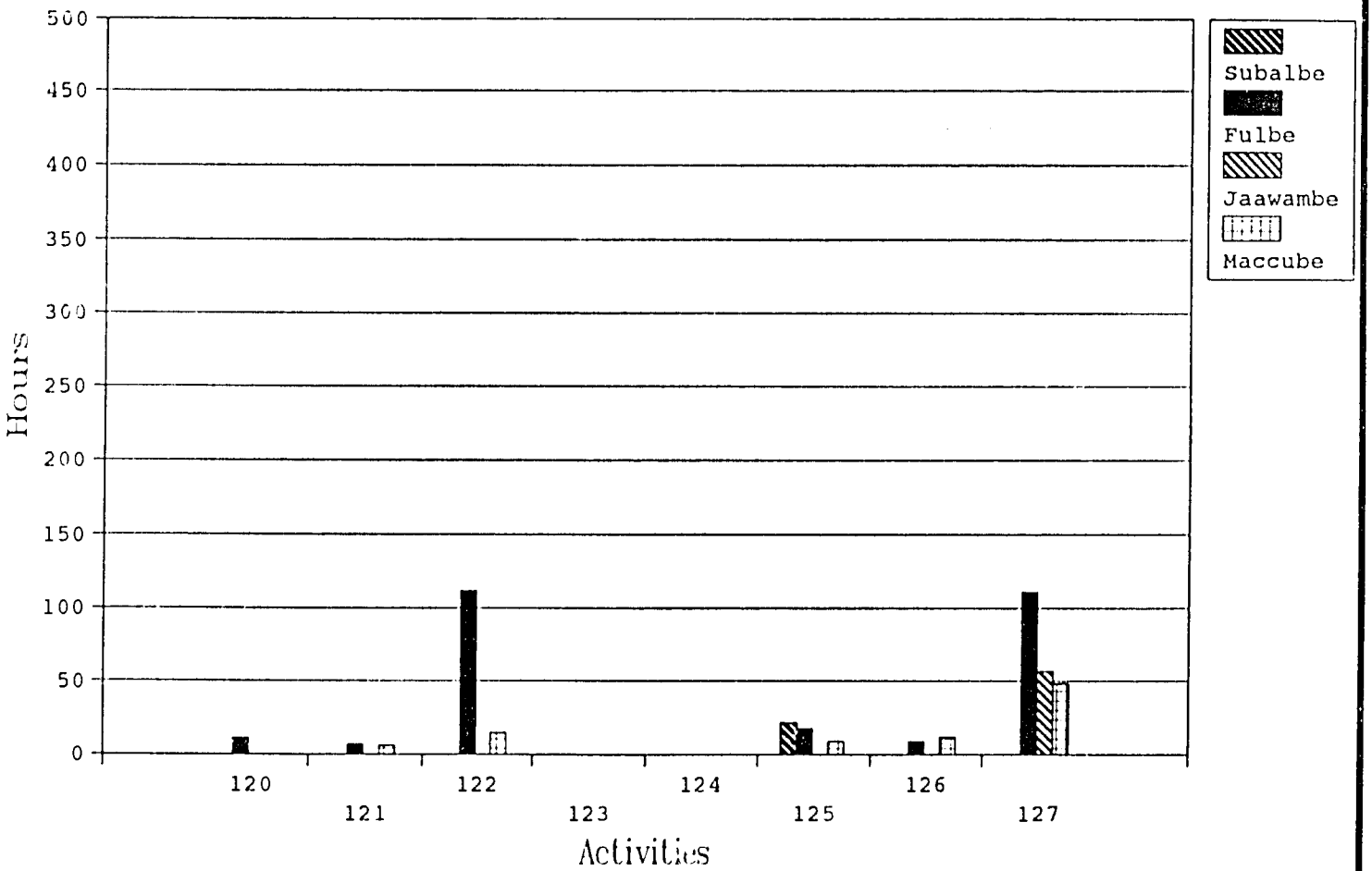
120	Commerce (shopkeeper, etc.)
121	Fishing
122	Artisanal (metalwork, wood-carving, hair braiding, etc.)
123	Service oriented (tailor, baker, butcher, marabout)
124	Salaried (functionary, retired, etc.)
125	Herding
126	Hunting and gathering
127	Other (talibe, student, etc.)

Fig.6.32. Average Nonagricultural Hours
for Men: 61+ (2)



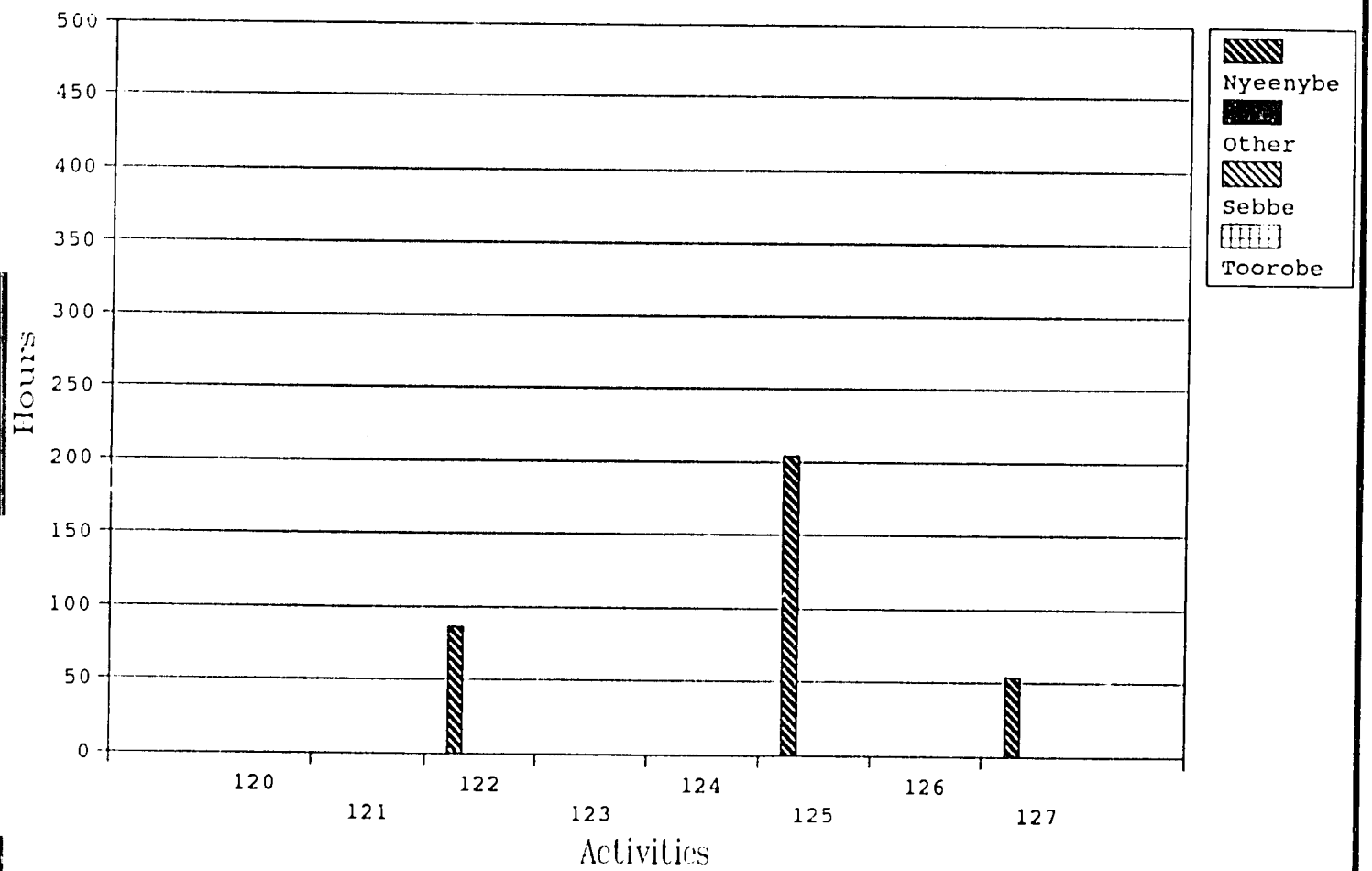
120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig.6.33. Average Nonagricultural Hours for Women: 61+ (1)



120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

Fig.6.34. Average Nonagricultural Hours for Women: 61+ (2)



120 Commerce (shopkeeper, etc.)
121 Fishing
122 Artisanal (metalwork, wood-carving, hair braiding, etc.)
123 Service oriented (tailor, baker, butcher, marabout)
124 Salaried (functionary, retired, etc.)
125 Herding
126 Hunting and gathering
127 Other (talibe, student, etc.)

than women in the same age group, females in the remaining groups expend far more labor hours than men. This gender differentiation in domestic labor is evident in Figure 6.35.

Table 6.12. Total Annual Labor Hours on Domestic Activities by Age and Gender

Activities	Male					Female				
	0-7	8-14	15-45	46-60	61+	0-7	8-14	15-45	46-60	61+
Housecleaning	0	516	594	288	28	8,599	33,615	99,847	21,862	5,312
Food Preparation	0	1,348	1,957	522	140	6,993	72,039	429,125	49,481	10,659
Child Care	0	226	1,139	602	426	2,337	7,663	101,807	32,326	10,635
Washing/ Ironing	0	282	889	0	56	2,192	31,085	121,013	6,264	844
Firewood Collection	3,236	28,931	7,290	1,344	628	7,310	38,211	27,062	3,351	1,454
Water Collection	117	8,595	8,628	626	56	15,968	93,670	301,328	34,675	4,420
House Construction/ Maintenance	49	3,081	12,837	3,242	5,319	485	3,299	20,433	10,930	3,014
Carrying Food to Field	309	564	28	0	0	669	1,252	1,466	413	0
Other	61	2,022	1,656	489	0	885	2,527	8,215	1,515	168
Total	3,772	45,564	35,018	7,115	6,654	45,438	283,361	1,110,297	160,816	36,507

The two activities requiring the most labor are food preparation and water collection. Housecleaning, child care, and washing and ironing seem to be about equally demanding.

Table 6.12 and Figure 6.35 show total labor hours, necessarily biased toward larger groups, so we display a number of graphs based on average annual labor per person. Figure 6.36 shows annual domestic labor per person by caste. We note that the Sebbe spend on average the most hours—over 800—on domestic activities, with Jaawambe and Toorobbe next (averaging slightly over 700 per person).

Although there are no significant caste differences in the absence of age and gender distinctions, the picture is somewhat changed when we bring in age and gender factors, as seen in Figures 6.37 and 6.38. Figure 6.37 shows the average time that females of various age groups expend on domestic activities. While the Sebbe are the most active group when age and gender differences are not considered, the proportion of their effort changes when the factors of gender and age are brought in. Sebbe females of the age group 15-45 spend the most time on domestic labor. In terms of average overall domestic labor, however, they are surpassed by the category "other," age group 8-14. "Other" girls are also the most active in the age group

Fig. 6.35. Male and Female Engagement
in Domestic Activities by Age Group

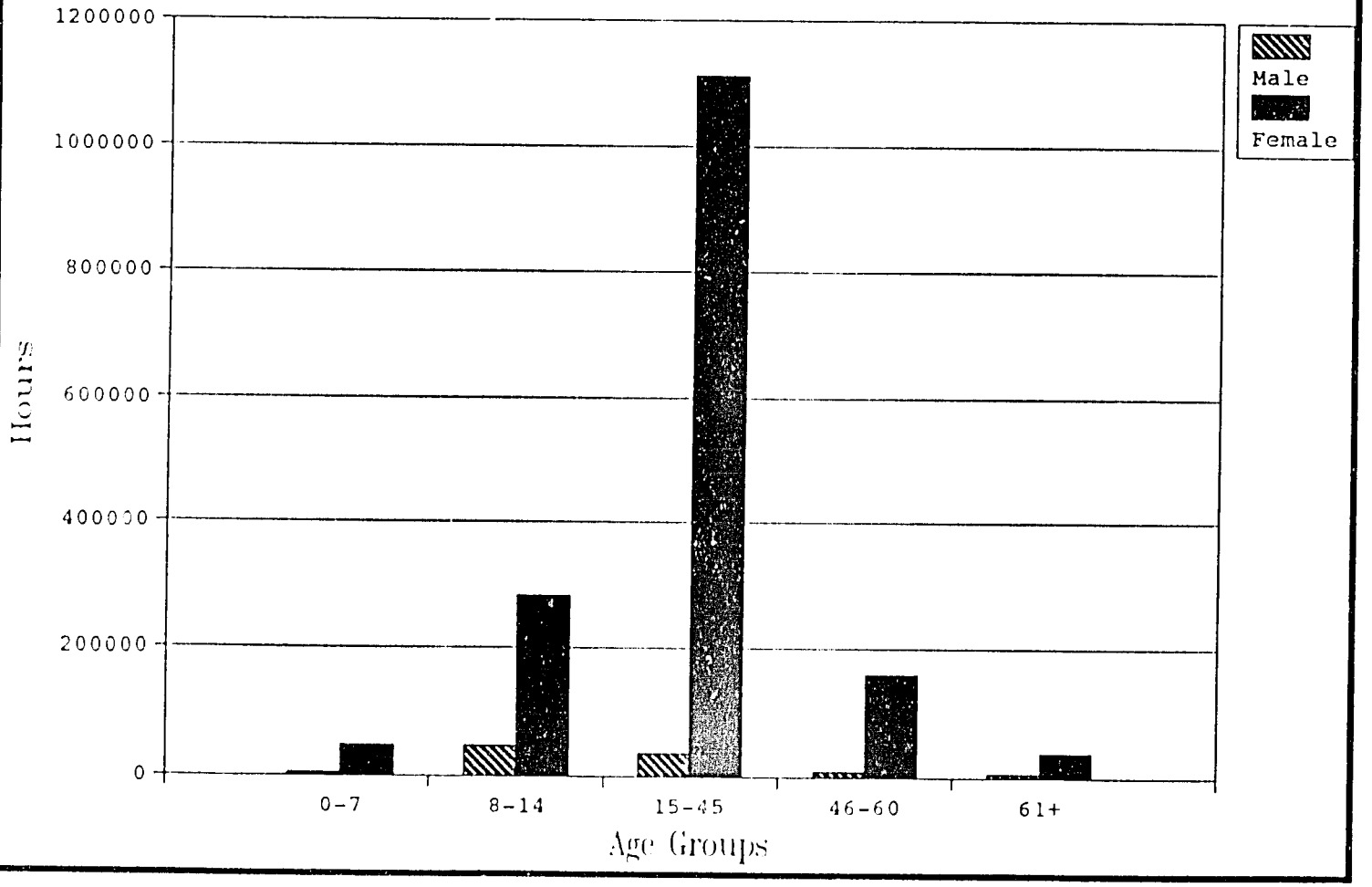


Fig. 6.36. Average Annual Domestic Labor by Caste

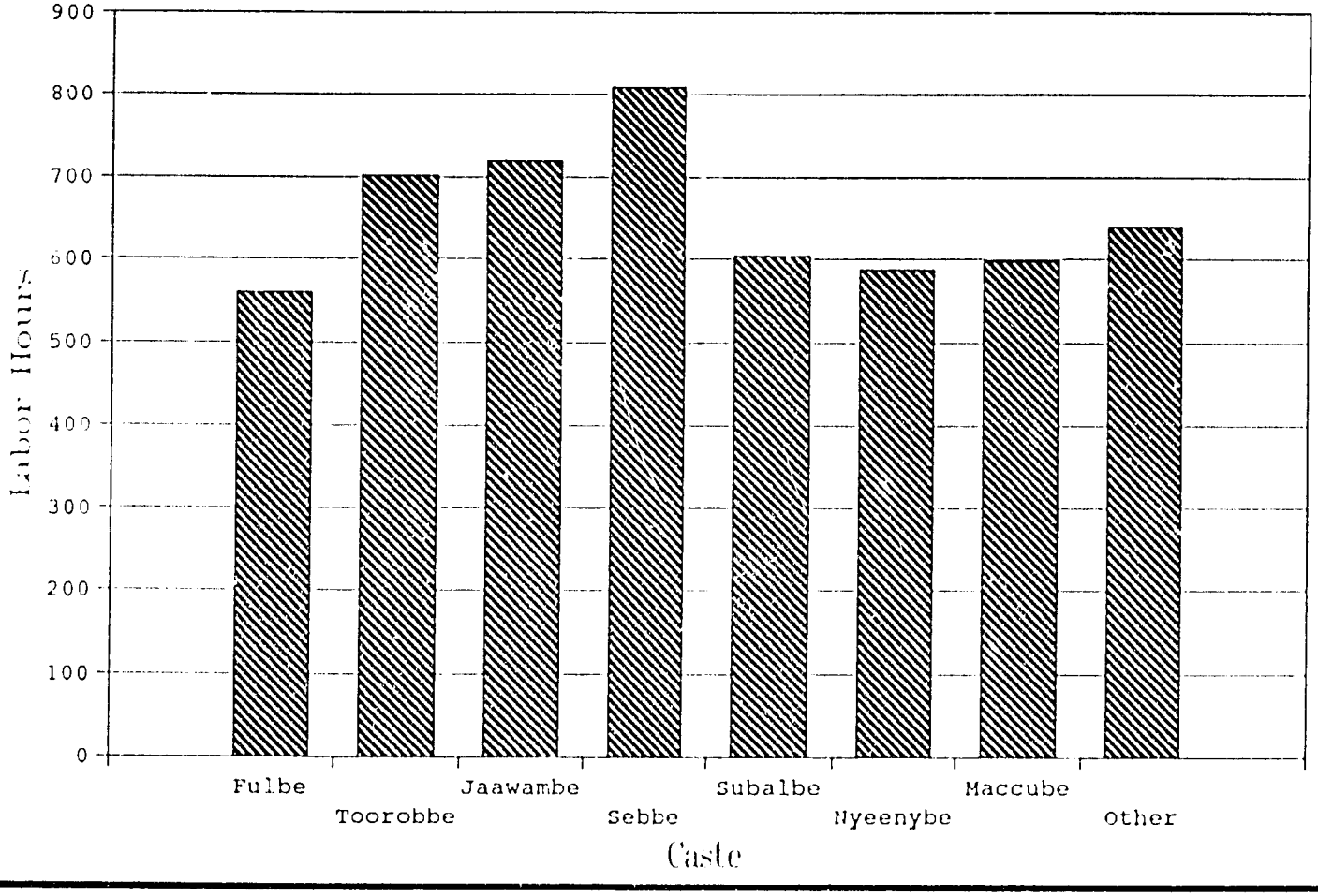


Fig. 6.37. Average Annual Female
Domestic Labor by Caste

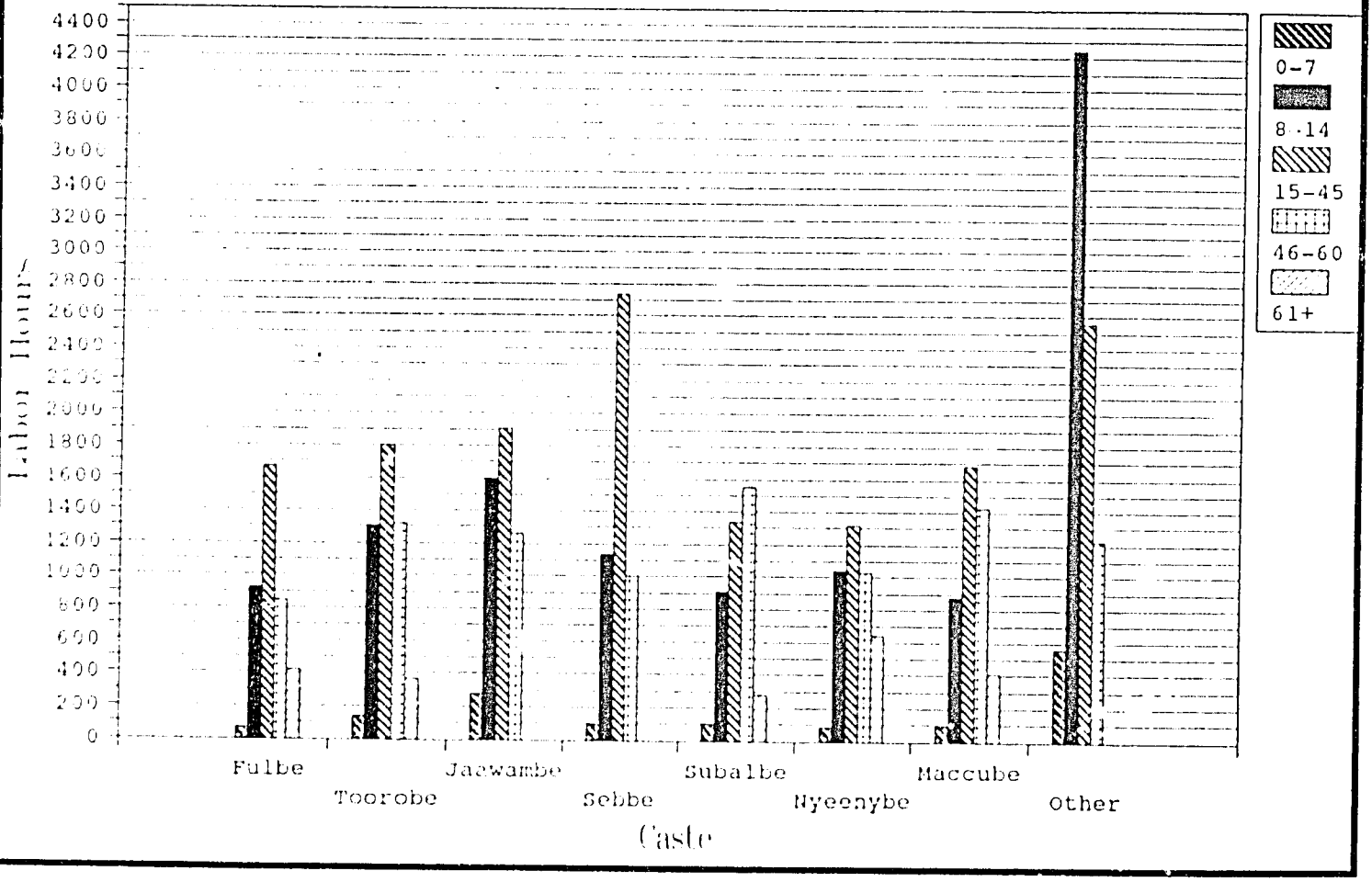
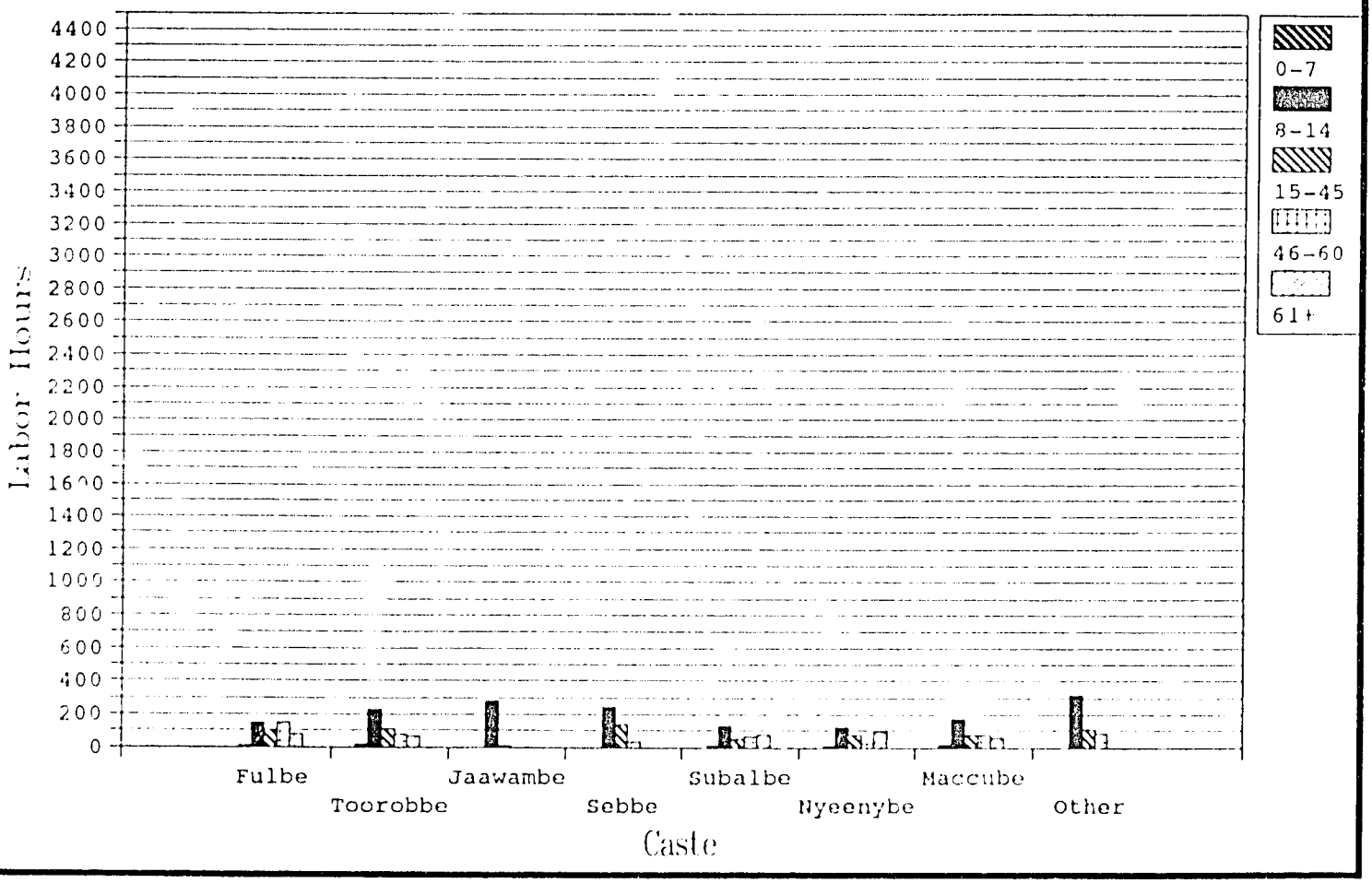


Fig. 6.38. Average Annual Male
Domestic Labor by Caste



0-7, with Jaawambe next: average annual hours are low for this youthful cohort, however. Despite these differences, there appears to be little correlation between a woman's caste affiliation and the amount of time she spends on domestic activities.

Figure 6.38 presents the same information for males. The first observation is the striking difference between the hours females and males spend on domestic activities, both by age group and by caste. Even the most active males, the Jaawambe, "other," and Sebbe of the age group 8-14, expend a small fraction of the time spent by the least active females. Looking back at Table 6.12 reveals that the two activities that engage males the most are collection of firewood and house construction and maintenance.

Since males are minimally involved in domestic activities, this section examines only females in looking at age and caste differentiation by household activity (Figures 6.39-6.43). Figure 6.39 shows the average number of hours that girls of age groups 0-7 and 8-14 expend on domestic activities by caste. In all caste groups (except "other"), the youngest girls (0-7) are minimally involved in domestic activities, with an all-caste annual average of 116 hours. The three activities that seem to involve young girls (0-7) the most are water collection, firewood collection, and housecleaning.

As girls pass age seven the degree of their involvement in domestic activities increases sharply as seen in Figure 6.39. Irrespective of caste affiliation, the activities that engage girls of this age group the most are food preparation, water collection, and firewood collection. By contrast, they are all only marginally involved in house construction and maintenance and carrying food to the field. In all activities, but particularly in food preparation, firewood collection, and water collection, "other" girls surpass the rest, but as remarked earlier, this may be a statistical aberration.

Even among women of ages 15-60, who are substantially involved in domestic work (Figures 6.40 and 6.41), caste differences among specific activities are rather insignificant. The two activities that engage women of this age the most are food preparation and water carrying. Average hours of domestic work are high, ranging for most caste groups between 500 and 600 hours a year for food preparation and about 400 hours for carrying water, often over long distances.

Figures 6.42 and 6.43 show the distribution of domestic activities among women aged 61 and over, by caste. Although some older women are slightly more involved than girls aged 0-7, women over 60 report relatively few hours at domestic activities. The zero value for the Sebbe (Figure 6.43) reflects the absence from our sample of Sebbe women in this age group, not necessarily zero hours for such women.

In sum, women are much more involved in domestic activities than men, as expected. The level of activity increases after childhood and only declines later in life, after age 60. Women's most time-consuming activities include food preparation, firewood collection, and water collection.

Fig. 6.39. Average Domestic Labor
Hours for Girls by Caste

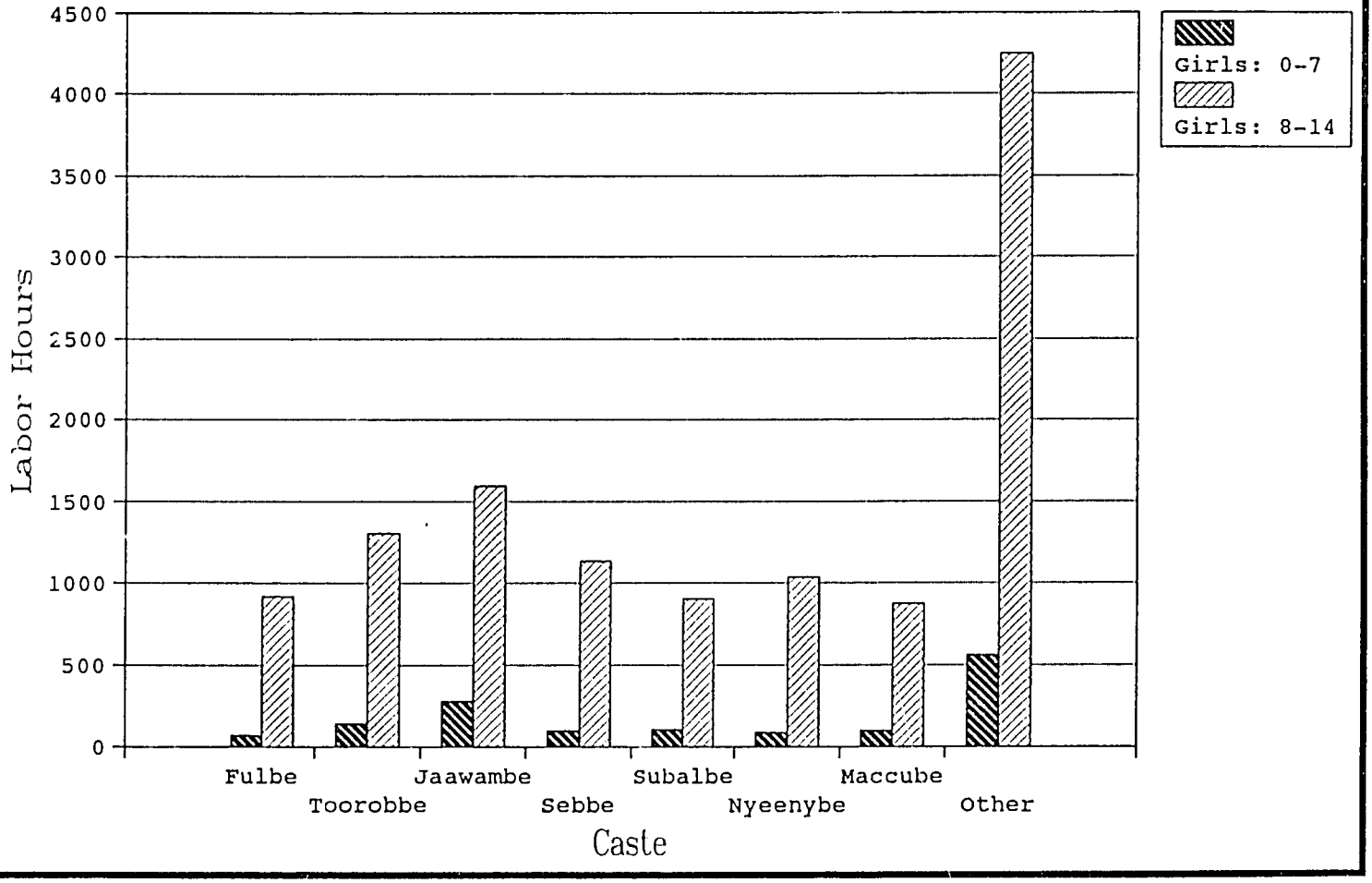
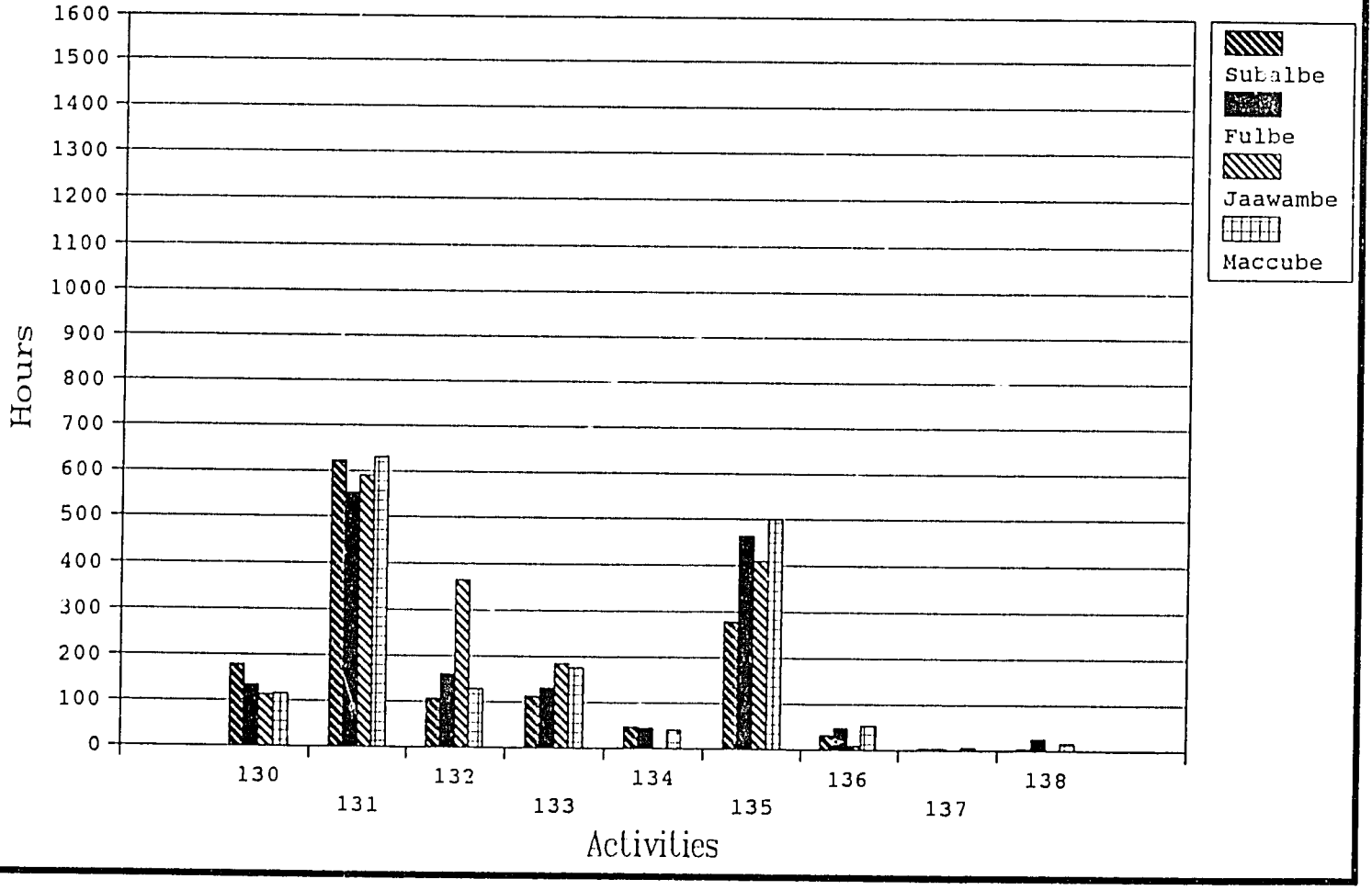
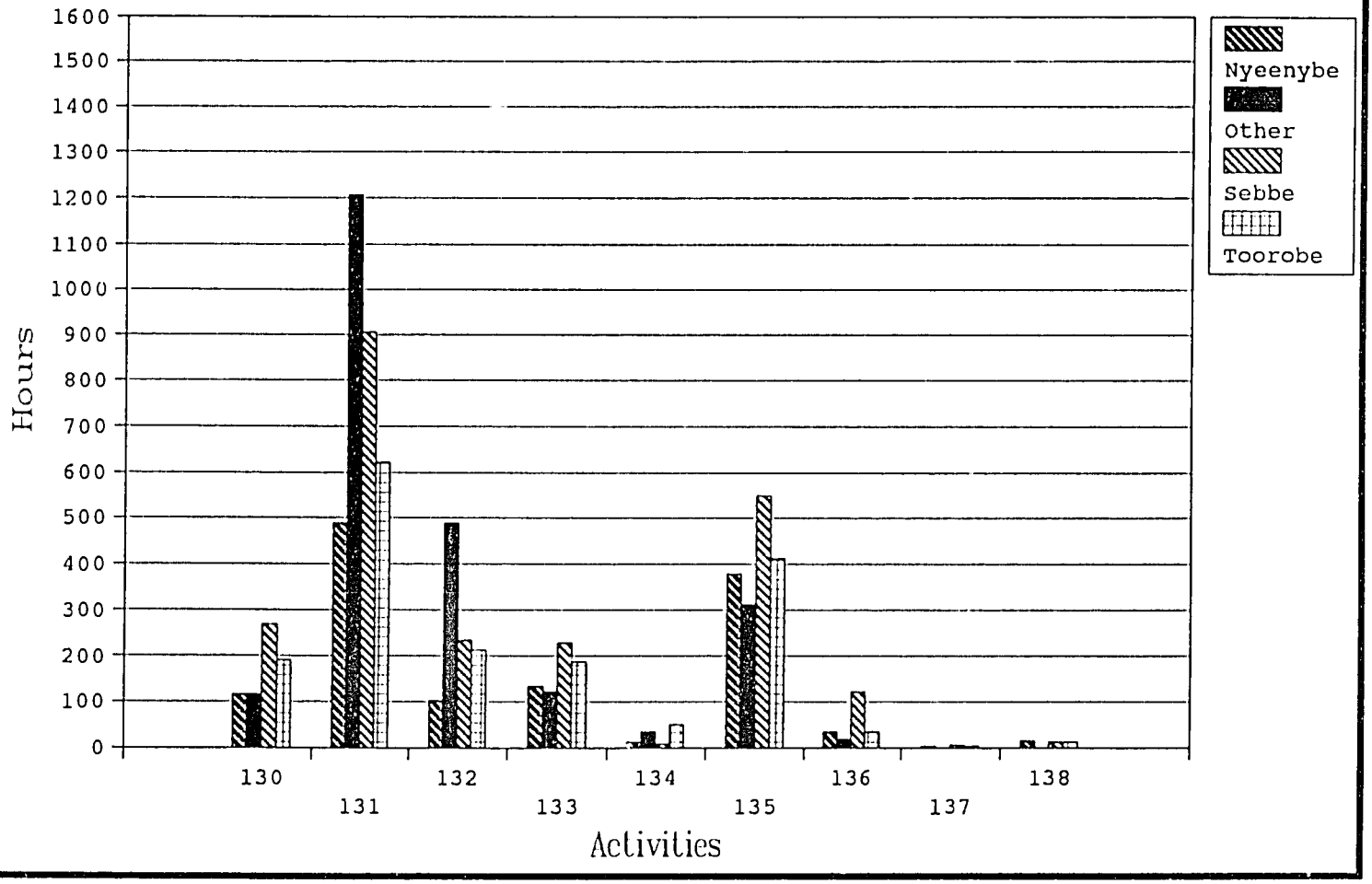


Fig. 6.40. Average Labor Hours for Domestic Activities: Women 15-60 (1)



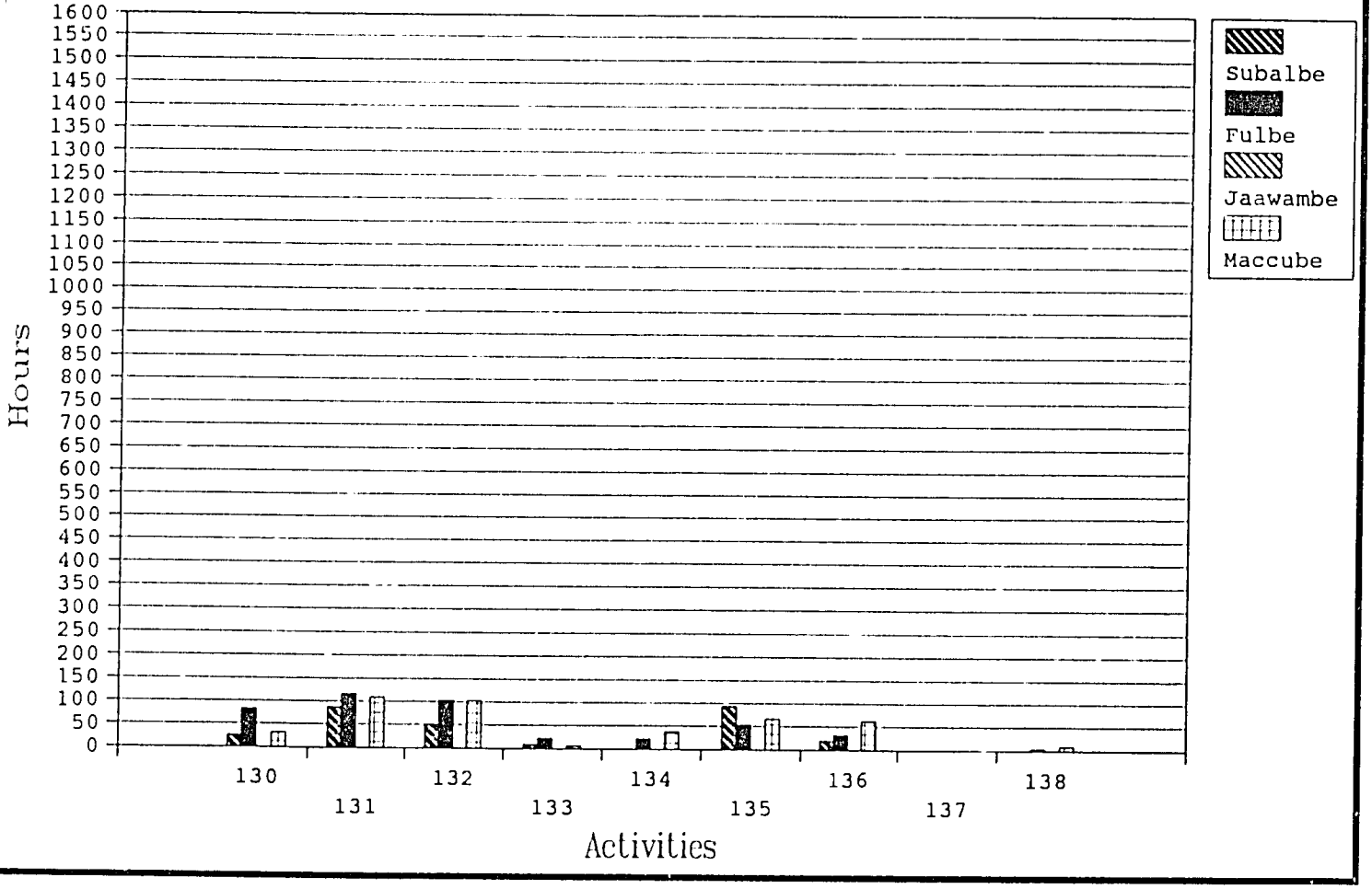
130 Housecleaning
131 Food preparation
132 Child care
133 Washing and ironing
134 Firewood collection
135 Water collection
136 House construction/maint.
137 Carrying food to field
138 Other

Fig. 6.41. Average Labor Hours for Domestic Activities: Women 15-60 (2)



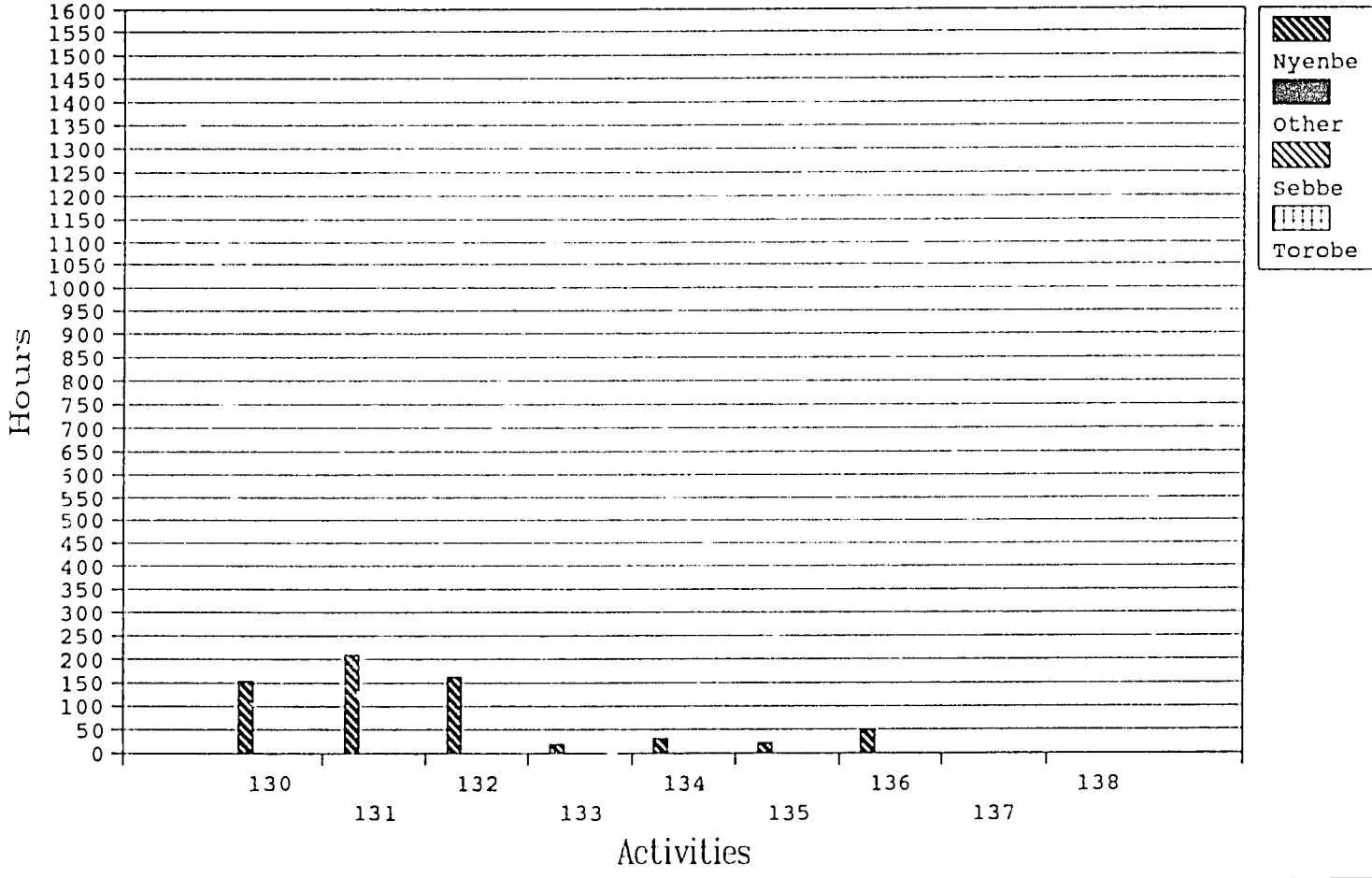
130 Housecleaning
131 Food preparation
132 Child care
133 Washing and ironing
134 Firewood collection
135 Water collection
136 House construction/maint.
137 Carrying food to field
138 Other

Fig. 6.42. Average Labor Hours for Domestic Activities: Women 61+ (1)



130 Housecleaning
131 Food preparation
132 Child care
133 Washing and ironing
134 Firewood collection
135 Water collection
136 House construction/maint.
137 Carrying food to field
138 Other

Fig. 6.43. Average Labor Hours for
Domestic Activities: Women 61+ (2)



130 Housecleaning
131 Food preparation
132 Child care
133 Washing and ironing
134 Firewood collection
135 Water collection
136 House construction/maint.
137 Carrying food to field
138 Other

E. Total Labor Allocation

As stated earlier, the PDRG bases its goal of irrigating the Middle Senegal Valley on the idea that additional labor will be readily available. In their words, "malgré l'importance de l'émigration des actifs, le potential de main d'oeuvre est élevé" (GERSAR-CACG 1991:9). The accuracy of this assumption is examined in this section in the light of the data presented. The analysis is based on the assumption that few of the migrant laborers are likely to return on a permanent basis. Accordingly, the activities reported here do not include the work of those involved in labor migration.

1. Labor Allocation: Percentages

The hours and percentage of time that different age and gender groups expend on three categories of activities—agricultural, nonagricultural, and domestic—is examined first to see if there are relationships between the proportion of time that different groups spend on the various economic activities and their age, gender, and caste. Next, average hours of labor are examined by age, gender, and caste. This will show the differential involvement of the diverse groups in productive activities and will also allow one to test the assumption of the ready availability of additional labor in the Middle Valley that a large-scale transition to irrigation will require.

2. Gender Differentiation in Productive Activities

Table 6.13 and Figures 6.44 and 6.45 show the proportion of time that males and females of different age groups spend on each of the three categories of economic activities: agricultural, nonagricultural, and domestic.

Irrespective of their age group, males spend a small fraction of their productive time on domestic activities. Except for the age group 8-14, males of the various age categories spend almost the same proportion of time on domestic activities—7 to 8 percent. (This is not a measure of hours actually spent, of course.) We see more variation by age in agricultural and nonagricultural activities: in agriculture, the proportion of time that males spend tends to increase with age. Men aged 61 and above spend the largest proportion of their time in agriculture, children and youths less. In nonagricultural activities, the opposite holds: the proportion of time spent decreases as age increases.

Empirical observation suggests that young men tend to seek jobs outside of the agricultural sphere, both on and off the farm, while men aged 46 and older become more involved in agriculture. Among the youngest boys (0-7), who spend most of their time in the village, nonagricultural activities are the most time-consuming outlet for their energies.

As expected, the largest proportion of women's time, in all age groups, is taken up in domestic activities, most noticeably within the age group 15-45. Differences among the other age groups are not substantial.

Table 6.13. Percentage of Time Allocated among Economic Activities by Gender and Age

Activity	Male					Female				
	0-7	8-14	15-45	46-60	61+	0-7	8-14	15-45	46-60	61+
Agriculture	36.6	36.0	42.1	56.4	60.1	15.4	14.9	11.4	13.3	13.0
Nonagricultural	56.4	51.8	50.5	36.2	32.2	18.3	14.1	6.8	16.0	24.3
Domestic	7.0	12.2	7.4	7.4	7.7	66.4	71.0	81.8	70.7	62.7
Total	100.0	100.0	100.0	100.0	100.0	100.1[a]	100.0	100.0	100.0	100.0

[a] Figures do not add to 100.0 because of rounding.

3. Caste Differentiation in Economic Activities

To look for correlations between the proportion of time people devote to different economic activities and their caste affiliation, the labor hours devoted to agricultural, nonagricultural, and domestic work of adult men and women (aged 15-60) were sorted by caste as seen in Tables 6.14 and 6.15 and Figures 6.46 and 6.47.

Adult men of all castes spend a very small proportion of their time on domestic activities. For all groups, less than 9 percent of working time is allocated to domestic activities, with a range of 0.5 percent for the Jaawambe to 8.6 percent for the Fulbe, and an overall average of 7.4 percent (Table 6.14). We have seen earlier that the time adult men spend on domestic activities is usually devoted to what might be considered "masculine" work, such as house construction and maintenance. Very high proportions of adult men's labor time thus remains to be divided between agricultural and nonagricultural activities. The Sebbe (69.6 percent) and Subalbe (63.6 percent) spend the largest proportion of their time on agricultural activities, followed by the Maccube (55.2 percent). As a caste, the Subalbe are fishermen. Since fishing was recorded as a nonagricultural activity, one might expect to see a higher proportion of Subalbe time devoted to this category. The data reveal, however, that fewer adult Subalbe men are involved in fishing than in farming. While every adult present is expected to participate in farming activities, fishing is usually relegated to one or two family members. In some families, there are no fishermen.

The Fulbe (31.4 percent), the Nyeenybe (34.6 percent), and "other" (28.1 percent) show a much lower proportion of agricultural time, as expected. For the Fulbe, animal husbandry is the main source of livelihood, while the Nyeenybe are an artisan caste. Adult men in the category "other," while they engage in agriculture—often seriously—during their stay in the region, are primarily employed in government positions or other nonagricultural jobs. The Toorobbe allocate only 41 percent of their time to agricultural activities, despite their sizable landholdings. This can probably be explained by the fact that Toorobbe often lease their lands to other castes, receiving the benefits of agriculture without being directly involved. It may also

Fig. 6.44. Male Labor Allocation by Activity and Age Group: Percentages

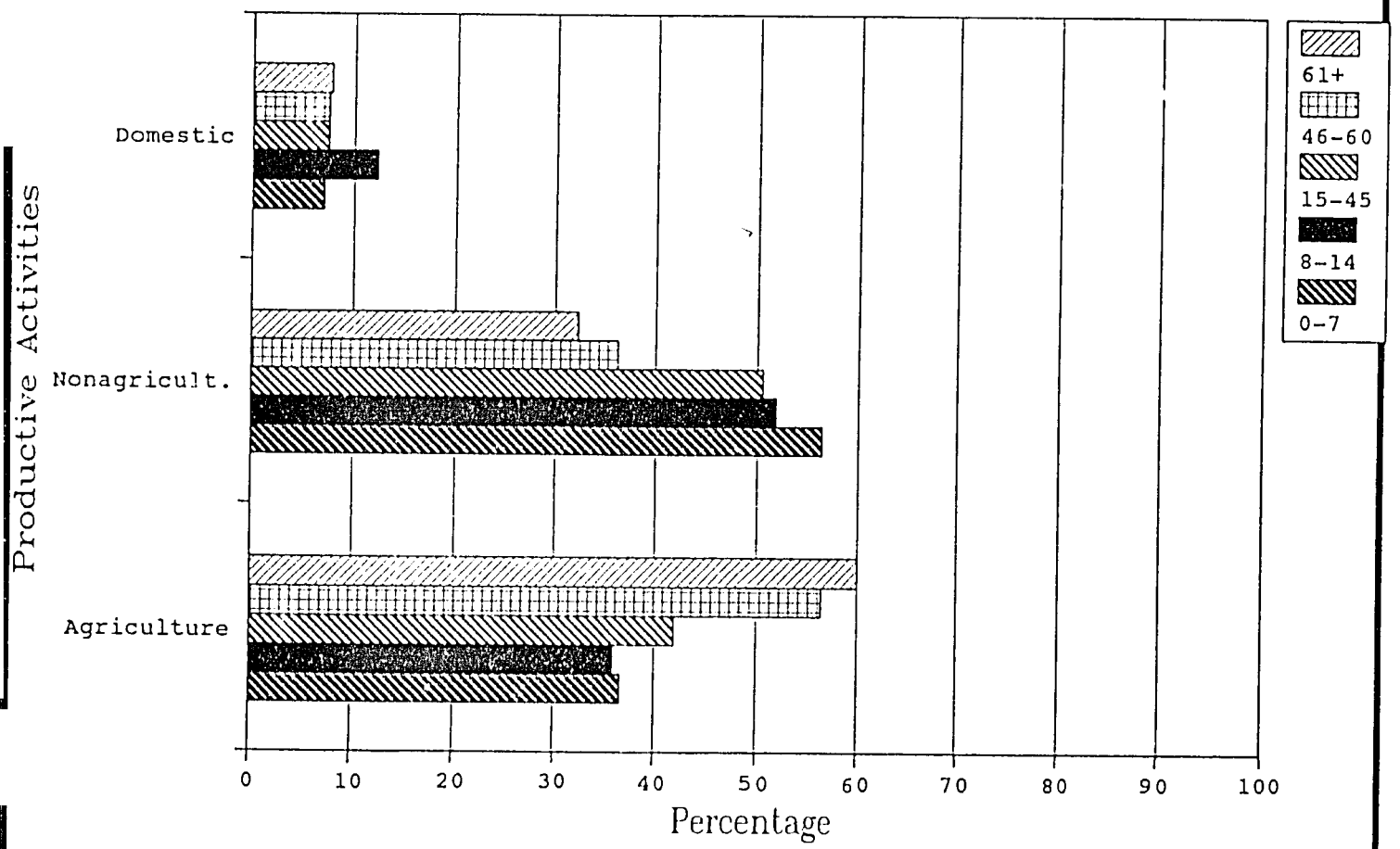


Fig. 6.45. Female Labor Allocation by Activity and Age Group: Percentages

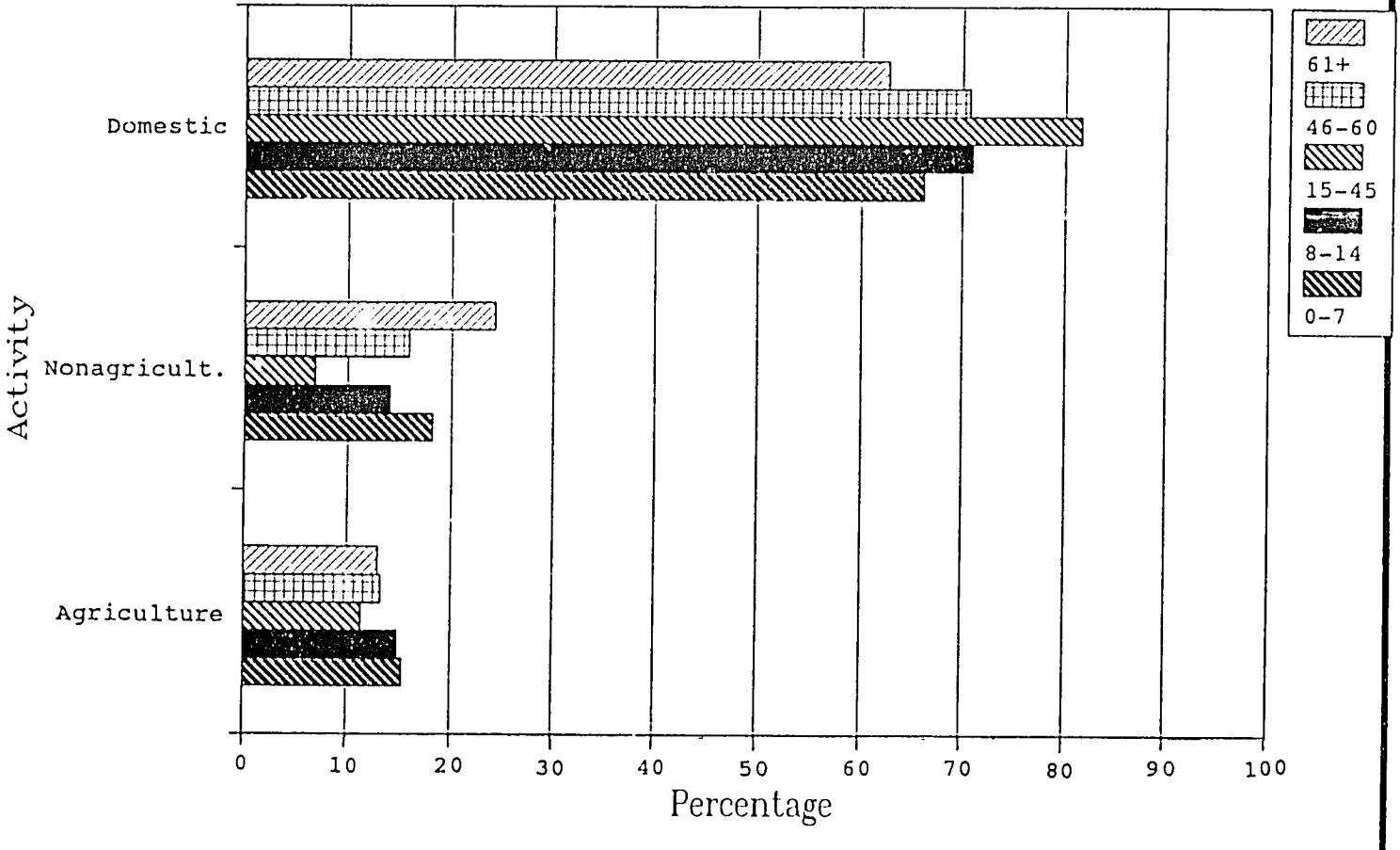


Table 6.14. Percentage of Labor Hours for Men 15-60 by Activity and Caste

Activity	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	Total
Agriculture	31.4	41.1	47.6	69.6	63.6	34.6	55.2	28.1	44.5
Nonagricultural	60.0	50.4	51.9	25.9	32.7	57.7	36.9	63.9	48.1
Domestic	8.6	8.5	0.5	4.5	3.7	7.6	8.0	8.0	7.4

Table 6.15. Percentage of Labor Hours for Women 15-60 by Activity and Caste

Activity	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other	Total
Agriculture	8.7	11.3	0.6	8.9	24.2	7.5	12.6	5.5	11.7
Nonagricultural	9.3	6.7	4.2	8.5	6.9	11.8	8.6	21.0	8.1
Domestic	82.0	82.0	95.2	82.6	68.9	80.7	78.8	73.5	80.2

be that, besides labor migration, more opportunities outside the agricultural sphere are available to the Toorobbe than to other groups.

Labor allocation among adult women is the inverse of that of men, with relatively small differences among castes. A very high proportion of time for all castes is spent on domestic activities, the highest by Jaawambe women (95.2 percent), who spend a minimal proportion of time on agricultural activities (0.6 percent). Subalbe women are the most involved in agriculture, which occupies 24.2 percent of their labor time, probably because Subalbe households have substantial access to falo farming, an activity that significantly engages women.[6]

F. Labor Allocation: Averages

This section examines the average labor hours per person for the various age and gender groups, first for each group of activities separately, and then for the activities combined.

[6] With just over 8 percent of the sample, Subalbe households have direct access to nearly 48 percent of falo plots (see Table 3.19).

Fig.6.46. Percentage of Male Labor
Allocation by Caste: 15-60

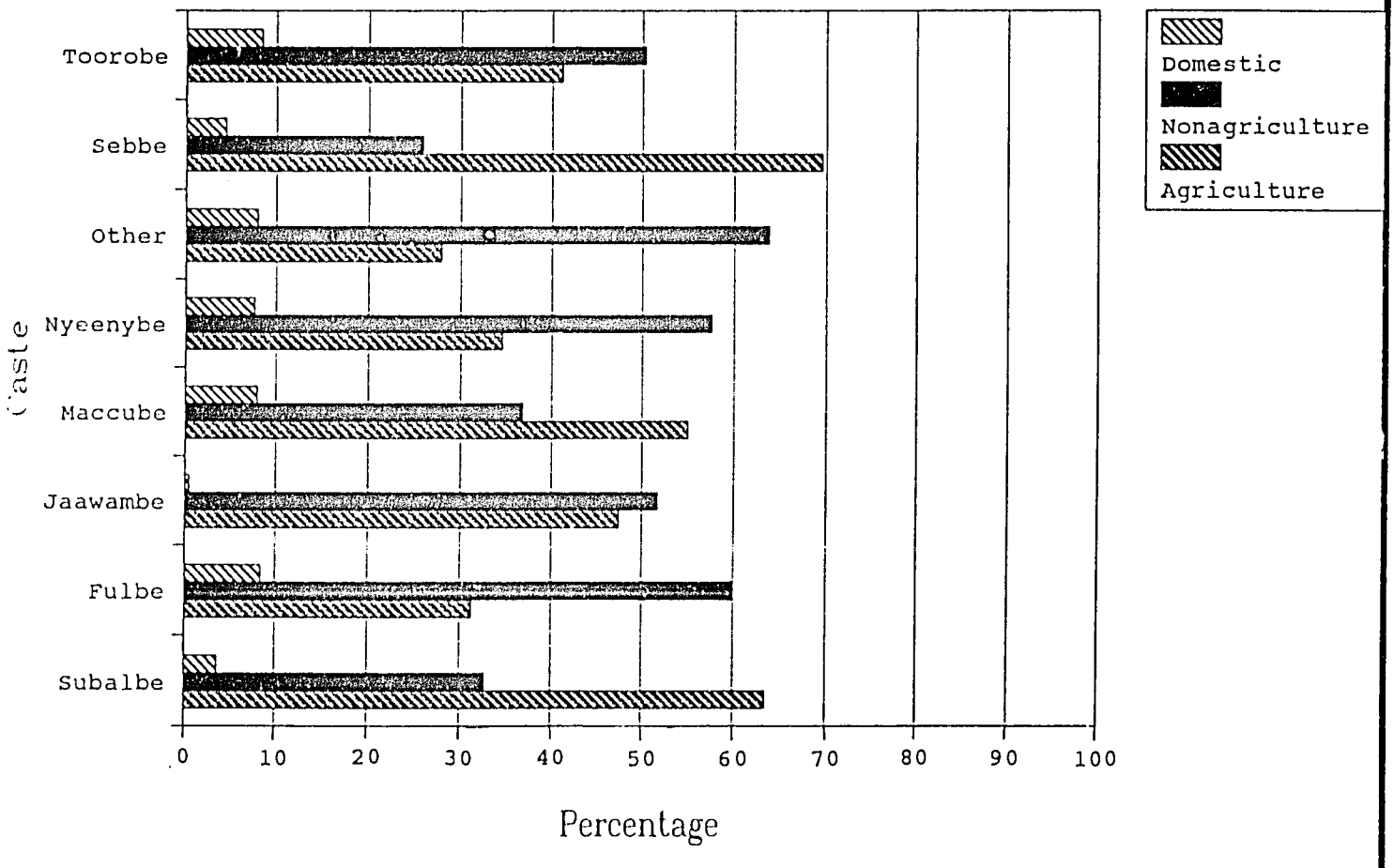
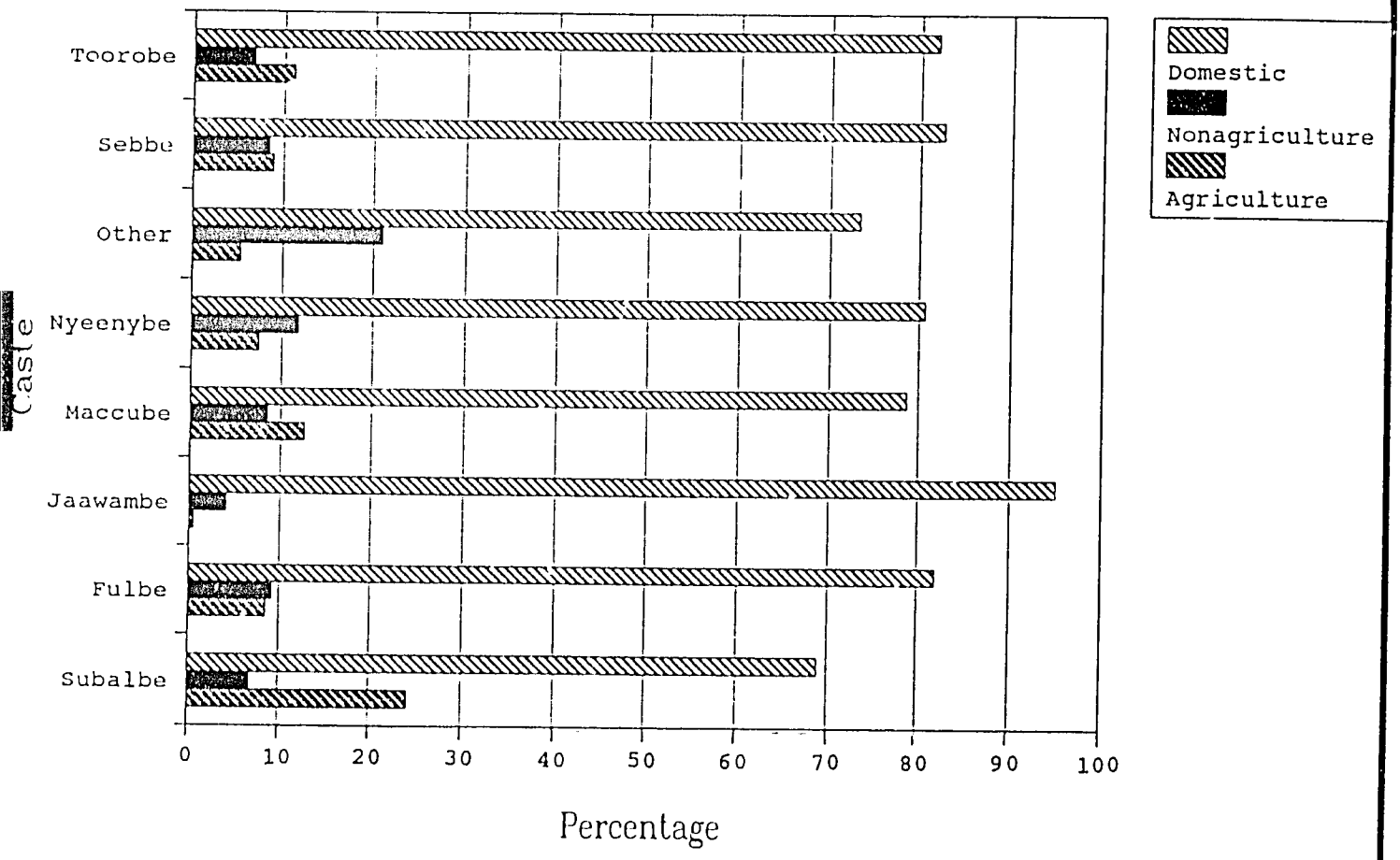


Fig. 6.47. Percentage of Female Labor Allocation by Caste: 15-60



1. Boys and Girls 0-7

Figures 6.48 and 6.49 compare the average number of hours that boys and girls of the age group 0-7, irrespective of caste affiliation, allocate to the different activities (Figure 6.48) and to the three types of activities combined (Figure 6.49).

Although neither gender expends very much energy on any one activity, girls, as expected, spend considerably more time on domestic activities than boys: almost 120 hours or 15 working days, as opposed to about 10 hours (a little over 1 day) for boys. Boys' involvement in agricultural and nonagricultural activities, however, is higher than girls'. Boys do not spend as much time on agricultural or nonagricultural activities as girls do on domestic chores, however. Also, the gaps between boys and girls in agricultural and nonagricultural work hours are smaller. Combining all activities, as seen in Figure 6.49, little girls spend more hours in productive activities than boys: 175 hours or almost 22 days as opposed to 140 hours or 17.5 days for boys.

2. Boys and Girls 8-14

Figures 6.50 and 6.51 compare the involvement of boys and girls, without respect to caste, in the age group 8-14 in the various economic activities. The first observation is that the general involvement of boys and girls in economic activities increases almost tenfold, comparing this age group with the younger one (note the difference in scale in Figures 6.48 and 6.50). As in the age group 0-7, girls spend many more hours on domestic activities than boys: over 1,000 hours or 125 days for girls, as opposed to less than 200 hours or 25 days for boys. Boys are more active in other work, however. While a boy spends an average of 800 hours or 100 days on nonagricultural activities, a girl in the same age group spends just over 200 hours or 25 days. The gap between boys and girls in the domain of agriculture is smaller. When all activities are combined, boys' and girls' hours do not differ substantially: 1,542 hours or about 193 days for boys as opposed to 1,517 hours or about 190 days for girls.

3. Men and Women 15-45 and 46-60

Figures 6.52 and 6.53 compare average labor hours for men and women in the combined age groups 15-45 and 46-60, by type of activity and all activities together. As with the younger age groups, women in these ages spend much more time than men in the domestic sphere. While a woman spends an average of 1,600 hours or 200 days on domestic activities, men spend less than 100 hours or 12.5 days. Men's labor hours in the other two spheres exceed that of women but the gaps are much smaller. Women are more involved in these male-oriented activities than men are in domestic ones. When we combine the number of hours for men and for women in all these activities (Figure 6.53), we see that women put in 65 percent more hours than men: 2,001 hours or 250 days as opposed to 1,212 hours or 151.5 days.

Fig. 6.48. Average Labor Hours by Activity for Boys and Girls 0-7

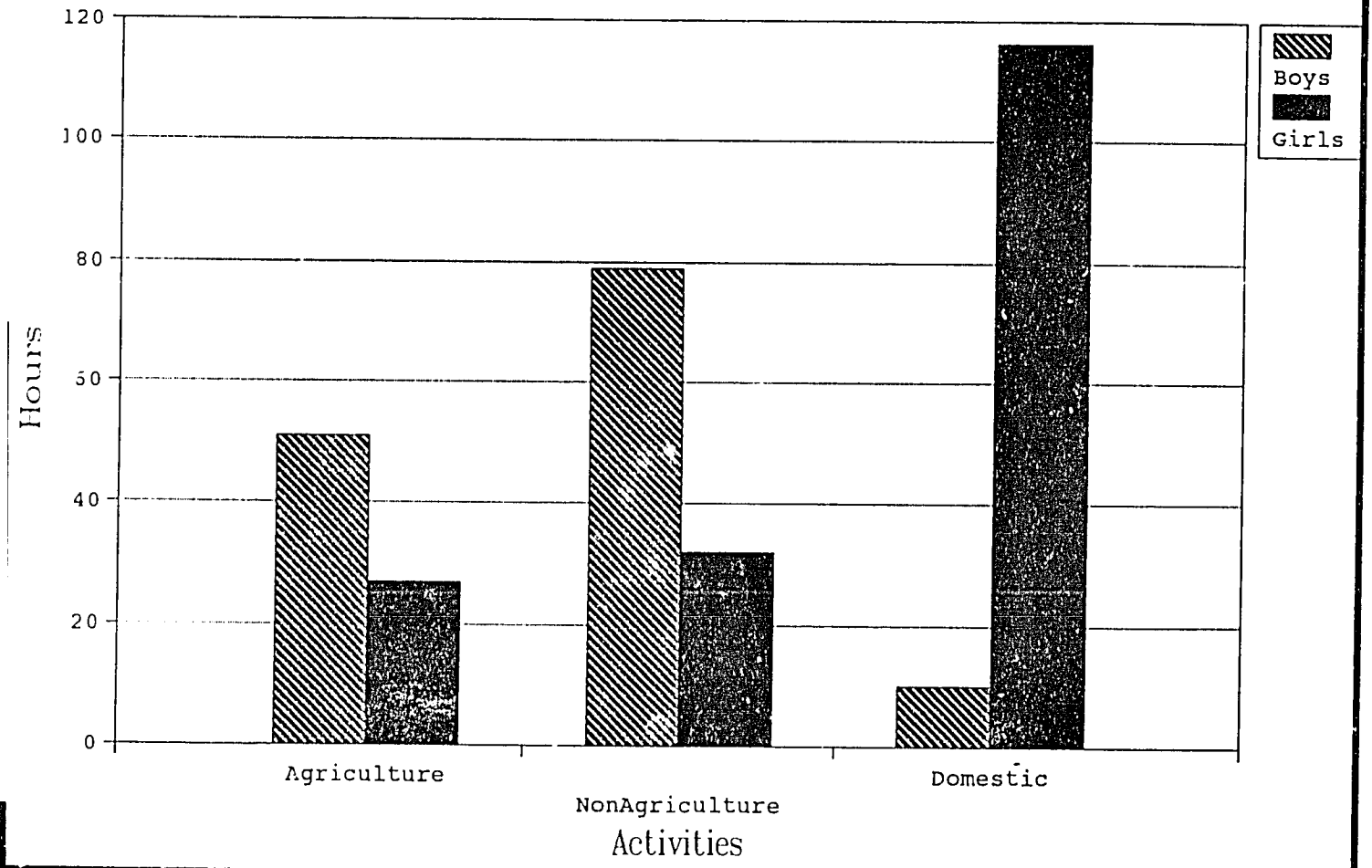


Fig. 6.49. Average Labor Hours for
Boys and Girls 0-7

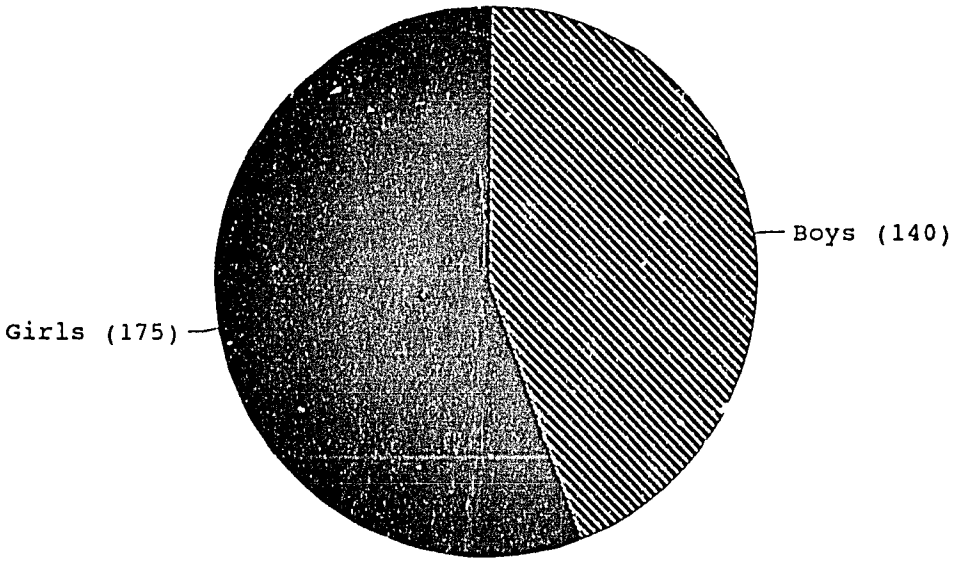


Fig. 6.50. Average Labor Hours by Activity for Boys and Girls 8-14

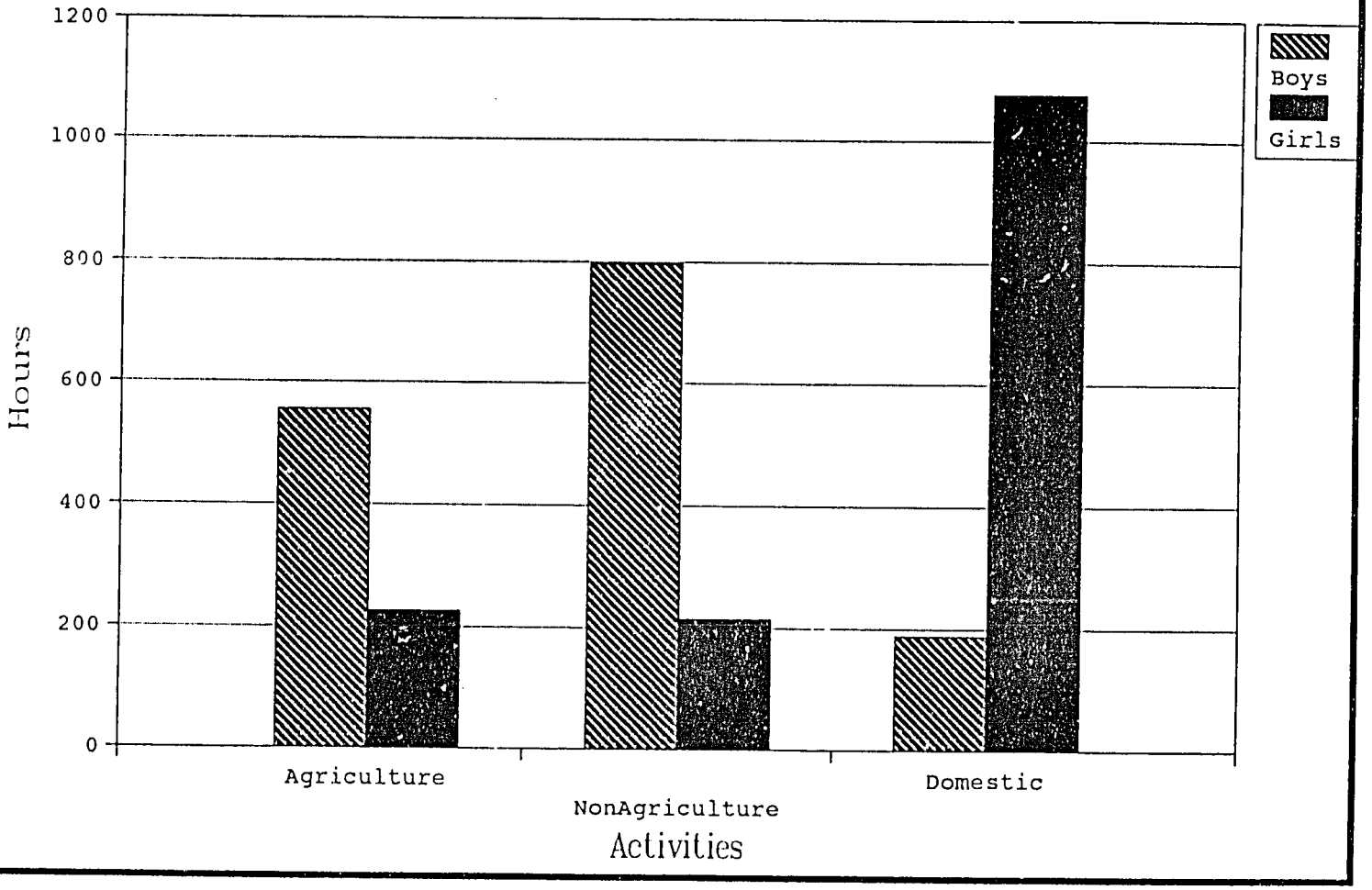


Fig. 6.51. Average Labor Hours for
Boys and Girls 8-14

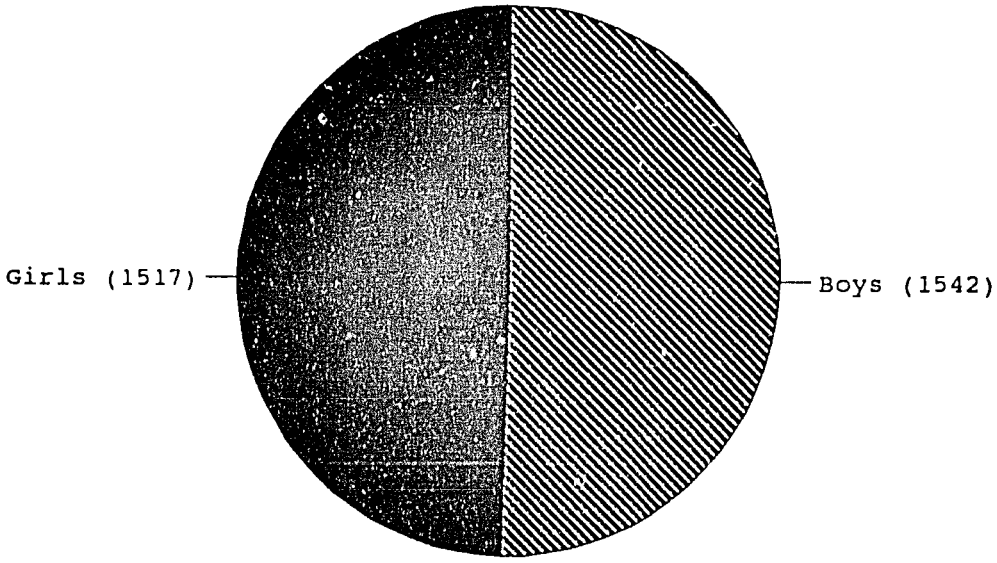


Fig. 6.52. Average Labor Hours for Men and Women 15-45 & 46-60 by Activity

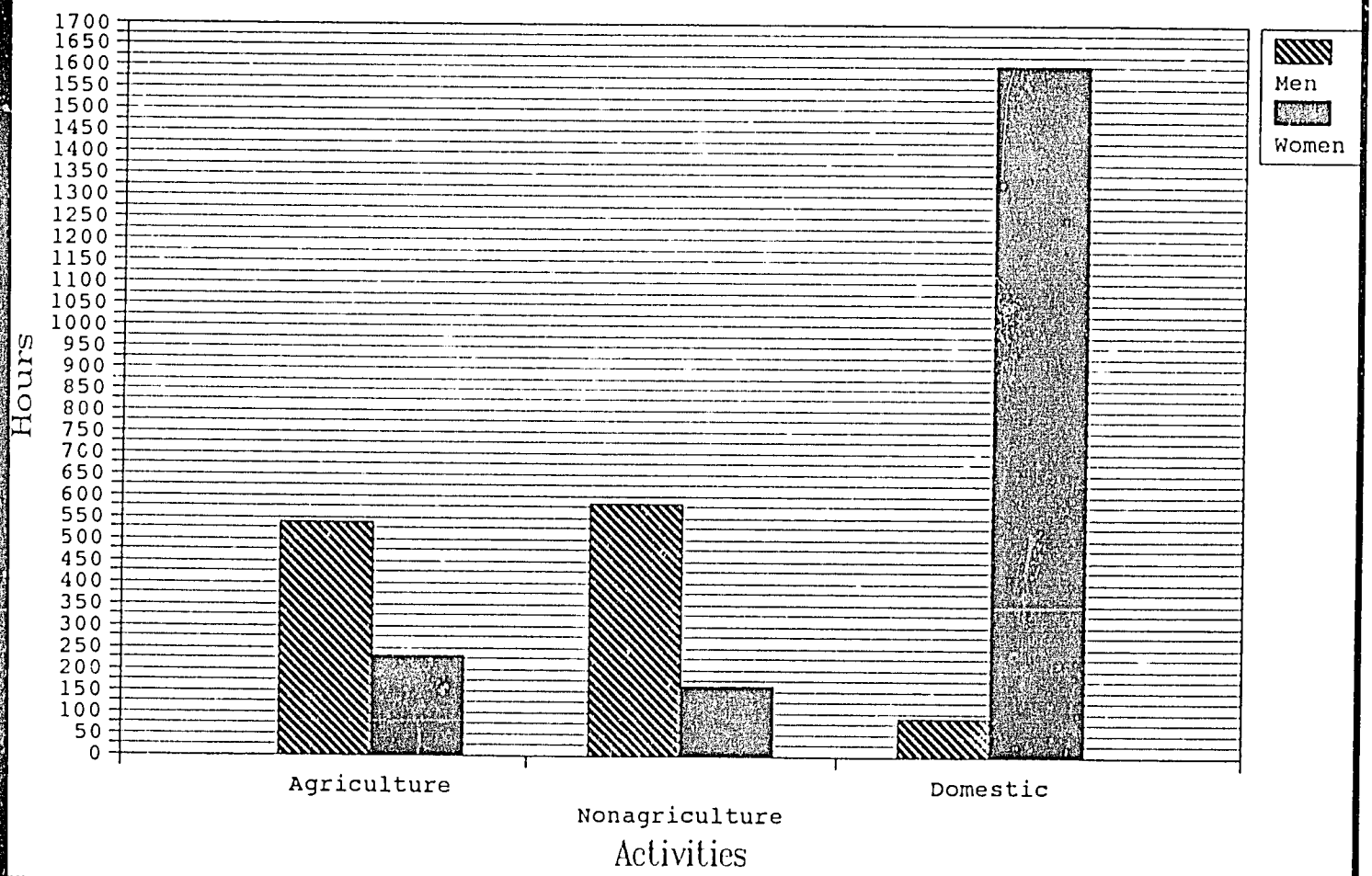
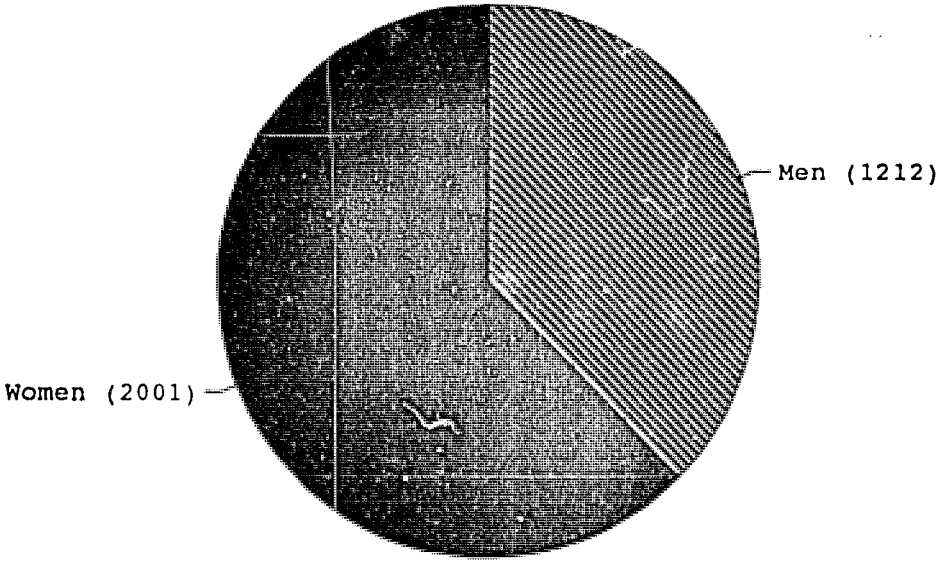


Fig. 6.53. Average Labor Hours for Men and Women: 15-45 & 46-60



When the two age groups 15-45 and 46-60 are treated separately (in Figures 6.54-6.57), the pressure of domestic duties on women in the younger (15-45) group is even more marked. Figure 6.54 compares average labor hours for men and women in this group by type of activity. On average, women spend 1,650 hours or over 206 days on domestic activities, as compared to men, who spend fewer than 100 hours (about 12 days). As in earlier figures, men's engagement in agricultural and nonagricultural activities exceeds that of women, but the margin in agriculture is smaller.

When the various types of activities are combined (Figure 6.55), women's total engagement exceeds that of men. While a woman spends an average of 2,051 hours, or over 256 days a year on the various activities, men spend only 1,244 hours or 155.5 days, again a 1.65-to-1 ratio.

Figure 6.56 shows average labor hours for men and women 46-60. Both men and women of the age group 46-60 work somewhat fewer hours in all activities combined as seen in Figure 6.57. Women of this age group spend about 1,200 hours or 150 days on domestic activities, while men spend about 75 hours (9 days), a slight narrowing of the gender gap as compared to the 15-45 age group. In agriculture, men's hours worked show a slight increase (about 16 percent) while women's remain essentially the same. The gender gap in nonagricultural activities becomes much narrower, however, with women's hours rising (by about 83 percent) and men's declining (by about 36 percent). When labor for all activities is considered (Figure 6.57), women's working time again exceeds that of men. Women spend 1,749 hours or over 218 days on productive activities, men spend only 1,082 hours, or a little over 135 days, a ratio of about 1.61 to 1.

G. Household Labor Allocation and Irrigated Development in the Middle Senegal Valley

To evaluate the accuracy of the PDRG's notion that labor would be available for widespread irrigated development in the Senegal River Valley, discussion is restricted to persons aged 15-60, since this is the age range that provides the bulk of labor in the area, whether agricultural, nonagricultural, or domestic. Figure 6.53 indicates that women in this age range provide an average of 250 days of productive labor a year, while men provide an average of 151.5 days, implying that, in a 365-day year of 8-hour workdays, women and men are "idle" 115 days and 213.5 days, respectively. This observation might drive planners anxious to launch development programs to assume a large capacity to fill an increased demand for labor. A few cautionary facts should be considered, however.

- The figures that we have are averages that even out extreme differences between highs and lows and assume that all members of this age are (a) equally available to perform the required labor and, (b) equally occupied. They do not take into consideration circumstances such as differential energy levels, sickness, pregnancy, etc. (not to mention holidays). This means that some members of this age group are working fewer hours than the group average, while others are

Fig. 6.54. Average Labor Hours for Men and Women 15-45 by Activity

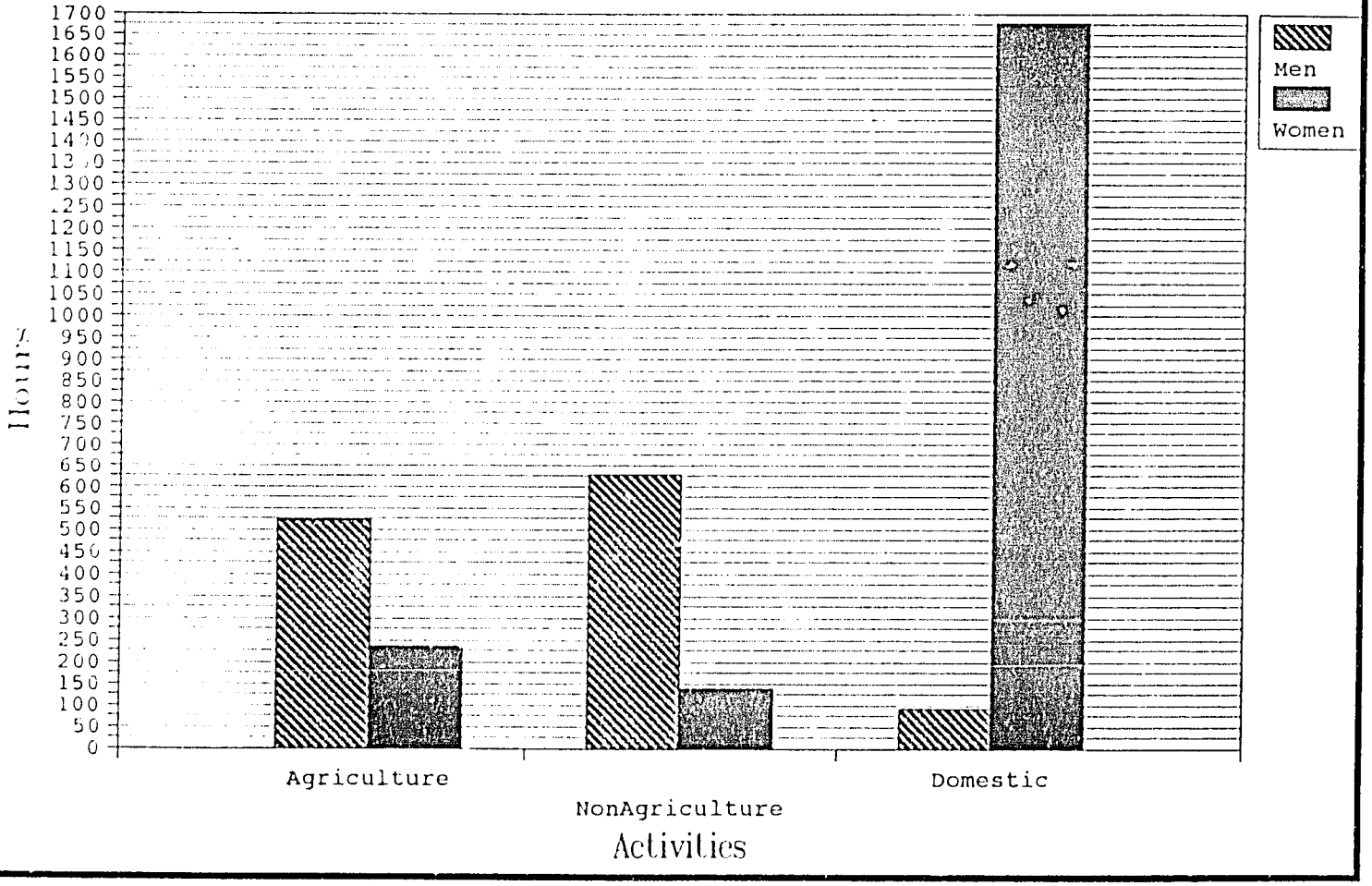


Fig. 6. 55. Average Labor Hours for Men and Women: 15-45

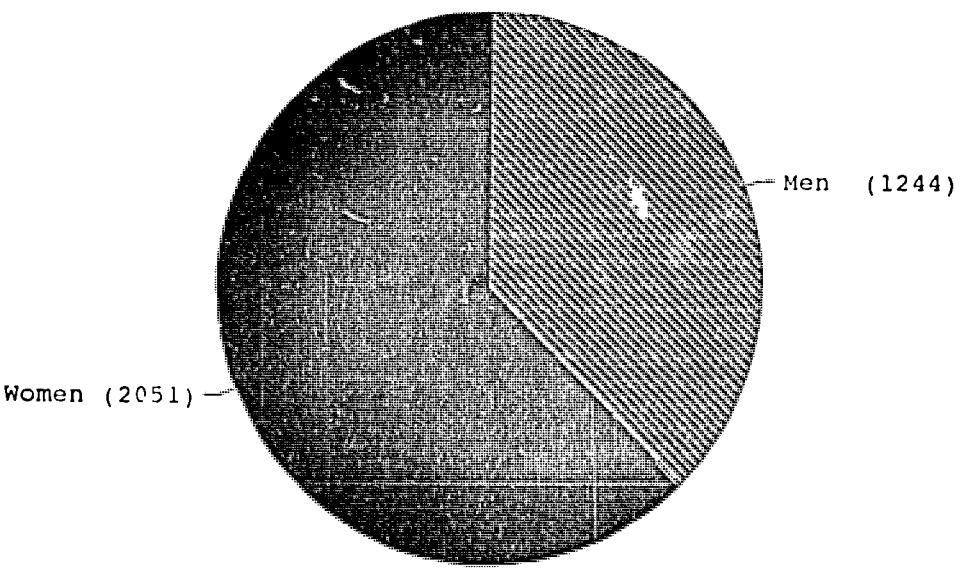


Fig. 6.56. Average Labor Hours for
Men and Women 46-60 by Activity

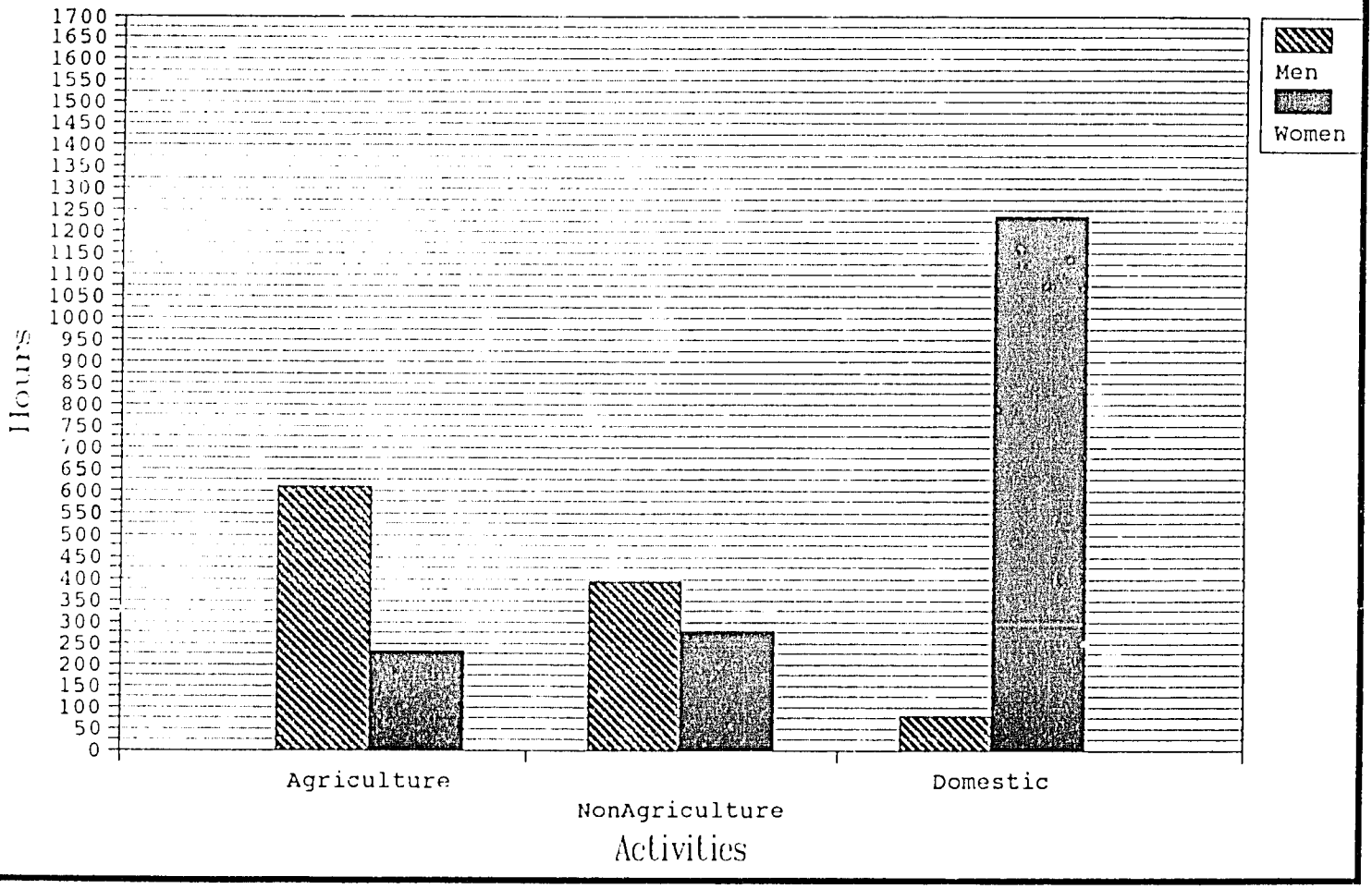
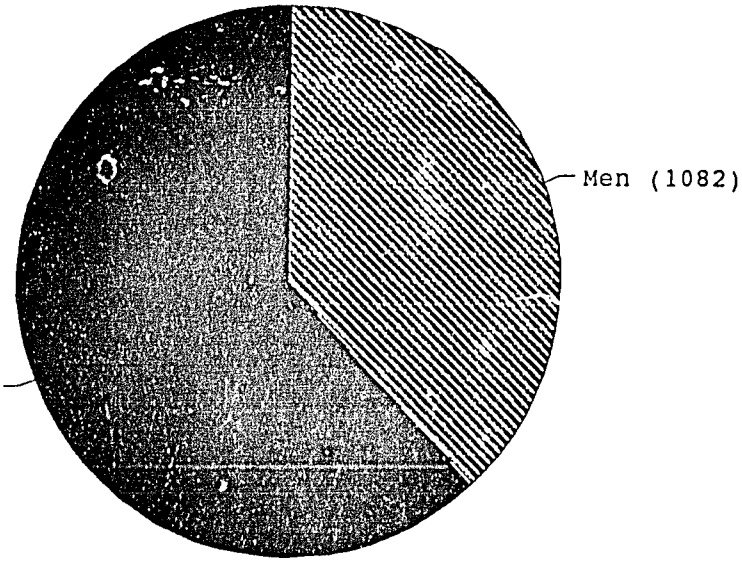


Fig. 6.57. Average Labor Hours for Men and Women: 46-60



contributing more hours. What is the ability of both groups to increase their levels of effort?

- As was noted in the section earlier in this chapter that discusses agricultural activities, agricultural work is very seasonal. Viewed in an annual context, the agricultural pace is bound to appear much more leisurely than it really is, even in the most industrialized societies. Work is performed in particular seasons, however, with their own peak periods. This knowledge presents a different picture. The irrigated system most widely practiced in the Senegal Valley today is that of irrigation in the rainy season, the period when farmers are most occupied with other types of agricultural tasks. What is the capacity of these farmers to increase their already heavy daily labor input?

- The data analyzed here were collected during a twelve-month period that extended from August 1991 to July 1992, not very good years for either dryland farming or recession cultivation. The labor reported on agricultural activities, accordingly, reflects the peculiarities of those agricultural seasons. In a year more favorable for rainfall and flood, production demands—and hence labor efforts—are likely to be much heavier.

- In most instances the data gathered underreport the amount of time actually spent on various activities. This is particularly true in the reporting of nonagricultural and domestic activities. For example, research assistants often failed to record the time it took women and children to get to sources of water and firewood when reporting such activities as firewood and water collection. In the agricultural domain, research assistants rarely recorded the time it takes to get to the farm and back. The time that shopkeepers spend in their shops was also grossly underestimated.

Observations here should not be interpreted as a recommendation to oppose irrigation. On the contrary, irrigation is a very important labor strategy for the river valley and the chances of residents surviving in such a harsh environment would be greatly reduced without such systems. New programs, however, should be based on realistic assessments of the labor situation in the area, rather than on optimistic assumptions of what would be desirable.

VII. MIGRATION

A. History

Out-migration of young men from the Senegal River Basin is a well-known, but perhaps less well-understood, phenomenon. History provides some answers about the development of migration and partial explanations for the present-day variation in migration patterns in the river basin.

Prior to 1850, the Middle and Upper Valley were heavily involved in the trans-Saharan trade. Expansion of trading posts at Dagana, Podor, Matam, and Bakel during the colonial period was closely linked to intensive merchant trading of gum arabic, millet, sorghum, and livestock for manufactured items. The Middle Valley was a grain-exporting region. Matam, in particular, was well-situated for such trade, as it was located both on gum-arabic trade routes, and at the center of a vast flood recession and rainfed agricultural zone extending from Orefonde to Semme.

Toward the end of the nineteenth century, conditions began to change, heralding a shift in the Middle Valley's role of grain exporter to labor exporter. Trade in gum arabic and cereals was disrupted as Khordofan merchants captured the gum market, and rapid growth in peanut production in southwestern Senegal created a new center of prosperity. Also during this period, the colonial administration levied taxes directly through cash payments and indirectly through forced labor on such colonial projects as the construction of rail and telegraph lines. Both forms of taxation drove men to leave the region. Marginalization of the Senegal Valley as a commercial and agricultural region was intensified in the early twentieth century with completion of the Bamako-Kayes and Thies-Kayes railroad. Transport of commercial goods through the interior of the country bypassed the river region, causing many of the trading firms there to leave. As revenue-generating opportunities diminished further, out-migration increased.

The twentieth century is marked by three general periods of out-migration (Ba 1983:19, in Marcoux 1990:108): the first occurred in the period between the two World Wars, the second during Independence, and the third in the 1970s and 1980s. Between the two World Wars the movement of labor was largely seasonal, with men moving back and forth between peanut plantations in the south and their own agricultural activities at home. At Independence, the destinations of migrants shifted to places abroad, principally France, thereby lengthening the time spent outside the valley. The new flow of migrants to France can be explained in part by the conflict in Algeria, which prompted France to favor migrants from other former colonies over those from Algeria. In the 1970s, severe drought intensified the out-migration. As Alioune Ba writes, "la principale réaction démographique à la secheresse n'a pas été la mort mais bien la migration" (Ba 1983:19, in Marcoux 1990:109). The drought did not affect all areas equally. Areas where flood recession and rainfed agriculture predominate were hardest hit. Information presented elsewhere in this report suggests that the important contribution of remittances today in areas where flood recession and rainfed agriculture predominate has its origin in the drought of the 1970s.

B. Migratory Patterns

It is commonplace to think of migration as a major demographic, sociocultural, and economic phenomenon in the Fuuta. At the level of the regional economy, the magnitude of migration as it creates labor shortages, affects social and cultural life, and greatly influences household revenues is well known and well researched. A priori assumptions concerning migration do exist, however: it is believed, for instance, that migration is greater in the Department of Matam than in that of Podor.

An examination of such assumptions at the local level, however, requires a modification of the generalizations. Observations from the field allow for a better exploration of the anticipated impacts of the Manantali Dam. For example, what will be the consequences for migration of a dam management strategy that does not generate a controlled flood? Is a strategy that favors irrigation exclusively compatible with actual migratory patterns?

In order to respond to these questions, two aspects of migration are examined. First, a comparison of migration patterns is identified for Podor and Matam departments. Second, seasonal migratory patterns in relation to the different contexts of access to irrigation and recession agriculture are explored (in Chapter X). These migratory flows were studied during a two-year agricultural cycle (1990-91 and 1991-92). The comparative analysis between departments is based on studies undertaken at Doumga Rindiaw, Kaawel, and Mbakhna during the first phase of research (SRBMA I) and at the nine production spaces selected under phase two (SRBMA II).

1. Magnitude and Patterns of Migration

The following analysis of the magnitude and typology of migration is based on the survey of sample households at the nine PSs involving 336 households and a population of 3,545 residents.[1] At the time of the census of this sample, 2,801 (79 percent) inhabitants were present and 744 (21 percent) were absent (Table 7.1). Absent migrants had relocated in other regions of Senegal (69 percent), other parts of Africa (25 percent), and other areas, principally Europe (6 percent) (Table 7.2). Contrary to the assumption stated earlier, migration in the Department of Matam (20 percent of the population), is not greater than in the Department of Podor (22 percent), at least in the sample.

The positive economic impact of migration can be understood more in qualitative than quantitative terms. This is elucidated by exploring migrants' destinations. Table 7.2 reveals that the large majority of migrants in Podor Department (80 percent) work in other regions of Senegal, exceeding that destination for migrants of Matam Department (58 percent). Depressed

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[1] Analysis of this section was performed on the original sample (336 households), before certain households were dropped over the course of the study, with the final sample comprising 331 households (see Chapter II).

economic conditions in Senegal provide few opportunities for success among migrants, however. Furthermore, because migrants within Senegal remain relatively close to their village of origin, strong pressures exist for them to support their families, particularly to receive such kin for visits of variable duration, and to return frequently to their village for various ceremonies.

Table 7.1. Residence of Sample Population for Departments of Podor and Matam (number and percent)

PS	Principal Residence				Total
	Village	Other Senegal	Other Africa	Rest of World	
1	256	52	16	0	324
2	173	57	8	5	243
3	313	68	15	0	396
4	249	55	22	0	326
5	262	47	4	0	313
Podor	1,253	279	65	5	1,602
Podor (percent)	78	17	4	0	100
6	379	64	34	24	501
7	452	81	13	7	553
8	243	47	18	4	312
9	474	39	57	7	577
Matam	1,548	231	122	42	1,943
Matam (percent)	80	12	6	2	100
Total	2,801	510	187	47	3,545
[illegible] (percent)	79	14	5	1	100

In terms of employment opportunity and wage earning potential, migrants are no better off in other African nations than they are in Senegal. Because of the distance, however, these migrants face less economic pressure to support family members directly. Consequently, their savings are greater than savings of those migrating within Senegal. The economic impact of the remittances of these migrants, known as "*Afriquenaabe*" in Pulaar, on their home villages is very visible. This visibility applies also to migrants in Europe, especially in France ("*Francenaabe*"). Migrants' destinations to other areas of Africa and to the rest of the world—largely Europe and

the U.S.—are lower in the Department of Podor (19 percent and 1 percent respectively) than in the Department of Matam (31 percent and 11 percent) (Table 7.2).

Table 7.2. Comparison of Migrant Destinations in the Departments of Matam and Podor

Department		Other Senegal	Other Africa	Rest of World	Total
PODOR	No. Absent	279	65	5	349
	Percent	80	19	1	100
MATAM	No. Absent	231	122	42	395
	Percent	58	31	11	100
TOTAL	No. Absent	510	187	47	744
	Percent	69	25	6	100

2. Migrant Destinations and Income Remitted

The amount of income remitted by migrants over the course of a year depends on a number of factors, including whether migrations are seasonal or long-term, the migrant's destination, age, and gender, and the mix of farm and off-farm productive opportunities in the home regions. Migrants remitting income to their villages are divided among four groups: those whose principal residence is in the village, those whose principal residence is outside the village but in Senegal, those whose principal residence is outside Senegal but in Africa, and finally those whose principal residence is outside Africa.

A considerable number of households in the sample have migrants whose principal residence is outside the village but who do not send remittances. Table 7.3 presents the number of sample households with migrants outside the village, the number receiving remittances, the number not receiving remittances, and the percent not receiving remittances. The table does not include the number of sample households with seasonal migrants who do not send or bring remittances back to the village because the data unfortunately do not include this information. Households with migrants in Senegal but outside the village have the highest rate of nonremittal, 37 percent. This probably reflects the difficult economic conditions in Senegal and the high concentration of river basin migrants in Dakar who are unable to find gainful employment. The groups with migrants in Africa and abroad had nonremittal rates of approximately 21 and 24 percent, respectively. Many households adjusted to the high rates of nonremittal by having more than one migrant, in more than one destination.

Table 7.3. Rate of Nonremittal among Households with Migrants outside the Village

Migrant Destinations	Number of Households			Percent of Households with Migrant(s) but Not Receiving Remittances
	With Migrant(s) Outside Village	With Migrant(s), Receiving Remittances	With Migrant(s) but Not Receiving Remittances	
Senegal	197	124	73	37
Other Africa	108	85	23	21
Rest of World (Europe and USA)	17	13	4	24

Table 7.4 presents summary statistics only for households that receive remittances, separated into those with migrants who are: seasonal, elsewhere in Senegal, elsewhere in Africa, and in the rest of the world (Europe and the United States). The table includes minimum and maximum annual household remittances, average annual remittances per household, and the annual amount remitted by each group. Migrants outside Senegal but in Africa contributed the largest proportion of remittances reported by the sample: 43 percent of the total. They also remitted the largest amount per household: 85 households received an average of 285,402 FCFA in one year.

Table 7.4. Migrant Remittances by Destination of Migrant

	Number of Households	Remittances (FCFA)				Percent of Total
		Minimum	Maximum	Per Household	Group Total	
Seasonal	183	500	456,923	66,181	12,111,074	21.4
Senegal	124	923	2,839,477	140,575	17,431,331	30.8
Other Africa	85	5,000	2,560,385	285,402	24,259,137	42.9
Rest of World	13	3,000	1,005,429	214,524	2,788,809	4.9
Total/Average	331[a]	n.a.	n.a.	170,968	56,590,351	100.0

n.a. Not applicable.
[a] Some households have more than one migrant.

The next largest source of remittance income for the region was Senegal. Those remitting income from Senegal include individuals engaged primarily in seasonal migration and living in the village, and those whose absence was longer term. Together, these individuals

remitted 52 percent of total sample remittances. On a per household basis, long-term migrants in Senegal remitted more than twice as much as seasonal migrants: 140,575 FCFA versus 66,181 FCFA.

Only 17 sample households had migrants outside Africa. The contribution of these migrants to total sample remittances was small, 5 percent. Per household, they remitted more than migrants in Senegal, but less than those in other African states. The maximum annual amount per household remitted by individuals overseas, moreover, was only 39 percent as large as the comparable figure for the Africa group. The higher remittances of migrants in Africa over those outside Africa may reflect the difficult economic conditions overseas, as well as a greater familiarity of migrants with Africa than with Europe or the United States. A young Senegalese migrant from Matam Department hawking glasses and T-shirts in New York City explained that the goal of him and his compatriots is to make enough money in the United States (approximately US$ 13,000) to invest in trade and commerce back in Africa (personal communication, New York 1993). Thus, overseas work provides the seed money for trading activities in Africa that on a large scale can be quite lucrative. Another possible explanation for higher remittances coming from Africa than from overseas is that migrants in Africa may be more involved in illegal activities—such as smuggling and poaching—than their counterparts overseas. Such activities are dangerous, but also more remunerative. Migrants overseas, particularly in France and the United States, tend to engage in lower-income but licit activities, like petty commerce, street cleaning, cooking, and bus of taxi driving. As Ahmadou Kane writes:

> Les afriquanabés, outre les activités de commerçants, tailleurs, bijoutiers, se livrent assez souvent à des pratiques dangereuses; chercheurs d'or et de diaments alors que ceçi leur est interdit, "passeurs" de pierres précieuses entre le Zaire et la Belgique, entre le Zaire et la Suisse.
>
> Certains afriquanabés pratiquent également le braconnage et livrent sur les marchés européens de l'ivoire, des cuirs et des peaux d'animaux protégés. D'une manière générale, ils font tous des "affaires" quelles que soient leurs veritables fonctions, que ces affaires s'appliquent au commerce local ou international. La reside leur grande difference avec leurs homologues vivant en Europe.
>
> Le Walafendo, Saracolle, Toucouleur, ou Peul est en général un homme ayant entre 20 et 40 ans d'âge, pouvant appartenir à l'une quelconque des castes du département, vivant en France où il exerce n'importe quel metier (éboueur, manoeuvre, cuisinier, garçon de café ou de restaurant, employé d'hotel, ouvrier . . .) (1984 [February]:31-34).

a. Seasonal Migrants

Individuals citing the village as their principal residence but also remitting income were categorized as seasonal migrants. The relatively high proportion (20 percent) of these

individuals who claimed farming as their main activity supports this categorization. Of the remaining individuals, 23 percent named schooling and related activities as their primary occupation, 22 percent did not specify their occupation, and the rest engaged in commerce, fishing, services (tailor, baker, marabout, etc.), salaried work, or herding. Men accounted for 71 percent of individuals categorized as seasonal migrants, women 29 percent. The number of men sending remittances was highest in the 15-to-45 age group. Men 46 and over were also an important source of remittances. Men over 60 remitted the highest annual per capita amount—82,275 FCFA per capita over a one-year period. The next highest per capita amount came from men between the ages of 46 and 60—54,075 FCFA. Men aged 15-45 remitted an average of 49,224 FCFA (Table 7.5).

The majority (70 percent) of the 74 women sending home remittances were in the 15-45 age group. Women remitted less than men in every age group. While remittances increase with age for men, the pattern is less clear for women. Women 60 and over remitted the largest amounts: 25,386 FCFA per capita over a one-year period. Remittances drop to 16,303 FCFA for women 46 to 60, and then rise again to 24,113 FCFA for women 15 to 45.

Table 7.5. Number of Seasonal Migrants and Per Capita Annual Remittances by Age and Gender

Age/Gender Group		Number of Individuals	Per Capita Annual Remittances (FCFA)
Men	0-7	1	1,714.29
	8-14	2	3,818.18
	15-45	76	49,224.38
	46-60	48	54,075.48
	60+	50	82,274.68
Women	0-7	1	553.85
	8-14	0	0
	15-45	52	24,113.46
	46-60	15	16,302.93
	60+	6	25,385.91

b. Migration to Other Parts of Senegal

Migration within Senegal differs from seasonal migration in several important ways. First, this form of migration does not allow men to engage in agriculture as does seasonal migration. The only person in this category claiming agriculture as his principal activity was

a man in the 15-to-45 age group. More than half the men claimed either commerce or service activities as their principal occupation. Second, the participation rate of women in this form of migration is much lower than their participation rate in seasonal migration (Table 7.6). Women made up 6 percent of migrants in this category as compared to 29 percent of the seasonal migrants. The annual per capita amounts they remitted, however, were considerably higher than those remitted by women who were seasonal migrants. This is probably because revenues from women engaged in seasonal migration were generated only during certain months of the year, while revenues from women established in other parts of Senegal (most likely Dakar) were generated over a full year. The third difference between seasonal and within-Senegal migration was a greater concentration in the 15-to-45 age group: 82 percent for males migrating within Senegal as opposed to 43 percent for seasonal migrants in this age group; 80 percent for female in-Senegal migrants vs. 70 percent for women who migrate seasonally. For men, remittances were highest in the 46 to 60 age category, however. For women, remittances were highest in the 15-to-45 age group.

Table 7.6. Number of Migrants in Senegal and Per Capita Annual Remittances by Age and Gender

Age/Gender Group		Number of Individuals	Per Capita Annual Remittances (FCFA)
Men	0-7	0	0
	8-14	1	1,000.00
	15-45	126	108,905.72
	46-60	15	143,995.96
	60+	11	79,116.36
Women	0-7	0	0
	8-14	0	0
	15-45	8	70,048.83
	46-60	2	58,800.00
	60+	0	0

c. Migration to Other African Countries

A total of 116 individuals sent remittances from other African countries (Table 7.7). As with migrants in Senegal, the main activity of migrants to other African states was commerce: commerce was cited as the main occupation of 80 percent of individuals remitting income from elsewhere in Africa. Men between 15 and 45 years of age accounted for 88 percent of all

migrants sending remittances. Men 46 and older, who made up 9 percent of these migrants, repatriated the highest per capita amounts, especially men 46 to 60.

Women made up only 2.6 percent of this population, and all three women were in the 15-45 age bracket. Per capita annual remittances were much higher for migrants in the rest of Africa than for those remaining in Senegal. In the 15-to-45 age group per capita remittances for migrants in other Africa countries were more than 80 percent higher than those of migrants in Senegal. In the 46-to-60 age group, the difference is even more striking. Per capita remittances from migrants elsewhere in Africa were almost three times as large as those from Senegal. The per capita amount remitted by women migrating to other parts of Africa was slightly less than the amount remitted by women seasonal migrants and considerably less than the amount remitted by women migrating within Senegal. Women's rates of participation in this type of migration were lower than those of women who are seasonal migrants and migrants within Senegal.

Table 7.7. Number of Migrants in Non-Senegal Africa and Per Capita Annual Remittances, by Age and Gender

Age/Gender Group		Number of Individuals	Per Capita Annual Remittances (FCFA)
Men	0-7	0	0
	8-14	0	0
	15-45	102	197,789.75
	46-60	8	412,197.25
	60+	3	240,880.68
Women	0-7	0	0
	8-14	0	0
	15-45	3	21,454.21
	46-60	0	0
	60+	0	0

d. Migration to the Rest of the World (Europe and the USA)

The principal residence for 19 individuals in the sample was overseas, in Europe or the United States (Table 7.8). All except two of these individuals were men between the ages of 15 and 60; the other two were women in the 15-to-45 age group. For 13 of the 17 men, some type of salaried employment or commerce were identified as the main occupations. Artisanal work, herding, and fishing were the activities of three of the men, and the occupation of one was

unknown. Housekeeping was the principal activity for the two women in the group. As noted earlier, migrants in Europe and the United States remitted less per household than did migrants in non-Senegal African countries. The per capita annual amounts for men reflect this same phenomenon. Per capita, men overseas in the 15-to-45 age group remitted 70 percent of what their counterparts in other African countries remitted. The difference is even more pronounced in the 46-60 age category: men overseas remitted only 41 percent of what men in Africa remitted.

For women, the situation is quite different. Women overseas remitted considerably more per capita than women seasonal migrants, women migrants within Senegal, or women in other parts of Africa. Because the data do not include sources of migration revenues, it is difficult to explain this difference. Initially, we hypothesized that women migrating overseas might be among the better educated and therefore able to find quite remunerative employment. The data do not support this, however: the two women overseas had no formal education whatsoever. A more extensive study of such women would be needed to explain the remittance level.

Table 7.8. Number of Migrants Overseas and Per Capita Annual Remittances by Age and Gender

Age/Gender Group		Number of Individuals	Per Capita Annual Remittances (FCFA)
Men	0-7	0	0
	8-14	0	0
	15-45	14	138,191.85
	46-60	3	168,993.41
	60+	0	0
Women	0-7	0	0
	8-14	0	0
	15-45	2	173,571.43
	46-60	0	0
	60+	0	0

To sum up, summary statistics on the incidence and profitability of migration by destination, gender, and age show that households with migrants in Africa had the highest rate of remittal and on average the highest annual remittance earnings. Thus, among sample households—and contrary to popular belief—Europe and the United States were not the most profitable destinations for migrants, at least in terms of remittances. Men between the ages of 15 and 45 participated most heavily in migration, but it was men between 46 and 60 who sent

home the most per migrant. Among women, the 15-to-45 age group was most active in migration and remitted the largest per capita amounts.

C. Migration and Agricultural Development

The issue of migration is of keen interest because of concern that migration stifles agricultural production and rural development. One argument, reflected in the work of Plath et al. (1987:158, in Russell et al. 1988:42), maintains that remittances from migration lead to a neglect of agriculture. Local economic activity is discouraged by the availability of migrant incomes, according to this position, and, although the focus on migration rather than on agricultural production may benefit the individual, the community suffers from increased dependency on remittances and the decline of agriculture.

A counter argument is that migration sustains and may even improve the agricultural sector. According to Parson (1984, in Russell et al. 1988:83), "migration weaves together the rural and urban sectors," and neither agriculture nor migration is sustainable without the other. In support of this position, Lucas (1987, in Russell et al. 1988:82) found that in Botswana out-migration was associated with a short-term decline in traditional crop *output*, but that in the long run remittances from migration raised *productivity*. Improvements in productivity occurred through financing and importing new technology, physical investments, and, less directly, through the insurance effect of remittances allowing for experimentation with new production methods (Russell et al. 1988:82). In Zambia, Chilivumbo (1985:59, in Russell et al.:83) found that farm size, output, farm income and expenditures, farm labor, application of fertilizer, and use of farm tools were greater among returned migrants than among non-migrants.

The continuing debate on the dynamics between migration and agricultural development reflects the changing nature of relationships across countries and regions as changes occur in the type of migration (e.g., seasonal or long-term), the age and gender composition of migrants, the structure of agricultural households, land availability, types of agriculture, and the existence of alternative sources of wage income.

In the Senegal River Basin, the concern is that the large outflow of men discourages the development of irrigation, a labor-intensive agricultural system. Analysis of SRBMA I data demonstrated the contradictory effects associated with irrigation and migration. Migration draws labor from the region, labor that could be used on the farm, particularly on irrigation perimeters. Yet migration is an extremely important source of revenue for households, and thus helps cover food costs, especially in years when rainfall and floods are inadequate. It also helps finance irrigation. The village of Agnam Godo in PS 8, for example, received 18 tonnes of rice in 1991 and more in 1992 from migrants in Gabon, France, and the United States (Salem-Murdock et al. 1992 [May]:141; Salem-Murdock et al. 1992 [November]:205). Migrants from Doumga Rindiaw in PS 7 sent 250,000 FCFA to the two village perimeters, Bossea I and III, to cover pump-repair costs (Salem-Murdock et al. 1992 [May]:132).

SRBMA II data were analyzed to verify the relationship between migration and investment in agriculture. The analysis began with the assumption that farm activities, migration patterns, and household income are closely linked to the particular geomorphology and infrastructure of the river basin. The geomorphology of the Middle Valley changes as one moves away from the river. A transect of river-falo-foonde-waalo-jeejegol-jeeri extends from the river inland to the Ferlo. Although villages and households situated in different parts of the transect may share its land and water resources, their fundamental livelihood strategies are likely to differ. For example, Subalbe households close to the river engaged in falo, and in some instances in irrigated agriculture, face different incentives and constraints than Toorobbe or Fulbe households situated away from the river near large flood basins.

To understand the link between household agricultural production and migration, we thought it best to group households according to their location in the transect. Doing so would both highlight differences in household production goals and labor strategies and make it possible to target policy recommendations to specific groups and areas. Because the production spaces contain villages located at different points of the transect, we could not use production spaces to group households for this purpose. Instead we divided the 331 households of the final sample into eight groups on the basis of their access to irrigated, flood recession, and rainfed land. We defined access broadly to include the household's ownership and use rights to land. Irrigated land includes land in small village schemes, medium-sized schemes, large schemes, and private schemes; flood recession land includes waalo and falo; and rainfed land includes jeeri and foonde. The eight groups identified are presented in Table 7.9.

Table 7.9. Household Configurations Based on Opportunities for Irrigation, Flood Recession, and Rainfed Agriculture

Irrigation, Flood Recession, and Rainfed Configurations*	Number of Households
1 +IRR, +RECESSION, +RAINFED	76
2 +IRR, +RECESSION, -RAINFED	14
3 +IRR, -RECESSION, +RAINFED	38
4 +IRR, -RECESSION, -RAINFED	17
5 -IRR, +RECESSION, +RAINFED	72
6 -IRR, +RECESSION, -RAINFED	24
7 -IRR, -RECESSION, +RAINFED	73
8 -IPR, -RECESSION, -RAINFED	17

* + means access, - means little or no access to the relevant type of land.

The groups with the largest numbers of households are 1, 5, and 7. Group 1 has access to irrigated, flood recession, and rainfed lands. Group 5 does not have access to irrigation, but

has access to both flood recession and rainfed land. Group 7 has access only to rainfed land. For each of the eight groups, Table 7.10 presents annual FCFA and percentage figures on average household income, average household per capita income, average household remittances, average household off-farm revenue, average household net farm income, and average household livestock income. Table 7.11 presents the average number of men per household between the ages of 15 and 60 living in the village, elsewhere in Senegal, in other parts of Africa, or in Europe or the United States for each of the eight groups.

Table 7.10. Farm and Off-Farm Revenues by Household Configuration Groups (FCFA and percent)

Group	Average Income (FCFA)		Remittances per Household (FCFA; percent)	Average Annual Off-Farm Revenue	Average Annual Income (FCFA; percent) from:				
	Total	Per Capita			Recession Agriculture	Irrigated Agriculture	Rainfed Agriculture	All Farm	Livestock
1	321,782	37,948	115,657 35.9%	201,570 62.6%	34,046	61,110	3,801	101,461 31.5%	18,751 5.8%
2	489,532	50,899	212,794 43.5%	258,057 52.7%	111,800	86,972	723	215,306 44.0%	16,169 3.3%
3	361,859	50,794	89,873 24.8%	269,569 74.5%	0	62,475	2,828	58,890 16.3%	33,400 9.2%
4	357,383	42,912	51,096 14.3%	224,545 62.8%	0	89,833	0	86,301 24.1%	46,537 13.0%
5	480,355	49,047	223,893 46.6%	346,830 72.2%	90,016	-3,675	10,889	107,625 22.4%	25,900 5.4%
6	456,479	58,456	246,379 54.0%	392,918 86.1%	40,545	0	4,221	44,726 9.8%	18,835 4.1%
7	329,127	41,973	205,477 62.4%	275,204 83.6%	-2,060	0	9,165	9,160 2.8%	44,763 13.6%
8	327,294	45,011	237,680 72.6%	319,363 97.6%	-1,510	220	399	-218 0.0%	8,151 2.5%

Table 7.10 shows that in groups 1, 3 and 4, where irrigation is the dominant system (Group 2 is omitted because it received more income from recession than from irrigated agriculture), average household remittances in absolute and percent terms are lower than in all the other groups. As an explanation of this we hypothesized that households engaged in irrigation allow fewer men to migrate because, as SRBMA I suggested, irrigation requires more labor for a given amount of output. The figures in Table 7.11 lend some support to this argument. Excluding group 7, the total number of migrants per household appears slightly lower than the overall average (1.36) among households 1 (1.26), 3 (1.32), and 4 (1.29). The table also indicates that the number of migrants residing in other African countries was generally lower for groups 1, 3, and 4 than for the average of all groups and lower than any individual

group except group 5. Since non-Senegal Africa was the most important source of remittance income for sample households (see Table 7.4), this helps to explain the low household remittances to these high-irrigation groups.

Table 7.11. Average Number of Migrants per Household by Destination and Household Configuration Groups (men aged 15-60)

Group	Principal Residence in:				Total Number of Migrants per Household
	Village	Other Senegal	Other Africa	Rest of World	
1	1.42	0.84	0.39	0.03	1.26
2	1.36	1.07	0.79	0.50	2.36
3	1.18	0.82	0.42	0.08	1.32
4	1.35	1.00	0.29	0.00	1.29
5	1.76	1.07	0.39	0.11	1.57
6	0.83	1.04	0.67	0.13	1.84
7	1.59	0.40	0.44	0.04	0.88
8	0.47	0.88	0.71	0.00	1.59
All	1.41	0.83	0.45	0.08	1.36

In groups 2, 5, and 6, where flood recession agriculture is the predominant system, remittances are high in absolute terms. Group 2 has the largest number of migrants per household of all the groups, while groups 5 and 6 have above the average number. Groups 2 and 6, moreover, have relatively large numbers of migrants in Africa.

Group 8, by far the worst off in terms of agricultural income (Table 7.10), also sends off large numbers of migrants and has a correspondingly low number of men whose principal residence is the village. The causal relation is not established here: lack of access to agricultural land and crop failures force individuals to seek income away from their villages, while the lack of agricultural labor because of migration can cut into a household's ability to farm successfully.

We cannot provide a definitive answer as to why remittances are less important for households that engage predominantly in irrigation than for other groups. The answer may lie in the strategy employed by flood recession households to cope with the drought of the 1970s and mid-1980s. During this period, the size of flooded areas was markedly reduced. Between 1946 and 1970 the number of flood recession hectares cultivated averaged 110,000 ha (Hollis

1990:30).[2] Between 1972 and 1986 the average size of flood basin areas cultivated dropped to 25,000 ha. This corresponds to a decline in flood volume for the months of August to October from an average of 22,475 million cubic meters between 1946 and 1970 to an average of 10,868 million cubic meters between 1971 and 1986. Areas depending on flood recession harvests as a key source of food turned to migration as a source of income for food purchases. Given the extended period of drought, migrants sought secure positions in trade or employment and passed these positions on to successive migrants. Thus, over the course of two decades they established relatively remunerative niches for themselves outside their home villages. The need to migrate was less urgent for households with access to irrigation and less dependent on flood recession agriculture. They did not need to seek productive migration destinations. This is a hypothesis that would have to be substantiated (or rejected) by further analysis.

We have shown that remittances seem to be less important for households that irrigate and more important for households that farm flood recession lands. Next, we examine the importance of remittances only for households that irrigated. We hypothesize that remittances contribute importantly to income and that as income increases yields also increase. Households with larger financial reserves are able to afford more and higher-quality inputs and to engage extrahousehold labor. As a result they achieve higher yields than households with low financial reserves. Specifically, we investigated whether input use, labor use, and yields increased per hectare with increases in per capita income. We also looked to see if the contribution of remittances to household income increased with increases in per capita income. We selected only those households that farmed as owner/cultivators in the 1991 rainy season on small village irrigation schemes, middle-sized schemes, large schemes, or private schemes.

We present a regression with labor hours per hectare, expenditures per hectare, and dummy variables to distinguish among the different types of irrigation and production systems in PSs 2, 3, 4, 5, 6, and 7, and yields per hectare. The dependent variable is per hectare yields. Only irrigation parcels with yields greater than zero were included. Thus, the results represent the productivity of irrigation in each of the production spaces that contains such irrigated parcels without capturing the riskiness of production in these production spaces. We did not include per capita income as one of the independent variables because of its likely correlation with expenditures. Expenditures were for seed, fertilizer, herbicides, insecticides, fuel, motor-pump maintenance, and motor-pump repair. In principle, some of these costs are divided equally at the producer group level among perimeter members (this is the case for fuel, motor-pump maintenance, and motor-pump repair costs). The other costs vary, depending on the amounts purchased by individual producers (as for seeds, fertilizer, herbicides, and insecticides). We include the former group in total expenditures because sometimes wealthy farmers are able to pay for additional water to their parcels, for example, by buying more fuel for irrigation pumps. In any case, if the costs of the former group are indeed constant for members of a perimeter, they do not affect the results because they are combined with costs that vary according to

[2] Some years were missing in the spreadsheet of data on areas flooded and cultivated that was available to us. These are: 1945, 1948, 1949, 1958, 1959, 1960, and 1962.

individual purchases. Because the equation is in log form, the small differences in the coefficients for the production spaces actually represent large differences in irrigation yields. The regression results are presented in Table 7.12.

Table 7.12. Regression Results for Households That Irrigated in the 1991 Rainy Season on Small Village Perimeters, Middle-Sized Schemes, and Large Schemes

Regression Output	
Constant	0
Standard Error of Y estimate	0.77
R-Squared	0.48
No. of Observations	54
Degrees of Freedom	46

Independent Variables	Coefficients	Standard Error of Coefficient
PS 2	5.903301	1.558144
PS 3	5.080736	1.495565
PS 4	6.234899	1.487334
PS 5	5.761790	1.417693
PS 6	5.900638	1.606843
PS 7	5.496819	1.496253
Labor per ha	0.438399	0.214443
Expenditure per ha	0.316441	0.120244

The estimated coefficients are all significant. Coefficients for the production spaces indicate which production spaces are more productive for irrigation. PSs 2, 4, and 6 overall have higher irrigation yields than the other production spaces. PS 2 includes the villages of Wassatake, Barobe, and Ngarane. Here, more people have access to irrigation than to waalo agriculture because during the conflict between Senegal and Mauritania, Wassatake lost access to its flood recession lands in Mauritania. Irrigation in this PS takes place on the middle-sized scheme of Salde-Walla. Household income in PS 2 is among the lowest (see Chapter VIII), averaging approximately 230,000 FCFA. PS 4, which includes the villages of Pate Galo, Marda, and Wa-Wa, is endowed with large flood basins between the Doue and Senegal rivers. Two of the viliages in this PS, Pate Galo and Marda, participate heavily in irrigation. Pate Galo maintains three PIVs, two private perimeters, and numerous GIE (Groupements d'Intérêt Economique). Marda maintains two PIVs. Household income in PS 4 is in the middle range, averaging approximately 420,000 FCFA. PS 6 includes the villages of Thiemping and Kanel. Waalo agriculture is by far the predominant system in this PS, which has the highest household income, averaging approximately 900,000 FCFA.

From this information we conclude that expenditure on inputs (which are closely related to income), the type of irrigated perimeter cultivated (e.g., small village schemes vs. middle-sized, large, and private schemes), and opportunity for participation in other production systems determine yields. In other words, where household income is high, yields tend to be high, since cultivators can afford to purchase all the essential inputs and to hire labor when needed.[3] In PS 6, where irrigation is limited to production on small village schemes and where income is highest, yields are also high. Where irrigation takes place on middle-sized and large schemes and where the opportunity for engaging in flood recession agriculture is limited, yields are also high because irrigation is a predominant component in the production system. Thus in PS 2, where farmers cultivate on a middle-sized scheme and have lost access to important tracts of floodplain, yields are high, even though household incomes are low. In PS 4, where incomes are higher, private irrigation takes place alongside village irrigation. We suspect that high yields on the private perimeters, where individuals are in full control of production, raised the yields generally for PS 2. To reject or substantiate this hypothesis would require additional investigation.

The coefficients for labor and expenditure per hectare are both significant and positive. Increases in labor and expenditures lead to increases in yields. Comparing productivity of the different production systems (in Chapter V), we indicate the greater labor and capital intensity of irrigation compared to flood recession agriculture.

We now relate our regression findings to figures in Tables 7.13 and 7.14. These two tables present per capita income and per capita remittances (ranked by income decile) for households in two groups. The first group includes all households irrigating in the 1991 rainy season. The second group includes only those households that financed production without recourse to credit from the CNCAS (Caisse Nationale du Crédit Agricole du Sénégal). High-income households (those in deciles 8, 9, and 10) consistently achieved high yields. But income did not preclude low income households (decile 5 in Table 7.13 and deciles 2 and 5 in Table 7.14) from also achieving high yields. Remittances contributed between 18 and 44 percent of income. Comparing value and percentage contribution of remittances in income in the two tables, we see that for deciles 8, 9, and 10 in Table 7.14, covering households that financed production themselves, the absolute and percent figures are larger than for the same deciles 8, 9, and 10 among all sample households that irrigated (Table 7.13). These findings suggest two conclusions: (1) although income is an important variable in determining yields, it is neither a necessary nor sufficient variable. The type of scheme and the opportunity to engage in other production systems are also important in determining yields. (2) The amount and percentage contribution of remittances in income are important in determining which households finance production themselves.

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[3] This seems to be the direction of causality in the Middle Valley, although there is doubtless an element of circularity, with high yields in one year enabling a household to purchase more and better inputs in subsequent years.

Table 7.13. Per Capita Income, Per Capita Remittances and Per Hectare Yields for All Households That Irrigated in the 1991 Rainy Season, by Income Decile

Income Decile	Per Capita Income (FCFA)	Per Capita Remittances (FCFA)	Remittances as Percent of Income	Per Hectare Yields (FCFA)
1	6,040	2,274	38	54,443
2	11,800	2,605	22	175,052
3	15,576	2,821	18	128,394
4	19,239	4,486	23	77,081
5	23,532	9,245	39	196,117
6	31,231	6,677	21	175,287
7	38,678	7,471	19	130,694
8	45,795	10,175	22	276,573
9	60,465	14,976	25	307,388
10	135,271	51,958	38	387,415

Table 7.14. Per Capita Income, Per Capita Remittances, and Per Hectare Yields for Households That Irrigated in the 1991 Rainy Season without Credit from the CNCAS (by income decile)

Income Decile	Per Capita Income (FCFA)	Per Capita Remittances (FCFA)	Remittances as Percent of Income	Per Hectare Yields (FCFA)
1	5,986	2,137	36	71,353
2	11,460	2,696	24	200,344
3	15,455	3,520	23	90,275
4	18,858	4,781	25	141,463
5	22,696	5,689	25	227,388
6	31,558	5,796	18	167,238
7	39,144	9,141	23	146,099
8	45,380	12,719	28	288,936
9	59,992	18,719	31	276,935
10	154,044	67,049	44	202,240

D. Conclusion

Migration in the Senegal Valley results from push and pull factors. Periodic hardship within the region and new opportunities outside the region have combined to produce a large outflow of men from the river basin. The SRBMA II data show that during the research period Africa outside of Senegal was the most lucrative destination for migrants, at both the household and per capita levels. In terms of participation rates, however, seasonal and longer-term migration within Senegal engage the most households. Except for seasonal migration, women participate only marginally in migration.

The data also show that remittances are less important for households with access to irrigation than for households with access to flood recession agriculture. This pattern is reflected in annual household remittances, as well as in the number of migrants per household. Migration rates were slightly lower for households that irrigated than for households that farmed flood basins. This suggests that to a certain extent, the presence of irrigation has curbed the flow of migrants from the region.

Among households that irrigated, income, the type of perimeter farmed, and opportunities to take part in other production systems were all important variables in determining yields. The amount and percentage contribution of remittances in income, moreover, were important in determining which households financed production costs themselves. Thus, although the presence of irrigation may have inhibited out-migration slightly, there is indication that households participating in irrigation continue to rely on remittances.

VIII. HOUSEHOLD BUDGETS AND INCOME-GENERATING STRATEGIES

A. Introduction

Precarious and unpredictable weather conditions and the resulting chronic threat of food shortages are determining factors in shaping the labor strategies of Middle Senegal Valley households. To maintain a minimum level of food security, households learn very quickly not only the value but the absolute necessity of diversifying sources of revenues and adopting the maximum flexibility in adjusting to economic conditions. This results in a very diversified and adaptive production system that can easily incorporate other income-generating opportunities, and it explains both the readiness of farmers to accept irrigation as an important element in the production system and their great resistance to replacing ongoing systems of agricultural production with irrigation. Farmers understand something that developers are slow to recognize: the risk of relying on a sole source of income, no matter how promising it might appear.

Hand-in-hand with diversification is the increasing reliance of the household on money income, not only for buying nonagricultural commodities, but to supplement grain and other food shortages in deficit years. In the last chapter we have shown the importance of migratory remittances. In this chapter we shall consider all income-generating opportunities including farm, nonfarm, and migration income.

B. Income Measurement

1. Sources of Income

To calculate household annual income we included the following sources:

- farm income;
- income from livestock transactions;
- revenues from sales other than livestock: general and small commerce, fish, firewood, personal effects, prepared foods;
- income from certain nonfarm activities: artisans, tailors, bakers, butchers, drivers, herders;
- income from wages and salaries: both government and private sectors;
- income from rental property and equipment;
- remittances;
- retirement pensions;
- income for marabouts and healers.

To estimate farm income for each household, we calculated the gross output from harvests, converted these quantities to FCFA on the basis of average prices (see Chapter V), and subtracted total expenses of production. Income from livestock transactions is measured as the value of livestock sales less the value of livestock purchases.

Households differ in size and composition and thus also in both consumption requirements and earning potential. To adjust for such differences we adjust the income of each household by the weights for each household member listed in Table 8.1.

Table 8.1. Weights for Individual Household Members by Age Group

Age	Weight
7 and below	0.50
8 - 14	0.75
15 - 60	1.00
61 and above	0.75

2. Annual Income Adjustments

Since the original income data covers a period of more than one year, and the time periods for recording farm and nonfarm income differ slightly, household income is adjusted to an annual rate.

a. Adjustments to Farm Income

To take into account seasonal, crop, and farm variation in calculating annual farm income we divided the season for each agricultural system into two sometimes-overlapping periods and defined a time frame for each of these activities—depending on the particular system—for the entire data set, as is shown in Table 8.2.

Table 8.2. Agricultural Calendar as Recorded in the Original Data Set

	Period			
	Expenses		Harvest	
Agricultural System	Season I	Season II	Season I	Season II
Falo	9/91 - 5/92		10/91 - 6/92	
Foonde	8/91 - 9/91	8/92 - 10/92	10/91 - 3/92	10/91 - 11/92
Waalo	9/91 - 1/92		11/91 - 6/92	
Jeeri	7/91 - 2/92	4/92 - 11/92	10/91 - 1/92	9/92 - 12/92
Gardens	12/91 - 6/92		1/92 - 8/92	
Large Irrigated Perimeters	8/91 - 11/91		12/91 - 2/92	
Intermediate Irrigated Perimeters	8/91 - 9/91		1/92 - 3/92	
Private Irrigated Perimeters	8/91 - 9/92		3/92 - 12/92	
Village Irrigated Perimeters				
Rainy Season	7/91 - 2/92	6/92 - 2/93	11/91 - 7/92	1/93 - 2/93
Off-Season Hot	2/92 - 7/92		2/92 - 7/92	
Off-Season Cold	11/91 - 5/92		2/92 - 6/92	

Data on three of the agricultural systems (foonde, jeeri, and village irrigated perimeters) cover two seasons each, and extend beyond a calendar year. Therefore, to estimate annual farm income for foonde and jeeri farms, we calculated expenses and harvests by averaging the data for the two seasons. For village irrigated perimeters (PIVs), data for the second season covered only four PSs; accordingly, for annual income calculation purposes we considered the first season's data only.

b. Adjustments for Nonfarm Income

Data on nonfarm incomes were collected on a monthly recall basis, for the period July 1991 to December 1992. In order to annualize income for this period and to account for the variation in number of visits per household, we adjusted household nonfarm income as follows:

adjusted annual nonfarm income = 12 * [total income / number of visits].

3. Other Adjustments

a. Calculation of Farm Income

As we mentioned earlier, farm income is the overall FCFA value of gross output, less total expenses of production. This measure thus includes the value of harvests used for the household's own consumption. The overall value of gross output is calculated as:

amount of harvest * weighted average unit price.

Except for vegetables, weighted average unit prices are derived from farmers' sales price data. The average unit price of vegetables is derived from market price data.

b. Calculation of Income from Livestock Transactions

Income from livestock transactions is calculated as:

(number of livestock sold * unit sale price) less (number of livestock purchased * unit purchase price).

c. Number of Households Deleted

Nine households, who were visited fewer than seven times for the survey, were dropped from the study. This reduced our overall sample size to 331 households.

C. Amount and Proportion of Household Budgets Earned from Farm and Nonfarm Revenue-Generating Activities

1. Sources of Revenues by PS

The data show that to a large extent households diversify the sources of their income. The degree of this diversification, including the totals and proportions of the amounts earned from different pursuits, varies by PS and to a lesser degree by caste. Tables 8.3, 8.4, and 8.5 show aggregate, proportional, and per household income by source of income and production space.

In these tables farm income includes only agricultural activities; income from herding, livestock sales, and other farm-related activities are treated separately. In most PSs, households resort to at least 15 of the 20 sources of income listed, although the degree of reliance on a particular activity, measured in terms of the total income generated, varies widely.

The highest total income is in PS 6, which receives large migratory remittances. Of a total income of 29.3 million FCFA, shared among 34 households in PS 6 (Table 8.3), remittances account for 13.2 million FCFA, 45 percent of the total (Table 8.4). Although total income is substantially lower in PSs 9, 8, and 7, respectively 19.0 million FCFA, 15.3 million FCFA, and 10.3 million FCFA, the proportions generated by migratory remittances in these PSs, as can be seen in Table 8.4, are higher in each of these PSs. To facilitate comparisons among the various sources of income, we reduced Table 8.3 to five major categories: agriculture, livestock, fishing, migration, and other nonfarm income. This is displayed in Figure 8.1, again by PS, which may be looked at in conjunction with Table 8.3. Overall totals and proportions vary from one PS to another, but the importance of nonfarm income in most regions is clearly indicated.

Table 8.4 and Figure 8.1 demonstrate the primary role of migration in generating cash revenues. This is most important in the Department of Matam, where migratory remittances account for 45 percent of overall revenues in PS 6, 67 percent in PS 7, 48 percent in PS 8, and 71 percent in PS 9. The contribution of migratory remittances to total household revenues is somewhat less important in the Department of Podor. In PS 5, where remittances are 10 percent of total income, it is the fourth highest revenue generator, after agriculture (30 percent), sales of livestock (23 percent), and commercial activities (15 percent). In the four other PSs remittances are substantially more important: 33 percent in PS 1, 31 percent in PS 2, 26 percent in PS 3, and 41 percent in PS 4.

The proportion of total revenues derived from agricultural activities is higher in most PSs in the Department of Podor than in Matam's PSs. This might be a function of greater reliance on revenues from irrigation at the downstream production sites. In PS 2, for example, farm income comprises almost 50 percent of the total. This is not true for the FCFA amounts of agricultural income, however, as is indicated in Table 8.3. Total farm revenues in the four PSs in the Department of Matam amount to 10.8 million FCFA, slightly lower than what is reported

Table 8.3. Sources of Aggregate Household Income by PS, in FCFA

PS	1	2	3	4	5	6	7	8	9
Number of Households	32	25	37	32	35	34	53	38	45
Total Income	14,488,854	7,269,396	8,445,265	13,572,601	8,606,532	29,283,975	10,309,575	15,250,931	19,039,223
Revenue Source									
Farm Income	343,412	3,577,235	1,832,973	4,761,500	2,564,884	6,594,900	1,555,209	2,260,401	427,050
Sale of Livestock	1,114,045	151,500	2,377,780	222,964	1,988,394	116,456	412,906	940,921	2,109,977
Hunting	0	0	147,968	0	0	0	0	0	0
Fishing	364,030	112,184	294,516	24,211	186,974	446,163	376,115	777,653	216,527
Artisanal	102,866	9,700	89,332	301,067	44,408	511,971	57,923	680,055	154,350
Service	979,397	398,268	358,317	751,597	438,493	249,692	42,051	170,196	446,870
Commercial	169,015	0	168,547	388,442	1,298,571	78,132	210,754	164,190	0
Small Shop	17,538	0	50,538	0	150,239	25,714	9,694	155,274	126,392
Transport	0	0	3,200	127,582	58,071	176,713	0	66,923	0
Ag. Equip. Rental	100,000	0	137,941	130,846	0	1,058,110	923	45,399	90,500
Rental Property	900,600	305,923	145,973	0	3,000	1,151,407	19,960	131,538	44,500
Sale of Personal Effects	341,239	167,273	50,169	71,870	48,000	70,286	14,769	78,142	78,708
Marabout	374,415	0	369	125,607	298,202	987,650	0	163,582	9,000
Government	140,615	0	0	0	4,154	1,187,538	0	4,154	0
Herding	0	0	26,769	0	0	60,000	0	0	24,500
Food Sale	4,000	0	0	0	0	17,176	923	0	5,000
Migration Remit-tances	4,762,714	2,281,685	2,191,883	5,599,712	826,007	13,180,035	6,929,631	7,247,426	13,571,259
Retirement	1,201,738	164,600	0	2,500	103,688	1,014,049	240,246	348,863	0
Private Sector Salaries	920,354	20,000	0	199,516	0	9,231	8,769	33,045	0
Other	2,652,875	81,027	568,989	865,186	593,445	2,348,752	429,703	1,983,168	1,734,589

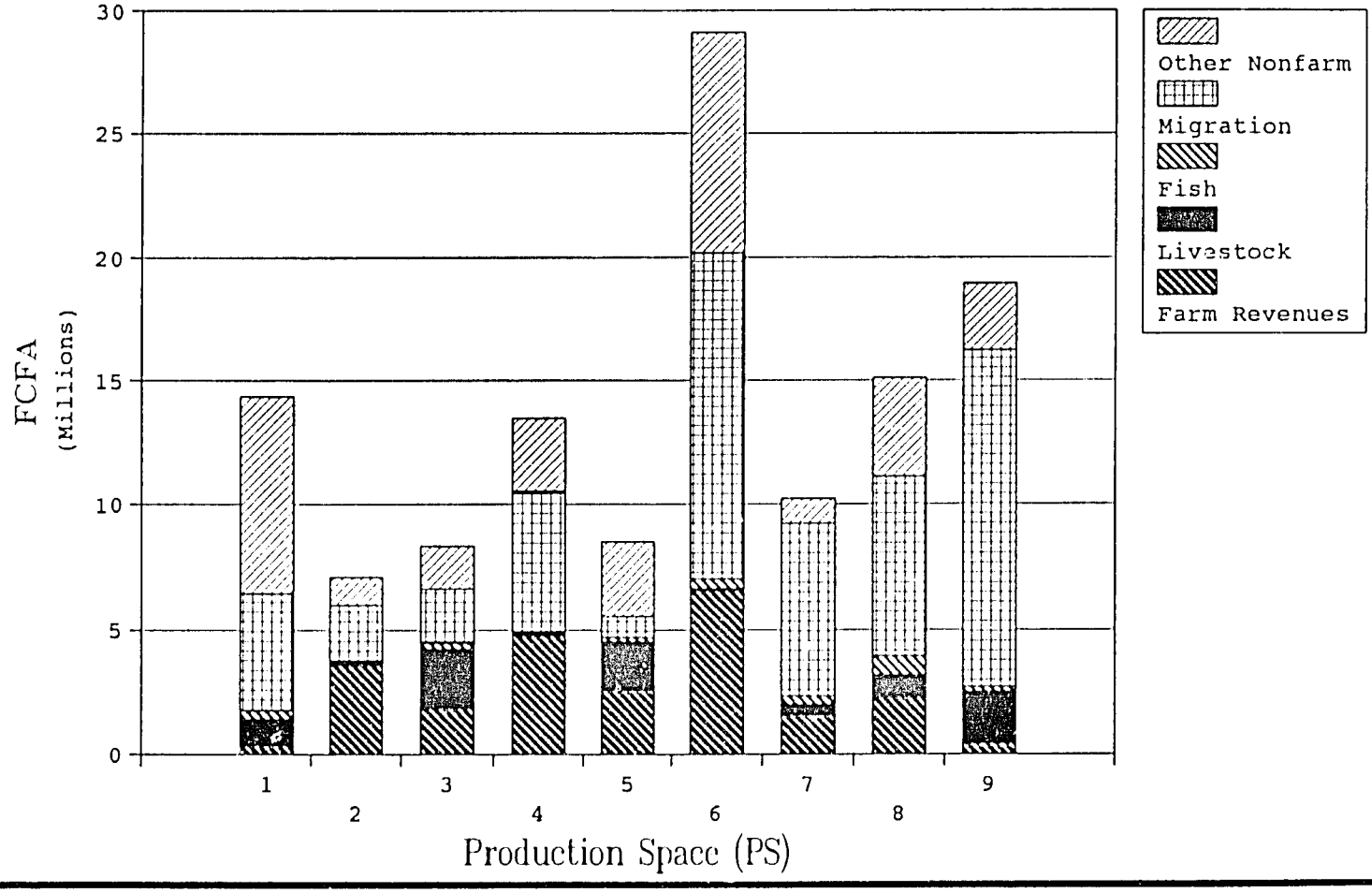
Table 8.4. Percentages of Household Income Earned, by Revenue-Generating Activity and PS

PS	1	2	3	4	5	6	7	8	9
Number of Households	32	25	37	32	35	34	53	38	45
Total Income (FCFA)	14,488,854	7,269,396	8,445,265	13,572,601	8,606,532	29,283,975	10,309,575	15,250,931	19,039,223
Total Income (percent)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Revenue Source									
Farm Income	2.37	49.21	21.70	35.08	29.80	22.52	15.09	14.82	2.24
Sale of Livestock	7.69	2.08	28.16	1.64	23.10	0.40	4.01	6.17	11.08
Hunting	0.00	0.00	1.75	0.00	0.00	0.00	0.00	0.00	0.00
Fishing	2.51	1.54	3.49	0.18	2.17	1.52	3.65	5.10	1.14
Artisanal	0.71	0.13	1.06	2.22	0.52	1.75	0.56	4.46	0.81
Service	6.76	5.48	4.24	5.54	5.09	0.85	0.41	1.12	2.35
Commercial	1.17	0.00	2.00	2.86	15.09	0.27	2.04	1.08	0.00
Small Shop	0.12	0.00	0.60	0.00	1.75	0.09	0.09	1.02	0.66
Transport	0.00	0.00	0.04	0.94	0.67	0.60	0.00	0.44	0.00
Ag. Equip. Rental	0.69	0.00	1.63	0.96	0.00	3.61	0.01	0.30	0.48
Rental Property	6.22	4.21	1.73	0.00	0.03	3.93	0.19	0.86	0.23
Sale of Personal Effects	2.36	2.30	0.59	0.53	0.56	0.24	0.14	0.51	0.41
Marabout	2.58	0.00	0.00	0.93	3.46	3.37	0.00	1.07	0.05
Government	0.97	0.00	0.00	0.00	0.05	4.06	0.00	0.03	0.00
Herding	0.00	0.00	0.32	0.00	0.00	0.20	0.00	0.00	0.13
Food Sale	0.03	0.00	0.00	0.00	0.00	0.06	0.01	0.00	0.03
Migration Remittances	32.87	31.39	25.95	41.26	9.60	45.01	67.22	47.52	71.28
Retirement	8.29	2.26	0.00	0.02	1.20	3.46	2.33	2.29	0.00
Private Sector Salaries	6.35	0.28	0.00	1.47	0.00	0.03	0.09	0.22	0.00
Other	18.31	1.11	6.74	6.37	6.90	8.02	4.17	13.00	9.11

Table 8.5. Average Income per Household by Type of Activity and PS, in FCFA

PS	1	2	3	4	5	6	7	8	9
Number of Households	32	25	37	32	35	34	53	38	45
Total Income	452,777	290,776	228,250	424,144	245,901	861,293	194,520	401,340	423,094
Revenue Source									
Farm Income	10,732	143,089	49,540	148,797	73,282	193,968	29,344	59,484	9,490
Sale of Livestock	34,814	6,060	64,264	6,968	56,811	3,425	7,791	24,761	46,888
Hunting	0	0	3,999	0	0	0	0	0	0
Fishing	11,376	4,487	7,960	757	5,342	13,122	7,097	20,465	4,812
Artisanal	3,215	388	2,414	9,408	1,269	15,058	1,093	17,896	3,430
Service	30,606	15,931	9,684	23,487	12,528	7,344	793	4,479	9,930
Commercial	5,282	0	4,555	12,139	37,102	2,298	3,976	4,321	0
Small Shop	548	0	1,366	0	4,293	756	183	4,086	2,809
Transport	0	0	86	3,987	1,659	5,197	0	1,761	0
Ag. Equip. Rental	3,125	0	3,728	4,089	0	31,121	17	1,195	2,011
Rental Property	28,144	12,237	3,945	0	86	33,865	377	3,462	989
Sale of Personal Effects	10,664	6,691	1,356	2,246	1,371	2,067	279	2,056	1,749
Marabout	11,700	0	10	3,925	8,520	29,049	0	4,305	200
Government	4,394	0	0	0	119	34,928	0	109	0
Herding	0	0	723	0	0	1,765	0	0	544
Food Sale	125	0	0	0	0	505	17	0	111
Migration Remittances	148,835	91,267	59,240	174,991	23,600	387,648	130,748	190,722	301,584
Retirement	37,554	6,584	0	78	2,963	29,825	4,533	9,181	0
Private Sector Salaries	28,761	800	0	6,235	0	271	165	870	0
Other	82,902	3,241	15,378	27,037	16,956	69,081	8,108	52,189	38,546

Fig.8.1 Household Revenue Sources
by Production Space



for the five PSs in the Department of Podor: 13.1 million FCFA. Of course, among other factors, total revenues is a function of the number of sample households in each PS. Accordingly, we turn to average income per household.

Table 8.5 presents average household income by activity and PS. Except for PS 7, where average per household migration revenues are somewhat lower than PS 1 and PS 4 (130,748 FCFA as opposed to 148,835 FCFA and 174,991 FCFA, respectively), revenues are higher in the Department of Matam than in Podor: 387,648 FCFA in PS 6, 301,584 FCFA in PS 9, and 190,722 FCFA in PS 8.

Revenues from agriculture and sales of livestock are also important, especially in PS 6 (193,968 FCFA from agriculture), PS 4 (148,797 FCFA from agriculture), PS 2 (143,089 FCFA from agriculture), PS 3 (64,264 FCFA from livestock sales), PS 8 (59,484 FCFA from agriculture), and PS 5 (56,811 FCFA from livestock sales).

In sum, diversification is a necessary survival strategy in the Middle Senegal Valley. Most areas depend on income from migrant remittances, followed by revenues from agriculture and sales of livestock. Other sources of revenues, regarded individually, look much less impressive. Aggregated, however, they contribute importantly to household survival.

2. Crop Transactions

a. Overview

Purchases of staple commodities for consumption occur when households are not self-sufficient in the product. This may be because the harvest was inadequate to meet their needs, because they want and can afford more variety in consumption than their agricultural activities produce, or because they specialize in certain crops and exchange part of their surplus (by sale or barter for other commodities). Sales of commodities take place when households produce more of a crop than they would normally need for consumption (including stocks for seed and anticipated future consumption), or when needs for cash or other commodities are more urgent.[1]

The commodities most frequently featured in such transactions appear in Table 8.6, with numbers of purchases and sales, average size of the transactions (in kg), average price per

[1] Some purchases and sales, of course, are made for speculation: buying for inventory in order to sell at expected higher prices; selling out of stock in order to take advantage of such higher prices (or because prices are expected to fall). The transactions data do not allow us to distinguish such sales and purchases at this time. Transactions will have to be examined on a household-by-household basis in order to separate speculative transactions from nonspeculative ones.

Table 8.6. Commodity Transactions: Sales, Purchases, Average Quantities, and Average Prices

Commodity	Commodity Sales					Commodity Purchases				
	Transactions		Average Size of Sale (kg)	Average Value of Sale (FCFA)	Average Price (FCFA/kg)	Transactions		Average Size of Purchase (kg)	Average Value of Purchase (FCFA)	Average Price (FCFA/kg)
	Number	%				Number	%			
Paddy Rice	142	13.7	117.2	6,520.2	55.6	963	14.2	76.4	4,766.9	62.4
Decorticated Local Rice	17	1.6	103.5	15,320.6	148.0	189	2.8	45.3	6,245.9	138.0
Imported Rice	281	27.0	52.4	8,744.1	166.9	1,584	23.4	58.0	8,665.4	149.5
Millet	15	1.4	36.1	2,350.0	65.1	150	2.2	42.0	4,501.4	107.3
Sorghum/ Recession	162	15.6	50.2	3,026.4	60.2	236	3.5	69.6	4,953.6	71.2
Sorghum/ Rainfed	23	2.2	45.2	4,702.2	104.0	282	4.2	92.4	8,897.9	96.3
Dried Corn	58	5.6	12.8	2,264.6	176.4	310	4.6	42.5	4,764.2	112.1
Cowpeas (niebe)	26	2.5	11.0	1,353.8	122.6	239	3.5	8.3	878.4	105.7
Sweet Potatoes	39	3.8	197.9	11,724.4	59.2	285	4.2	7.6	1,019.9	133.8
Potatoes	0	-	-	-	-	8	0.1	10.9	1,956.2	179.9
Sorghum/ Imported	198	19.1	44.6	5,037.9	113.0	1,017	15.0	70.1	5,983.3	85.4
Tomatoes/ Concentrated	26	2.5	298.1	10,221.9	34.3	264	3.9	6.9	816.5	119.0
Onions	52	5.0	26.8	3,780.5	141.1	1,196	17.6	5.9	638.5	107.3
Semolina	0	-	-	-	-	20	0.3	29.7	5,371.5	180.8
Kinkeliba[a]	0	-	-	-	-	8	0.1	43.8	4,625.0	105.7
Other	0	-	-	-	-	26	0.4	-	-	-
Total	1,039	100.0	-	-	-	6,777	100.0	-	-	-

[a] A leaf used for making herb tea.

kilogram bought or sold for the commodity, and average value of a transaction for each commodity listed. The commodities most frequently purchased are imported rice (with 1,584 purchases), onions (1,196), imported sorghum (1,017), and locally produced paddy rice (963). Those most frequently sold are imported rice (281 sales), imported sorghum (198), recession sorghum (162), and paddy rice (142). The number of purchases substantially outweighs the number of sales (6,777 to 1,039). This is because many farmers plant crops for subsistence use only, and many who anticipated an adequate surplus for sale in the market experienced shortages during the poor growing conditions of 1991-1992. Moreover, a few of the commodities

considered important for consumption are not produced locally at all in some of the PSs. Only 2 of the sample households made no purchases of food staples; 93 made no sales.

Certain staple commodities are, on average, purchased in relatively large quantities. Sorghum stands out: the average quantity of rainfed sorghum purchased was 92.4 kg; imported sorghum purchases averaged 70.1 kg and recession-cultivated sorghum 69.6. Paddy rice, at an average of 76.4 kg per purchase, is another such staple. Other types of rice and dried corn are also purchased in fairly large quantities.

These grains are, to some extent, substitutes for each other. Among the three types of rice, the one with the largest average quantity per purchase is paddy, which has the lowest average price per kg (62.4 FCFA). The average price of imported rice was more than twice as high as paddy, and the quantity per purchase was smaller. The total volume of imported rice bought, however, was larger because of the frequency of purchases, but imported rice—like decorticated local rice but unlike paddy—is husked, so the average prices are not comparable.[2] The total volume of imported sorghum (in kilograms), with a price between that of recession and rainfed sorghum, is nevertheless considerably larger than the sum of the two local types. Purchases of imported grains were needed to make up for the poor harvests caused by the dearth of rain and unfavorable flood conditions during the research period. In our sample of the Middle Valley alone, 13.7 million FCFA was spent on imported rice, more than twice the sum paid for paddy plus decorticated local rice (6.8 million FCFA). Similarly, imported sorghum cost 6.1 million FCFA, against 3.7 million FCFA paid for the sum of recession and rainfed sorghum.

Turning to sales, sales of the staple grains—rice, sorghum, millet—comprised more than 80 percent of the number of sales. The number of rice sales was 42 percent of the total, with imported rice sales twice as numerous as paddy sales, and only a handful of sales of decorticated local rice. Sorghum sales were 37 percent of all sales, with transactions involving imported sorghum slightly ahead of recession sorghum and few sales of rainfed sorghum—partly a result, of course, of scant rainfall during the seasons covered. As with purchases, millet sales were relatively unimportant.

As for comparative selling prices, imported rice, at 167 FCFA/kg, was three times as expensive as paddy (56 FCFA), again reflecting not only the difference in net quantity (refined against unrefined) but also the shortfalls in local grain production. Local decorticated rice (at 148 FCFA/kg) was nearly as high in price as imported, but only 1,760 kg were marketed as compared to the 14,720 kg of imported rice. Similarly, prices of rainfed and imported sorghum

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[2] A kilogram of decorticated or imported rice is equivalent to about two kilograms of (unhusked) paddy rice, so the purchase price ratios (2.2:1 for the price of local decorticated rice to the price of paddy, and 2.4:1 for the ratio of imported rice to paddy prices) are not unreasonable. The sales price ratios (2.7:1 for local and 3:1 for imported rice to paddy) are higher.

sold were close (104 FCFA/kg and 113 FCFA/kg, respectively), and recession sorghum considerably cheaper (60 FCFA/kg), but there was not enough of both kinds of locally produced sorghum (8,139 kg of recession sorghum and 1,040 kg of rainfed sold) to meet the demand; an additional 8,828 kg of imported sorghum was sold.

Table 8.6 and Figure 8.2 show differences between the average prices of sales and purchases for the three types of rice and of sorghum. As would be expected, the two imported products, rice and sorghum, are sold for more than their cost of purchase: some of those who sell imported commodities in the Middle Valley are traders who have bought from outside the valley in larger lots and sell in smaller quantities.[3] This is borne out by the average sizes of the transactions, especially for imported sorghum: purchases averaged 70 kg, sales 45 kg. The differences in prices and quantities for sales and purchases of imported rice are somewhat smaller, but in the same direction. The average selling price is also higher than the purchase price for decorticated local rice and rainfed sorghum, although the average quantity of a sale is higher than the average size of a purchase for the local rice (smaller for rainfed sorghum). These last two crops are minor components of total sales and purchases, however. For paddy rice and recession sorghum, the average purchase price exceeds the average selling price. This may be indicative of local conditions that force producers to sell at harvest, when prices are low, and buy later, at higher prices, to meet food needs. Paddy transactions are about 14 percent of sales and of purchases; recession sorghum sales are as important a fraction of sales (nearly 16 percent), but less than 4 percent of purchases.

The two important grains, rice and sorghum, are analyzed below with respect to seasonal patterns, price and income effects, and relationships to location (PS) and caste.

b. Seasonal Patterns

Commodity transactions are, of course, related to seasonal availability. As the transaction data analyzed here refer to at most 14 months of a period that experienced unusual rain and flood conditions, however, conclusions about seasonality cannot necessarily be generalized.

Rice. To some extent, **purchases** of local rice complement each other seasonally (Figure 8.3). Reported purchases (solid lines) of paddy rice were fairly stable from month to month between August 1991 and May 1992, then peaked in June and August 1992 (the dip in July is unexplained). Decorticated local rice purchases were generally high between August and December 1991, falling off considerably in January 1992 and remaining low from February through August 1992. Rice harvesting in the irrigated perimeters, where much of the rice is

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[3] Future analysis of the data may be able to compare the numbers of households selling and buying these commodities, and relationships to their sources of income, place of residence, caste, and range of productive activities.

Figure 8.2 Selected Commodities:
Prices of Sales and Purchases

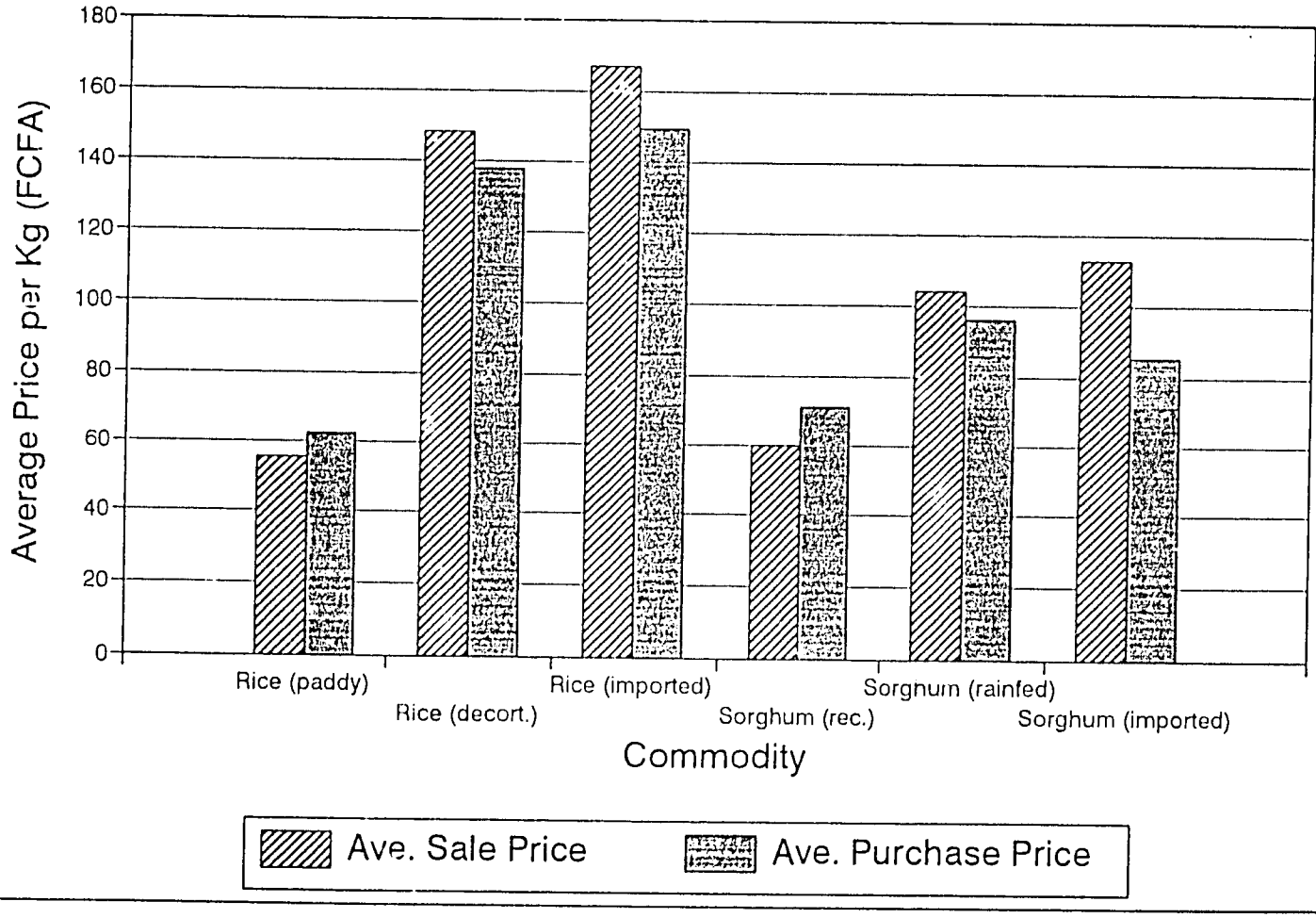
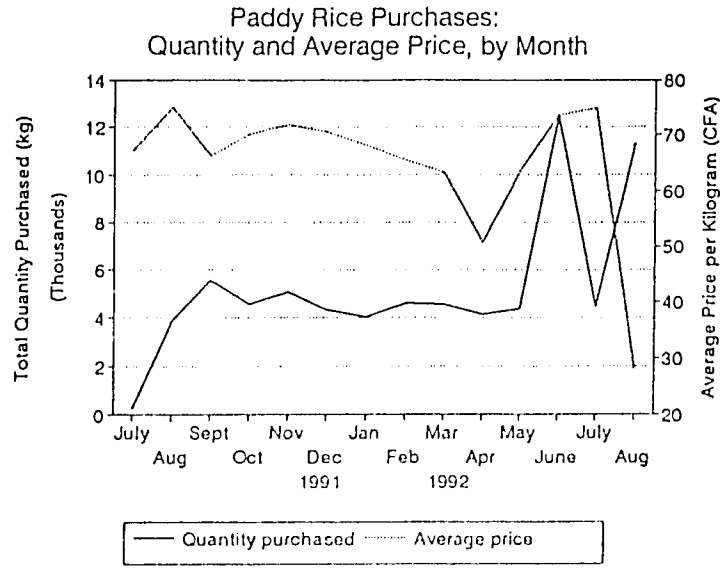
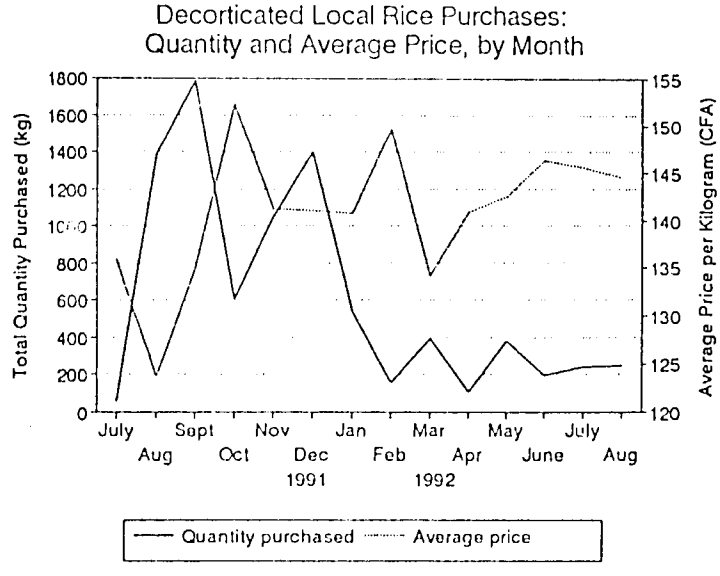
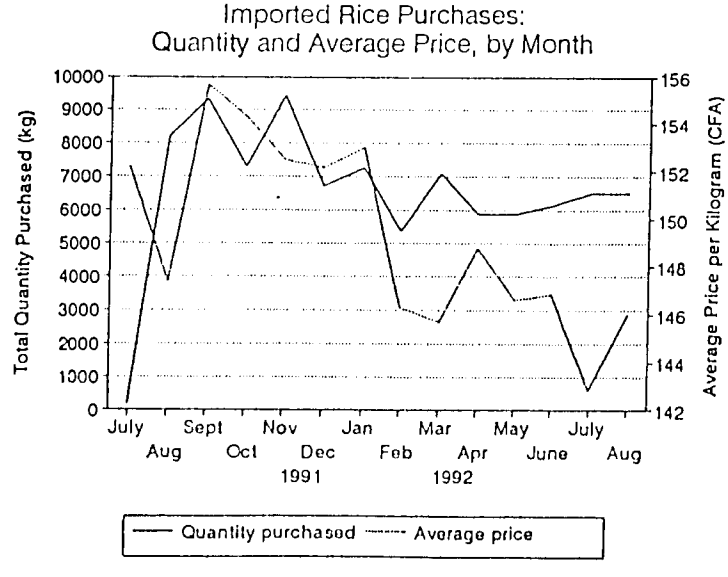


Figure 8.3. Rice Purchases: Quantity and Average Price, by Month







grown, occurs in mid-December. The largest (in number and volume) rice purchases, as noted above, were purchases of imported rice: quantities bought were high from August through November 1991, leveling off somewhat between December 1991 and August 1992 in the range of 6,000 to 7,000 kg purchased per month. The quantity of imports was to some extent related to local weather and flood conditions: 1992 harvests were not as bad as 1991's, so the need for imports was less in 1992.

Sales of domestic rice (Figure 8.4) show rather wide swings (perhaps only because fewer transactions—especially of decorticated local rice—were recorded). The quantity of paddy sold was highest in March and July 1992.[4] In contrast, decorticated local rice sales peaked in September and December 1991, and imported rice in August-October of that year. Quantities of imported rice sold, as reported by the sample households, were above 5,000 kg in both August and September 1991, fell to 3,200 in October, and dropped precipitously thereafter, remaining below 250 kg per month during the remainder of the research period.

Sorghum. Imported sorghum, as shown in Figure 8.5, dominated sorghum **purchases** from August 1991 to January 1992, peaking in December.[5] Sorghum is usually harvested on the floodplains in March and April, so, as might be expected, the quantity of recession sorghum purchased was higher than that of imported sorghum in April, May, and June 1992; purchases were at their peak in June. From January through March 1992 the quantity of rainfed sorghum bought was at its highest; in March, at 4,541 kg, it exceeded the total of imported plus recession sorghum bought (3,576 kg).

Sales of recession sorghum, like purchases of this crop, were highest in April and May, following the harvest (Figure 8.6). Imported sorghum was sold in large quantities from August through October 1991 (over 2,000 kg in each of these months); reported sales totaled less than 200 kg in all the other months. Sales of rainfed sorghum have two peaks, in January and May 1992, but such sales were very few in all (23), so no pattern can be inferred.

c. Price and Income Effects

Economic analysis predicts that purchases of most goods will increase with the purchaser's income (given the price) and decrease with the price of the good (given the purchaser's income). For sellers, sales would be expected to increase with the price of the good, but the effect of income is not as easily predictable. To the extent that wealthier households control more land and other productive resources they could produce more, have larger crops, and thus have more available for sale than low-wealth households; sales would

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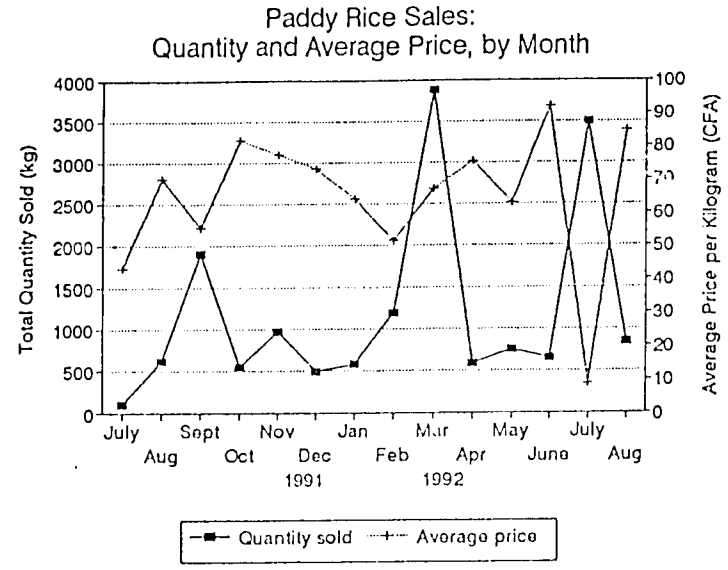
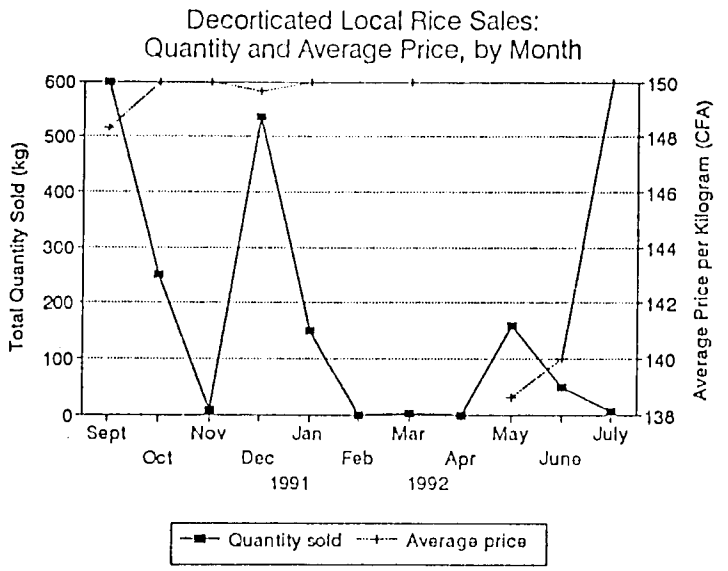
[4] Perhaps not coincidentally, its price was lowest in the latter month. Price-quantity relationships are discussed below.

[5] As with sales of paddy rice, this commodity's price was at a low in the month when its purchases were highest.

Figure 8.4. Rice Sales: Quantity and Average Price, by Month





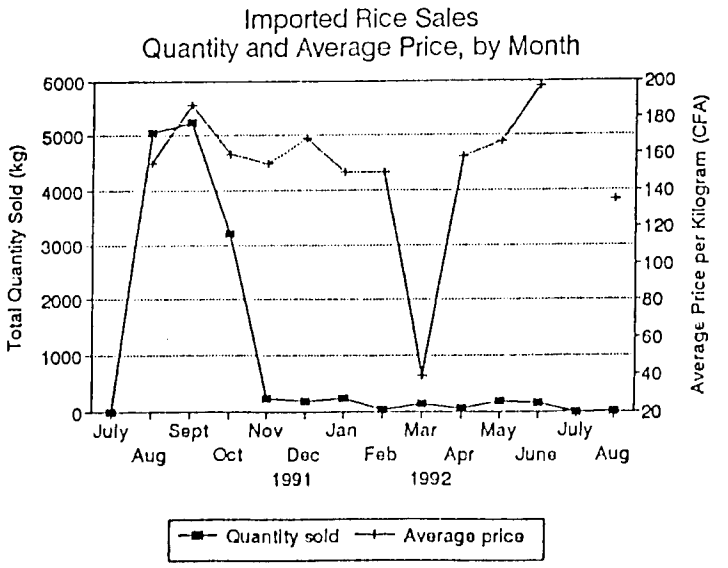
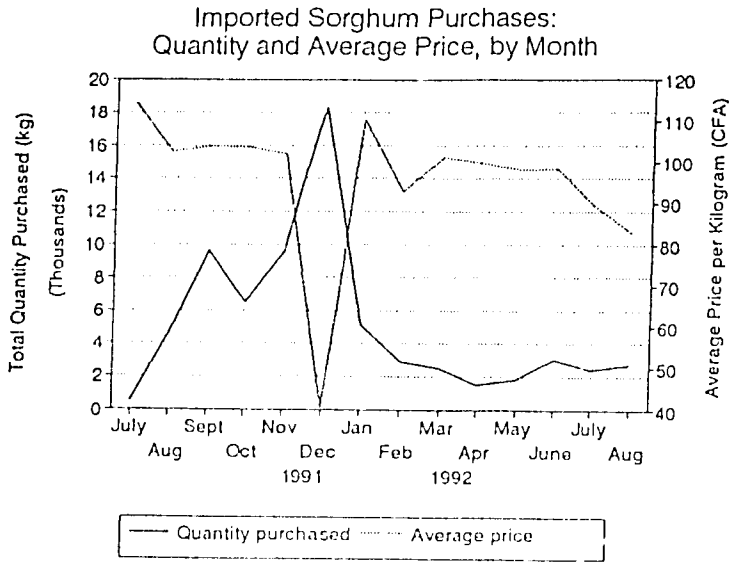
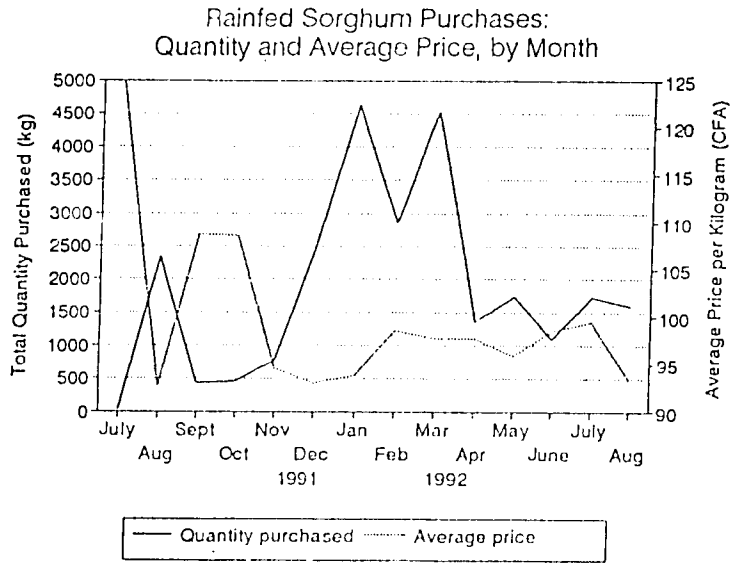


Figure 8.5. Sorghum Purchases: Quantity and Average Price, by Month





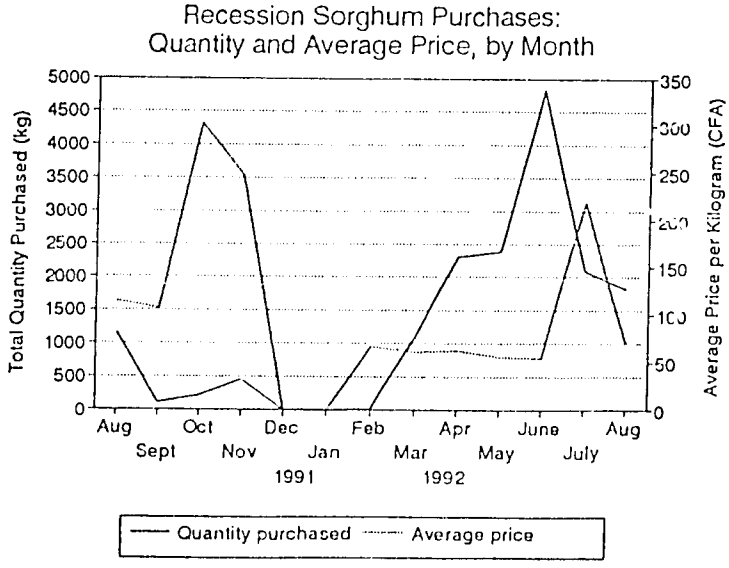
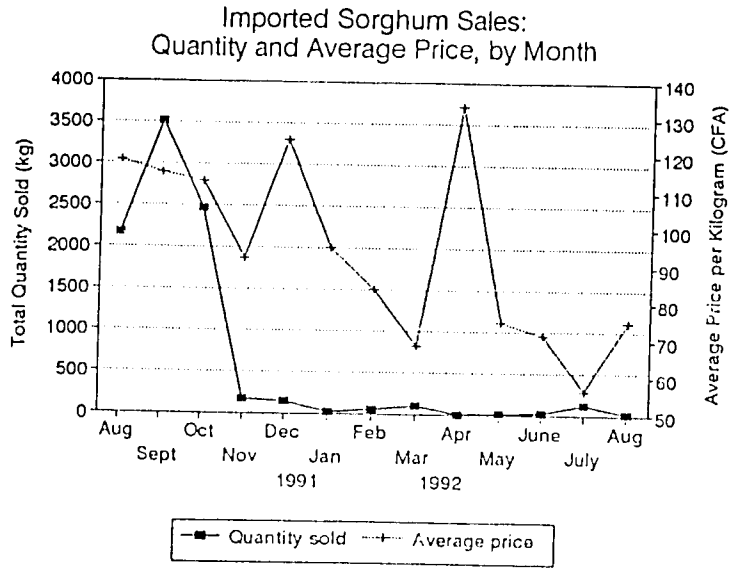
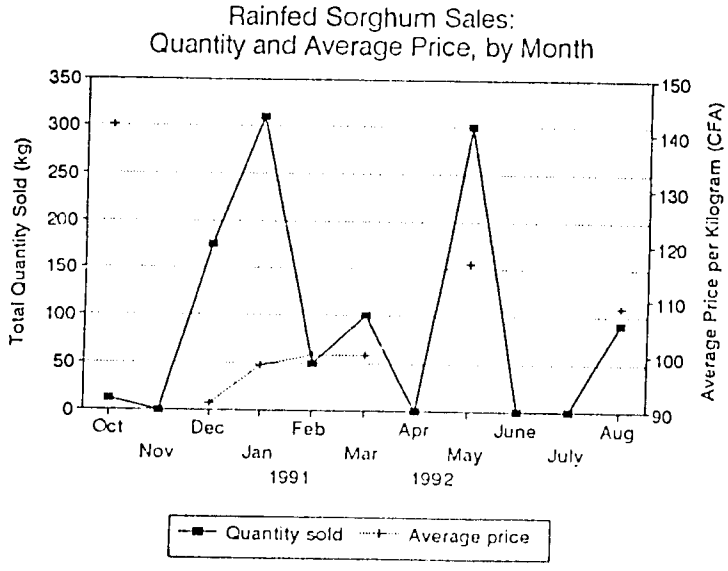
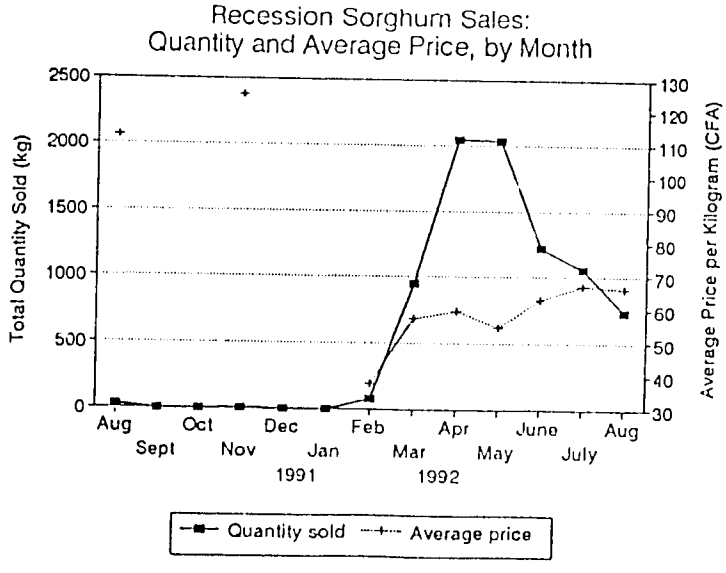


Figure 8.6. Sorghum Sales: Quantity and Average Price, by Month







then presumably increase with income (*ceteris paribus*). Moreover, high-income households may be able to buy up commodities for speculation, so that, in general, the higher the income the greater will be the sales. However, if low-income holders of a commodity are forced to sell in order to purchase more urgently needed goods even—perhaps especially—when prices are low, while higher income households can afford to hold stocks at low prices and sell at higher prices, the effect of income is not independent of price and it is not easy to disentangle the effect of income alone.

Rice. Table 8.7 summarizes the results of two regressions performed on the sales and purchases of each type of rice. In the first group, each individual purchase or sale by a household (the dependent variable) is matched with the household's adjusted (by age and sex) per capita income and the price of the particular transaction. For five of the six categories—purchases of all three types of rice and sales of paddy and decorticated local rice—per capita **income** has a significant effect on the quantity bought or sold (holding the price of the transactions constant).[6] In all six cases, the income coefficient is positive: the higher the household's income, the more rice it tends to buy and/or sell. Thus, for purchasers, the income effect works as predicted. For sellers, the hypothesis that more income means more sales (holding price constant) is given greater credence by these findings.

The **price** effects (still in the top section of Table 8.7) for rice **purchases** are as predicted for imported rice: the higher the price, the less bought (given the income). The price coefficients for paddy and decorticated local rice purchases are positive rather than negative, however, although neither is statistically significant. This would support the hypothesis that (given a household's income—although particularly for low-income households) rice must be bought when the need for food is high, and that may be when grain prices are high. Grain prices are likely to be low just after harvest, when local rice is relatively plentiful and households may be consuming their own stocks without needing to buy. For rice **sales**, the price effect is negative for paddy and imported rice (contrary to what economic theory predicts, though not significant in the latter case), and positive (but not significant) for decorticated local rice.

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[6] For the sixth category, sales of imported rice, the normal curve intercept is 1.95 standard errors, barely short of the 5 percent level of significance (1.96).

In the standard linear multiple regression used here, the coefficient of each independent variable implies that the other independent variable is held constant. This result depends, among other things, on the assumption that the independent variables are not themselves correlated. For purchases of paddy rice, as is indicated in the second set of regressions of Table 8.7, this assumption does not hold: price of paddy purchases is significantly related to per capita income.

Table 8.7. Regression Results: Purchases and Sales of Rice

Regression	Purchases			Sales		
Quantity on Per Capita Income and Price	Ratio: Coefficient to its Standard Error (t or z)[a]		R^2 (percent explained)[b]	Ratio: Coefficient to its Standard Error (t or z)[a]		R^2 (percent explained)[b]
	Income Per Capita	Price		Income Per Capita	Price	
Paddy	4.58**	1.54	2.5	5.68**	-2.26*	21.8
Decorticated Local	7.74**	1.70	2.5	2.94* [1%≤p≤2%]	1.22 [20%≤p≤50%]	42.5
Imported	7.44**	-3.19**	4.1	1.95	-0.07	1.4
Price on Per Capita Income						
Paddy	-2.13*		0.5	0.60		0.3
Decorticated Local	-0.31		0.0	0.13 [p>50%]		0.1
Imported	-1.64		0.2	-0.42		0.1

[a] In each case, the (null) hypothesis being tested is that there is no relationship between the dependent variable (quantity bought or sold in the first set, price received or paid in the second set) and the independent variable(s) (adjusted per capita income and price in the first set, adjusted per capita income in the second): that is, the "real" coefficient is zero, and only sampling error gives a nonzero number. A coefficient "far" from zero (in relation to its variability, or standard error) throws doubt on the null hypothesis, suggesting that there is a real relationship between the pair of variables concerned. Unless otherwise indicated (i.e., when the sample size is less than 32 or 33, in which case a probability range is given), a ratio ≥ 1.96 implies that the coefficient is significantly different from zero at a 5% level of probability (in repeated tests of similar samples one would expect only 5 in 100 coefficients to be this large or larger if the dependent and independent variable were unrelated); a ratio ≥ 2.56 that the coefficient is significant at a 1% level of probability.

[b] R^2, the coefficient of determination, indicates what proportion of the total amount of variability in the dependent variable is "explained" by the independent variable(s). This value is relatively small in most of these regression equations, an indication that unspecified other factors have much to do with the variability of the dependent variables (including, for example the prices and availability of other grains, a possibility we did not have time to analyze.

* Significant at 5% level.

** Significant at 1% level.

The lower half of the table tests the hypothesis that the price at which a household buys or sells rice depends in part on its income. Evidence from SRBMA I suggested that price and income are inversely (negatively) related for purchases and positively for sales. The only significant coefficient is for **purchases** of paddy rice, though in each case of rice purchases the sign is negative: price rises as income declines. The poor pay more. This may be partly a matter of the size of the purchases (rich households may obtain quantity discounts for buying in larger lots), but it also sustains the hypothesis that immediate necessity rather than planned

welfare maximizing over time drives the low income household's actions.[7] Conclusions cannot be drawn for **sales:** the coefficients are not significant and the signs are mixed.

Sorghum. As with rice, **income** has a significant impact on the quantity of sorghum a household buys and sells, with price held constant (Table 8.8). Except for sales of rainfed sorghum (with only 23 transactions reported), the signs of the income coefficients are all positive and only the coefficient for purchases of imported sorghum is not significant. Income is positively related to **purchases** of recession and rainfed sorghum and to **sales** of recession and imported sorghum. The supposition that wealthier households sell imported sorghum to less affluent households is supported, but then purchases of the imported grain should also be related positively to income: as it is not a domestic crop, the supply must be purchased before it can be sold. Lack of significance of the income coefficient for purchases of imported sorghum and the low R^2 indicate that many other factors influence imported sorghum purchases: size of the local harvest is probably a key one.

Price effects on sorghum purchases and sales, again with the exception of the small sample of sales of rainfed sorghum, are all negative, though only two (purchases of recession and of imported sorghum) are significant. For **purchases,** holding income constant, the negative signs for price coefficients support the prediction: the higher the price, the lower the quantity bought. For **sales,** no price coefficients are significantly different from zero. The two negative signs (for recession and imported sorghum sales) hint, as with rice, that even controlling for household income, sales are higher when the price is low and lower when the price is high. Seasonal pressures may account for this in part. As was remarked above, however, these coefficients are not significant.

Looking at the lower part of Table 8.8, prices paid and received for sales and purchases of sorghum seem to be unrelated to the individual household's per capita income, whether the household is seller or buyer. The SRBMA I-based prediction would be that the coefficients for purchases would be negative (the poor buy at high prices, the rich at low) and sales coefficients would be positive (the poor sell at low prices, the rich at high). For purchases, two of the three signs are negative and for sales, two are positive, but none are significantly different from zero.

The low R^2's in nearly all these cases—purchases and sales, of rice and of sorghum—indicate that the greatest part of the variability in sales and purchases is not explained by price and income. We therefore turn to location (PS) and caste as other possible determinants.

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[7] Economists might conclude also that these markets are not well-enough developed and that credit is insufficiently available to allow for the kind of price hedging and speculation that stabilizes rather than accentuates price swings, particularly more-or-less predictable seasonal fluctuations.

Table 8.8. Regression Results: Purchases and Sales of Sorghum

Regression	Purchases			Sales		
Quantity on Per Capita Income and Price	Ratio: Coefficient to its Standard Error (t or z)[a]		R^2 (percent explained)[b]	Ratio: Coefficient to its Standard Error (t or z)[a]		R^2 (percent explained)[b]
	Income Per Capita	Price		Income Per Capita	Price	
Recession	2.41*	-4.10**	8.1	3.38**	-1.31	8.0
Rainfed	2.71**	-0.75	2.8	-0.52 [p>50%]	0.50 [p>50%]	2.2
Imported	0.50	-2.16*	0.5	3.05**	-1.34	5.8
Price on Per Capita Income						
Recession	1.82		1.4	-0.84		0.5
Rainfed	-0.10		0.0	0.76 [20%≤p≤50%]		2.6
Imported	-0.52		0.0	1.00		0.8

[a] In each case, the (null) hypothesis being tested is that there is no relationship between the dependent variable (quantity bought or sold in the first set, price received or paid in the second set) and the independent variable(s) (adjusted per capita income and price in the first set, adjusted per capita income in the second): that is, the "real" coefficient is zero, and only sampling error gives a nonzero number. A coefficient "far" from zero (in relation to its variability, or standard error) throws doubt on the null hypothesis, suggesting that there is a real relationship between the pair of variables concerned. Unless otherwise indicated (i.e., when the sample size is less than 32 or 33 in which case a probability range is given), a ratio ≥ 1.96 implies that the coefficient is significantly different from zero at a 5% level of probability (in repeated tests of similar samples one would expect only 5 in 100 coefficients this large or larger if the dependent and independent variable were unrelated); a ratio ≥ 2.56 that the coefficient is significant at a 1% level of probability.

[b] R^2, the coefficient of determination, indicates what proportion of the total amount of variability in the dependent variable is "explained" by the independent variable(s). This value is relatively small in most of these regression equations, an indication that unspecified other factors (including, for example the prices and availability of other grains, a possibility we did not have time to analyze have much to do with the variability of the dependent variables.

* Significant at 5% level.

**Significant at 1% level.

d. Location (PS) and Caste Effects

Rice. Both the number of purchases and the number of households purchasing the three kinds of rice, by **PS**, are shown in Table 8.9. Except for PS 6 and PS 9, the number of households buying paddy was close to the number of households in the sample. Nearly three-quarters of all households made paddy purchases. In contrast, only in PS 3 and PS 5 did at least half the households buy decorticated local rice. Indeed, almost 60 percent of the total number of purchases of decorticated rice originated in PS 3. Very few households in the other production spaces, except for about 36 percent of PS 7 households, bought this product. Turning to imported rice, PS 5 was unusual in that only 1 of 35 sampled households reported buying it; in all the other PSs, most households (every household, in the cases of PSs 1, 6, and 7) purchased imported rice. In contrast, the limited supply and relatively high price operate to constrain purchases of decorticated local rice. Paddy is desirable because it is less expensive

than decorticated rice. Very small quantities can be purchased, and processing can be done by the household. Imported rice, bought by nearly 80 percent of all households in the sample, was expensive but available when other grains were not.

Table 8.9. Purchases of Rice: Number of Households Purchasing and Number of Purchases, by PS

	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	Total
Number of Households										
Paddy	30	20	34	32	32	1	41	36	14	240
Decorticated Local	0	3	31	1	22	2	19	1	0	79
Imported	32	19	30	19	1	34	53	32	44	264
Number of Households in Sample	32	25	37	32	35	34	53	38	45	331
Number of Purchases										
Paddy	104	66	77	211	177	3	147	162	17	964
Decorticated Local	0	4	111	1	47	2	23	1	0	189
Imported	258	22	81	58	1	338	337	188	301	1,584

Table 8.10 presents the same information summed by caste. Within each caste group, households made rice purchases in about the same proportion as all the sample households: about 73 percent bought paddy, 24 percent decorticated local rice, and 80 percent imported. Only the Fulbe departed noticeably from the pattern, with more (30 households, or 42 percent) purchasing decorticated local rice and fewer (under 60 percent) buying imported rice.

For rice sales by location (Table 8.11), only 23 percent of all sample households (77 of 331) made any sales of paddy. Although sales are scattered through all the PSs except for PS 9, they were concentrated in four areas: PSs 1, 3, 4, and 5. Rice is essentially a product of irrigated agriculture, and where irrigation is largely unavailable (as in PS 8 and PS 9), paddy sales are not to be expected. Few households have equipment for hulling substantial quantities of rice, so sales of decorticated rice are also few, with only PSs 3 and 5—and only 9 households—reporting this activity. For imported rice, 85 percent of the households reporting sales come from three PSs: PS 6, PS 8, and PS 9, all areas with few or no sellers of domestic rice. Over 91 percent of the number of sales are from these three PSs.

Table 8.10. Purchases of Rice: Number of Households Purchasing and Number of Purchases, by Caste

	Total	Castes							
		Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Number of Households									
Paddy	240	50	77	1	7	28	18	56	3
Decorticated Local	79	30	15	1	0	7	6	20	0
Imported	264	42	87	7	10	28	29	57	4
Number of Households in Sample	331	71	106	7	10	30	32	71	4
Number of Purchases									
Paddy	964	219	329	4	34	103	71	194	10
Decorticated Local	189	59	29	2	0	20	27	52	0
Imported	1,584	261	507	85	63	119	188	344	17

Table 8.11. Sales of Rice: Number of Households Selling and Number of Sales, by PS

	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	Total
Number of Households										
Paddy	13	5	14	15	15	6	8	1	0	77
Decortic. Local	0	0	7	0	2	0	0	0	0	9
Imported	13	0	3	2	0	31	1	37	36	123
Number of Households in Sample	32	25	37	32	35	34	53	38	45	331
Number of Sales										
Paddy	29	6	20	38	26	10	12	1	0	142
Decortic. Local	0	0	10	0	7	0	0	0	0	17
Imported	14	0	5	4	0	86	1	117	54	281

Comparing rice sales by **caste** (Table 8.12), relatively more of all Nyeenybe-headed households sold imported rice (15 percent of all households selling this product), and fewer sold paddy (8 percent) than their overall representation in the sample (10 percent). The opposite is true for Subalbe: 9 percent of all sample households, they comprise 14 percent of the 77 households selling paddy and only 3 percent of those selling imported rice. Toorobbe household percentages of those selling both types of rice are close to their percentages in the sample, but relatively few Fulbe households sold imported rice (as noted above, relatively few bought it as well). A total of 58 percent of the number of sales of paddy were made by Toorobbe and Fulbe households, who make up about 53 percent of all sample households. Toorobbe and Maccube households, also 53 percent of the sample, made the largest numbers of sales of imported rice: coincidentally, 58 percent again.

Table 8.12. Sales of Rice: Number of Households Selling and Number of Sales, by Caste

	Total	Castes							
		Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Number of Households									
Paddy	77	18	25	0	1	11	6	14	2
Decorticated Local	9	2	1	0	0	1	1	4	0
Imported	123	15	42	6	8	4	19	28	1
Number of Households in Sample	331	71	106	7	10	30	32	71	4
Number of Sales									
Paddy	142	37	46	0	2	19	7	25	6
Decorticated Local	17	7	1	0	0	1	2	6	0
Imported	281	31	95	20	22	6	37	68	2

Sorghum. More than three-quarters of the sample households (254/331, or 77 percent) purchased imported sorghum (Table 8.13). Smaller numbers bought recession (39 percent) or rainfed (30 percent) sorghum. In five PSs (PS 1, 3, 6, 7, and 8) all or nearly all households made at least one purchase of imported sorghum. In contrast, only 1 household in PS 2 bought any of the three types of sorghum. Among the other three areas, only 12 of the 35 households in PS 5 bought imported sorghum and only 1 bought recession-cultivated sorghum, but in PS 4 almost half the households bought recession sorghum and in PS 9 nearly all households purchased rainfed. PS 8 had almost as many households buying recession sorghum as imported, while a relatively large number of households in PS 3 and PS 7 also bought recession sorghum. Like those in PS 9, most households in PS 6 bought rainfed sorghum.

Table 8.13. Purchases of Sorghum: Number of Households Purchasing and Number of Purchases, by PS

	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	Total
Number of Households										
Recession	6	0	26	15	1	9	34	36	2	129
Rainfed	13	0	3	0	0	29	11	3	40	99
Imported	31	1	37	24	12	32	50	38	29	254
Number of Households in Sample	32	25	37	32	35	34	53	38	45	331
Number of Purchases										
Recession	9	0	57	26	1	9	48	83	3	236
Rainfed	14	0	5	0	0	91	11	5	156	282
Imported	104	1	184	76	17	104	272	190	69	1,017

The total number of sorghum purchases averaged 4.6 per household (1,535/331), with the bulk going to the imported grain (an average of 3 purchases per household) and less than 1 per household for both recession and rainfed sorghum. Concentrations of the number of **purchases** among PSs were not dissimilar from those among the numbers of **households** buying sorghum: the 38 households of PS 8 made over 7 sorghum purchases per household, and the 53 households of PS 7 averaged more than 6, while PS 2 and PS 5 averaged less than 1 purchase per household.

By **caste** (Table 8.14), the only match between the number of households making sorghum purchases and the number of **households** is for Jaawambe: all Jaawambe households in the sample bought imported sorghum at least once during the research period. In general, the ratio of the number of households in a particular caste buying imported sorghum to the total number of households buying that grain was about the same as that caste's proportion of all households in the sample. The distributions of households buying recession and rainfed are somewhat less similar to their shares in the sample, but the numbers are smaller. More Nyeenybe and Jaawambe households reported buying rainfed than recession sorghum, while the reverse was true for the other castes. Half of all Maccube households bought recession-grown sorghum but only 35 percent of Fulbe households did; the two castes were about even in rainfed sorghum purchases. Toorobbe households, the largest group (32 percent of all sample households), bought their "share" of each type of sorghum: they comprise 31 percent of households buying recession sorghum, 30 percent of those buying rainfed, and 32 percent of those buying imported sorghum.

Table 8.14. Purchases of Sorghum: Number of Households Purchasing and Number of Purchases, by Caste

	Total	Castes							
		Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Number of Households									
Recession	129	25	40	3	7	7	10	36	1
Rainfed	99	21	30	6	1	3	15	22	1
Imported	254	51	81	7	8	21	24	58	4
Number of Households in Sample	331	71	106	7	10	30	32	71	4
Number of Purchases									
Recession	236	55	70	3	13	10	20	64	1
Rainfed	282	42	93	30	4	5	49	57	2
Imported	1,017	230	292	29	39	53	75	288	11

Proportions of the total number of sorghum purchases also largely match caste proportions in the sample: the Toorobbe households made 30 percent of all purchases, the Fulbe (21 percent of households) 21 percent or purchases, Nyeenybe between 9 and 10 percent of both households and purchases. The largest discrepancies were among Subalbe (almost 10 percent of the households making fewer than 5 percent of the purchases) and Maccube (21 percent of households, nearly 27 percent of purchases).

Sorghum sales, by PS and by caste, are shown in Tables 8.15 and 8.16. As pointed out earlier, sorghum sales are relatively few. This is a crop grown primarily for household use. No households in PS 2 reported any sales of sorghum, and no households in PSs 1, 5, and 9 sold recession sorghum. In four PSs (2, 4, 5, and 7) no households sold rainfed sorghum. What sales were made cluster in a few PSs: sales of recession sorghum are concentrated in PSs 3, 4, and 8; 11 of the 15 households selling rainfed sorghum were in PSs 6 and 9; 66 households of the 107 households selling imported sorghum were in just two production spaces—PS 6 and PS 8. PS 8 has a particularly high proportion of sorghum sales as well as sorghum-selling households. All but one household in this PS sold imported sorghum, and a large majority sold recession sorghum as well; with fewer than 12 percent of the sample households, PS 8 accounted for nearly 46 percent of all sorghum sales.

As Table 8.16 indicates, every caste has households that sold at least two types of sorghum. Nyeenybe are slightly overrepresented as sellers compared to their proportion of the sample households: with fewer than 10 percent of households, they are 15 percent of households selling imported sorghum and 12 percent of those selling recession sorghum. Toorobbe maintain

Table 8.15. Sales of Sorghum: Number of Households Selling and Number of Sales, by PS

	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	Total
Number of Households										
Recession	0	0	20	18	0	2	6	29	0	75
Rainfed	2	0	1	0	0	6	0	1	5	15
Imported	4	0	10	4	4	29	3	37	16	107
Number of Households in Sample	32	25	37	32	35	34	53	38	45	331
Number of Sales										
Recession	0	0	36	31	0	2	7	86	0	162
Rainfed	2	0	2	0	0	11	0	1	7	23
Imported	4	0	13	10	7	53	3	88	20	198

Table 8.16. Sales of Sorghum: Number of Households Selling and Number of Sales, by Caste

	Total	Castes							
		Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Number of Households									
Recession	75	8	25	0	5	6	9	21	1
Rainfed	15	3	4	1	0	0	2	5	0
Imported	107	18	32	6	7	5	16	22	1
Number of Households in Sample	331	71	10[illegible]	7	10	30	32	71	4
Number of Sales									
Recession	162	11	56	0	14	9	20	49	3
Rainfed	23	3	6	1	0	0	3	10	0
Imported	198	29	68	13	17	7	22	41	1

their relative position, with about a third of sample households selling about a third of each type of sorghum. Maccube households account for a somewhat higher proportion of households selling recession and rainfed sorghum than their proportion in the sample. Sixty percent of the total number of sorghum sales were made by two castes: Toorobbe (130 sales) and Maccube (100 sales) that comprise about 53 percent of the sample households. Fulbe were relatively

underrepresented (21 percent of households; 11 percent of sales), and Maccube relatively overrepresented (21 percent of households, 26 percent of sales).

3. Livestock Transactions

Sheep and goats make up the bulk of livestock sales and purchases by the sample households (Table 8.17). Some 739 transactions involving 1,173 animals were identified.[8] Eighty percent of these transactions, including 81 percent of the animals, were sales.[9] More

Table 8.17. Animal Transactions: Sales, Purchases, Average Prices

Animal	Animal Sales					Animal Purchases				
	Transactions		Animals		Average Price per Animal (FCFA)	Transactions		Animals		Average Price per Animal (FCFA)
	Number	%	Number	%		Number	%	Number	%	
Bull	20	3.4	20	2.1	47,650	1	0.7	1	0.4	30,000
Ox	44	7.5	56	5.9	34,362	1	0.7	1	0.4	37,500
Cow	38	6.4	43	4.5	28,750	2	1.3	2	0.9	30,000
Calf	4	0.7	4	0.4	14,875	4	2.7	5	2.2	30,100
Horse	5	0.8	6	0.6	43,583	4	2.7	4	1.8	55,250
Goat	237	40.2	437	46.0	4,772	47	31.5	74	33.2	3,916
Sheep	237	40.2	379	39.9	8,367	88	59.1	134	60.1	11,807
Donkey	5	0.8	5	0.5	7,200	2	1.3	2	0.9	10,750
Total	590	100	950	100	-	149	100	223	100	-

[8] An additional group of 37 transactions (27 sales and 10 purchases) involving 64 animals (47 sold and 17 bought) is not included in the analysis. Listed under a general heading of "traction animals," almost all were clearly too low in value to involve the sale or purchase of a traction animal. Some were probably rentals of traction services (for unrecorded time periods). Separate categories for oxen, horses, and donkeys, which are included in Table 8.17, give some indication of actual sales and purchases of "traction animals." Moreover, a search through the questionnaires indicated that several transactions in this general category in fact referred to poultry, so it is assumed to have been used for miscellaneous transactions not otherwise codable.

[9] Sales and purchases can differ widely, of course, because this is not a closed system. The households analyzed here are only a sample of all households in the production spaces; moreover, transactions take place with people outside the PSs and, indeed, outside the Middle Valley.

than four times as many animals were sold than bought during the survey period, in part because about a fifth of the households are Fulbe, many of whom depend primarily on animal husbandry for their livelihood, although some households of other castes raise animals for sale. In addition, however, the disastrous state of agriculture and herding in much of the area during the period of the study, because of sparse rainfall and inadequate or untimely floods, forced many families to sell some of their livestock for cash. As one *peul* told a research assistant, "The absence of the flood forced us to sell our cattle for a song in order to survive."[10] Of all the animals sold, 46 percent were goats and 40 percent sheep, with each category accounting for slightly more than 40 percent of the total number of sales. As to purchases, more sheep were bought than goats (60 percent and 33 percent, respectively), with comparable proportions of the number of sales (59 percent and 32 percent). Except for purchases of bulls, oxen, and cows, too few transactions involved animals other than sheep and goats to make for meaningful analysis.

a. Sheep

Sales of sheep over time are shown in Figure 8.7. Although the lines of the number sold and the per animal price show some similarity, regression coefficients for price and adjusted per capita income,[11] using quantity sold as the dependent variable, are not significant, nor does including time as an independent variable help.[12] Information from SRBMA I suggested the hypothesis that selling price and income are positively correlated, wealthier families being able to afford to hold on to stock until prices are favorable, while families with low incomes are forced to sell when food and forage are scarce, glutting the market. A simple regression of price of sheep sold on income per capita does yield a positive coefficient, but one that would be significant only at about a 20 percent level of significance; the relationship explains less than 1 percent of the variation.

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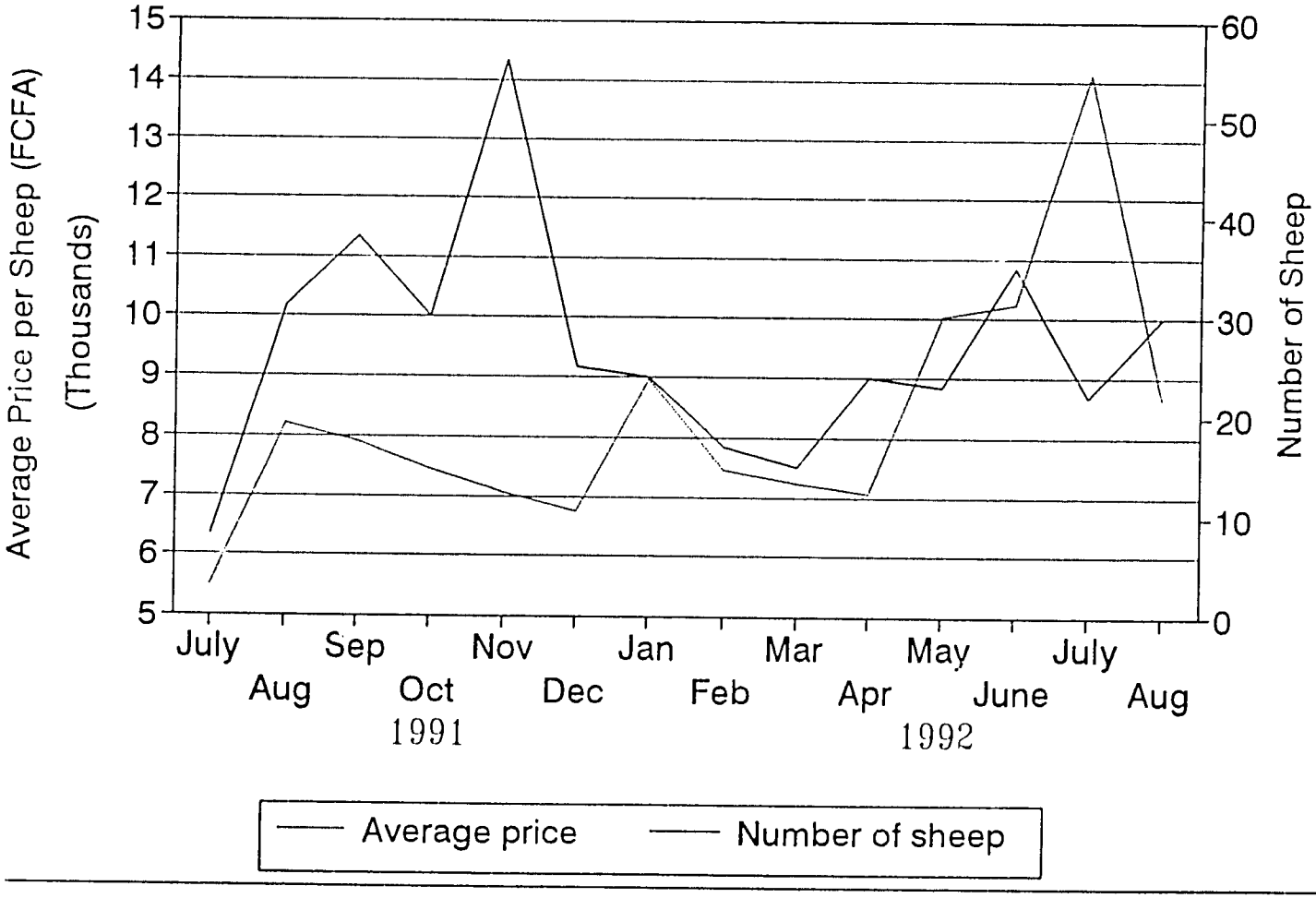
[10] "L'absence de crue nous a obligé à brader notre bétail pour survivre" (Salem-Murdock et al. 1991 [December]:125).

[11] Income from all sources adjusted for reported costs and family size (weighted by age).

[12] The identification of separate supply and demand curves from transaction price and quantity data is not straightforward, as each transaction implies an intersection (at least a momentary equilibrium) of supply and demand. The expected relationship between number sold and price (the supply curve) would be positive (*ceteris paribus*). The actual relationship of the data is negative (signs for both price and income coefficients), though not significant. The distribution of number sold by price is quite skewed to the right, with nearly half the transactions in the modal group, 4,000-8,000 FCFA, and the mean at 8,367 FCFA. The animal transaction data, which are likely to be highly intercorrelated, seemed inadequate for constructing a simultaneous equation model to try to overcome the identification problem.

Figure 8.7 Sales of Sheep

Number and Average Price by Month



The brevity of the research period and the unusually poor flood and rainfall conditions may help to account for the lack of significance of the regression coefficients. For example, the peak month for the number sold, November, coincided with a period when *nyaayko*—sorghum stalks and leaves—were being sold (and purchased) in large quantity at the market at Agnam Civol because that was the only commodity that could assure the survival of livestock, since no grass was available.[13]

Other factors influence the timing of animal sales and purchases as well, among them Muslim holidays that prompt the consumption (for sacrifice and/or feasting) of livestock. Korité (or Eid al-Fitr), celebrated at the end of Ramadan, took place in early April 1992, and Tabaski (Eid al-Adha), the feast of the sacrifice,[14] in mid-May. Families that do not already own animals tend to buy a sheep (if they can afford one) or a goat (on average costing less than two-thirds the price of a sheep), especially for Tabaski, some time before the actual holiday. Mawlud (Eid Milad-al-Nabi), the celebration of the birthday of the Prophet Muhammad, occurred in late September 1991. While this holiday does not call for animal sacrifice, in at least one village (Doumga Rindiaw) three migrants returned for several days to celebrate it (Salem-Murdock et al. 1992 [November]:187). Such visits, and visits of representatives of political, religious, and foreign donor groups may be accompanied by feasting, as are celebrations of weddings and other important local events.

Looking at sales by caste and PS (Table 8.18), during the research period 96 households sold sheep. The largest numbers—making up about 44 percent of the households selling sheep and accounting for 55 percent of the sheep sold—were in PS 3 and PS 5. Fulbe-headed households, as expected, are most prominent. Comprising fewer than 22 percent of all sample households, they are 33 percent of the households selling sheep and sold 34 percent of the sheep sold. The Fulbe are a particularly high proportion (74 percent) of the households in PS 5. The next largest group of sellers are Toorobbe: 23 Toorobbe households (or 24 percent of the selling households) sold sheep, although this caste is 32 percent of the whole sample. Somewhat fewer Maccube households (19 percent of households selling) sold sheep than are represented in the sample (21.5 percent).

For **purchases** of sheep (shown by month in Figure 8.8), a positive relationship exists for a simple regression of price of sheep purchased and per capita income. This would support

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[13] "Au marché de Civol, le *nyaayko* se vendait en grande quantité : c'était la seule denrée qui permettait d'assurer la survie du bétail car il n'y avait pas eu d'herbe au cours de l'hivernage" (Salem-Murdock et al. 1992 [November]:204; notes of Mamadou Athie, Research Assistant).

[14] This is a Muslim holiday based on Abraham's willingness to sacrifice his son Isaac at God's command (Gen. 22). At Abraham's demonstration of faith, an angel forestalled the death of Isaac, while his father spied a ram—caught by his horns in a thicket—that he offered as a sacrifice instead.

Table 8.18. Sales of Sheep: Number of Households by Caste and PS

PS	Number of Sales	Number of House-holds	Number of Sheep	Caste							
				Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
1	24	11	25	4	5	0	0	1	0	1	0
2	6	4	9	0	2	0	0	1	1	0	0
3	73	22	130	5	5	0	0	6	2	3	1
4	9	5	10	1	4	0	0	0	0	0	0
5	52	20	79	12	2	0	0	0	0	6	0
6	4	4	4	0	0	1	0	1	1	1	0
7	8	6	20	3	1	0	0	2	0	0	0
8	26	11	47	3	1	0	1	0	3	3	0
9	35	13	55	4	3	0	0	0	2	4	0
Total	237	96	379	32	23	1	1	11	9	18	1

the hypothesis that sheep are a "normal" good: wealthier families buy more sheep than poorer families. Less than 8 percent of the variability (R^2) is explained by the relationship, however.[15] The relationship does not support the hypothesis that richer households can afford to wait until prices are low to make purchases, and then profit by selling when prices are high. Except for specialized animal traders, purchases by wealthier families may be relatively inelastic with respect to price: that is, they buy sheep when it is convenient rather than when the price is low. For the set of purchases in the sample, with the number of sheep purchased as the dependent variable and price, income, and time as independent variables, neither the price coefficient nor the per capita income coefficient is significant, nor is a time trend present.[16]

As with sales, other factors influence sheep purchases. By PS and caste (Table 8.19), PS 6 had by far the most households purchasing sheep (23 of the 63 households) and the most sheep purchased (61 of 134). It is also clear that Toorobbe households were the most frequent buyers of sheep, with twice as many Toorobbe households (22) as Fulbe (11) or Maccube (10). In each case the numbers are higher than their representation in the whole sample: PS 6 has just over 10 percent of the sample households but over 36 percent of the households buying sheep

[15] Prices paid for purchases of sheep have a bimodal distribution, with 27 sheep bought at prices between 6,000 and 9,000 FCFA, and 25 between 3,000 and 6,000 but also 25 between 15,000 and 18,000 FCFA, so it is not clear that the regression fits the model that assumes normality in the distributions.

[16] The signs of the coefficients are positive for price (rather than the anticipated negative relationship), negative for income (also counterintuitive), and positive for time, but less than 1 percent of the variation is explained by these three independent variables.

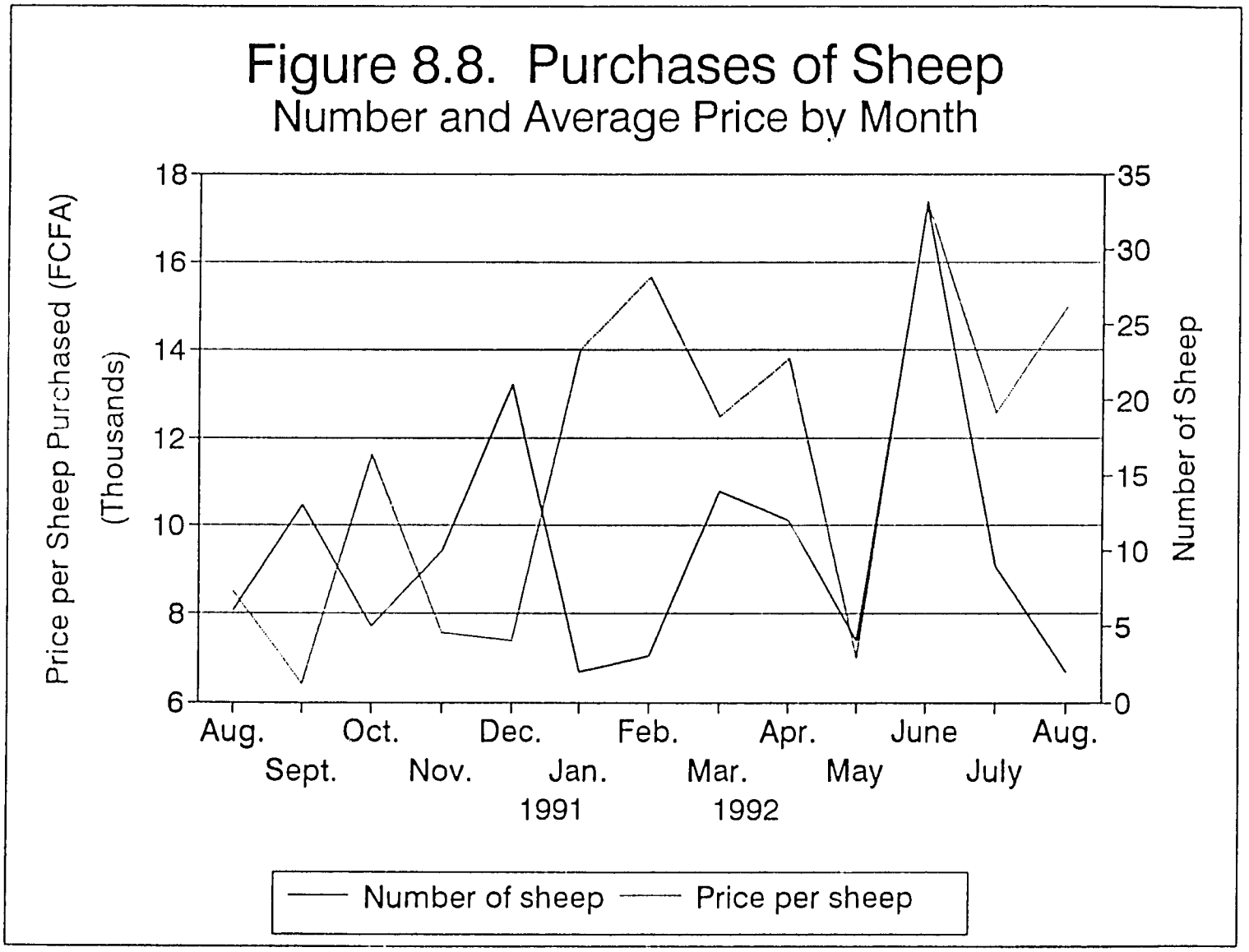


Figure 8.8. Purchases of Sheep
Number and Average Price by Month
Price per Sheep Purchased (FCFA)
(Thousands)
18
16
14
12
10
8
6
35
30
25
20
15
10
5
0
Number of Sheep
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
1991
Feb.
Mar.
1992
Apr.
May
June
July
Aug.
Number of sheep
Price per sheep

Table 8.19. Purchases of Sheep: Number of Households by PS and Caste

PS	Number of Purchases	Number of Households	Number of Sheep	Caste						
				Fulbe	Toorobbe	Jaawambe	Subalbe	Nyeenybe	Maccube	Other
1	3	2	3	0	1	0	1	0	0	0
2	1	1	3	0	0	0	0	1	0	0
3	13	11	19	5	1	0	2	0	2	1
4	12	7	19	1	5	0	0	0	0	1
5	5	4	7	3	1	0	0	0	0	0
6	38	23	61	0	9	6	1	4	3	0
7	3	3	3	1	1	1	0	0	0	0
8	12	11	17	1	3	0	0	2	5	0
9	1	1	2	0	1	0	0	0	0	0
Total	88	63	134	11	22	7	4	7	10	2

and nearly 46 percent of the sheep purchased; Toorobbe are 32 percent of the sample households but 35 percent of those buying sheep.

b. Goats

Monthly sales of goats are shown in Figure 8.9, along with the average prices received by sellers. Although there is some similarity between the two lines, a regression of the number of goats sold against the price received and household per capita income does not produce significant coefficients. The signs of the coefficients are both positive, however; more goats are sold as prices and sellers' incomes rise. As is to be expected, goat prices rose from March to May 1992, then fell after Tabaski. It was hypothesized from the information from SRBMA I that households with high incomes will sell more goats when the price is high and fewer when prices are low, taking advantage of price movements, while low income households are forced to sell animals when forage is lacking and for such necessities as food and agricultural inputs before harvest, when their supplies are low, or when crops have failed. This means selling when almost everyone else sells, hence at low prices. The correlation between selling prices and household income in the sample data, though positive, is not significant, however.[17]

The peak in the price of goats sold, in May 1992, coincided with Tabaski (Eid al-Adha), when the demand for sacrificial goats would have been high. The high points of the quantity

[17] There does seem to be a real relationship between income and prices above a price of about 4,500 FCFA per goat.

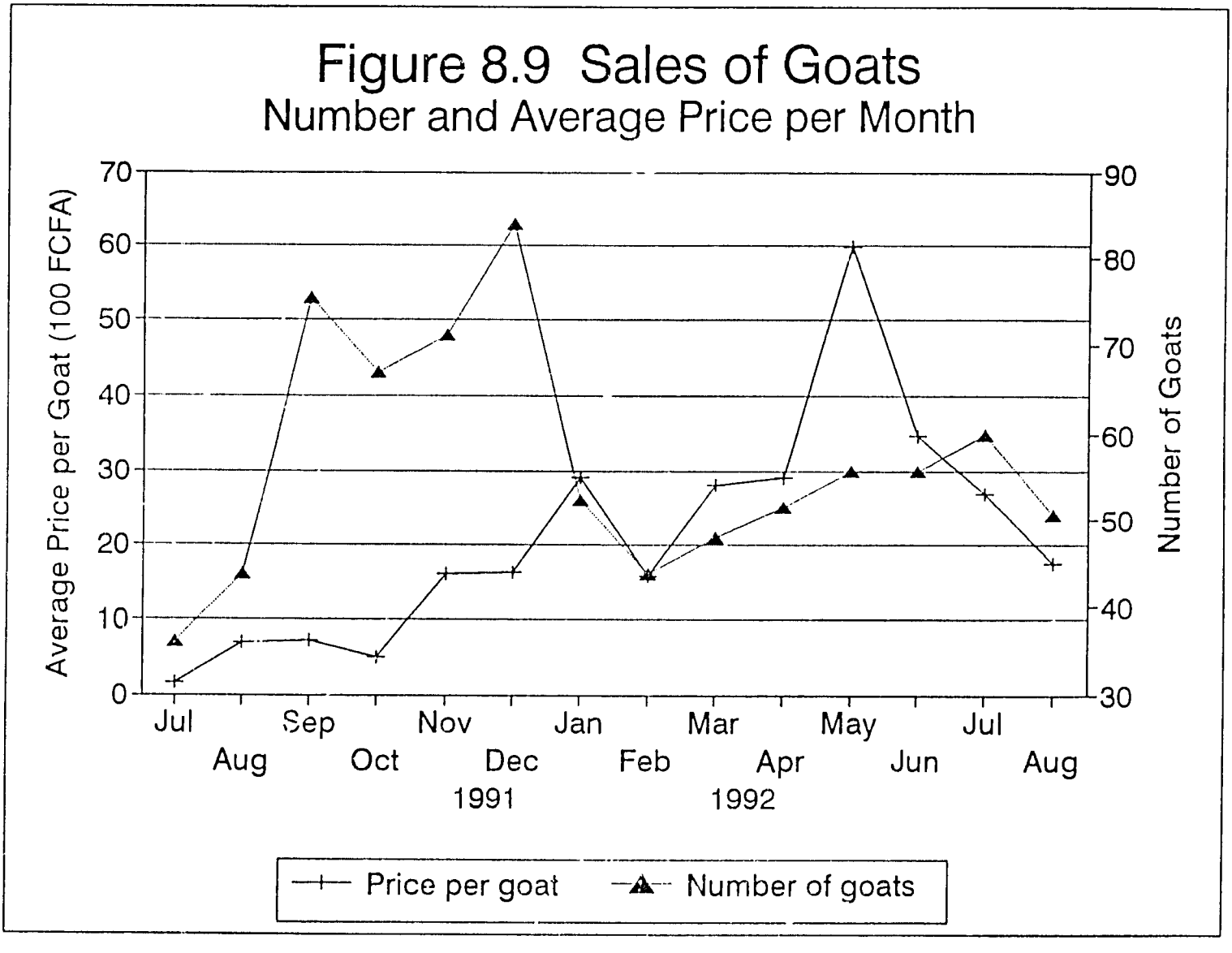


Figure 8.9 Sales of Goats
Number and Average Price per Month
Average Price per Goat (100 FCFA)
Number of Goats
70
60
50
40
30
20
10
0
90
80
70
60
50
40
30
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
1991
1992
Price per goat
Number of goats

sold series, from September through December 1991, may be have been spurred by the need for cash for agricultural inputs and food, especially for farm households hard-hit by the poor flooding conditions of that year (see the section above on sheep sales).

Sales of goats by PS and caste are given in Table 8.20. Half the households that sold goats live in PSs 3 and 5. These 48 households sold nearly 62 percent of the goats; 10 households in PS 8 sold another 10 percent. Fulbe-headed households, not surprisingly, make up a large fraction of the sellers—40 percent—and they are a high proportion of the sample households in PS 5. Toorobbe and Maccube households are each about 20 percent of the sellers, which is approximately the proportion of Maccubes in the sample (21 percent), but below the proportion of Toorobbe households in the sample (32 percent).

Table 8.20. Sales of Goats: Number of Households by PS and Caste

PS	Number of Sales	Number of Households	Number of Goats	Caste							
				Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
1	8	5	8	2	1	0	0	2	0	0	0
2	11	6	21	3	2	0	0	1	0	0	0
3	78	25	168	5	5	0	0	4	3	7	1
4	21	10	34	2	7	0	0	0	0	0	1
5	66	23	102	16	2	0	0	0	0	5	0
6	2	2	20	1	0	0	0	0	1	0	0
7	11	5	21	1	0	0	0	2	0	2	0
8	25	10	43	4	1	0	2	0	0	3	0
9	15	9	20	4	2	0	0	0	1	2	0
Total	237	95	437	38	20	0	2	9	5	19	2

Goat **purchases** and price paid per goat are shown in Figure 8.10 (no purchases were reported for January by the sample households). The number of goats bought peaked in September 1991, at 23 goats. Prices paid were at their maximum in April.[18]

Like goat sales, goat purchases were not significantly related to price and income. Both coefficients were negative, the coefficient for price "correctly" so, implying that fewer goats are bought at higher prices, but the negative sign of the income coefficient hints of an "inferior

[18] The peak price, 5,000 FCFA, was also reached in March and June of that year, but households reported buying only one goat in each of those months.

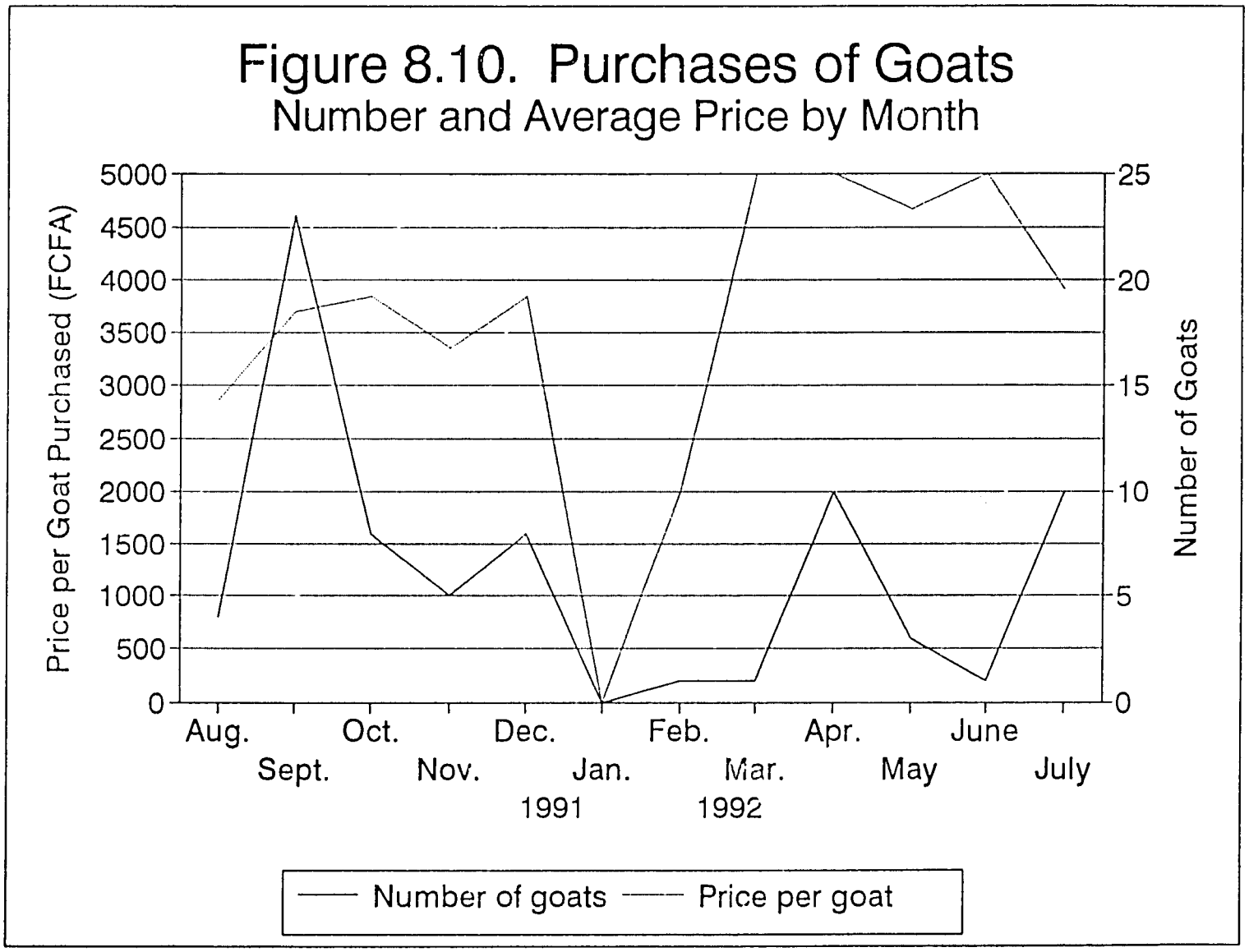


Figure 8.10. Purchases of Goats
Number and Average Price by Month
Price per Goat Purchased (FCFA)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
Number of Goats
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
1991
Feb.
Mar.
1992
Apr.
May
June
July
Number of goats
Price per goat

good"—one for which purchases decrease as income increases. This result may reflect both the custom that makes sheep a superior substitute for goats at Tabaski, and the substantial price differential between the two animals (in addition to husbandry cost differences). When date of purchase is included in the regression, a negative time trend is found, while the coefficients of price of goats bought and income remain nonsignificant (although the sign of the price coefficient changes). The period covered is only 14 months, however, so a judgment about time trends is clearly unwarranted.

As shown in Table 8.21, households in PS 3 and PS 4 purchased nearly three-quarters of the goats bought, with 10 households in PS 3 buying 26 goats and 9 households in PS 4 buying 29. Sample households of PS 7 and PS 9 reported no goat purchases. Twice as many Toorobbe households bought goats as Fulbe (16 against 8). Few households of other castes were goat buyers.

Table 8.21. Purchases of Goats: Number of Households by PS and Caste

PS	No. of Purchases	Number of Households	Number of Goats	Caste					
				Fulbe	Toorobbe	Subalbe	Nyeenybe	Maccube	Other
1	1	1	1	0	1	0	0	0	0
2	1	1	1	0	1	0	0	0	0
3	12	10	26	2	2	3	0	2	1
4	19	9	29	1	7	0	0	1	0
5	5	5	5	4	1	0	0	0	0
6	1	1	1	0	0	0	1	0	0
7	0	0	0	0	0	0	0	0	0
8	8	7	11	1	4	0	1	1	0
9	0	0	0	0	0	0	0	0	0
Total	47	34	74	8	16	3	2	4	1

c. Cows

Forty-three sales of cows were reported, two-thirds of them at prices between 20,000 and 40,000 FCFA, with the mean price 28,750 FCFA. The median per capita income of households selling cows was slightly higher than the median for the full sample. Among the 26 households that reported selling cows, 15 (58 percent) were Fulbe, selling 27 (63 percent) of the cows. The distribution of cow sales by PS and caste is given in Tables 8.22 and 8.23, the first giving the distribution of the 26 households selling cows and the second giving the distribution of the 43 cows sold. A large number of the cattle sold—44 percent—came from the 10 households in PS 9. Recorded purchases of cows were only two, no doubt reflecting the hard times of the farmers and herders of the Middle Valley.

Table 8.22. Number of Households Selling Cows, by PS and Caste

PS	Caste					Total
	Fulbe	Toorobbe	Subalbe	Nyeenybe	Maccube	
1	2	0	0	0	0	2
2	0	0	0	0	0	0
3	0	3	1	0	0	4
4	0	0	0	0	0	0
5	4	0	0	0	0	4
6	0	0	0	0	0	0
7	2	0	1	0	0	3
8	1	1	0	1	0	3
9	6	1	0	2	1	10
Total	15	5	2	3	1	26

Table 8.23. Number of Cows Sold, by PS and Caste of Household Selling

PS	Caste					Total
	Fulbe	Toorobbe	Subalbe	Nyeenybe	Maccube	
1	2	0	0	0	0	2
2	0	0	0	0	0	0
3	0	5	1	0	0	6
4	0	0	0	0	0	0
5	7	0	0	0	0	7
6	0	0	0	0	0	0
7	4	0	2	0	0	6
8	1	1	0	1	0	3
9	13	1	0	3	2	19
Total	27	7	3	4	2	43

d. Bulls

Transactions involving bulls numbered 20 sales and 1 purchase (Table 8.17). Sixteen households, whose median income was well above the sample median, were sellers, 7 of them Fulbe and 5 Nyeenybe. The only other castes selling bulls were Maccube and Toorobbe, with 2 households each. More than half the households (9) are from PS 9, and these sold half the animals (10). Only three other PSs are represented: 4 households are from PS 8, 2 from PS 1, and 1 from PS 5, with sales of 7, 2, and 1 bull, respectively.

e. Oxen

Thirty sample households sold 56 oxen during the survey period; one ox was purchased. Numbers of households selling and numbers of oxen sold by caste are presented in Tables 8.24 and 8.25. As with sellers of cows and bulls, sellers of oxen had relatively high incomes. The distribution by PS was somewhat different, however. PS 1 had the most sellers (11, or 37 percent), followed by PS 3 with 7, and PS 9 with 5. The most prominent caste, though, remains Fulbe (43 percent of the households selling), with Toorobbe next (37 percent). An equal number of oxen (23) was sold by each of those two castes.

Table 8.24. Number of Households Selling Oxen, by PS and Caste

PS	Caste					Total
	Fulbe	Toorobbe	Subalbe	Nyeenybe	Maccube	
1	4	5	1	1	0	11
2	0	0	0	0	0	0
3	0	4	2	1	0	7
4	1	0	0	0	0	1
5	3	1	0	0	0	4
6	0	0	0	0	0	0
7	1	0	0	0	0	1
8	0	0	0	0	1	1
9	4	1	0	0	0	5
Total	13	11	3	2	1	30

Table 8.25. Number of Oxen Sold, by PS and Caste

PS	Caste					Total
	Fulbe	Toorobbe	Subalbe	Nyeenybe	Maccube	
1	12	9	1	1	0	23
2	0	0	0	0	0	0
3	0	11	6	1	0	18
4	1	0	0	0	0	1
5	5	1	0	0	0	6
6	0	0	0	0	0	0
7	1	0	0	0	0	1
8	0	0	0	0	1	1
9	4	2	0	0	0	6
Total	23	23	7	2	1	56

4. Migration

This is discussed in Chapter VII.

5. Revenue-Generating Activities by Caste

Earlier, we discussed the differences among PSs in sample households' abilities to generate revenues, including farm, nonfarm, and migration. Here we look at income differentiation by caste. Tables 8.26 and 8.27 and Figure 8.11 show the sources of average household income by caste, and the proportion of income generated from different sources.

Table 8.26. Sources of Average Household Revenues by Caste (in FCFA)

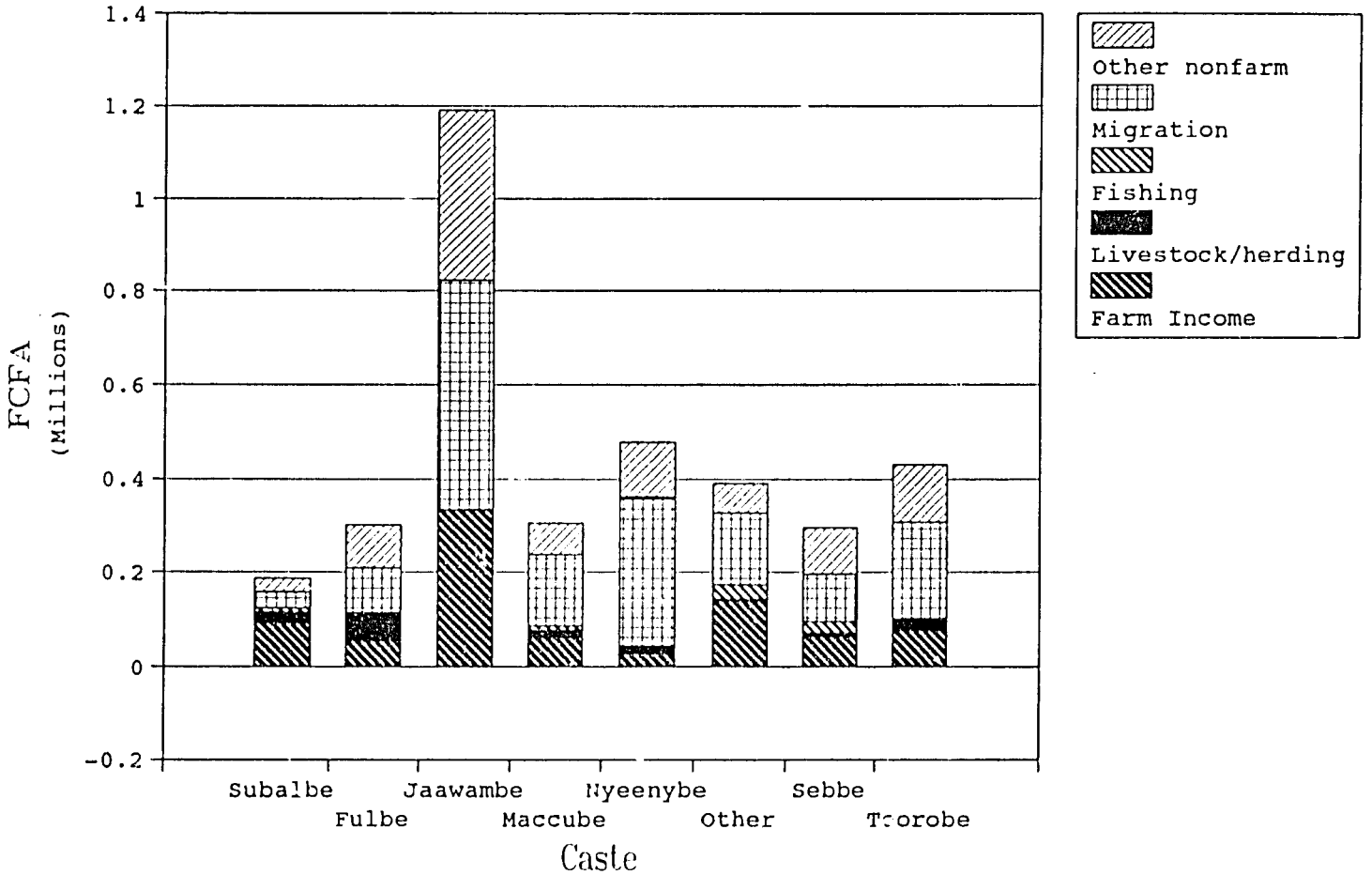
Caste	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Number of Households	71	106	7	10	30	32	71	4
Total Income	313,900	443,089	1,200,932	306,552	202,852	485,315	314,428	399,996
Revenue Source								
Farm Income	54,675	77,996	336,346	65,947	94,742	27,757	62,772	141,705
Sale of Livestock	63,650	22,342	(424)	8,668	24,573	15,004	17,303	4,495
Hunting	370	523	0	0	929	159	448	375
Fishing	4,179	5,770	1,643	29,228	12,548	5,222	12,800	33,482
Artisanal	2,043	724	3,673	1,633	265	45,573	2,732	6,905
Service	17,791	10,740	1,224	27,885	5,739	6,764	10,449	3,857
Commercial	20,045	6,516	918	133	6,485	43	2,243	206
Small Shop	1,769	709	0	11,413	67	0	2,836	4,286
Transport	725	1,989	0	5,446	0	201	1,377	2,893
Ag. Equip. Rental	2,279	9,188	1,469	462	1,031	838	4,158	15,034
Rental Property	127	10,721	159,608	5,538	92	3,555	3,074	12,513
Sale of Personal Effects	6,611	1,532	7,041	990	1,099	2,525	1,631	0
Marabout	5,559	14,412	0	0	0	12	0	9,027
Government	117	800	92,383	0	0	2,548	7,256	0
Herding	1,190	132	0	0	333	0	39	0
Food Sale	0	9	0	0	0	125	312	0
Migration Remittances	97,479	210,582	493,242	103,723	38,172	319,813	152,929	155,156
Retirement	2,122	16,022	46,870	23,887	0	4,913	7,077	0
Private Sector Salaries	429	6,607	0	0	15	10,312	1,826	0
Other	32,740	45,776	56,939	21,598	16,762	39,951	23,167	10,063

Table 8.27. Percentages of Household Income Earned from Various Activities by Caste

Caste	Fulbe	Toorobbe	Jaawambe	Sebbe	Subalbe	Nyeenybe	Maccube	Other
Number of Households	71	106	7	10	30	32	71	4
Total Income (percent)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Revenue Source								
Farm Income	17.42	17.60	28.01	21.51	46.71	5.72	19.96	35.43
Sale of Livestock	20.28	5.04	-0.04	2.83	12.11	3.09	5.50	1.12
Hunting	0.12	0.12	0.00	0.00	0.46	0.03	0.14	0.09
Fishing	1.33	1.30	0.14	9.53	6.19	1.08	4.07	8.37
Artisanal	0.65	0.16	0.31	0.53	0.13	9.39	0.87	1.73
Service	5.67	2.42	0.10	9.10	2.83	1.39	3.32	0.96
Commercial	6.39	1.47	0.08	0.04	3.20	0.01	0.71	0.05
Small Shop	0.56	0.16	0.00	3.72	0.03	0.00	0.90	1.07
Transport	0.23	0.45	0.00	1.78	0.00	0.04	0.44	0.72
Ag. Equip. Rental	0.73	2.07	0.12	0.15	0.51	0.17	1.32	3.76
Rental Property	0.04	2.42	13.29	1.81	0.05	0.73	0.98	3.13
Sale of Personal Effects	2.11	0.35	0.59	0.32	0.54	0.52	0.52	0.00
Marabout	1.77	3.25	0.00	0.00	0.00	0.00	0.00	2.26
Government	0.04	0.18	7.69	0.00	0.00	0.53	2.31	0.00
Herding	0.38	0.03	0.00	0.00	0.16	0.00	0.01	0.00
Food Sale	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.00
Migration Remittances	31.05	47.53	41.07	33.84	18.82	65.90	48.64	38.79
Retirement	0.68	3.62	3.90	7.79	0.00	1.01	2.25	0.00
Private Sector Salaries	0.14	1.49	0.00	0.00	0.01	2.12	0.58	0.00
Other	10.43	10.33	4.74	7.05	8.26	8.23	7.37	2.52

Table 8.26 shows sources of average household revenues in FCFA. In terms of total income per household, the Jaawambe, comprising 7 sample households, surpass all other castes: each Jaawambe household brings in an average of 1,200,932 FCFA, while among Nyeenybe, the second highest, an average household brings in 485,315 FCFA. The proportions of income generated from different sources also vary, as we see in Table 8.27 and Figure 8.11.

Fig. 8.11. Sources of Average Household Revenues by Caste



One outstanding revenue source for the Jaawambe that is of little importance to other groups is income from rental property: over 13 percent of Jaawambe household income. For all castes except the Subalbe, whose largest percentage of revenue is from farm income, migration remittances is the most significant source of household earnings. Nyeenybe households on average garnered nearly two-thirds of their income from this source; Maccube and Toorobbe nearly half. Interestingly, the proportion of income that the Subalbe fishing caste make from the sale of fish is much less than that generated from agriculture and livestock. Fulbe earn somewhat more from livestock sales and herding (caring for others' animals) than from farming, hunting, and fishing (20.66 percent vs. 18.87 percent), but not as much more as might have been expected. This should not be used to conclude that livestock/herding and fishing are of little importance to the area. In the calculation of income generated from livestock/herding, we did not include the value of the herds themselves: only cash received from the sale of animals or from a person's hiring himself/herself out as a herder was included.

In all these groups, a significant portion of revenues is generated from nonfarm activities and migration, which reveals the dependency of households on incomes outside the farm sector, and the vulnerable nature of farm production as a reliable source of income. Moreover, the low fishing and livestock revenues in this period demonstrate the frail nature of these production activities and the extent to which both have been negatively affected by climatic patterns (low rainfall and poor flooding) and a fragile environmental base.

D. Distribution of Income Among Middle Valley Households: Income Deciles

In addition to caste- and region-based income disparities, Middle Valley households are also highly differentiated by income alone, with staggering differences between those on the lower and upper ends of the income scale. Table 8.28 and Figure 8.12 summarize the distribution of income among the sample households. While the first (lowest income) decile controls less than 2 percent of total income, the tenth controls almost 31 percent. In absolute terms, while the minimum per capita income of households is 1,455 FCFA, the maximum is 339,711 FCFA. The top 20 percent of the people control almost 50 percent of the income, and the lowest 20 percent less than 5 percent of income. Average per capita income (45,377 FCFA) exceeds median income (34,695 FCFA) by 30 percent, another manifestation of the skewing of the income distribution toward high-income households.

E. Summary

This chapter has examined the nature of household budgets in terms of revenue sources, the nature of crop and livestock transactions, and differential levels of income distribution. As anticipated, the data show that households diversify their sources of income and that the level of diversification is influenced by geographical locality (production spaces or PSs) and to a lesser degree by social structure (caste hierarchies). In general, households in the upstream production spaces (Matam Department) rely more heavily on off-farm revenues from migration, while those downstream (Podor Department) are more dependent on farm-generated income.

Table 8.28. Distribution of Household Per Capita Income by Decile

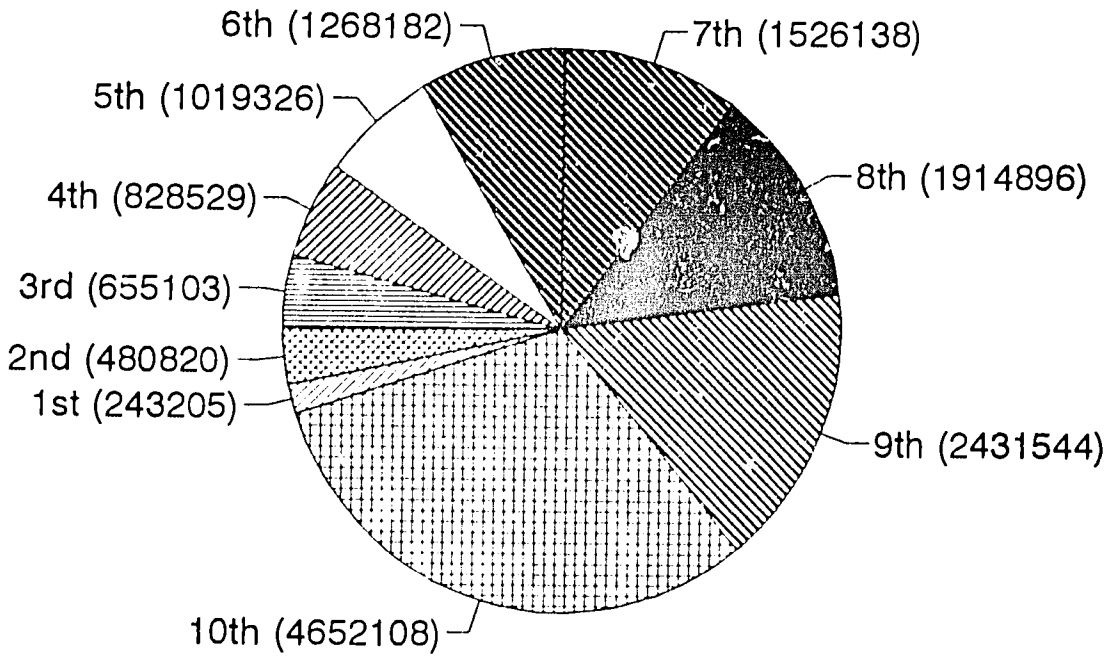
Household Decile	Total Income (FCFA)	Share of Income (percent)	Cumulative Share of Income (percent)
1st	243,205	1.62	1.62
2nd	480,820	3.20	4.82
3rd	655,103	4.36	9.18
4th	828,529	5.52	14.70
5th	1,019,326	6.79	21.49
6th	1,268,182	8.44	29.93
7th	1,526,138	10.16	40.09
8th	1,914,896	12.75	52.84
9th	2,431,544	16.19	69.03
10th	4,652,108	30.97	100.00
Total	15,019,850	100.00	

Data on crop transactions confirm that local farm production is primarily directed toward subsistence rather than toward the market. This is due, in part, to modest levels of crop output resulting from poor climatic conditions that do not favor a level of surplus production for the market. As a result, large quantities of imported cereal grains (rice and sorghum) were purchased on the market to make up for severe shortfalls in local cereal production.

The nature of livestock transactions corroborate the observation above on the deleterious effect of the environment on local production levels. The sale of animals exceeded purchases considerably during the study period, suggesting that many area smallholders were forced to sell off animals due to severe drought-like conditions in order to meet the basic reproductive needs of their families. Some distinctions do appear in terms of specific herd species transactions in relation to geographical setting (production space) and socio-occupational status (caste), but the immediate reasons for this are not all clear.

Differential levels of income distribution reveal that one social stratum, the Jaawambe, has incomes far in excess of the other groups. Again, the immediate reason for this is uncertain. Finally, levels of income distribution by decile illustrate the disproportional skewing of wealth and income toward a relatively small segment of the population, with 20 percent of households collecting 50 percent of the total income.

Fig. 8.12. Income Distribution by Decile Among Middle Valley Sample Households (FCFA)



IX. HOUSEHOLD CONSUMPTION

A. Introduction

This chapter looks at the impact a poor flood period has on food consumption patterns of households that are differentiated by income and access to production systems. We hypothesize generally that high-income households are less vulnerable to changes in climate and dam management policies. In years when floods and rainfall are inadequate, they continue to purchase and where possible to irrigate. Low-income households, by contrast, are directly and negatively affected by poor flood conditions. Because of their limited access to resources, particularly cash income, they rely heavily on traditional flood recession and rainfed production methods. In years of poor flooding and rainfall, they are unable to compensate fully for reduced agricultural output by purchasing food or engaging in capital-intensive production methods. As a result, they consume less food, including such staples as rice, sorghum, and millet, than do households with higher incomes, and depend more heavily on gifts, borrowing, and exchanges as sources of food. These hypotheses are based on analyses of SRBMA I data collected in 1988-1990 in Thiemping.

The section begins by presenting the findings of analyses on SRBMA I data from Thiemping for the period 1988-1990. These findings are the basis for the hypotheses tested with the SRBMA II data. This is followed by a discussion of the methodological problems that made analysis of the SRBMA II consumption data difficult. We then look at the consumption patterns of SRBMA II sample households sorted by per capita income. This is followed by a more detailed section in which the sample is partitioned into eight groups on the basis of the production systems available to households. Grouping households by the production system configurations available to them enables us to evaluate the importance of both location and income in determining how households respond to poor flood periods.

B. Consumption Patterns in Thiemping for Households Differentiated by Land, Labor, and Income (1988-1990)

1. Sample Stratification

Sample households from Thiemping studied during the first phase (SRBMA I) of the Senegal River Basin Monitoring Activity were grouped into low-, middle-, and high-resource categories on the basis of their endowments in land, labor, capital, and off-farm revenues. The approach used to stratify 3,405 households during the second phase (SRBMA II) is adopted here with only slight modifications.

A Total Resource Index (TRI) for each household was calculated using the following formula:

TRI = land index + labor index + capital index + (3 x off-farm revenue index)

The off-farm revenue index was weighted more heavily than the other indexes to take account of the economic importance of off-farm revenues in the river basin. The mean household TRI for the SRBMA I sample (15 households) is 600.31, and for the SRBMA II population (3,405 households) it is 602.3.

Sample households were grouped into low-, middle-, and high-resource categories using the same strata cut-off points used for the SRBMA II population. Households with a TRI of 630 or below were included in the low-resource stratum, those with a TRI between 631 and 1,113 were included in the middle-resource stratum, and those with a TRI greater than 1,113 were included in the high-resource stratum. The percentage of households in the low-resource stratum is 62.8 for the population and 80 (12 households) for the sample. In the middle-resource stratum the percentage is 24.4 for the population and 6.6 (1 household) for the sample, and in the high-resource stratum it is 12.8 for the population and 13.3 (2 households) for the sample.

2. Background

Thiemping is a riverine village located in PS 6, 17 miles east of Matam in the Middle Senegal Valley. Its villagers engage in a variety of agricultural and agropastoral activities, including flood recession farming—on the floodplains (waalo) and riverbanks (falo)—irrigation for growing rice and vegetables, fishing, and small-animal husbandry. Among these activities waalo agriculture predominates, in terms of both the number of people it employs and the contribution it makes to household food stocks. Thiemping villagers cultivate fields in ten waalo basins, not all of which are flooded regularly.

Like other villages in the region, Thiemping has experimented with irrigation. The experience for most households, unfortunately, has not been a good one. Two perimeters, one established in 1975 and another in 1980, are no longer functioning, in part because of poor soil conditions. A third perimeter was established in 1989 on waalo land, but in 1988 and 1989, when flood waters inundated the perimeter, it was cultivated as waalo. The wealthiest household did produce on a family-owned irrigated perimeter, however. This household has been farming its private perimeter with the help of hired labor since 1988, when UNICEF donated a free pump and replacement parts. During the 1988-1990 research period, the two-hectare parcel was planted in maize and vegetables, which were sold in the village market. Family members, who carried out much of the work on the perimeter, were assisted by two full-time wage laborers recruited from outside.

Analysis of data from Thiemping reveals that wealthy households relied less on traditional production methods to feed themselves than did poorer households. High levels of land, labor, and income combined allowed wealthy households to engage in irrigation and to buy a large proportion of what they ate. The wealthiest household benefited additionally by being able to sell food grown on its private irrigated perimeter to other households. Households with fewer resources, on the other hand, depended more heavily on traditional, low-cost flood recession and rainfed production methods.

Strategies to satisfy food needs such as deciding on the level of household production versus purchases and the types of production methods adopted, differed for households in different economic strata. For the low-resource group, household-produced grains, along with gifts of meat, fish, and nonfarm food items were important sources of food. Low-resource households relied less on purchases than did high-resource households. The vegetables that low-resource households did buy were purchased from the wealthiest household, which produced them on its private irrigated field. Low-resource households did not produce food using capital- and labor-intensive forms of production, relying primarily on traditional rainfed and flood recession techniques. For the high-resource group, however, imported rice was the staple grain, and unlike their poorer counterparts, high-resource households purchased most of the sorghum, millet, and maize they consumed. The wealthiest household used capital- and labor-intensive production methods to grow the maize and vegetables that it sold in the local market.

The following discussion compares average household and per capita consumption of grains, meat, fish, locally grown vegetables, and nonfarm food items by the three resource groups. Distinctions were made among foods purchased, foods received as gifts, and foods produced by the households. The figures in Table 9.1 are in FCFA, representing the value of the foods consumed.

3. Local Grains[1]

Low- and middle-resource households consumed more local grains than high-resource households, both at the household level and on a per capita basis (see Table 9.2). Of the total local grain consumed by low- and middle-resource households, moreover, a significant proportion (over 70 percent) was household-produced. The proportion of household-produced grain among high-resource households was much smaller (under 40 percent). These are not surprising findings considering the relatively low costs of producing millet, sorghum, and corn. For low-resource households with small capital reserves, these grains are an ideal food.

High-resource households, able to afford imported rice, consumed relatively more rice than grains. Eighty-six percent of the total value of rice and grains consumed by high-resource households is attributable to rice consumption alone. The comparable figures for low- and middle-resource households are 49 and 61 percent, respectively. High-resource households also consumed larger amounts of meat and fish (Table 9.1) (although per capita consumption of all fish among the smaller-sized, low-income households is somewhat higher, as we note below). In varying their diets and consuming more protein, high-resource households may rely less on protein-rich grains.

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[1] Local grains include millet, sorghum, and corn. Millet, or nyendiko, is grown on rainfed land. There are two varieties of local sorghum: one, samme, is grown on flood recession land, and the other, fela, is grown on rainfed land. Corn is generally grown on riverbank lands (palle), which are farmed in much the same way as flood recession basins.

Table 9.1. Average Household Consumption of Foods by Resource Group (in FCFA)

Food Type and Resource Group		Average Consumption	Household-Produced	Purchased	Gifts
Local Grains	Low (n = 12)	53,082 100%	38,238 72%	4,756 9%	10,087 19%
	Middle (n = 1)	63,858 100%	63,858 100%	-	-
	High (n = 2)	25,086 100%	9,711 39%	2,925 12%	12,450 50%
Rice*	Low	51,910 100%	-	51,910 100%	-
	Middle	99,840 100%	-	99,840 100%	-
	High	151,200 100%	-	151,200 100%	-
Meat	Low	15,822 100%	2,870 18%	7,333 46%	5,618 36%
	Middle	-	-	-	-
	High	96,280 100%	45,650 47%	45,650 47%	4,980 5%
Fish (local)	Low	56,347 100%	40,393 72%	8,120 14%	7,833 14%
	Middle	6,960 100%	-	6,960 100%	-
	High	34,030 100%	-	34,030 100%	-
Fish (imported)	Low	66,463 100%	na	61,568 93%	4,895 7%
	Middle	192,270 100%	na	192,270 100%	-
	High	171,810 100%	na	171,810 100%	-
Vegetables (local)	Low	35,072 100%	18,612 53%	13,969 40%	2,491 7%
	Middle	44,457 100%	16,965 38%	27,492 62%	-
	High	37,972 100%	36,727 97%	-	1,245 3%
Nonfarm food items	Low	413,331 100%	na	364,418 88%	48,913 12%
	Middle	772,821 100%	na	736,455 95%	36,366 5%
	High	967,575 100%	na	958,362 99%	9,213 1%

* Rice is valued at 96 FCFA per kilo, the price at which husked rice was sold in local markets.

Table 9.2. Per Capita Consumption of Foods by Resource Group (in FCFA)

Resource Group	Average Household Size	Local Grains	Rice	Meat	Fish (local)	Fish (imp.)	Local Veg.	Nonfarm
Low	6	8,847	8,652	2,637	9,391	11,077	5,845	68,888
Middle	12	5,322	8,320	-	580	16,022	3,705	64,402
High	14	1,792	10,800	6,877	2,431	12,272	2,712	69,112

4. Meat

Meat includes beef, lamb, goat, and milk. High-resource households on average consumed over 6 times as much meat as low-resource households, while per capita, the high-resource group consumed 2.6 times as much meat as households with lower incomes (see Table 9.2). Not only did the high-resource households eat more meat than the other two groups, but a larger proportion of the meat they consumed came from household herds. Of the total meat consumed by the high-resource group, household herds and purchases each contributed 47 percent. For the low-resource group, on the other hand, only 18 percent of the total meat consumed came from household herds. Purchases accounted for 46 percent of the value of meat consumed by this group. The small amounts of meat produced and bought by the low-resource group was supplemented by gifts of meat, which supplied this group with 36 percent of the total meat consumed.

5. Fish

The two categories for fish refer to fish harvested locally and fish imported from St. Louis, on the Atlantic coast. The large fish harvests of two low-resource households are included in the analysis; as a whole, the low-resource group consumed more local fish per capita than did high-resource households. When just the purchases of local fish are examined, high-resource households come out ahead: as a group, they bought four times as much local fish at the household level, or twice as much per capita. This suggests that household fish production is an important source of protein among low-resource households, but is less significant for high-resource households. Low-resource households also relied on gifts of fish to a greater extent than high-resource households. Four low-resource households received gifts of local fish, and eight received gifts of imported fish. No middle- or high-resource households received gifts of fish.

Consumption of imported fish was highest among middle- and high-resource households, who purchased approximately three times as much imported fish as households in the low-resource group. Per capita consumption of imported fish, however, differed less among the three resource groups: middle-income households consumed the most, while high-income

households' per capita consumption of imported fish exceeded the low-income group's by about 11 percent.

6. Locally Produced Vegetables

On a household basis, the three resource groups consumed roughly the same amount of locally produced vegetables. Per capita, low-resource households consumed more than twice as much as high-resource households. The source of vegetables differed for the three groups, however. While the wealthiest household produced vegetables on a private irrigated field and then sold them in the village market, low- and middle-resource households made many market purchases, buying, respectively, 40 and 62 percent of the vegetables they consumed. The low-resource group produced for itself more than half its vegetable consumption.

7. Food Gifts

There was no substantial difference in the value of the average amount of grain received as gifts by low- and high-resource households. This probably reflects the role of grain in maintaining reciprocal ties among households. Gifts of grain are given under various arrangements. *Caatal* is a gift of grain given at harvest time by field owners or principal cultivators to women with whom they maintain close social ties, or to women family members. Women frequently sell these gifts to purchase items such as clothing and jewelry. *Dooftal conal* is a gift of grain given at harvest time to family members or friends who have helped with the harvest. *Muudu korka* is a measured gift of 2.5 kg given by the household head to family women during the final phase of fasting at Ramadan. And finally, *asakal dinne* is a gift of one-tenth of the harvest offered by the household head to destitute family members, generally the elderly or widowed women. Gifts in grain are also exchanged during religious ceremonies, such as marriages, baptisms, and funerals.

As note earlier, low-resource households received considerably more gifts of fish than did high-resource households. Fish is considered a "prestige" food and is given in solicitation of social and political support.

8. Nonfarm Foods

Nonfarm food items include condiments for sauces (tomato paste, dried onion, hot peppers), sugar, salt, cooking oil, powdered milk, tea, Nescafé, bread, and macaroni. At the household level, the low-resource group consumed less than half as much as the high-resource group. Per capita, there was little difference in the value of nonfarm food items consumed among the three groups. Gifts were more important as a source of nonfarm food items among the low-resource group, however. Of the total value of these items consumed by the low-resource group, 12 percent is attributable to gifts. Comparable figures for the middle- and high-resource groups are 5 and 1 percent.

9. Conclusion

To get a sense of the relative importance of local production for the three resource groups, the value of grain, meat, fish, and vegetables produced by households (i.e., excluding purchased food and food received as gifts) is calculated as a proportion of households' average annual gross money income. As Table 9.3 indicates, in 1989 low-resource households were in a more vulnerable position than middle- and high-resource households. The value of the food they produced was nearly 22 percent of their gross annual income, and grain accounted for 38 percent of the value of the food they produced. The value of food produced by the high-resource households was a much smaller portion of their annual gross income (4 percent), and only 7 percent of the value is attributable to grain production.

Table 9.3. Household-Produced Grain, Meat, and Fish as Percent of Household Gross Income (household average in FCFA)

Resource Group	Value of Household-Produced Grain, Meat, Fish, and Vegetables (average)[a]	Average Household Gross Income	Household-Produced Grain, Meat, Fish, and Vegetables as Percent of Average Household Gross Income
Low	100,113	461,997	22
Middle	80,823	1,037,700	8
High	147,449	3,484,850	4

[a] The large fish harvests of two households in the low-resource group are included here.

These findings suggest that in poor flood periods, high-resource households are less likely to feel the negative impact of reduced production and rising prices because they consume proportionately more imported rice (whose price is fixed) than grains, and because they have access to irrigation. They may even benefit from fluctuating prices by selling vegetables and other crops grown on irrigated fields. Low-resource households, however, must purchase at elevated prices the grains they cannot grow.

C. Problems with the SRBMA II Consumption Data

When analysis of the SRBMA II consumption data began, it became evident that for the majority of households the total value of annual household consumption greatly exceeded the value of annual household income. For some households, the value of food consumed in a one-year period was as high as 1,000 percent of total annual income. On average, the value of food consumed per household in a one-year period was 260 percent of total annual household income. Several factors explain the large discrepancy.

First, the methods the SRBMA II researchers used to collect consumption and income data were quite different. Income data were collected every month, and households were asked to recall revenues earned or received as gifts for the entire month. This approach, with its long recall period, could not possibly include all revenues received by each household member. Consumption data also were collected once a month, but household members were asked to recall only what had entered the household in the previous 24-hour period. In this case, the recall period was much shorter and therefore less information was lost. The assumption behind the second method of data collection is that each monthly visit represents a typical day, and that extrapolation from the monthly visits provides a fairly accurate measure of annual household consumption.

Second, households have a tendency to understate income and to overstate consumption. People are wary of income questions because they fear that disclosing true household income will result in an increase in their taxes. When it comes to questions related to consumption, however, households may exaggerate what they eat because it is culturally shameful for others to know that food is not plentiful.

Third, questions related to consumption were changed to accommodate cultural sensitivities. As a result, the information collected also changed and became less precise. Initially, households were asked to recall what they had eaten in the previous 24-hour period. This approach created problems for the field assistants because in Pulaar society it is shameful to state what one has eaten, especially if food is not plentiful. Early on in the research, then, the question posed was changed slightly. The field assistants asked household members what had entered the household in the previous 24-hour period either through purchases, exchanges, gifts, borrowing, payment of land rental charges, or harvests. A review of the data revealed that the amounts cited by households did not always correspond to one day's worth of food. In many cases items entered the household in bulk. Thus, in multiplying each monthly visit's value of food by 30 and summing all the values for the year, the amount for each household turned out to be much larger than total annual household income.

Initially, we tried to correct this problem by making two assumptions: first, that bulk entries were consumed over a number of days or weeks rather than in one day, as might be the case if a feast or celebration were taking place; and second, that the value of food consumed by households in a one-year period could not exceed income for the same one-year period. With these two assumptions as a basis for correcting the data, we proceeded to eliminate bulk entries and then to calculate how many days one monthly visit actually corresponded to. To do this, we selected the group of households (48 in total) whose value of consumption was greater than 300 percent of their income. For these households, we included food from purchases, harvests, exchanges, and land rental payments, and excluded food from gifts and food obtained on credit. For each of the 48 households, we summed the value of food consumed as reported in the monthly visits and divided this sum by the number of monthly visits. We then divided annual income by this average household daily total. For each household the resulting number divided into 365 produces the number of days to which the food recorded in the monthly visits corresponds. The average for the group of 48 households was 4.5 days.

This approach greatly reduced the value of consumption in total income—to approximately 50 percent for the sample of 331 households. However, in light of data from SRBMA I showing that the value of food purchases alone accounted for between 50 and 80 percent of income (Horowitz et al. 1991:364 [Table 10.2]), and because of the meager rainfall levels and inadequate floods during the SRBMA II research period, we felt that the corrected data was not reflecting the true situation in the river basin.

We therefore decided to return to the original uncorrected data set. Instead of eliminating the bulk entries we kept them because we were not sure which entries were consumed little by little over an extended period of time, and which represented bulk items acquired for baptisms, marriages, and religious feasts, that would be consumed more quickly. Such feasts are a regular occurrence in Halpulaar society and it is not uncommon for households to go into some debt to finance them. We realized that in eliminating these bulk entries, we were eliminating a true cost of consumption. We also rethought our assumption that the value of consumption in a one-year period cannot exceed income for the same period. In times of food crisis, the poorest can incur considerable debt in trying to meet food demands.

A final point to be made about the consumption information presented here relates to how the cash value of foods was assigned. In the case of purchases, the research assistants noted the amount actually paid by households. Because we look at the value rather than at the kilogram or volume weight of consumption, we are faced with two problems. First, households within any given area may pay different amounts for the same food. This arises when, for example, poor households buy food in very small amounts. These households often pay more for the same food because unit prices tend to increase as quantities purchased decrease. Second, prices in the Middle Valley varied for grains, meat, and other foods. When comparing the value of consumption of households from different regions, the differences discovered may be due to price variations as much as to differences in the amounts consumed. We do not know at this point how important unit price variation is in explaining variations in the value of foods consumed by households. The time we had to analyze the data was not enough to investigate this thoroughly. Food received as gifts, or payment for land, or through exchanges and credit, often did not have a value assigned to them at the time of data collection. Foods in these categories were assigned a value based on the average for the sample. We can assume, therefore, that differences in the value of these foods reflect differences in the amounts consumed.

D. Consumption Patterns in the Senegal Middle Valley for Households Differentiated by Income Level and Access to Production Systems (1990-1992)

1. Sample Stratification

SRBMA II households were sorted by per capita income,[2] rather than by an index of weighted land, labor, and capital resources as was done with the Thiemping data. We did this because the weighted index used with the SRBMA I data did not allow us to see which resources determined the consumption patterns of households. In the context of the river basin economy, we focused on income, and accounted for land resources by grouping households by location (see the analysis below). Even though the method of grouping households is different in the two periods, we feel comfortable in comparing households in Thiemping in 1988-1990 with households in PS 6 in 1990-1992 because for all households in the Thiemping sample, income from off-farm revenues increased with increases in the total resource index (TRI).

2. Hypotheses

Analysis of the Thiemping data convinced us that there exist important differences in the consumption patterns of households endowed with varying amounts of land, labor, and capital. Identifying these patterns increases our understanding of how economically differentiated households respond to the constraints imposed by climate and policy. Studying the Thiemping data generated a set of hypotheses on the impact of bad flood years on households differentiated by income. The hypotheses tested with the SRBMA II data are as follows:

- During a poor flood period, low-income households, who normally rely on household production for staple grains, experience food shortages. They not only consume less food overall, but also smaller quantities of staple grains than high-income households.

- Low-income households compensate for their inability to cover their food needs through purchases by relying more on gifts, exchanges, and borrowing for food than do high-income households.

- High-income households produce and consume more irrigated rice than do low-income households.

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[2] Household income includes: (1) farm income, (2) income from livestock transactions, (3) revenues from sales other than livestock, (4) income from wages and salaries, (5) income from certain nonfarm activities, (6) income from rental property and equipment, (7) remittances, (8) retirement pensions, and (9) income from marabouts and healers. For all sources except farm and livestock income, gross revenues are recorded. Farm income is the value of output less production expenses. Farm income was not adjusted for land tenure arrangements because of conflicting land tenure information in the data. Livestock income is equivalent to net sales, measured as the value of sales less the value of purchases.

3. Sources of Food

Analysis of the uncorrected SRBMA II data yielded somewhat unexpected results. While consumption patterns do differ among household income groups, the differences are not as large as we expected. Overall, low-income groups consume less per capita than high-income groups, but the sources of food and the composition of diets do not differ very much among income groups.

Table 9.4 presents household data by deciles of per capita income, the value of annual food consumption per household, and the per capita value of food consumption per household. The number of consumers per household was calculated by weighting household members according to their age: men and women 15-to-60 years old were each weighted 1; children 7 and under were assigned a weight of 0.5; and young adults and the elderly, in the 8-to-14 and 61-and-over age groups, were assigned weights of 0.75. The number of consumers does not vary uniformly as per capita household income increases: in several deciles below the median, family sizes are relatively large, but the largest number of (weighted) consumers per household is the in the second highest decile (Table 9.4). As expected, the value of annual household food consumption increases (though not smoothly) as per capita income increases. Per capita food consumption doubles between the lowest and highest income decile.

Table 9.4. Total and Per Capita Household Food Consumption by Income Decile

Decile of Per Capita Income	Average Number of Consumers per Household[a]	Income Per Capita (FCFA)	Annual Household Food Consumption (FCFA)	Annual Food Consumption Per Capita (FCFA)
1	8.40	5,865	392,865	46,770
2	9.57	12,096	391,805	40,941
3	9.17	17,217	502,662	54,816
4	9.34	21,335	438,285	46,926
5	8.00	26,364	582,258	72,782
6	7.89	33,739	465,754	59,031
7	8.57	40,422	528,560	61,676
8	7.70	47,979	679,472	88,243
9	9.62	61,702	739,153	76,835
10	7.80	116,475	735,386	94,280

[a] Weighted average, with weights by age group: children 0-7 years = 0.5; 8-14 years = 0.75; 15-60 years = 1.0; 61 and over years = 0.75.

We checked to see whether sources of food differed between low- and high-income households. When the data was being collected, the field research assistants asked households

to specify the sources of food entering households. Seven different sources were identified: purchases, exchanges, gifts, credit, household production, land payments, and other. Table 9.5 presents the value and percent of food obtained from each of these sources by income decile. Considering the large margin by which consumption exceeds income for all decile groups except decile 10, we were surprised to see the relatively large proportion of food entering households through purchases. For all deciles, the value of household food purchases accounts for over 60 percent of the value of all food consumed. It may be that the poorest households overstated purchases of nonessential food items such as sugar, coffee, tea, spices, etc. These households may have declared amounts households normally consume, rather than what they themselves actually consumed. The data show clearly that the value of purchases increases with income. The value of purchases for income group 10 is over twice the value for income group 1. The value of purchases as a proportion of total consumption is lowest in income decile 3 (62 percent) and highest in income deciles 8 (75 percent), 9 (80 percent), and 10 (75 percent).

We had expected exchanges, gifts, and purchases of food on credit to be fairly important, particularly for the low-income groups. Instead, **exchanges** represent a very small proportion of total food consumed for all groups, although the value of exchanges is generally higher for low-income groups. For deciles 1, 2, and 3, the average value of exchanges ranges between 12,334 FCFA and 22,044 FCFA. For deciles 8, 9, and 10 the average value of exchanges ranges between 5,668 FCFA and 8,084 FCFA. **Gifts** also represent a small proportion of total consumption for all groups. The value of food received as gifts by income groups 1 and 2 (28,708 FCFA and 23,199 FCFA, respectively) is considerably higher than the value of food received as gifts by groups 9 and 10 (5,785 FCFA and 17,824 FCFA, respectively). For the groups in between, the relationship between income and amount of food received in gifts is less clear. Food purchased on **credit** as a proportion of total consumption is also quite small. The value of food received on credit or borrowed is substantially lower for groups 1-5 (averaging about 20,000 FCFA) than for groups 6-10 (averaging about 61,000 FCFA). The value of food acquired on credit or borrowed among low-income households reflects the very difficult position in which they find themselves. The fact that high-income households have access to relatively large amounts of credit for food, on the other hand, may be a tribute to their high economic status.

The value of food produced and consumed by households accounts for 10 to 23 percent of total household consumption. In this category, which includes household-produced grains, meat, milk, fish, and vegetables, rice and flood recession sorghum are the most important foods. Income deciles 1 and 9 produce the smallest proportion of the food they consume. The absolute value and proportion of food produced and consumed by households increases steadily from decile 1 to decile 4, then declines. Beyond the fifth decile, the value increases again, but not rapidly enough to become as large a fraction of total food consumption as in decile 4.

Contrary to what we had anticipated, we found that the poorest 50 percent of households (deciles 1-5) produced and consumed approximately 30 percent more rice than the richest 50 percent of households, but almost 50 percent less flood recession sorghum. This is the opposite of what our findings from the Thiemping analysis showed. A possible explanation is that in

Table 9.5. Sources of Food Consumed, Value per Household by Income Decile (FCFA and percent)

Decile of Per Capita Income	Purchase	Exchange	Gift	Credit	Household Production	Land Payments	Other	Total*
1 FCFA	267,900	14,245	28,708	30,175	37,703	12,895	1,240	392,865
Percent	68.2	3.6	7.3	7.7	9.6	3.3	0.3	100
2 FCFA	265,578	12,334	23,199	14,072	57,834	14,821	3,968	391,805
Percent	67.8	3.1	5.9	3.6	14.8	3.8	1.0	100
3 FCFA	314,056	22,044	49,451	16,450	87,408	7,549	5,705	502,662
Percent	62.5	4.4	9.8	3.3	17.4	1.5	1.1	100
4 FCFA	295,843	7,214	9,178	14,066	99,956	7,422	4,607	438,285
Percent	67.5	1.6	2.1	3.2	22.8	1.7	1.1	100
5 FCFA	408,855	10,029	63,908	26,119	66,712	3,621	3,013	582,258
Percent	70.2	1.7	11.0	4.5	11.5	0.6	0.5	100
6 FCFA	308,964	15,832	7,571	49,541	70,617	8,478	4,752	465,754
Percent	66.3	3.4	1.6	10.6	15.2	1.8	1.0	100
7 FCFA	342,299	15,542	13,530	74,005	79,425	3,041	718	528,560
Percent	64.8	2.9	2.6	14.0	15.0	0.6	0.1	100
8 FCFA	506,767	5,668	6,613	71,215	81,257	4,615	3,337	679,472
Percent	74.6	0.8	1.0	10.5	12.0	0.7	0.5	100
9 FCFA	589,125	6,584	5,785	59,105	73,625	2,387	2,540	739,153
Percent	79.7	0.9	0.8	8.0	10.0	0.3	0.3	100
10 FCFA	550,330	8,084	17,824	51,079	89,102	11,096	7,872	735,386
Percent	74.8	1.1	2.4	6.9	12.1	1.5	1.1	100

* Differences in line totals result from rounding. This column is the same as "Annual Household Food Consumption" in Table 9.4.

sorting households by income alone, we did not take location into account, and therefore could not control for the fact that irrigation is more important in the Department of Podor, where incomes tend to be lower. Below, we try to control for climate, geography, and infrastructure by grouping households according to the availability of different production systems.

There does not seem to be a relationship between income decile and the value and proportion of food entering the households as payment for use of land. This is expected, since

allocative rights of households to waalo, falo, foonde, and jeeri land are not determined by income, but rather by the historical pattern of settlement and land conquest.

4. Composition of Diets

Foods consumed by households were categorized into three groups: (1) grains, including locally produced rice in paddy form, locally produced decorticated rice, imported rice, flood recession sorghum, rainfed millet and sorghum, locally produced corn, and imported sorghum; (2) meat, fish, and pulses, including beef, lamb, goat, chicken, ocean fish, river fish, dry fish, cowpeas, and watermelon seeds; and (3) miscellaneous items such as tea, coffee, powdered milk, oil, bread, and spices.

Table 9.6 presents the percentages of the three food groups in household diets for each income decile. The value of grains consumed is virtually the same for all groups except deciles 9 and 10, whose households consume higher amounts of grains. Given that the demand for staple grains is relatively inelastic, this pattern suggests that overall, households were able to satisfy their needs in grains. Proportionately, grains are a more important component of household diets for the low-income groups than for the high-income groups, an expected result. Income deciles 1 and 2 have the highest proportions of grains in total consumption (about 34 percent), while income groups 8, 9, and 10 have the lowest proportions (between 20 and 22 percent).

The value of meat, fish, and pulses consumed by households fluctuates among the 10 income groups, ranging from 59,000 to 111,000 FCFA, but shows a slightly more positive relationship with income than grains. In value of food per household, deciles 1-3 consume less meat, fish, and pulses than deciles 7-10. The middle deciles, 4-6, are mixed. In percent of total foods, however, their relative importance in household diets does not seem to be determined by income. Meat, fish, and pulses account for between 12 and 25 percent of total consumption.

Food items considered generally to be unessential or luxury items show the strongest positive relationship with income. The value of food in this category generally increases from the lowest to the highest income group, with the two lowest deciles averaging under 200,000 FCFA per household and the two highest averaging above 450,000. The large difference in amounts consumed suggests that low-income households cut back on the purchase of these food items in order to satisfy their needs in grain, meat, fish, and pulses. Because these items are costly, however, they comprise more than 40 percent of food expenditures in all deciles, with higher percentages (over 60 percent) for the three wealthiest deciles (8-10), but also for deciles 3 and 5.

Tables 9.7 and 9.8 display the percent and value of imported and locally produced grains in total grains consumed, by income decile. The percentages give the proportion of each type of grain in the average consumption of all grains by households in the decile. Thus, adding the percentages in the subtotals of the two tables gives a total of 100 for each decile.

Table 9.6. Value and Percent of Three Food Groups in Total Consumption by Income Decile

Income Decile	Value and Percent of Grains in Total Consumption	Value and Percent of Meat, Fish, and Pulses in Total Consumption	Value and Percent of Other Foods in Total Consumption	Total Consumption
1 Percent	34.80	18.27	46.93	100
FCFA	136,707	71,789	184,369	392,865
2 Percent	33.53	22.51	43.95	100
FCFA	131,383	88,212	172,210	391,805
3 Percent	26.55	11.74	61.71	100
FCFA	133,460	58,998	310,204	502,662
4 Percent	30.59	24.70	44.71	100
FCFA	134,082	108,236	195,967	438,285
5 Percent	22.34	11.72	65.94	100
FCFA	130,053	63,246	383,959	582,258
6 Percent	28.38	13.66	57.96	100
FCFA	132,183	63,632	269,939	465,754
7 Percent	26.25	17.38	56.37	100
FCFA	138,757	91,839	297,964	528,560
8 Percent	20.11	13.42	66.47	100
FCFA	136,641	91,157	451,674	679,472
9 Percent	22.29	13.56	64.15	100
FCFA	164,726	100,247	474,180	739,153
10 Percent	21.13	15.07	63.80	100
FCFA	155,392	110,797	469,197	735,386

Somewhat surprisingly, decile 1 consumed approximately the same amount of imported grains as deciles 8, 9. and 10. These four groups use between 72,000 and 81,000 FCFA worth of imported grains. The value of imported grains consumed by groups 2-7 is substantially lower, ranging between 51,000 and 59,000 FCFA. Except for income groups 1 and 8, where the value of imported grains is above 50 percent of all grains consumed, imported grains are not as important as local grains in household diets, comprising from 39 percent to 49 percent of total grains.

Table 9.7. Percent and Value of Imported Grains in Household Grains Consumed, by Income Decile

Income Decile	Percent and Value of Imported Rice in Total Grains Consumed	Percent and Value of Imported Sorghum in Total Grains Consumed	Subtotal
1 Percent	35.31	21.59	56.90
FCFA	48,273	29,510	77,783.00
2 Percent	18.15	20.80	38.95
FCFA	23,848	27,321	51,169.00
3 Percent	23.15	20.18	43.33
FCFA	30,899	26,933	57,832.00
4 Percent	25.67	14.28	39.95
FCFA	34,417	19,152	53,569.00
5 Percent	27.33	14.92	42.25
FCFA	35,540	19,406	54,946.00
6 Percent	22.90	16.46	39.36
FCFA	30,264	21,752	52,016.00
7 Percent	32.60	10.02	42.62
FCFA	45,239	13,908	59,147.00
8 Percent	37.89	14.64	52.53
FCFA	51,780	20,008	71,788.00
9 Percent	38.04	10.84	48.88
FCFA	62,667	17,864	80,531.00
10 Percent	36.89	12.54	49.43
FCFA	57,314	19,482	76,796.00

Irrigation is an important source of grains for the sample population, particularly for deciles 2-6, for which locally produced paddy contributes between 28 and 35 percent of all grains consumed. For income groups 1 and 7-10, locally produced rice (paddy) contributes between 17 and 26 percent of all grains consumed and is less important in household diets than imported rice. Imported sorghum is a more important source of grain for income groups 1-3 than for the wealthier deciles. Flood recession sorghum, on the other hand, is generally a more important food source for the upper income groups than for the lower income groups.

Table 9.8. Percent and Value of Locally Produced Grains in Household Grains Consumed by Income Decile

Income Decile	Local Paddy	Local Rice (Decorticated)	Flood Sorghum	Rainfed Millet	Rainfed Sorghum	Corn	Subtotal
1 Percent	25.93	3.01	5.26	2.89	2.26	3.75	43.10
FCFA	35,447	4,110	7,193	3,954	3,087	5,132	58,923
2 Percent	31.39	6.97	8.53	2.66	3.34	8.16	61.05
FCFA	41,247	9,155	11,204	3,501	4,388	10,719	80,214
3 Percent	34.63	5.15	6.39	1.46	2.09	6.95	56.67
FCFA	46,217	6,874	8,531	1,942	2,789	9,274	75,627
4 Percent	27.80	5.84	8.67	4.32	3.72	9.70	60.05
FCFA	37,275	7,835	11,620	5,788	4,992	13,004	80,514
5 Percent	32.98	3.59	7.18	2.93	2.05	9.02	57.75
FCFA	42,889	4,668	9,333	3,817	2,670	11,729	75,106
6 Percent	31.28	7.20	9.65	1.53	2.48	8.50	60.64
FCFA	41,352	9,523	12,762	2,017	3,278	11,234	80,166
7 Percent	23.77	6.15	10.25	1.59	4.78	10.84	57.38
FCFA	32,986	8,528	14,222	2,205	6,636	15,034	79,611
8 Percent	16.95	3.45	13.29	5.49	3.27	5.01	47.46
FCFA	23,164	4,714	18,162	7,502	4,465	6,846	64,853
9 Percent	18.80	5.32	11.54	3.98	3.40	8.08	51.12
FCFA	30,964	8,759	19,005	6,552	5,604	13,310	84,194
10 Percent	17.87	4.05	9.94	7.13	3.70	7.90	50.59
FCFA	27,763	6,298	15,439	11,074	5,743	12,276	78,593

The greater reliance on imported rice and flood recession sorghum among high-income households is a result of their location in areas where flood recession agriculture is, in normal years, an important component of the production system. Lower income households are concentrated in areas where flood recession agriculture is less important and irrigation more widespread.

Tables 9.9, 9.10, and 9.11 display the values and percentages of meat, fish, and pulses by income decile. Included in this group are ocean fish, river fish, and dried fish (Table 9.9); cowpeas, cowpea leaves, and watermelon seeds (Table 9.10); and beef, mutton, goat, and

Table 9.9. Value and Percent of Ocean Fish, River Fish, and Dried Fish in Total Household Meat, Fish, and Pulses Consumed, by Income Decile

Income Decile	Ocean Fish	River Fish	Dry Fish	Subtotal
1 Percent	33.63	1.68	19.68	54.99
FCFA	24,144	1,204	14,130	39,478.00
2 Percent	31.58	1.31	13.94	46.83
FCFA	27,859	1,157	12,300	41,316.00
3 Percent	51.66	8.47	15.73	75.86
FCFA	30,481	4,998	9,282	44,761.00
4 Percent	29.19	3.15	9.82	42.16
FCFA	31,590	3,405	10,626	45,621.00
5 Percent	49.56	4.39	14.97	68.92
FCFA	33,826	2,999	10,213	47,038.00
6 Percent	43.65	7.87	21.14	72.66
FCFA	27,774	5,011	13,453	46,238.00
7 Percent	47.68	7.42	13.79	68.89
FCFA	43,786	6,811	12,669	63,266.00
8 Percent	60.55	3.41	9.61	73.57
FCFA	55,193	3,107	8,759	67,059.00
9 Percent	64.84	4.89	8.77	78.50
FCFA	65,001	4,904	8,797	78,702.00
10 Percent	47.88	4.96	12.59	65.43
FCFA	53,044	5,496	13,950	72,490.00

chicken (Table 9.11). The percentages represent the proportion of each food type in the average total consumption of meat, fish, pulses, and vegetables by households in each income decile. Thus, the percentages for each decile in the three tables combined total 100.

The value of meat, fish, vegetables, and pulses combined accounts for between 12 and 25 percent of the total value of consumption per household (see Table 9.6). Fish is by far the most important source of protein for all the income groups except for decile 4. For all income groups the proportion of fish is greater than 40 percent in this category of meat, fish, pulses, and vegetables. Of the fish consumed, ocean fish (especially) and dried fish (secondarily) predominate. The value of ocean fish consumed by households more than doubles from the lowest to the highest income group, and its proportion in household diets is positively correlated with income. The value of river fish consumed by households increases fourfold from the lowest to the highest income group. This type of fish accounts for a very small proportion of

Table 9.10. Value and Percent of Cowpeas, Cowpea Leaves, and Watermelon Seeds in Household Meat, Fish, and Pulses Consumed, by Income Decile

Income Decile	Cowpeas	Cowpea Leaves	Watermelon Seeds	Subtotal
1 Percent	24.10	5.16	2.11	31.37
FCFA	17,303	3,701	1,517	22,521
2 Percent	2.51	29.29	13.99	45.79
FCFA	2,211	25,835	12,342	40,388
3 Percent	3.32	10.57	3.84	17.73
FCFA	1,959	6,236	2,264	10,459
4 Percent	2.64	44.40	2.90	49.94
FCFA	2,860	48,059	3,136	54,055
5 Percent	4.39	6.38	9.64	20.41
FCFA	2,996	4,353	6,578	13,927
6 Percent	4.42	5.74	6.91	17.07
FCFA	2,810	3,654	4,397	10,861
7 Percent	5.03	3.59	3.32	11.94
FCFA	4,621	3,298	3,048	10,967
8 Percent	5.43	5.64	1.69	12.76
FCFA	4,951	5,143	1,536	11,630
9 Percent	4.37	6.21	1.89	12.47
FCFA	4,382	6,226	1,894	12,502
10 Percent	5.72	12.69	2.65	21.06
FCFA	6,339	14,056	2,936	23,331

total food consumption, however. This is probably the combined result of poor fish harvests and the appearance in recent years of relatively cheap ocean fish in local marketplaces. The value of dried fish consumed by households shows no clear relationship with income.

Cowpeas, cowpea leaves, and watermelon seeds are the next most important protein source, particularly for low-income groups. Cowpeas are grown primarily on flood recession lands, while watermelons are grown on rainfed lands. Deciles 7-10 consume more cowpeas than all other groups except for decile 1. The relative importance of cowpeas is lower in groups 2-4, where it is about 2-3 percent, than for income groups 5-10, where it ranges from 4 to 6 percent.

Table 9.11. Value and Percent of Beef, Mutton, Goat, and Chicken in Household Meat, Fish, and Pulses Consumed, by Income Decile

Income Decile	Beef	Mutton	Goat	Chicken	Subtotal
1 Percent	3.56	1.78	8.31	0.00	13.65
FCFA	2,552	1,275	5,964	0.00	9,791
2 Percent	0.16	4.40	2.83	0.00	7.39
FCFA	137	3,877	2,493	0.00	6,507
3 Percent	2.87	2.55	0.98	0.00	6.40
FCFA	1,694	1,507	578	0.00	3,779
4 Percent	6.60	0.00	0.76	0.56	7.92
FCFA	7,138	0.00	819	603	8,560
5 Percent	0.31	6.07	4.29	0.00	10.67
FCFA	213	4,143	2,926	0.00	7,282
6 Percent	3.99	0.00	2.37	3.91	10.27
FCFA	2,538	0.00	1,506	2,489	6,533
7 Percent	2.49	16.07	0.61	0.00	19.17
FCFA	2,283	14,761	561	0.00	17,605
8 Percent	2.24	4.65	5.38	1.42	13.69
FCFA	2,040	4,235	4,902	1,290	12,467
9 Percent	3.79	0.00	3.94	1.29	9.02
FCFA	3,800	0.00	3,953	1,290	9,043
10 Percent	6.28	3.86	2.41	0.97	13.52
FCFA	6,957	4,272	2,673	1,074	14,976

Meat is the least important source of proteins overall. Deciles 7, 8, and 10, all above the middle of the income range, consumed substantially more meat per household than the other deciles (Table 9.11). The highest ratio of meat consumed to protein consumed is decile 7's 19 percent, but that is only 19 percent of a food group that for decile 7 comprises only 17 percent of all food consumed (cf. Table 9.6); it is thus just over 3 percent of the total.

5. Conclusion

Analysis of our data shows that low-income households purchase less food than high-income households. We also found that the value of food received by low-income households as gifts or obtained through exchanges is higher than it is for high-income households. We were

surprised, however, to see that overall gifts, exchanges, and credit provide the lowest income groups with a very small proportion of the total food they consume. Furthermore, we discovered that contrary to what we had hypothesized, the lowest income groups produce and consume more rice than the highest income groups. In the next section we control for the effects of climate, geography, and infrastructure by grouping households according to the availability to them of different production systems.

E. The Impact of the Flood on Households Differentiated by Income Level and Access to Irrigated, Flood Recession, and Rainfed Agriculture

In this section, we group households according to the combination of production systems accessible to them. We do this to check whether variations in the production and consumption of irrigated rice among households differentiated by income were blurred by grouping together households with distinct production strategies.

Our general hypothesis, as presented in the introduction of this chapter, is that high-income households are less vulnerable to changes in climate and dam management policies. In years when floods and rainfall are inadequate, they continue to purchase and, where possible, to irrigate. Low-income households, by contrast, are directly and negatively affected by poor flood conditions. Because of their limited access to resources, particularly cash income, they rely heavily on traditional flood and rainfed production. In years of poor flooding and rainfall, they are unable to compensate fully for reduced agricultural output by purchasing food or engaging in capital-intensive production methods. As a result, they consume less food, including such staples as rice, sorghum, and millet, than do households with higher incomes, and depend more heavily on gifts, borrowing, and exchanges.

When we examined sources of food for households grouped into per capita income deciles, we found that contrary to our hypothesis, the lowest income groups produced and consumed more rice than the highest income groups. We explained this by noting that in sorting households by income alone, we did not take location into account, and therefore could not control for the fact that irrigation is a more important component of the production system in the Department of Podor, where household incomes tend to be lower than in the Department of Matam.

To take account of the availability of the different production systems, we use the same household classification system that is found in the section on migration (Chapter VII). That is, we classify the 331 sample households into eight groups according to their access to irrigated, flood recession, and rainfed agriculture. We define access broadly, to include household ownership and use rights to land. Irrigated land includes land in small village schemes, middle-sized schemes, large schemes, and private schemes. Flood recession land includes waalo and falo, and rainfed land includes jeeri and foonde. The eight groups are presented, with their average per capita incomes, in Table 9.12.

Table 9.12. Irrigation, Flood Recession, and Rainfed Configurations for SRBMA II Sample Households

Irrigation, Flood Recession, and Rainfed Configurations	Number of Households	Average of Weighted Consumers	Average Per Capita Income
1 +IRR, +FLOOD REC, +RAINFED	76	9	37,948
2 +IRR, +FLOOD REC, -RAINFED	14	10	50,899
3 +IRR, -FLOOD REC, +RAINFED	38	8	50,794
4 +IRR, -FLOOD REC, -RAINFED	17	9	42,912
5 -IRR, +FLOOD REC, +RAINFED	72	10	49,047
6 -IRR, +FLOOD REC, -RAINFED	24	8	58,056
7 -IRR, -FLOOD REC, +RAINFED	73	8	41,973
8 -IRR, -FLOOD REC, -RAINFED	17	6	45,011

Groups 1-4 all have access to irrigation. Groups 1 and 2 also have access to flood recession agriculture. Groups 5-8 do not have access to irrigation. Groups 5 and 6, however, have access to flood recession agriculture. Thus, we differentiate among four general groups of households: (1) those that irrigate and engage in flood recession agriculture (groups 1 and 2); (2) those that irrigate, but do not engage in flood recession agriculture (groups 3 and 4); (3) those that engage in flood recession agriculture, but do not irrigate (groups 5 and 6); and (4) those that do not irrigate or engage in flood recession agriculture (groups 7 and 8). We then subdivide, sorting the households within each production system group by per capita income, and then partitioning each of the eight groups into thirds, corresponding to low-, middle-, and high-income households.

We now look at whether in fact production and consumption of irrigated rice is highest among households with the lowest income. Table 9.13 presents the annual per capita value of local paddy and local decorticated rice for the low-, middle, and high-income households in groups 1 through 8. The first four groups correspond to households with access to irrigation. Group 1 is made up of 76 households, of which 71 percent reside in PSs 3, 4, and 7. PS 4 boasts particularly large flood basins between the Doué and Senegal River. Two villages, Pate Galo and Marda, participate heavily in irrigation. Flood recession agriculture is also important in PS 7. Two of the four villages in this PS have been irrigating since 1978. Group 2 includes only 14 households, most of them residing in PSs 2, 6, 7, and 8. The last three production spaces correspond to the arrondissements of Thilogne, Ogo, and Kanel in the Department of Matam, and include the village of Thiemping. There, one finds large flood basins, but little opportunity for irrigation, at least not year-round, because of the absence of permanent water flows throughout the year. This region has the highest rate of out-migration, as reflected in the considerably higher per capita income in group 2 than in group 1 (50,899 vs. 37,948 FCFA).

Table 9.13. Household-Produced Rice and Flood Sorghum by Production System Group: Per Capita Value and Percent of Total Grains[a]

Prod. Sys. Group		Per capita HH-Prod. Rice	Per capita HH-Prod. Flood Sorghum	Per capita Total Grains
1-Low	Percent	29	5	14,142
	FCFA	4,113	718	
1-Mid	Percent	35	5	15,182
	FCFA	5,241	806	
1-High	Percent	37	9	18,430
	FCFA	6,790	1,735	
2-Low	Percent	54	9	13,935
	FCFA	7,571	1,229	
2-Mid	Percent	31	15	12,224
	FCFA	3,775	1,881	
2-High	Percent	41	13	17,692
	FCFA	7,291	2,311	
3-Low	Percent	39	3	14,100
	FCFA	5,436	416	
3-Mid	Percent	46	0	16,135
	FCFA	7,398	0	
3-High	Percent	42	1	22,993
	FCFA	9,581	293	
4-Low	Percent	42	1	12,153
	FCFA	5,048	147	
4-Mid	Percent	64	0	19,017
	FCFA	12,182	0	
4-High	Percent	31	5	14,866
	FCFA	4,669	689	
5-Low	Percent	8	9	13,969
	FCFA	1,164	1,201	
5-Mid	Percent	5	18	13,813
	FCFA	669	2,422	
5-High	Percent	2	16	17,647
	FCFA	382	2,816	

Prod. Sys. Group		Per capita HH-Prod. Rice	Per capita HH-Prod. Flood Sorghum	Per capita Total Grains
6-Low	Percent	5	8	14,364
	FCFA	748	1,129	
6-Mid	Percent	2	11	18,554
	FCFA	353	2,070	
6-High	Percent	1	17	20,232
	FCFA	194	3,540	
7-Low	Percent	11	4	18,685
	FCFA	2,073	757	
7-Mid	Percent	13	2	17,950
	FCFA	2,318	329	
7-High	Percent	3	2	16,767
	FCFA	427	335	
8-Low	Percent	14	1	14,029
	FCFA	1,996	147	
8-Mid	Percent	3	7	20,718
	FCFA	645	1,473	
8-High	Percent	0	2	17,312
	FCFA	0	266	

* The value of total grains includes purchased and other grains not shown here. Percentages are proportions of the value of per capita household-produced rice and sorghum to the per capita value of total grains.

Average annual net income from flood recession agriculture is also considerably higher in group 2 than in group 1. Group 2 households produced a net average of 111,800 FCFA worth of flood recession crops, while households in group 1 produced only 34,046 FCFA worth of such crops (Table 7.10).

When we look at the annual average household per capita value of locally produced and consumed rice, we find that in group 1, high- and middle-income households produce and consume more than low-income households. In group 2, low- and high-income households produce and consume approximately the same amount of rice. We believe the reason for this is that three of the five low-income households in group 2 are from PS 2, where the middle-sized scheme of Salde-Walla is located, and where, during the conflict between Senegal and Mauritania, the village of Wassatake lost access to most of its flood recession lands. By contrast, only one of four high-income households in group 2 is from PS 2. The remaining three are from PSs 1, 4, and 6, all of which have access to large flood recession tracts. In other

words, among the low-income households in group 2, irrigation is the predominant production system. That is why rice production and consumption is as high among these households as it is among high-income households. For the high-income households in group 2, on the other hand, flood recession agriculture is the most important production system. This is corroborated by the column of Table 9.13 that shows high-income households producing and consuming almost twice as much flood sorghum as low-income households. Per capita total grain consumption, moreover, is higher among high-income households than among middle- and low-income households in this group.

The value of household-produced rice in the household diets of group 3 increases with income, as does the value of all grains consumed. Group 4 presents a more confusing picture. In this group, middle-income households produce and consume considerably more rice than either low- or high-income households. Total grain consumption per capita is also higher among middle-income households. We believe this pattern results from the fact that most households in the middle-income group are from PS 5, where large irrigation perimeters make up for the paucity of flood lands. Output on large schemes is higher than on small village perimeters. Thus, households with access to large schemes are able to produce relatively large amounts of rice at a cost that is below the market price of rice. The rice produced and consumed by middle-income households accounts for over 64 percent of all grains consumed, whereas comparable figures for the low- and high-income households are, respectively, 42 and 31 percent.

Before concluding this section, we point out that when households are categorized by income and access to different production system configurations, we see per capita household consumption of grains is higher for high-income households than for low-income households for all groups except group 7. Because grains are staples and therefore do not increase in consumption beyond the point at which households are properly fed, this finding suggests that low-income households have been obliged to cut back on their consumption of grains.

F. Conclusion

We hypothesized in the beginning of this section that (1) in poor flood periods, low-income households face shortages of food, particularly of staple grains; (2) that gifts, exchanges, and credit are more important sources of food for low-income households than for high-income households; and (3) that high-income households produce and consume more irrigated rice in poor flood years than do low-income households. Our findings indicate that the value of food consumed by low-income households is substantially less than the value consumed by high-income households. Purchases were also lower among low-income households than among high-income households. Furthermore, when we group households by income and access to production systems, we find that the value of grains consumed is less for low-income households than for high-income households. These findings lend support to our first hypothesis. We also find that food received by low-income households as gifts or through exchanges is higher than it is for high-income households. Food obtained on credit, however, is substantially higher among high-income households. Overall, gifts, exchanges, and credit provided the lowest

income groups with a small proportion of the total food they consumed. Our findings do not allow us to conclude definitively that high-income households produce and consume more irrigated rice in poor flood years. While it may be true that high-income households were in a better financial position to irrigate, other factors related to the performance and availability of flood recession agriculture and to the type of irrigation schemes present in a given area are also important in determining the production and consumption of irrigated crops.

X. HYDRO-CLIMATIC SITUATION AND PEASANT STRATEGIES: 1990-1992

A. Introduction

This chapter centers around two topics: (1) a description and analysis of the reactions of the Middle Senegal Valley populations to the 1990 and 1991 hydrologic situation, and (2) a discussion of an equitable management of the Manantali Dam.

As we examine these two questions, frequent references will be made to the study carried under Phase I (1988-1990) of the SRBMA project. Among the conclusions drawn by SRBMA I are:

- Diversification, especially in the agricultural sector, constitutes a cornerstone in the risk-minimization strategies pursued by Middle Valley households, in the face of unpredictable and hazardous hydro-climatic conditions.

- The annual flood plays an essential role in the satisfaction of Valley households' basic needs. The importance of the flood is not restricted to the practice of recession cultivation on waalo and falo lands, but extends to fishing and herding as well.

- The rapid expansion of irrigation has transformed the area radically and altered the systems and relationships of production.

- Advocates of terminating the portion of the annual flood controlled by the Manantali Dam, after a transitional period, base their arguments on a cost-benefit analysis that compares hydropower, in other words irrigation, with flood-recession cultivation. These analyses do not take into consideration the full range of costs if the annual flood is terminated, nor do they count the flood's full benefits. Moreover, they are based on the false notion that maintenance of an artificial flood and the pursuit of irrigation are incompatible. The two have been proved compatible from a technical viewpoint. From the viewpoint of the farmer, the ability to pursue both strategies (irrigation and recession cultivation) is essential for food security, not to mention its utility for providing more equal access to resources, as irrigation parcels ideally are available to all members of the society.

We begin by comparing the methods by which field information was gathered, as well as the hydrological and rainfall conditions during SRBMA I and SRBMA II. We then analyze the reactions of Middle Valley populations to the hydrological conditions of 1990 and 1991. Finally, we attempt to analyze, from the farmers' point of view, the constraints imposed on an equitable management of the Manantali Dam.

B. From SRBMA I to SRBMA II: Evolution of Approach and Changes in the Hydro-Climatic Context

For a better understanding of what might be construed as differences—no matter how slight—between the results of SRBMA I and SRBMA II, the difference of approach as well as differences in the prevailing hydrological and rainfall conditions in the two periods should be considered.

In terms of methods, the Senegal River Basin Monitoring Activity, including both SRBMA I and SRBMA II, has undergone three phases:

- June 1988-March 1990 (SRBMA I)

During this phase, three Ph.D.-level researchers conducted very intensive research in three sectors that consisted of three villages each. As the sample size was small, they were able, with the assistance of research assistants (RAs), to visit sample households more frequently and to get to know them more intimately than was the case for SRBMA II, a considerably larger undertaking. Since each of the three principal researchers was based in one of the villages in each sector, they participated actively in the conduct of the surveys, in addition to supervising the surveys carried out by research assistants more closely than in SRBMA II.

- April-September 1990

This was a transitional phase, in which participant observation and qualitative data gathering continued in only one of the three sectors, as two of the principal researchers had come to the end of their terms. Research results from this intermediary phase have been incorporated in the analysis of SRBMA II data.

- October 1990-December 1992 (SRBMA II)

As is explained in Chapters II (Research Methodology) and III (Research Context), the number of sectors (village groups) referred to as production spaces (PSs), has been increased to nine. Nine research assistants were recruited and assigned the responsibility of collecting data, one in each PS. For purposes of statistical representativeness, household sample size in each PS was also much larger than was true for SRBMA I. While all sectors that were covered under SRBMA I were located in the Department of Matam, SRBMA II covered the departments of Matam and Podor, selecting a PS from each of the eight arrondissements, except for the Arrondissement of Salde in the Department of Podor, where two were selected.

Rainfall and hydrological conditions in the Senegal River Valley also varied considerably between 1988, the beginning of SRBMA I research, and 1992, the end of SRBMA II research. There has been a noticeable reduction in average rainfall and flood levels, caused by a combination of natural factors (e.g., rainfall patterns) and human factors (e.g., the management of the Manantali Dam). Sahelians have, in general, become accustomed to dealing with the

vagaries of nature. Middle Valley populations have developed labor strategies that are adaptive to uncertainties and variations, in both rainfall and hydrological conditions.

There seemed to be some hope in the Middle Valley in 1987, which saw an annual rainfall of 477 mm as measured at the Matam station. People hoped the year was going to mark the beginning of a new wet period, after over ten years of adverse conditions. This hope for recovery was not realized, however. In 1988, only 424 mm of rain were measured at Matam, followed by 356 mm in 1989, and 350 mm in 1990. Rainfall became even scarcer in 1991, with an accumulation that decreased to 241 mm in Matam, and in 1992 with an accumulation of only 140 mm at the same station.

Even during the years 1988, 1989, and 1990, when cumulative rainfall was high compared to 1991 and 1992, the frequency and distribution of rainfall were hardly favorable, whether for jeeri cultivation or for pasture. In 1989, for example, two-thirds of the rain measured at Matam occurred during the month of August: 235 mm for August as opposed to 356 mm for the entire year. In 1990, the rains did not really start until the month of August: the total accumulation for the months of June and July did not exceed 50 mm.

Thus the two periods of research, SRBMA I and II, saw marked variations in the timing of rainfall, as well as in its distribution. Nevertheless, during SRBMA I research, even though rainfall was not abundant, farmers were able to cultivate and to harvest; during SRBMA II, however, jeeri and foonde cultivation were almost total failures throughout the Middle Valley.

With respect to the flood, both periods of research witnessed strong, repeated, and frequently unforeseen variation in flow. Hydrological perturbations caused by the management of the Manantali Dam added to the natural irregularities of river flow. Moreover, the agricultural seasons monitored by the two research periods coincided on the one hand with an exceptionally good flood (1988, during SRBMA I), and with tests of the operations of the Manantali Dam (1990, during SRBMA II).

The two agricultural seasons monitored by SRBMA II have coincided on the one hand, with the beginning of the operation of the Manantali Dam and, on the other, with some very strong floods. The last natural flood (with contributions from the three tributaries of the Senegal River: the Falame, Bafing, and Bakoye) was in 1986, with a peak of 3,145 m^3/second. The flood of 1987 was virtually nonexistent. In 1988, inundation reached a level unknown since 1975, with a peak of 4585m^3/s, which surpassed that associated with Hydrogram "C", one of five possible scenarios for the management of the Manantali Dam proposed by the Plan Directeur de Devéloppement Intégré pour la Rive Gauche de la Vallée du Fleuve Sénégal (GERSAR/CACG et al. 1991 [October]:14) and the most favorable toward the flood (3000 m^3/s for inundation of over 100,000 ha): "Scénario à crue artificielle maximale, garantissant 67.500 ha de cultures de décrue et 61.000 ha de pâturages et boisement" (ibid.). During this period, the effect of the Manantali Dam on the regime of the Senegal River in its middle course is not evident. The 1989 water release was not very far above that of 1988. However, there were two peaks, the first toward the end of August and the beginning of September, and the second toward

the end of September. This resulted in a prolonged duration of inundation in some fields, but, depending on their location, the fact that two peaks occurred caused many farmers to lose the seeds planted after the first peak.

During the transitional period, which coincided with the start of the research period of SRBMA II, the effects of the Manantali Dam on the regime of the Senegal River were felt more strongly. In 1990, to allow the reservoir to fill to the maximum level of 1,208 m, the dam management decided to withhold the release of water. Accordingly, the main channel of the river was fed by two minor tributaries only, the Falame and the Bakoye, and as a result, the river never overflowed its main channel. The floodplain (waalo) remained dry, while the narrow riverbank (falo) strip was flooded somewhat.

In 1991, the flood reached a peak of about 2,600 m^3/s as measured at Bakel, which corresponds to what is referred to as Hydrogram "A," 2,500m^3/s, the river management scenario adopted by the PDRG (ibid.). As in 1989, the hydrogram of the river witnessed two peaks during this period, the first essentially due to water that was fed into the main channel by the two undammed tributaries, the Falame and the Bakoye, and the second by a release from Manantali. (For a more detailed description of the flood, please consult Chapter III).

In brief, whether we are speaking about rainfall or hydrology, the contexts of SRBMA I and II reveal differences that are at times rather important. Undoubtedly, these differences influenced the research results. For example, peasant labor strategies for the rest of the season and of the year can vary significantly depending on whether rainfed (jeeri) farming or recession cultivation were successful or unsuccessful, and whether farmers realize this early on in the season or somewhat later. The effects of the changes in peasant labor strategies in mid-course can be seen in the allocation and reallocation of family labor, the disruption of seasonal movements, the increased and earlier migration of people and animals, and the reevaluation of other agricultural systems that follow the failed ones, such as irrigation and vegetable gardening.

C. Middle Valley Residents' Reactions to the Hydrological Conditions of 1990 and 1991

The hydro-climatic situation of 1990 (June-July 1990 to May-June 1991) and 1991 (June-July 1991 to May-June 1992) reveal two scenarios that occur more regularly in the years that follow. In 1990 and 1991, the hydrologic situation approximated what is referred to in the PDRG as scenario "Z," also known as "scénario zéro," and scenario "A," the "compromise" scenario. Scenario "Z" is described as:

> Scénario productiviste développant à terme le maximum de surfaces irriguées garanties (154.500 ha de cultures vivrières) et le maximum d'hydro-électricité, mais sans garantie pour les cultures de décrue ou l'environnement si la crue naturelle était inexistante (GERSAR/CACG et al. 1991 [Octobre]:14).

Scenario "A" is characterized by:

> Développement important de la surface irriguée (88.000 ha), avec délivrance d'une crue artificielle garantissant plus de 33.000 ha de cultures de décrue (submersion supérieure à 15 jours) et assurant environ 63.000 ha de pâturages et boisement (submersion inférieure à 15 jours) (ibid.).

It would have been interesting and instructive to be able to study the other proposed scenarios. In the absence of such a possibility, a socioeconomic study of the two flood scenarios that occurred in 1990 and 1991 might enable us to: (1) estimate the significance of the regime of the Senegal River to living conditions in the Middle Valley; (2) inventory and analyze the responses of the people to each of the two scenarios; and (3) test the effectiveness of the measures adopted by the people in the face of two hydrologic deficits.

1. Reactions to the Hydrologic Conditions of 1990

For most of the people of the Middle Valley, the year 1990-1991 was a very trying one. Deficit rainfall conditions, coupled with a near absence of the flood (except on narrow strips of the riverbank) were the reasons behind the general pessimism witnessed in October 1990. Although rainfall was somewhat better than in the previous year (1989), it was still very low. This translated into a mediocre harvest on jeeri fields and a near absence of pasture thereafter for the incoming animals.

The absence of a flood in 1990--after two generous years that led the people to count on the Manantali Dam—generated a great deal of surprise, though a no-flood situation had occurred in the past with some frequency, and, consequently, this possibility had been taken into account in the gradual development of peasant survival strategies. A major consequence of the absence of the flood was that people were unable to cultivate their waalo lands, although some of the falo fields were planted. In addition, fishing was greatly diminished if not reduced to zero.

Since we did not expect a total absence of flood in 1990 we were unable to study it systematically. The tools used to determine the impact of a no-flood situation were those devised for a normal year, modified to fit the then-current situation.

Both formal and informal interviews with villagers of the Middle Valley confirm the gravity of the situation. The problems outlined below are those that appeared clearly in the responses furnished by those who were questioned on this subject (1) in the village of Doumga Rindiaw, an agricultural Toorobbe village that is situated in the intermediary zone referred to as the jeejegol, between the jeeri and the waalo; (2) Kaawel, an agropastoral Fulbe village, situated on the jeeri; and (3) Mbakhna Less, a Subalbe agricultural/fishing village. The impressions recorded are grouped into three categories discussed below: appraisals of the 1990-1991 situation, locating responsibility for absence of the flood, and strategies adopted in response to the circumstances.

a. Appraisals of the 1990-1991 Situation

The unanimous view of the people was that it was going to be a hard year, even harder than the previous year, which had been far from generous, with a totally failed rainfed harvest that had rapidly exhausted the cereal stocks from the preceding year's irrigation and recession cultivation.

Rainfed millet harvests on the jeeri for 1990-1991 were almost zero; returns on sorghum cultivation on the lower sandy-clay fields were also insignificant. Among the sample households of Doumga Rindiaw, the maximum harvest of sorghum (fela) received by any one household was a cartload.

Herders expected hardships as a result of serious forage deficits, which might be caused not only by a scarcity of rain, but also by its distribution. Although rainfall was much lower than the previous year, it had been in general better distributed over time. In 1989 some loss of seeds had resulted from a long interval, of about three weeks (20 July-10 August in Bokidiawe, for example), between rains near the beginning of the growing cycle.[1] Accordingly, herders were prepared to move their herds in a southerly direction, toward the ferlo, rather than take their usual northerly course toward the river, as in normal years.

In the fishing village of Mbakhna Less, on the Diamel, the variation in the height of the river kept on tenterhooks a population that was prevented from rainfed cultivation by lack of access to jeeri fields and therefore was very conscious of its extreme dependence on the flood for fishing and recession cultivation on waalo and falo fields. Some fishermen who proved to be mistaken in their predictions about the progression of the flood were badly hurt. This was the case of a 21-year-old, whose endeavors were reported by the RA who monitored the village of Mbakhna Less:

> Nous étions partis faire la pêche, mon jeune frère et moi. Nous étions à Civol[2] [le 29 août 1990] où nous avons fait 15 jours pendant lesquels la pêche ne marchait pas bien à cause du faible débit du Diamel. Nous avons été obligés d'arrêter la pêche. Nous sommes revenus à pied au village, laissant nos pirogues à Civol car le Diamel n'avait pas assez d'eau et nous n'avions pas d'argent pour prendre un taxi-brousse. A la reprise de la crue, quinze jours après, nous sommes retournés à Civol. A notre grande surprise, la crue n'a duré que cinq jours. Nous y sommes restés cependant dans l'espoir d'une remontée de l'eau mais cette année fut vaine et nous avons été obligés de revenir définitivement au village. C'est le désastre car à la veille de notre départ nous avions pris de la nourriture et des

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[1] During the rainy season of 1989, a rainfall of 250 mm was recorded by SAED at the Bokidiawe site, in the month of August only.

[2] Agnam Civol, situated about 15 km downstream from Mbakhna.

filets de pêche à crédit. Après nos mauvais résultats, nous sommes incapables de payer nos dettes. Nous avons été obligés d'écrire à nos parents qui sont à Dakar pour nous aider à éponger ces dettes. Nous mêmes nous nous apprêtons à partir en émigration en Gambie pour essayer d'aider la famille.

[We had gone out to fish, my young brother and I. We were at Civol (Agnam Civol, about 15 km downstream from Mbakhna; August 29, 1990) where we had been for 15 days, during which fishing was not good because of the weak flow of the Diamel (River; a defluent of the Senegal). We were forced to stop fishing and return to the village on foot, leaving our boats behind since there was not enough water (to row back), and we did not have enough money to take a bush taxi. At the resumption of the flood, 15 days later, we went back to Civol. We were shocked to discover that the flood lasted only five days. We stayed there, nevertheless, hoping that the water would rise again, but in vain; (once again) we were forced to return to the village. It was a disaster, since the night preceding our departure we had purchased food and fishing supplies on credit. Because of our bad luck, we were unable to pay back our debt. We were forced to write to relatives in Dakar to help us discharge the debt. We were even preparing to leave on migration to the Gambia to try to help our family.]

b. Locating Responsibility

The reasons advanced by the Valley population for the absence of flood are diverse and are an indication of the total absence of information directed to them by the dam management. Feelings of vexation and deep disappointment about the dam and the public authority responsible for its management are clear in a number of interviews, but people also display a very fatalistic vision that attributes all mishaps to divine will.

The dams as well as their managers have very bad reputations in the Fuuta, since, for the most part, people blame the absence of floods on the Manantali Dam but also on Diama Dam. What they find particularly upsetting is that at first these dams were portrayed as having been erected for the benefit of the region; the "after-dam" propaganda led them to believe that, in the near future, the dams would bring prosperity to the region. The point of view of an inhabitant of the village of Mbakhna Less elucidates the situation eloquently:

Nous avons été surpris par la mauvaise crue de cette année. Nous sommes déçus car on ne cessait de nous parler des bienfaits des barrages. Aujourd'hui, nous savons que tout ce qu'on nous disait des barrages était amplifié... Lorsqu'on nous a dit qu'avec les barrages, il était possible de faire inonder une superficie assez vaste pour la culture du waalo, on était très content. On espérait que chaque année on allait cultiver le waalo qui est notre tout. Sans le waalo, le Fouta entier souffre. Nous sommes déçus aussi car au niveau de la pêche, nous n'avons rien cette année. C'est la pire des années pour ce qui concerne la pêche. On nous avait aussi parlé de la pisciculture avec les barrages afin de permettre la reproduction des poisson, mais de tout cela on n'a rien vu.

[We were surprised by this year's bad flood. We are disappointed because they kept telling us about the benefits of the dams. Today, we know that everything we were told about the dams had been greatly exaggerated. . . . When we were told that, with the dams, it would become possible to inundate a large area of waalo, we were happy, hoping that we would be able to cultivate the waalo every year. Without the waalo the whole Fuuta suffers. We were also disappointed by the condition of fishing: we have had nothing this year. It is the worse year we have ever had for fishing. They also told us about the possibilities of aquaculture with the dams, to make it possible for fish to reproduce, but we have seen nothing like that.]

When people think of the dams and want to assign responsibility for bad management, it is always the government that they fault. No one speaks of the OMVS, perhaps because most people may not even be aware of its existence. The dams are perceived as exclusively the property of the Government of Senegal.

Confronted with a question as open and general as "What do you think of the absence of a flood this year?" none of the respondents considered searching for reasons why the "no-release" decision might have been made, as if to say it was a decision without a particular cause. In the village of Mbakhna, however, some people thought that the absence of the flood was due to the presence of a middle-scale irrigated perimeter at the site of Ndouloumadji Dembe, 2 to 3 km upstream from Mbakhna, that was cultivated in 1990 for the first time and caused the pumping out of large quantities of water from the Diamel.

In addition to natural causes, including divine will, and human intervention (the Ndoulumadji Dembe perimeter), many people saw a direct relationship between the weakness of the flood and local rainfalls, remembering a Pulaar proverb that says, "ko toBi e jeeri ilat e waalo" [it is the rains of the jeeri that flood the waalo]. As we noted earlier, divine providence was frequently advanced to explain the absence of flood, but often along with other causes. This is not at all surprising in a society as pious as that of the Fuuta.

In brief, the fact that the dam decision makers did not provide the Valley population with any information about the management of the dams, particularly the Manantali, resulted in a multiplicity of explanations and interpretations, most of them incomplete at best; some simply erroneous.

c. Strategies of Response

In general, the people questioned were sorry that no longer were governmental or donor aid available to ease the pain of a difficult and stressful year. They felt that they were left to deal with the situation unassisted, forced to mobilize their own, very limited, resources. They resorted to strategies that principally involved irrigation, migration, and herding.

In **irrigation,** three types of adaptations were noted:

- For some who were already engaged in irrigation during the course of the rainy season, the failure of the jeeri planting and the absence of the flood encouraged substantial transfers of labor, capital, and other inputs to irrigated gardens.

- Those who were not engaged in rainy season irrigation solicited and obtained gifts of rice from relatives and friends who had access to irrigated parcels.

- In general, off-season irrigation was practiced at a much larger scale than normal. This type of irrigation, however, was in no way able to compensate for the loss of earnings caused by the absence of a flood. This aspect of the question is discussed later.

Migration has the advantage over irrigation of being the least discriminatory strategy since, in principle, it is open to anyone who seeks it. Consequently it was the strategy most often adopted to soften the impact of food deficits. Migration started early and was massive, with many people who had not left for years resorting to migration again, in the full knowledge that conditions of life for city migrants had become very trying.

The people who stayed behind, mostly the elderly, women, and children, relied heavily on those who migrated and expected additional efforts on their part, knowing that their efforts are already remarkable, even in normal years. Migration remittances, despite their importance, supplement rather than substitute for local productive activities, however,: "Si nous ne produisons rien ici, la charge sera trop lourde pour nos enfants qui sont à Dakar". [If we produce nothing here, the burden on our children in Dakar will be too heavy.] This increased effort expected of migrants applied not only to immediate family members who remained in the village, but extended to the larger family, especially relatives who had no migrating sons.

It becomes even more difficult to resolve food shortage problems by monetary transfers when, in the absence of harvests other than rice, the price of cereals on local markets rises excessively. We know that at harvest time the prices of finger millet and waalo sorghum are low. In years like 1990 the people face two problems: where to find grain and how to pay for it.

Herders reported having had to resort to massive sales of their animals to provide themselves and their families with foodstuffs. In 1990-1991, terms of exchange between cereal and animal products were very unfavorable to the latter. For the same quantity of cereal in a normal year, herders had to sell more animals and more milk. An agropastoralist of Kaawel said in this regard, "We risk selling all of our animals to survive."

The year 1990-1991 was not exceptional in terms of a cereal deficit in the context of the Fuuta, where people are used to such hardships. Village solidarity has apparently responded well.

The absence of the flood has had a wide range of effects, varying among localities. Because of significant differences in access to floodplain land and irrigated parcels, in any year the interseasonal and interannual adjustments that are put into practice in a particular location—depending on the preceding performance of each production system—is a verifiable reality. However, rarely is this reality verified at the only scale where verification would make sense: the level of the units that produce and consume. Given the status of development of irrigated agriculture in the Middle Valley, most households cannot combat a cereal deficit by increasing the area they have under irrigation in the off-season because they do not have access to irrigated parcels.

2. Reactions to the Hydrologic Conditions of 1991

The people of the Middle Valley awaited the 1991 season with a great deal of anxiety. By mid-September, jeeri cultivation had already been doomed to failure because the rainfall registered during July, August, and the first three weeks of September had been insignificant. This year's situation was even more disturbing than the previous year's, which was very trying for the people and the animals of the region. Faced with the certainty of jeeri failure and a deficit of forage, the only hope left for villagers was recession cultivation. Thus, the regime of the Senegal River during the months of August and September left people of the area on edge.

After two successive years (1989 and 1990) of deficit rainfall, the rainy season of 1991 seem to plunge the Middle Valley into a new cycle of drought that recalled that of the early 1980s. Moreover, for the last dozen years a successful jeeri harvest had been more the exception the rule in the region. Thus there was fear that the normal risks of household survival would be magnified by questions of whether recession cultivation would or would not be possible and whether pastures would or would not flourish. The harsh pasture conditions of the previous year (1990-1991) added to herders' anxieties in the same way that the catastrophic jeeri harvest added to farmers' anxieties.

a. An Exceptional Deficit of Rainfall

The 1991 rainy season had a very late start in the Middle Valley, as in the rest of the country. In fact, the amount of rain registered at Kanel and at Semme at the beginning of June was so low (19 mm and 16 mm, respectively), that people were unable to plant their seeds. The five rain stations in the Department of Matam (Semme, Kanel, Matam, Ourossogui, and Thilogne) did not register any significant amounts of rain until the middle of July, when an average amount of precipitation was measured in Ourossogui, but somewhat more in Semme (33 mm in four days). In Semme, the first seeds were put in the ground during this period, although people had to wait longer elsewhere. Even in Semme, it turned out, this planting was a false start, since the rains of mid-July were followed by a dry period of 24 days. Everything had to be started over.

At the end of the first week (and certainly during the second week) of August, seeding was completed in the Department of Matam, except in the northwest area of the Arrondissement

of Ogo (formerly Ourossogui), and in the Arrondissement of Thilogne. In Thilogne the first drop of rain did not fall until 31 August. Only the most optimistic farmers attempted to plant at that late a date.

In the Department of Podor, where people are more accustomed to the vagaries of weather than in Matam, there was a glimmer of hope from the end of August to the beginning of September, especially in the Arrondissements of Gamadji (PS 4), Thille Boubacar (PS 5), and Salde (PS 1 and PS 2). The situation was particularly ironic in that the Arrondissement of Cascas (in Podor), but also the Arrondissement of Thilogne and the northwest part of the Arrondissement of Ogo (both in Matam Department), did not have enough rain to permit planting at any time that season.

The second half of September put an end to the illusions of some (in Thille Boubacar, Gamadji, and Salde) and gave rise to feelings of helplessness among others (in northwest Ogo, Thilogne, and Cascas). In these areas, the almost uninterrupted drought prevented the regeneration of the natural pasture, forcing herders to prolong their stay in the Ferlo, to the south.

The hydrologic deficit[3] and the very irregular spatial distribution of rainfall in 1991 constitute well-known traits of the Sahelian regime, although they were exacerbated in that year. The peculiarities of this season gave the appearance of normalcy until the middle of September, as evidenced by the existence of perpendicular bands that alternated between good and bad rainfall conditions. For example, a green band between Semme and Nabadji Civol (in the Arrondissement of Ogo) succeeds a completely denuded zone that extends until about Galoya (in the Arrondissement of Salde). From Pete up to the outskirts of Mboumba, the scene becomes wintery again. Beyond Galoya, the herbal tapestry suddenly disappears. It is only past Dodel (in the Arrondissement of Gamadji) and up to the surroundings of Taredji that one again discovers a grass cover.

As the season advanced, the overall shortage of rainfall, following a south-north gradient, was confirmed. In the southeast part of the Arrondissement of Ogo, and in the Arrondissements of Kanel and Semme, the vegetation was green and the farmers busied themselves all day in their sorghum and millet fields, fields whose extreme heterogeneity was the result of a very unsettled season marked by multiple seeding in intervals of several weeks. But, in the general context of the Valley, the Damga (Arrondissements of Kanel and Semme) could consider itself happy: the harvest would not be zero even though it would not be large. The animals that had gone on transhumance at the beginning of the dry season had returned en masse.

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[3] At the end of August, cumulative rainfall compared to rainfall in the same period during the previous year—which was far from being a good one—showed a deficit of 65 percent in Matam, 32 percent in Kanel, 57 percent in Ourossogui, 58 percent in Semme, and 79 percent in Thilogne.

In the third week of September anxiety revived, however, in the wake of a persistent hiatus in the rains. The Damga had only one good rainfall from the farmers' point of view, just enough to avoid the worst. Elsewhere, all hope had long since vanished.

In brief, since 1989, the Senegal River Valley has suffered a chronic rainfall deficit, which has severely affected the natural environment and its human and animal populations as well.

b. Uncertainties about the Flood

Faced by a complete failure of the rainfed season, Valley populations had nothing to count on but the waalo, in other words, the flood. After their disillusion of 1990 they had learned that despite the existence of the dams—or perhaps because of them—nothing had been gained in the region. They were still at the mercy of uncontrollable elements: the management of the dams had only added to the capriciousness of nature.

For hydrologic years as different as 1988, 1989, 1990, and 1991, the curves tracing the height of the water as measured at Matam for the months of June, July, and August, present very similar profiles (see Figure 5.2). This encouraged people who depend on the flood for their livelihood to engage in self-deception, at least at the beginning of September. In 1991 as well as in 1990, the condition of the river at the start of that month generated a considerable degree of hope, as the levels of water were very promising between June and August.

In contrast to 1990, when the water level did not exceed a height of 4 meters at Matam, 1991 saw the water level rise quickly to above 5 meters by the end of August and 6 meters before mid-September. This pointed to the likelihood of a flood of the magnitude of the flood of 1988, which surpassed 8 meters at Matam. Reaching a maximum height of 6.6 meters on 8 August, the flood of 1991 was high enough to inundate the lower depressions of the Middle Valley. From this date on, however, the fall in the height of the water occurred at the earliest date and in the most abrupt fashion in four years. In some places rather significant areas of waalo had been flooded: in Kanel, Thiemping, and Agnam. But in others, the level of the river never reached high enough to flood such cuvettes as Doumga Rindiaw, Haoure Pete, and Doumga Lao in a meaningful way.

These latter localities waited, hoping there would be another release from Manantali, while the former adopted two strategies that reveal the degree of disorientation the Middle Valley population was experiencing. At the end of September, the most discussed topic of the day was the role that the Manantali would play in the immediate future. Speculation was wide, and contradictory rumors circulated. The dilemma preoccupying those whose fields were partially flooded was whether to plant immediately or wait. Both strategies would engender a certain degree of risk:

- Deciding to plant without being sure of what the Manantali dam managers would do in the next few days meant that a farmer risked throwing away precious seeds, which were

becoming increasingly scarce. What seeds farmers had in their possession dated back to the March-April 1990 waalo harvest, that is, from the 1989-1990 waalo season. As people had not realized any harvest from their jeeri or waalo fields since that time, many farmers could not resist the temptation of whittling away even reserve seeds in order to survive. In the face of a serious scarcity of sorghum in the Valley and the mounting increase in consumer demand, an explosion in prices had taken place. In Agnam Godo, for example, the price of a muud of samme (floodplain sorghum) rose from 300-400 FCFA in normal years to 1500 FCFA.

- Deciding to wait until they were certain there would be an artificial flood meant that farmers risked bitter disappointment. If the Manantali management did not proceed with a release that would generate a flood of at least the same magnitude of the then-current natural flood, farmers risked losing the opportunity to contain the hardships imposed by food shortages that were already the lot of most rural households in the Departments of Matam and Podor. The risks associated with this choice are better evaluated if seen against the harsh conditions that prevailed in the area for at least 1½ years. Uncertainty concerning the flood imposed a Russian-roulette scenario on the population.

In the last ten days of September, even though water was rapidly receding from flooded cuvettes, people were still wondering. It was in this climate of high anxiety that the National Radio of Mauritania broadcast that the Manantali Dam was going to start releasing water as of 23 September and advised people not to proceed with planting the waalo. Reports of this radio announcement from the opposite side spread rapidly in the region, further evidence (if one needed it), of the thirst for information regarding the management of the Manantali Dam and the total absence of such information even in those arenas that touched the inhabitants' daily lives most intimately. In certain localities, such as Sinthiou Garba in the Arrondissement of Ogo, or Agnam in the Arrondissement of Agnam, some farmers started to plant despite the announcement and the uncertainties over what was to come.

Thus, the release from Manantali was not coordinated with the natural flood. In certain localities, substantial areas of waalo benefited from a long period of inundation caused by two floods, which translated into a good beginning for the waalo season. In general, however, recession cultivation (waalo and falo) was catastrophic in the Department of Matam as well as in Podor. Recognizing the seriousness of the situation, the government distributed foodstuffs.

D. The Agricultural Calendar: Factors Limiting Adjustment

One reason why disturbing the regime of the Senegal River has such deleterious effects on the region is that the natural agricultural calendar allows farmers to make few adjustments. Rainfed or jeeri farming, rainy season irrigation, and recession cultivation occur successively, with the tail end of one season coinciding with the beginning of another, and all are squeezed into a rather short period of time: June/July to February/March (see Figure 10.1).

1. The Agricultural Calendar: General Aspects

By the time that a farmer concludes that any of these agricultural systems is doomed to failure, it is often too late for him to invest his energies into one of the others. In recession cultivation, for example, a farmer has to wait until October before he knows whether there will be a flood or not, let alone with what characteristics. Realizing there will be no flood as late as October precludes the farmer from resorting to jeeri farming, since seeds would have to have been planted as early as July, or from engaging effectively and profitably in rainy season irrigation, which starts in June-July or at the latest, August. In a pinch, a farmer with access to irrigation might be able to ameliorate the consequences of a catastrophic rainy season and/or the absence of flooding by engaging in off-season irrigation.

Figure 10.1. The Agricultural Calendar in Doumga Rindiaw: Rainfed Agriculture and Rice Cultivation in Bossea I and III, and Recession Cultivation, 1989-1990

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                 July  Aug   Sept  Oct  Nov  Dec  Jan  Feb  Mar   Apr  May
PIV (Bossea I)     *============ ========== ===*
PIV (Bossea III)       *=======================*
Jeeri            *===============*
Foonde (rainfed)      *===================*
Waalo                          *==========================*
Falo                           *=====================================*
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While it is often impossible to launch another system of cultivation when the preceding one fails, people involved in this mixture of activities might be able to proceed by putting the energies targeted to one type of culture into another. For example, an unsatisfactory jeeri season or a prediction of a weak flood could drive farmers to allocate more than normal labor and resources to irrigated parcels. Ironically, off-season irrigation, when the river water level permits, is helped by the failure of one or more rainy season activities. It also seems that agricultural decisions from a previous year or season have a strong impact on farmers' subsequent decisions. In 1990-1991 farmers learned that despite the existence of the dams, or perhaps because of them, they cannot rely on recession cultivation. Consequently, they focused on rainy season irrigation in the following year, 1991-1992.

Because of the quasi-synchronized nature of the agricultural activities in the different systems, the adjustments made by rural households are not constant but differ from one season to another, obeying an interannual or even interseasonal logic that might appear irrational when observed on an annual scale.

Table 10.1. Effects of Outcomes of the Preceding Year's Traditional Farming Systems on the Exploitation of Irrigated Parcels (Rainy Season 1988/1989 and 1990 in the Diamel Sector of the SAED Delegation of Matam)

Jeeri and Jeejegol Zones

Season	Irrigation			Preceding Year's Results	
	Area Developed (ha)	Area Cultivated (ha)	Percent Exploited	Jeeri	Waalo
Rainy 1988	1268.77	660.69	52.0	good	bad
Rainy 1989	1268.77	450.23	35.5	good	good
Rainy 1990	1630.70	950.86	58.3	bad	good
Rainy 1990 (CIN)	1194.60	514.76	43.1	bad	good

The Daande Maayo Zone

Season	Area Developed (ha)	Area Cultivated (ha)	Percent Exploited	Preceding Year's Results*	
				Jeeri	Waalo
Rainy 1988	2461.63	1412.84	57.4	good	bad
Rainy 1989	2461.63	1394.43	56.7	(good)	(bad)
Rainy 1990	2526.87	1524.25	60.3	bad	(good)

* The Daande Maayo zone on the bank of the river has not unequivically profited from good rainfall and flood conditions because of the Senegalo-Mauritanian crisis, which caused a considerable loss of rainfed and floodplain lands. This is why some results are enclosed in parentheses.

Table 10.1. illustrates this point. Comparing surfaces developed and cultivated in the course of three rainy season in the SAED sector of Diamel, downstream from Matam, is revealing. This sector was divided into two subsectors: the first contains the localities situated in the jeeri zone and those situated in the intermediate zone (the jeejegol) between the jeeri and the waalo. In principle, this subsector groups localities that have good access to rainfed land. The second subsector contains riverine villages of the Senegal and the Diamel; access to dryland (rainfed) farming is, therefore, much more restricted. The table illustrates the three scenarios described below.

2. Satisfactory Jeeri and Waalo Harvest in the Preceding Year

In the part of the sector where rainfed cultivation is a principal component of the production system (the jeeri and jeejegol area in the south and along the national highway between Ourossogui and Orefonde), the area cultivated is significantly smaller than the area that has been developed and thus is potentially cultivable. In 1989 only 35.5 percent of the area

developed was cultivated. We attribute this to successful harvests in both jeeri and waalo fields in the previous year (1988).

The preceding year's successful jeeri and waalo harvest had little influence on the rate of cultivation in the riverine localities of the Senegal and the Diamel (daande maayo), however. In 1989, 56.7 percent of the developed area was cultivated as opposed to 57.4 percent the previous year. The borders of the Diamel contain villages (such as Tiguere Cire, Yene, Thioubalel, Kbakhna Dow, and Mbakhna Less) that have poor access to rainfed land; accordingly, the success of that agricultural season has not had much influence on people's attitudes toward irrigation. For villages situated on the banks of the Senegal River, the potential impact of the previous year's success was largely tempered by the Senegalo-Mauritanian conflict. The people of this area no longer have access to their rainfed, falo, and waalo lands on the other side of the River.[4] Consequently, good rainfall and flood conditions cannot persuade these people to turn away from irrigation.

3. Good Jeeri But Bad Waalo in the Preceding Year

The agricultural rainy season of 1988 was preceded by an extremely poor flood (1987) but a rather good rainfall that allowed adequate harvest. The degree of involvement in irrigated agriculture was thus moderate during the period in the jeeri and jeejegol villages that have access to rainfed lands (52 percent) and in the riverine villages that were able to exploit their rainfed lands on the right bank of the river, since these lands are situated away from the border conflicts.

4. Good Waalo But Bad Jeeri in the Preceding Year

It is in the rainy season of 1990—the flood having been acceptable the previous year but the jeeri harvest catastrophic—that we see an example of this scenario. In the subsector of the jeejegol and the jeeri, the rate of cultivation of irrigated perimeters was higher than in the previous year (58.3 percent). This seems to have been a result, however, of the installation of the new middle-sized irrigated perimeter of Ndouloumadji, which had just been handed over and was fully cultivated. On the other perimeters, the rate of cultivation, though better than in a year that coincided with good jeeri and waalo conditions, remained lackluster (43.1 percent).

In the daande maayo, farmers' decisions seem to have been much less affected by earlier conditions of recession cultivation and fishing. With the persistence of the Senegalo-Mauritanian conflict it is probable that they reasoned they would be better off putting more effort into irrigation. Hence, despite the good flood of 1989, the rate of cultivation on irrigated perimeters rose above 60 percent.

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[4] It is no coincidence that shooting incidents are the most frequent in localities that border the river: Navel, Matam, Diamel, Sadel, Nguidjilone, Dondou, etc.

5. Prospective Elements

These figures suggest that the most unfavorable condition for irrigation is a doubly successful preceding year, one with a good jeeri harvest and good recession cultivation and other flood-related activities, such as fishing. An antecedent year with only a good flood has a more negative impact on irrigation than one with only a successful jeeri season. In other words, one might suggest that the ideal situation for the promotion of irrigation is a preceding year characterized by a double failure of jeeri and waalo as happened in 1991, the year that witnessed an unprecedented engagement in irrigation.

It is tempting to jump to the conclusion that suppression of the flood, coupled with severe rainfall deficits might create in the Middle Valley conditions similar to those that promoted irrigated development in the Delta. If we look at the practice of irrigation in the Middle Valley, however, especially in the context of Village Irrigated Perimeters (PIVs), it is easy to see the great interdependence between irrigation and other productive activities. A crisis in fishing, rainfed farming, recession cultivation, or herding can affect the performance of irrigation significantly because of the financial reliance of irrigation on monetary resources generated from other activities.[5]

E. Hydrological Conditions and Migration Flow

1. Migration Flows in a No-Flood Year

Because of the narrow margin for maneuvering that an agropastoral year allows, in a stressful year recourse to migration remains the only option open to large numbers of households. Migration serves a double function: it decreases pressure on existing cereal reserves, and allows for the building of reserves through grain purchases from local markets (Niasse *in* Salem-Murdock et al. 1989 [December] and 1990 [May]).

The flow of migration was observed carefully in the villages monitored during SRBMA I. For the villages of Doumga Rindiaw and Kaawel, data are available for the years 1989 and 1990. The 1989 data have been analyzed and discussed elsewhere (Niasse *in* Salem-Murdock et al. 1990 [May]). Since the monitoring of migratory movements in the village of Mbakhna did not start until April 1990, the data available concern the 1991 rainy season only. In 1989, the procedure used consisted of having a research assistant in the village of his residence register in a notebook the arrivals and departures of migrants. It is possible, therefore, that there were some omissions, especially when migrants arrived or departed in large numbers. In 1990 the technique consisted of a resurvey, household by household, using as reference the surveys that were conducted earlier in those villages, which contained the names of all household members. Hence, the data are more complete in terms of who migrates, although the exact time

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[5] For more details see Niasse, M. (1990): "Culture irriguée, budgets familiaux. Etudes à partir du village de Doumga Rindiaw," *in* Salem-Murdock et al. 1990 (May).

of arrival and departure might be somewhat less precise than in the 1989 rainy season. In sorting migratory movements by months, the imprecisions associated with arrival and departure dates are to some degree leveled out (Table 10.2).

The three villages studied form a part of a perpendicular transect on the Senegal River and have close historical linkages based on use rights in the same territories and complementary exchange relationships. All three villages practice recession cultivation. Mbakhna, which is situated on the banks of the Diamel, is a fishing village that, in addition to waalo cultivation has access to falo fields. Doumga Rindiaw is an agricultural village with substantial access to rainfed lands. Kaawel is an agropastoral village that possesses sizable herds of large and small animals and practices rainfed cultivation. Fishing and falo garden products from Mbakhna, and dairy and meat products from Kaawel, as well as grains from Kaawel and Doumga are the objects of exchange among the three communities. Today, because of their more favorable locations, the villages of Doumga Rindiaw and Mbakhna also have access to village irrigated perimeters.

Table 10.2. Migratory Flow in the Rainy Seasons of 1989 and 1990 (Doumga Rindiaw, Kaawel, and Mbakhna Less)

1989	4/89	5/89	6/89	7/89	8/89	9/89	10/89	11/89	12/89	Total
Arr Kaawel	1	1	6	54	10	5	5	4	0	86
Dep Kaawel	1	6	1	4	1	18	10	20	22	83
Arr Doumga	1	2	13	-	8	4	7	1	3	39
Dep Doumga	0	0	1	-	13	14	13	12	21	74
1990	4/90	5/90	6/90	7/90	8/90	9/90	10/90	11/90	12/90	Total
Arr Kaawel	-	3	12	37	19	6	2	6	0	85
Dep Kaawel	-	4	0	1	3	19	30	20	4	81
Arr Doumga	-	20	35	38	14	8	7	4	-	126
Dep Doumga	-	15	8	11	3	13	53	23	-	126
Arr Mbakhna	2	7	1	1	2	0	0	0	0	13
Dep Mbakhna	-	10	11	4	4	2	3	17	2	53

The observations of rainy season migratory flows were thus conducted in three villages that are very typical of the river valley. The site of a village, the components of its existing production system, and the year's rainfall and flood situation have strong influences on the migratory behavior of the population of the three localities.

Migrant arrival patterns are quite comparable in the villages that practice rainfed cultivation: Doumga and Kaawel. The similarity between the two sites suggests that marginal involvement in irrigation has a limited influence on the migration calendar of certain villages. To be precise, however, in 1990 the arrival of migrants was earlier and more staggered in time in the village of Doumga Rindiaw, where irrigation is practiced, than in Kaawel. The arrival pattern in Mbakhna Less, where rainfed cultivation is not available, reveals a characteristic that might be at least partly related to irrigation. This concerns the small number of arrivals, which indicates that in the first quarter of the year the rate of absence of seasonal migrants from the village was relatively low. This assumption is reinforced by the knowledge that in the same year (1990) the village cultivated its irrigated perimeter in the hot off-season, in part because of the disastrously low water level in the Diamel, suggesting that the village had sufficient labor for this venture. It is also possible that the rather favorable fishing conditions after the flood of 1989 contributed to limiting migration.

In all three villages the migrant arrival curve is rather simple. It is nearly unimodal, with the maximum occurring between May and July. The annual recession seems to have had little effect on the pattern of arrivals, perhaps indicating anticipation of success in rainfed farming, recession cultivation, irrigation, fishing, and herding. The events that followed, however, had a strong impact on the departure curve, which incorporates the reaction to the deficit in rainfall and/or absence of the flood, circumstances that accelerated and precipitated the departure of the migrants.

In 1989, in Doumga Rindiaw as well as in Kaawel, departures were staggered over a long period of time, going from August through September, and following a regular rhythm until the end of the year. In this period, during which the failure of the jeeri planting was recognized somewhat late—around the middle of August—and where there was a rather good flood that permitted recession cultivation, households, having assembled their maximum labor complement in July, began progressively to free their workers as the agricultural tasks advanced. One contingent of migrants was thus able to depart at the end of September or later, during the first half of October, after planting, hoeing, and weeding on the jeeri; transplanting in the irrigated fields; and planting in the waalo had been completed. Had the jeeri harvest been successful, a second contingent of seasonal migrants would have been able to sell part of the jeeri harvest to defray travel costs. In Doumga Rindiaw, a third wave of departure took place after the December harvest in the irrigated perimeter, when an increase in the number of migrants was noted. After December, departures continued with some regularity, leaving the tasks of guarding and harvesting the waalo to women and the elderly.

In 1990, when failure of the jeeri added to the failure of the waalo, the curve of departures is different: migrant departures were early, numerous, and concentrated in time in the three villages of Doumga, Kaawal, and Mbakhna, with maximums in October and November. Even in Doumga and Mbakhna, where irrigated perimeters had been cultivated, migrants did not wait for harvest time. This might indicate that, in the villages monitored, migration behavior is more closely related to the flood (recession cultivation in waalo and falo fields and fishing) than to rainfed farming or irrigation.

2. The Flow of Migration in an Average Flood Year (1991-1992) in the Research Assistants' Villages of Residence

Migration flows in 1991-1992 were studied in the context of the existing components of the local production system, especially recession cultivation and irrigation. The flood remains a major component of the production system in the Senegal River Valley even though in the last few years the Manantali Dam has seriously disturbed the regime of the Senegal River on which the flood depends. From the point of view of the dam managers, irrigation is seen as an alternative to recession cultivation that justifies and legitimizes the suppression of the flood, or at least allows them to reject the idea of a controlled annual flood.

In addition to this conflict of interests, which brings face to face those who are for and those who are against a controlled flood, another equally important question is at stake, the question of migration in the Valley. This poses not only a development problem—the depopulation of rural area in favor of cities—but, expressed in terms of the movement of labor, an increase in migration could pose a real obstacle to all development programs in the Senegal River Valley, whichever option is finally chosen. The question then becomes, what impact would different scenarios for the management of the Manantali Dam have on migration? What impact would a choice that favors a maximum flood or one that favors irrigation exclusively have on migration? What about a more balanced choice between the various systems?

The method of we used to collect this type of information was simply to note all migratory movements in and out of the villages, indicating the gender, age, caste, and arrival and departure dates. Sometimes the origin and destination were also recorded. For analysis we considered only the nature of movement (arrival or departure) and the number of persons involved. Because of the ongoing nature of the task and the necessity of an intimate knowledge of the villages surveyed, only the residence villages of the RAs were considered for this exercise.

The discussion of the migratory flows here has two parts:

- A general profile of migratory flows in the villages that were monitored.
- A comparison of the curves of migration in the context of differential access among villages to recession cultivation and to irrigation.

a. General Characteristics of Seasonal Flows

The migratory curves (of arrivals and departures) observed in the resident villages of the RAs from June 1991 to April 1992 suggest a few comments. In general, during the 11 months of monitoring, the number of arrivals was much higher than that of departures (see Figure 10.2). This indicates a positive balance, which could signify an reversal of the usual large demographic losses that all villages in the Middle Valley endure. More likely, however, it is due to omissions of departures in reporting by the RAs.

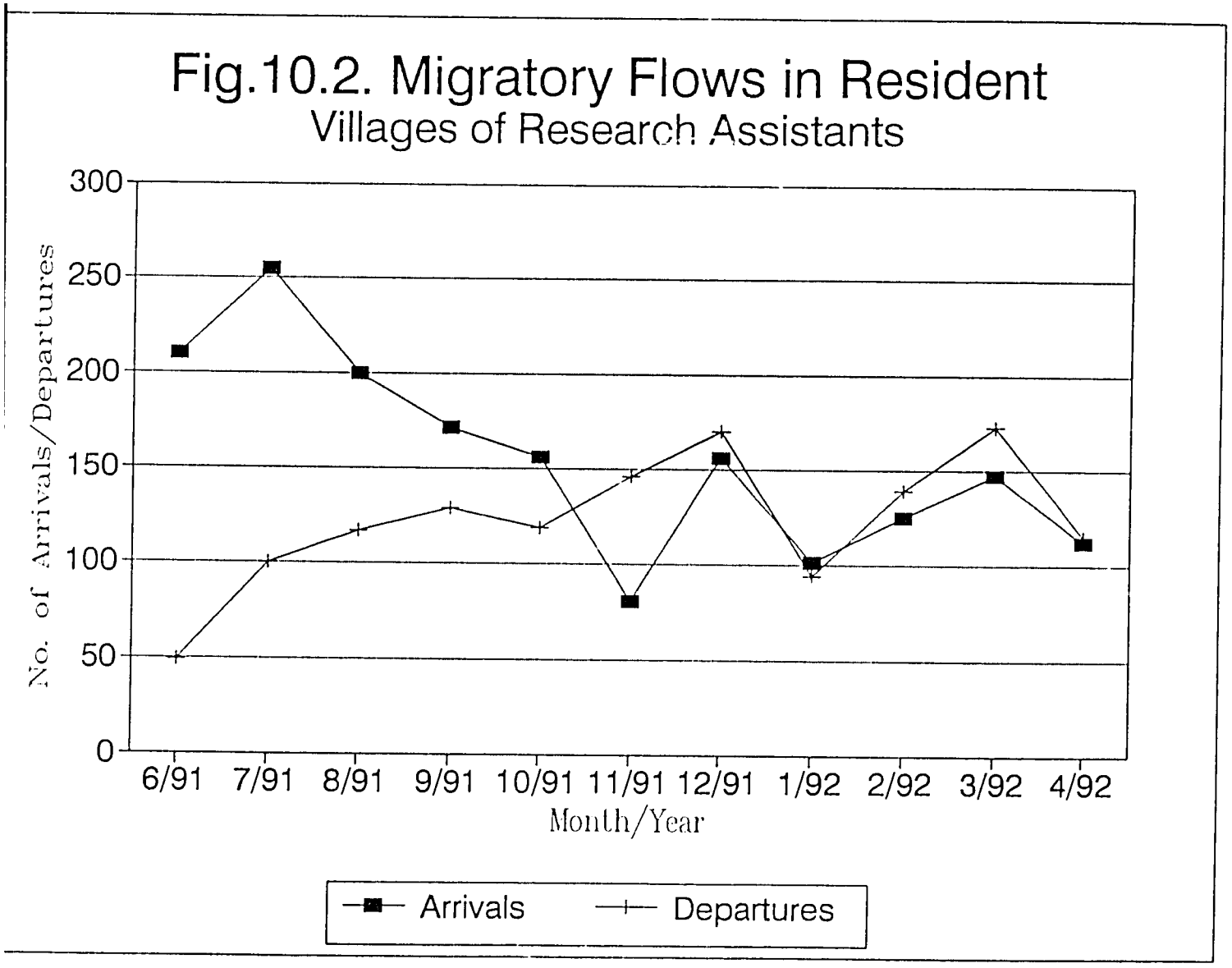


Fig.10.2. Migratory Flows in Resident
Villages of Research Assistants
No. of Arrivals/Departures
300
250
200
150
100
50
0
6/91
7/91
8/91
9/91
10/91
11/91
12/91
1/92
2/92
3/92
4/92
Month/Year
Arrivals
Departures

Migration in the Senegal River Valley is strongly impacted by seasonal events. This is not surprising, as 79 percent of the migrants who were monitored during SRBMA I lived inside Senegal and consequently were capable of returning to the village seasonally. The largest inflow of migrants toward the Valley occurs between the months of June and October, with a maximum in July (Figure 10.2). The outflow of migrants spreads out more in time and covers the period from October to March. In addition to its attenuation, the outflow during this period is characterized by a saw-toothed configuration, seen in the arrival curve as well. Two substantial waves of departure are seen, the first in December and the second in March. Knowing that the rainfed season terminates in October, that the harvest for rainy season irrigation takes place around December, and that the waalo season comes to an end toward March, one cannot help but recognize a relationship between seasonal migration and the mixture of agricultural activities practiced in the Valley.

Migratory flows observed between June and October have become part of the traditional behavioral patterns of the area, well known and understood. Migrants to who come to villages in the rainy season are known as *ramtooBe jeeri* (jeeri sharecroppers, in reference to rainfed farming). The peculiarity of the migratory behavior of this period is that it is not a function of the actual annual rainfall situation. Rather, it is based on the hope for a good jeeri season. Thus, the size of the inflow that is recorded cannot be related either to rainfall conditions or to access to rainfed land. At best, changes in the migration curve might be observable over the long run, in conjunction with a cyclical improvement or worsening of the pattern of rainfall.

b. Migratory Balance Sheet and Access to Irrigation and Recession Cultivation

The relationships between seasonal migratory movements, on the one hand, and irrigation and recession cultivation, on the other hand, are very close. For recession cultivation and irrigation, the uncertainties are more limited and the risks fewer than for rainfed farming. Irrigation is an agricultural activity that is programmable, and the conditions of recession cultivation become clear from the amount of land that can be cultivated as early as September. As a result, instead of anticipating uncertain conditions, as they do with rainfed farming, migrants react to a known situation. Thus, it is interesting to elucidate the relationships between seasonal flows of migration and access to irrigation and recession cultivation in the monitored villages, that is, the villages of residence of the RAs. First, however, we should clarify this notion of access:

- It is not very rigorous since it is based essentially on our knowledge of the RAs' villages of residence rather than a classification based on quantitative data;

- It refers to the agricultural year 1991-1992, during which villages had limited access to recession cultivation because of the characteristic of the 1991 flood. A more powerful flood in other years would be likely to increase the area under cultivation significantly.

- The level of access in a certain village is not necessarily the same as that of the PS in which the village is located. For example, in PS 7, which contains the villages of Kaawel,

Mbakhna Less, and Doumga Rindiaw, the general level of access is relatively high, the first two villages having been favored that year with sizable tracts of cultivable waalo land (for Kaawel) and falo land (for Mbakhna). In contrast, the lands of Doumga Rindiaw that were well flooded in 1988 and 1989 were barely touched by the flood of 1991.

- The analysis of access to land, elsewhere in this report, is based on the idea behind the definition of a PS. The analysis made here is based on only one village from each PS. None of the villages discussed here thus represents the PS of it forms a part since it is the complementarily among component villages that fundamentally defines a production space (PS) under SRBMA II.

- The notion of a migration balance sheet (the difference between arrivals and departures in a particular village) is expressed here in absolute numbers and not as a percentage of the population of the village studied.

c. Migratory Flows in the Context of Production Systems Predominantly Recession Cultivated or Irrigated

The development of irrigation in the Senegal River Valley came unwound in a rather spectacular though not homogeneous fashion in recent years. In certain areas, irrigation has even become the dominant component of the agricultural system, as in Wassatake in PS 2, with the erection of the middle-sized perimeter of Salde Walla, and in Nguendar Jeeri in PS 5, with the large scale perimeter of Nianga. In other areas, however, irrigation remains absent from the scene, as in Agnam Godo in PS 8, or distinctly marginal, as in Thiemping in PS 6. On the other hand, in Agnam Godo as well as in Thiemping, access to recession land is immense, even in a year with a weak flood, such as 1991.[6]

(1) Recession Cultivation Dominant

Migration flows in the villages of Thiemping (in PS 6) and Agnam Godo (in PS 8) reveal a monthly balance sheet that is in surplus in the period June to December and deficit the rest of the year (Figure 10.3). The surplus period show two peaks. The first corresponds to the months of June and July and is explained more by rainfed farming than by anything else. In the absence of access to irrigation, it is rainfed farming that complements recession cultivation. The second peak corresponds to the period September October and results from the demands of waalo cultivation. It is less pronounced than that of June July, but this should not be interpreted as a preference for jeeri over waalo. The relative weakness of the September October period can be explained by the fact that a large number of the people who returned to the village at the start of the rainy season are still there when the waalo season starts. Afterwards, the migratory

[6] The 1991 flood, which achieved a peak of about 2,600 m^3/s, is close to what is called scenario "A" by the PDRG (2,500 m^3/s), which should allow the cultivation of 50,000 ha of land.

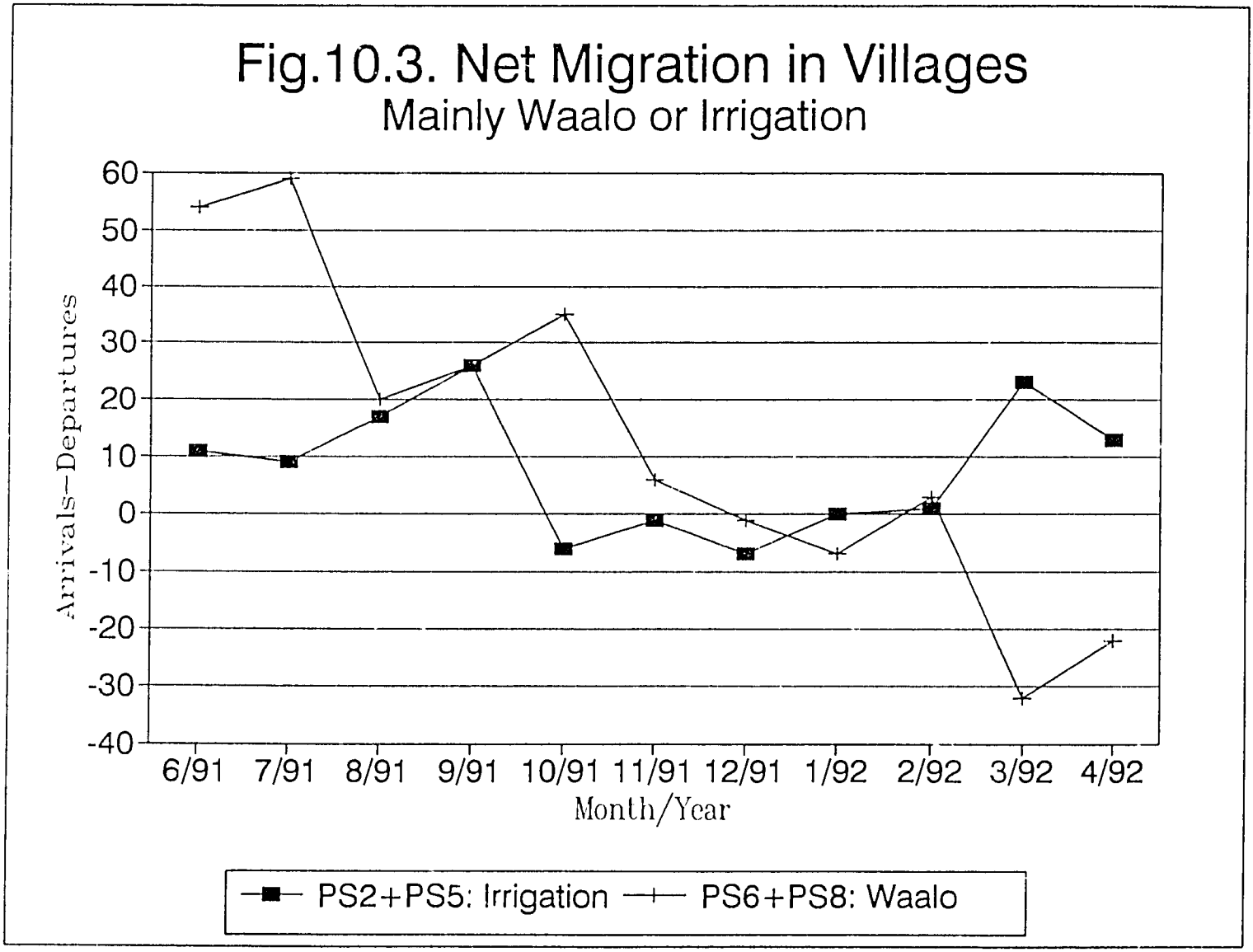


Fig.10.3. Net Migration in Villages
Mainly Waalo or Irrigation
60
50
40
30
20
10
0
-10
-20
-30
-40
Arrivals–Departures
6/91
7/91
8/91
9/91
10/91
11/91
12/91
1/92
2/92
3/92
4/92
Month/Year
PS2+PS5: Irrigation
PS6+PS8: Waalo

balance sheet balances out (November to February): this period does not see a significant deficit except in the month of March, at the beginning of the waalo harvest.

(2) Irrigation Dominant

In the villages of Wassatake and Nguendar, where irrigation dominates the production system, the annual migration balance sheet is in surplus in the period March-September; thereafter it shows a small deficit between October and February. The response, in terms of migratory flow, is more moderate than for rainfed cultivation, with a modest surplus in June and July. In the Departments of Matam and Podor irrigation is practiced almost exclusively in the rainy season (June-July to December). In the migratory flows that were observed, the impact of rainy season irrigation did not seem direct or strong. The migration surplus in March and April is surprising, although in Wassatake some Unités Autonomes d'Irrigation (UAI) normally cultivate in the hot off-season.

One gets the impression that in sites dominated by large- and medium-scale irrigated perimeters, the movement of labor is not as much a function of agricultural activities as is migration in other sites. Perhaps in the localities with these larger perimeters migration is influenced by a combination agricultural demands and other factors that have not been precisely identified. Among these factors may be the seasonal movements of herders in Nguendar, of fishermen in Wassatake, and specific migratory practices that operate in the context of large-scale perimeters which, unlike the small ones, hold out the possibility of large monetary gains.

Balance sheets (net migration curves) for villages with strong, weak, and no diversification in agricultural systems are shown in Figure 10.4.

F. Constraints on the Equitable Management of the Manantali Dam

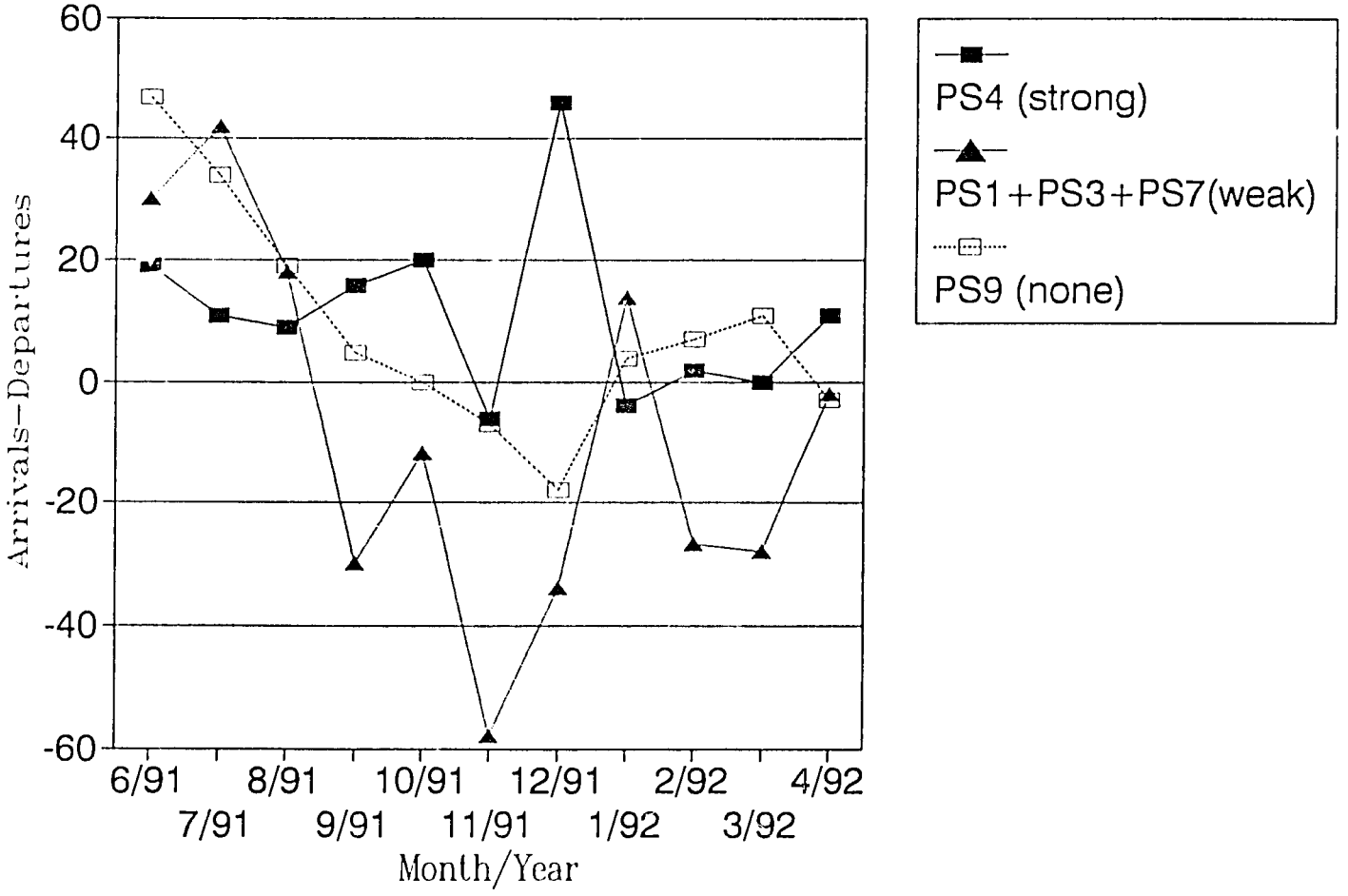
1. A Difficult Reconciliation at the Regional Scale

One of the major difficulties facing an equitable management of the Manantali Dam is that the riverine states, especially the member states of the OMVS, have divergent interests and conflicting priorities. Another difficulty is the need to assure the financial profitability of the works either already completed or expected to be completed under the development plan for the river valley.

- Profitability and Microeconomic Considerations

From a financial viewpoint, the production of hydroelectric energy is the most, if not the only, profitable facet of the OMVS program. Moreover, it allows for a reduction of the high petroleum bills of the three states and the development of industry. In terms of irrigation, water consumers are supposed to be charged user fees. Recession cultivation, however, is not in a position to support water dues because of its low productivity. Irrigation has the additional

Fig.10.4 Net Migration in Villages with Strong, Weak, and No Diversification



advantage of allowing member states to promote import-substitution crops, thereby reducing trade deficits and helping to achieve food self-sufficiency.

- Divergent Interests of OMVS Member States

The member states of the OMVS do not have the same preoccupations; rather each nurses different ambitions and aspirations with respect to the utilization of this common resource.

Mali. The Malian area of the Senegal River Basin is situated in higher land with a narrow alluvial strip that substantially reduces the possibilities of recession cultivation and irrigation. Moreover, Mali is a landlocked country whose transcontinental trade takes place by roads or railways that originate in the border countries of Senegal and Côte d'Ivoire. Accordingly, for Mali, the most interesting aspects of the Manantali Dam are navigation and hydropower generation. Mali would be hard-pressed to sacrifice these two goals in favor of a controlled flood that would allow recession cultivation and other flood-related activities, since this would imply a significant reduction in the amount of power generated. But navigation of the river between Saint Louis and Kayes requires a minimum permanent annual flow of 300 m^3/s, which might not be guaranteed if the reservoir must, at the same time, release enough water to amplify the natural flow for a good flood.

Mauritania. It is estimated that about 40 percent of the floodplain of the Senegal River Basin is situated on the right bank of the river, in Mauritania. The alluvial valley of the right bank is inhabited by the Halpulaar and the Soninke, and, other than at the oases, it is the only region in the country where agriculture is possible. It has therefore become the object of political and racial conflicts with high stakes. The White Maures in power and their allies the haraatin, intend to put these lands under the control of the state (stature of 1983 or) in order to permit their colonization, at least partially, by these northern entrepreneurs. There has been an attempt to purge the land of any customary autochthonous rights of blacks by making traditional forms of exploitation impossible. The means of achieving this goal are to suppress the flood (and consequently recession cultivation), and to promote irrigation, which diminishes the importance of control over land in favor of capital. While they are not yet settled about the future of the flood, Mauritania is not likely to be, for the moment, among the most ardent defenders of the flood.

Senegal. Senegal is the member state which has at least potential access to large tracts of floodplain, irrigated, and irrigable land along the Senegal River. As the most industrialized among the riverine states, Senegal is also very interested in the hydroelectric aspect of the dam. Even though, in the beginning, Senegal leaned toward the OMVS's position vis-à-vis the flood, the Government of Senegal has progressively modified its position concerning the flood, and in general the management of the dams. In its final versions (April 1991), the Plan Directeur de Développement Intégré de la Rive Gauche (PDRG) has adopted a development scenario refer to as scenario A, which calls for a flood that will allow the recession cultivation of 50,000 ha, of which 33,000 ha are on the left bank. This will reduce by 10 percent the amount of

electricity originally envisaged to be generated. At the same time, 80,00 ha will be put under irrigation with an intensification rate of 160 percent.

The problem that arises is how to make other member states share Senegal's position. This might require some time, especially because the problems between Senegal and Mauritania do not facilitate reaching agreement. The position of donors engaged in financing the dams and the accompanying work will be decisive.

Guinea's objectives in the Fuuta Djallon have not yet been defined clearly. Given that a large portion of the Senegal River waters originate in Guinea, its participation in sustainable development plans for the region will be indispensable. Meanwhile, the stakes remain high for the households that live along the river as well as for the Senegal River Basin ecosystem.

2. Divergent Zonal Priorities

Ecological conditions as well as production systems change significantly as we go from upstream to downstream areas of the river. In the Upper Valley, the riverbed is hemmed by steep banks and hills and the floodplain is insignificant. Accordingly, the significance of the flood to the production systems in this zone is distinctly less evident than in the Middle Valley. Irrigation, despite SAED's concentrated efforts, remains marginal. Rainfed cultivation, accordingly, plays a major part in the agricultural production system of this zone.

In the Middle Valley, rainfall conditions are clearly less favorable than in the Upper Valley, which renders rainfed agriculture relatively precarious. Irrigation, on the other hand, has known a spectacular development since 1975. Compared to downstream areas of the river, however, irrigation remains relatively weak. In this zone, recession cultivation (waalo and falo) constitutes the most noticeable feature of the countryside, and it is the most important component of the production system.

In the downstream part of the Middle Valley, rainfall is generally so weak that rainfed farming is nothing but a futile activity despite people's determination to continue its pursuit. Recession cultivation, on the other hand, is very common, especially on the Ile à Morphil. Irrigation in this area has known a spectacular growth, to the point that it competes for consideration as the most important agricultural activity, with waalo and falo cultivation.

In the Delta, the possibilities for recession cultivation are almost nonexistant. Moreover, rainfed farming has been abandoned almost totally because of poor rainfall. Agricultural activities hence center around irrigation. Along with large-scale and medium-scale perimeters, other types of perimeters have spread all over the zone. Today, from Saint Louis to Dagana, virtually all irrigable land is planned for irrigation or is already irrigated.

In face of such diversity, it is clearly not easy to manage equitably the water resources of the river. While the flood is regarded as high priority in Matam, it seems a matter of indifference to the people of Bakel; for farmers of Podor, the flood is regarded with some

hesitancy, while those in the Delta feel they are penalized by a flood that might not leave enough water in the reservoir for hot, off-season cultivation.

3. Divergent Priorities as a Function of Agricultural Systems

In this section we analyze the types of farmlands in the Middle Valley. The information available allows us, in the context of a minimal controlled flood, to evaluate the place that recession cultivation and irrigation occupy in different areas of the Middle Valley. In some of the development scenarios envisaged for the area, these two are seen as incompatible. Looking at the level of access to land, we will be able to determine those areas most at risk of food shortages, according to the various development options chosen and favoring one system over the other (recession cultivation and irrigation).

a. The Notion of Access to Cultivated Farmlands

Here, access is defined in connection with the eventual consequences over household revenues of modifications of the regime of the Senegal River or modifications of rainfall patterns. Households that derive all or part of their revenues from waalo, falo or irrigation depend, in different degrees, on the regime of the Senegal River. Those who derive part of their revenues from rainfed farming on the jeeri or the foonde are dependent on the quality and quantity of annual rains. The notion of access to cultivated farmlands is thus a matter of agricultural operations. Therefore, a household is considered to have access to a certain farmland if it meets the following conditions:

- Direct exploitation of the parcel, irrespective of the land tenure system: direct ownership, individually or in association with other households; free-of-charge borrowing; annual renting (*coggu*); or sharecropping.

- A parcel given to another household with the expectation of a substantial share of the harvest or, in the case of coggu, some monetary returns.

The common feature of the two cases is that the household derives a substantial part of its revenues from the specific system of cultivation. However, to be more rigorous, we determined the exact mode of access, taking into consideration types of arrangements, in other words, how much each household might expect of the produce of the parcels to which it has access.

To arrive at this type of calculation, we proceeded in the following manner.

Table 10.3. Access to Cultivated Farmlands

Direct Access	Tenure	Part of Surface Area of Parcels Retained
	DJG or RRB or RCG	Total area
	RRD or JOW/2	Total area/2
	RRT or JOW/3	Total area/3
	JOW/4	Total area/4
	JOW/5	Total area/5
Indirect Access	CRD or CCG	Total/2
	CRT	Total/3

The asakal (a religious tithe - 1/10) has not been taken into account, either for those who have ceded their parcels or for those who profited from this cession. Using the preceding scheme, sample household access to waalo, falo, irrigation, and jeeri/foonde has been calculated carefully, and with these elements, the average profile of types of exploitation was derived. The specifics by village, PS, and ecologic niche were also determined.

(1) Average Size of Farmlands in the Area Studied

The average farm in the area covered by SRBMA II has access to 0.74 ha of waalo land, 0.04 ha of falo, 0.2 ha of irrigation, and 1.11 ha of jeeri and foonde. It goes without saying that the sizes of waalo and falo parcels vary depending on the hydrologic conditions of a particular year. Figure 10.5 estimates land size for a type A average flood.

(2) Average Size of Farmlands by PS

At the level of the PS, the profile of average access to farmlands looks very different. Table 10.3 and Figure 10.6 show average access to different types of farm land by PS. Even though, as we have seen in figure 10.5, the largest average land that households have is in the jeeri/foonde, followed by the waalo when we look at the area as a whole, that order does not obtain when we distinguish among the various PSs. To start, the size of foonde-jeeri farms ranges between a high of 3.14 ha (PS 3) to a low of 0.35 ha (PS 4), depending on the PS. Waalo ranges between 2.29 (PS 8) and 0 (PS 1), and falo between 0.14 (PS 2) to 0 (PS 5), while irrigation ranges from 0.94 (PS 2) to 0 and 0.01 (PSs 8 and 9). Moreover, jeeri/foonde land is not the largest in every PS. In PS 2, for example, the average size of irrigated lands that households have access to (0.94 ha) is larger than their access to any of the other types of land. In PSs 4, 6, and 8, on the other hand, waalo land is, on average, the largest type.

Fig.10.5. Average Household Access to the Various Farming Systems: 91-92 (ha)

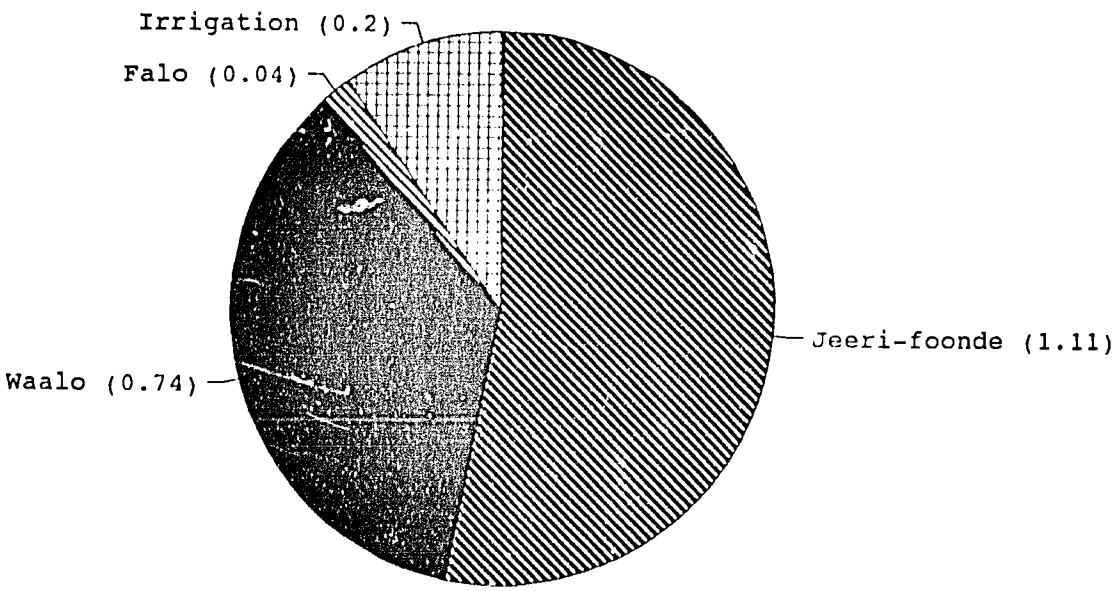


Table 10.4. Average Access to Cultivated Farms by PS: 1991-1992 (ha)

PS	Number of Households	Agricultural System			
		Foonde-Jeeri 1991	Irrigation 1991-92	Falo 1991-92	Waalo 1991-92
1	32	0.88	0.24	0.08	0.00
2	25	0.83	0.94	0.14	0.03
3	37	3.14	0.21	0.04	2.09
4	32	0.35	0.63	0.09	2.09
5	35	1.03	0.61	0.00	0.06
6	34	1.21	0.11	0.02	2.68
7	53	1.14	0.22	0.10	0.94
8	38	1.90	0.00	0.01	2.29
9	45	1.54	0.01	0.06	0.72
ALL	331	1.38	0.29	0.06	1.23

(3) Average Size of Farm Lands by Ecological Niche of Residence

The profile of farmlands also changes according to a household's residence within a given ecological niche (Figure 10.7)[7]. In waalo areas, for example, an average farm cultivates more falo (0.14 ha) and more irrigation than the global average. In the jeejegol, the profile of the average farm is very close to that of the global average with the difference that here the household is not engaged in falo cultivation. The profile of the average jeeri farm is distinguished from the others by very little irrigation (0.03 ha), and a complete absence of falo. An interesting point, however, is that the average farm in each ecological niche cultivates the same amount of waalo, about 0.70 ha, in an average flood year.

[7] The correspondence between ecological niche of residence (i.e., waalo, jeejegol, jeeri) and production system engaged in (waalo and falo recession farming, irrigation, and rainfed jeeri-foonde cultivation) should not be confused here. All production activities are not necessarily found within a given ecological niche. Rather, smallholders must often leave their zone of residence seasonally in order to carry out farming activities located in another zone (e.g., jeeri inhabitants cultivating waalo fields and irrigated parcels in the waalo zone).

Fig. 10.6. Average Access to Cultivated Farmlands by PS: 1991-1992 (ha)

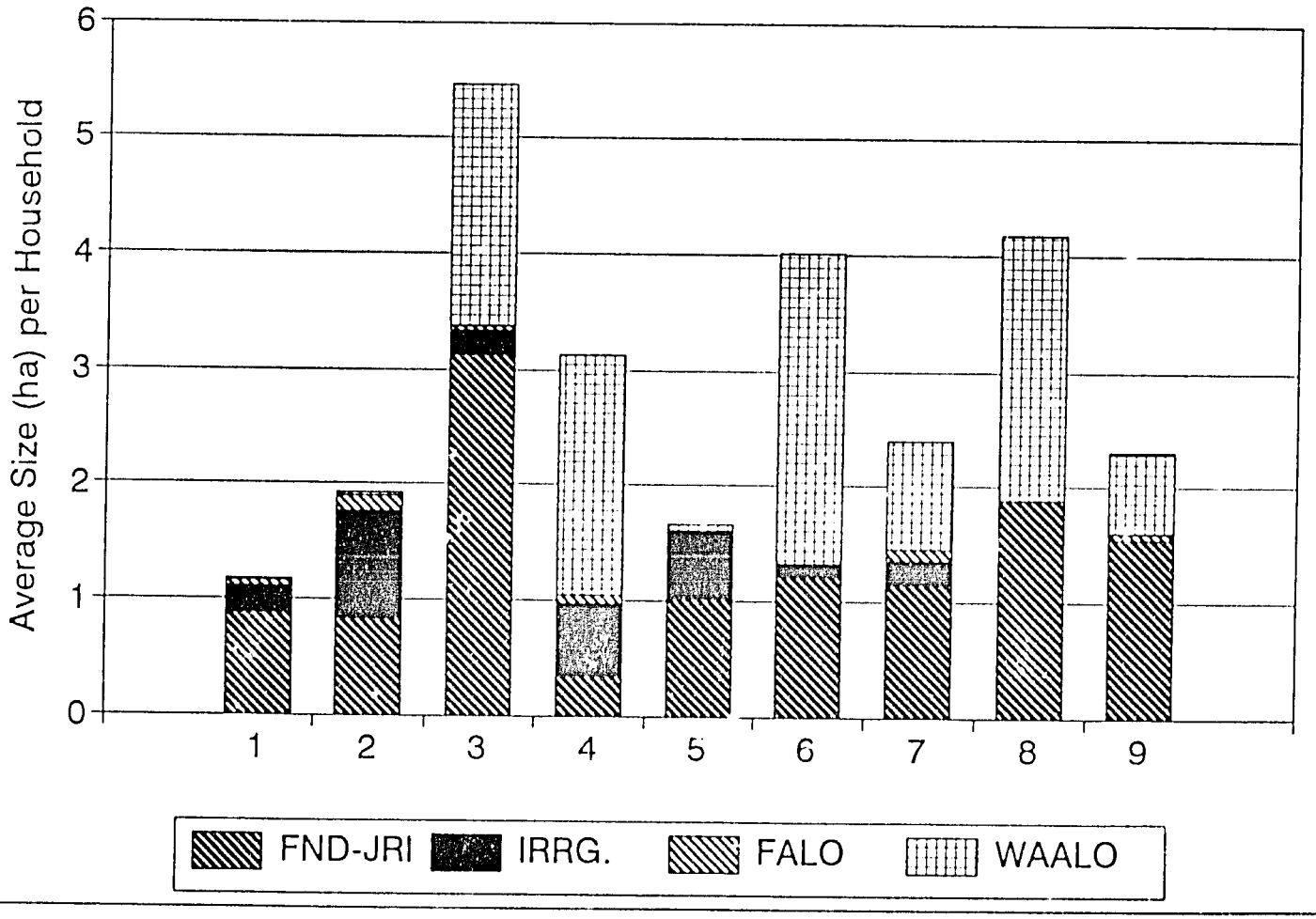


Fig. 10.7. Access to Agricultural Systems by Ecological Niche

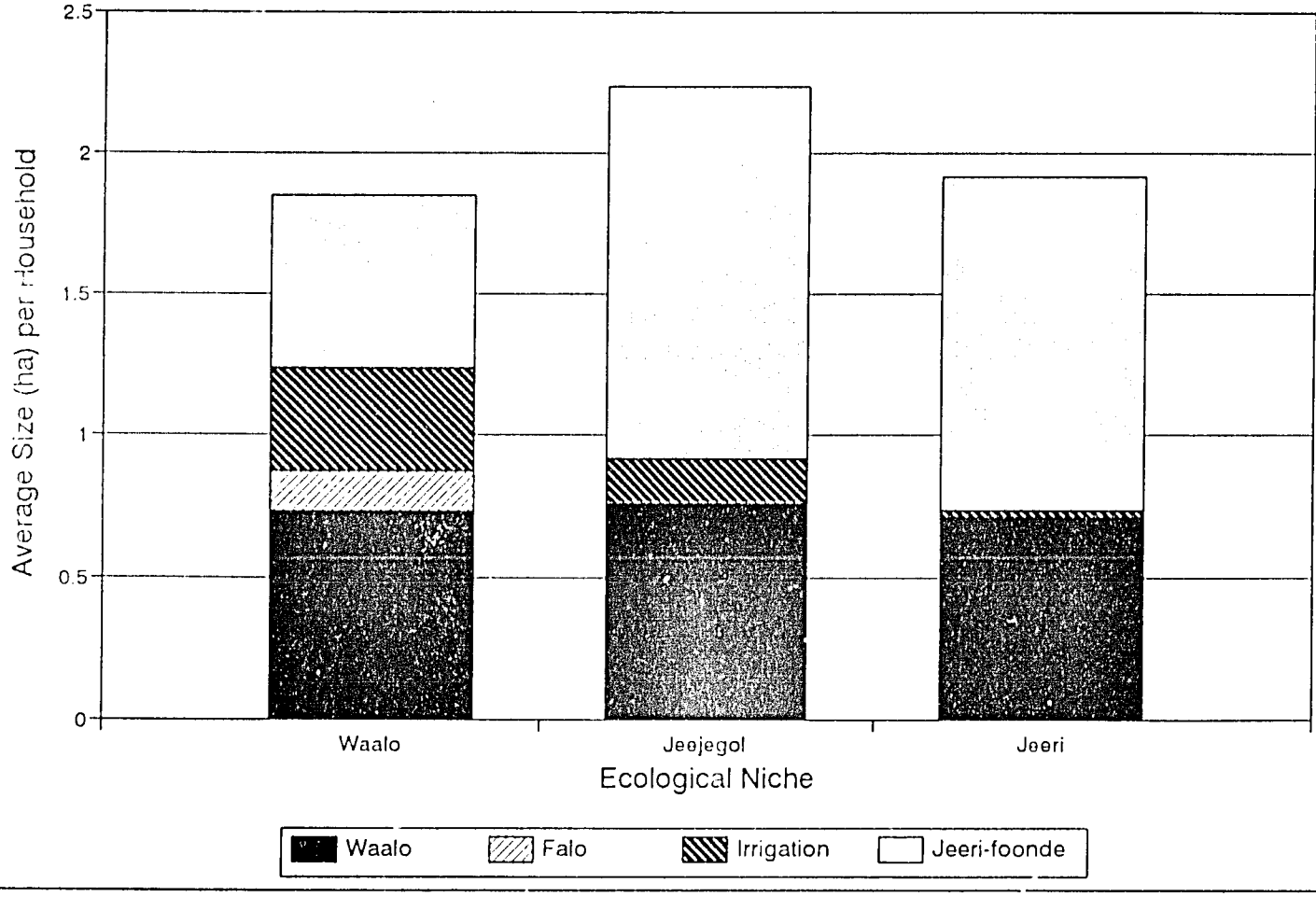


Fig. 10.8. Access to the Agricultural Systems in Jeeri Sites

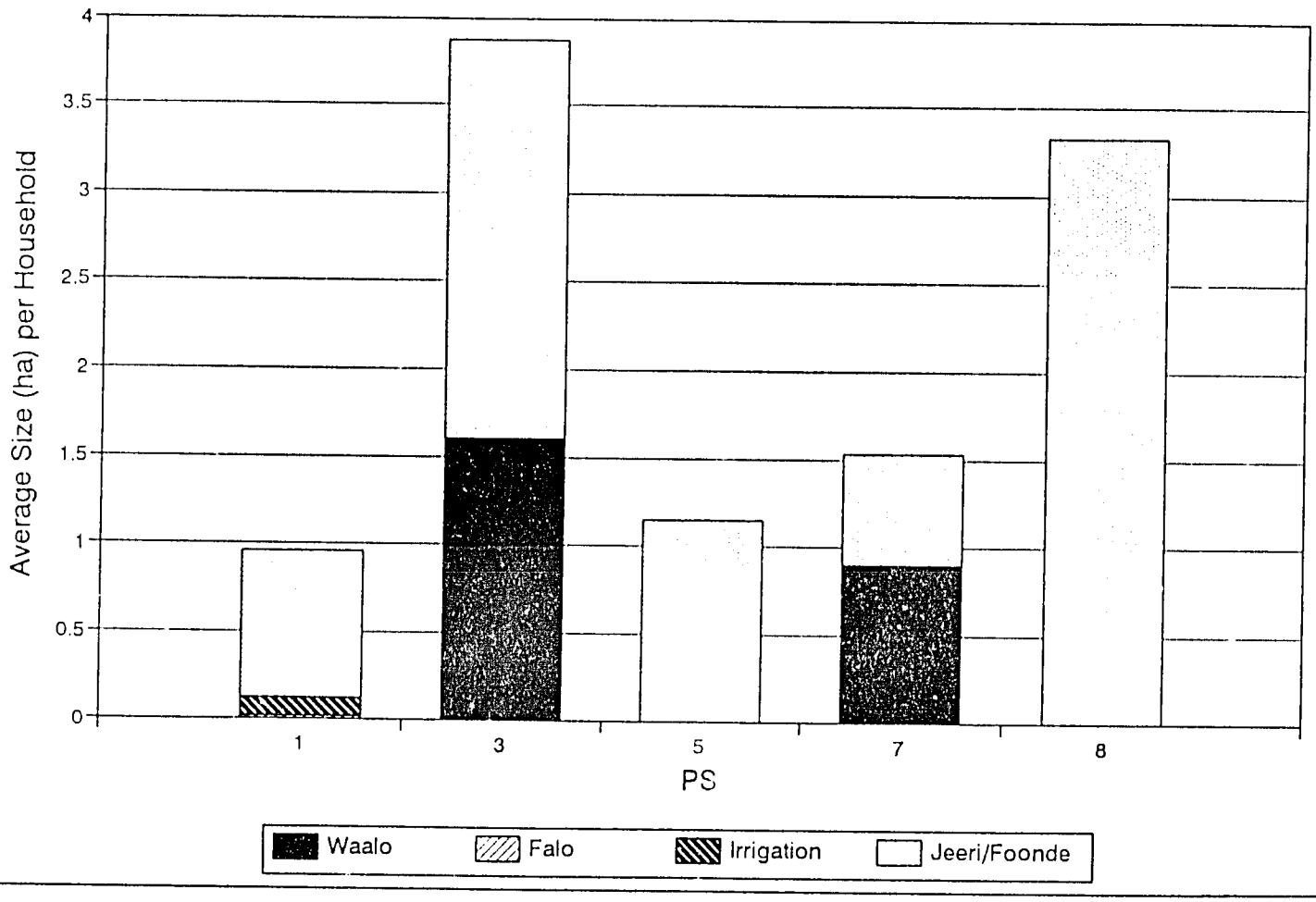


Fig.10.9. Access to Agricultural Systems in Jeejegol Sites

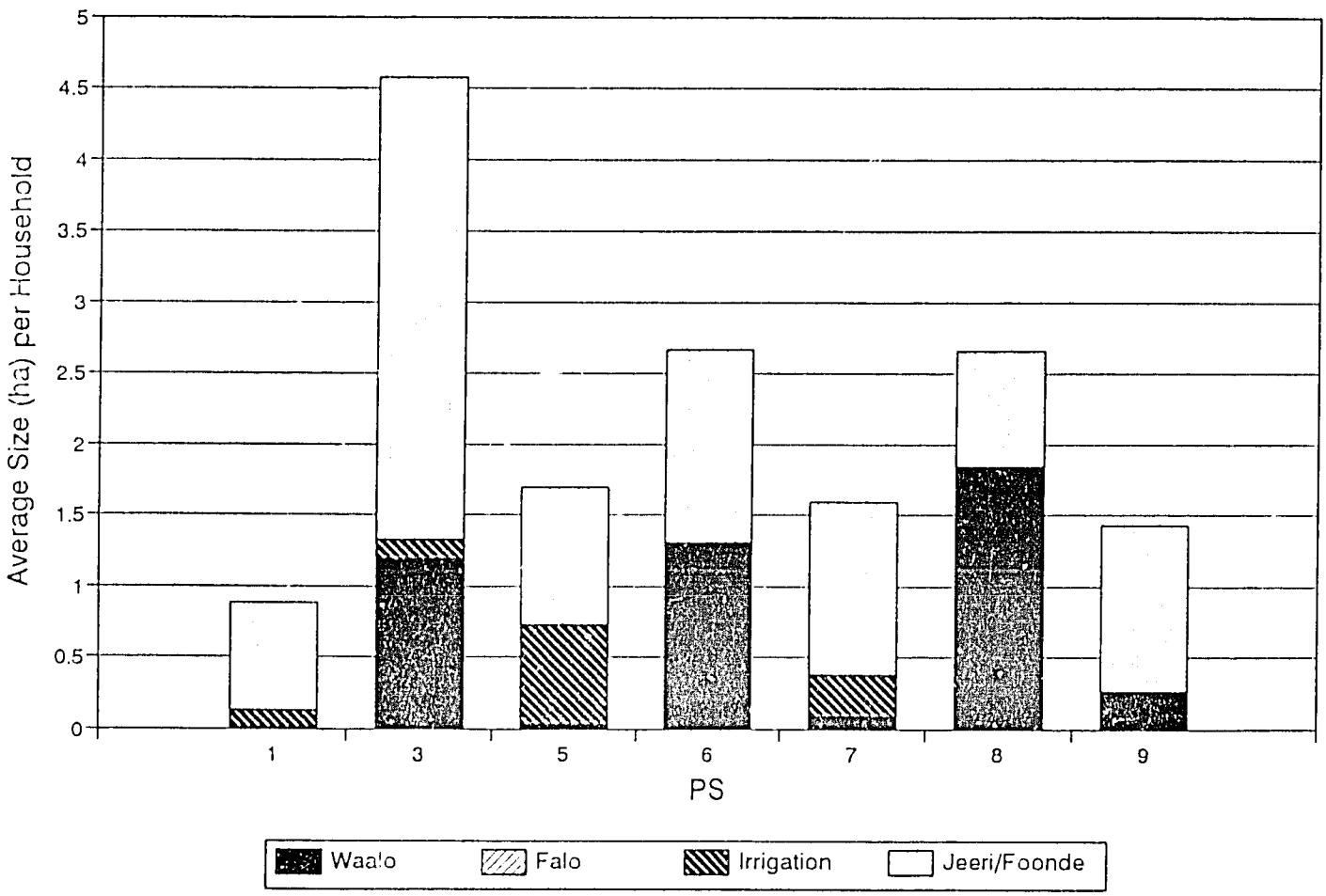
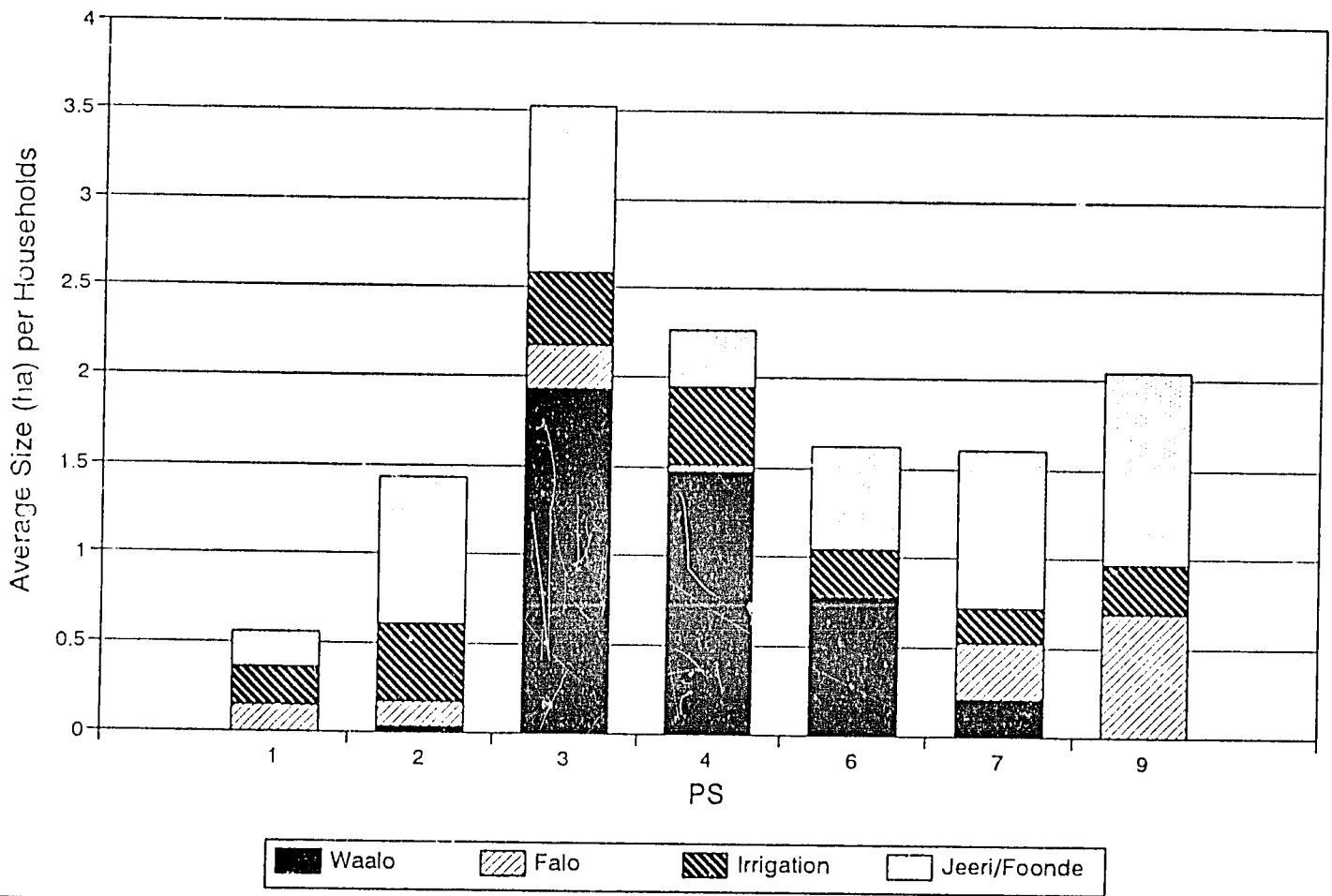


Fig. 10.10. Access to Agricultural Systems in Waalo Sites



b. Fishing

(1) Fishing in a No-Flood Context

Since fishing depends as much on the annual flood as does recession cultivation, in a no-flood year such as 1990-1991, fishermen have very little recourse. The monitoring done in Mbakhna Less, a village traditionally very active in fishing, shows how badly injured this activity was by a no-flood scenario. The method used was to follow the activities of ten village fishermen who volunteered their services, and weigh their daily fish catch. Accordingly, we cannot say that we have a representative sample. On the contrary: the fishermen with whom we worked, as signalled by their readiness to volunteer to participate in the study, were very enthusiastic fishermen who collaborated closely with the research assistant based in this village, and gladly brought in their daily catch to be weighed. In a normal year this would have much more cumbersome since fishermen move frequently, and for various lengths of time, to various marigots and cuvettes, and along the Diamel, in pursuit of their profession. In this year, fishing remained local and the RA was able to monitor them on a continuing basis.

Table 10.5. Quantities of Fish Caught between July and November 1990 (10 households monitored in Mbakhna Less)

Hh. Code	1.1	10.1	12.1	14.1	25.1	32.1	35.1	42.1	44.1	44.2	Total
Date											
7/20					4.00	6.00					10.00
7/31			5.50		6.50	6.50					18.50
8/10	0.75	12.00	15.00	1.00				2.75			31.50
8/20			7.50		6.00	1.25		2.50			17.25
8/31	4.25	11.25	13.50	8.50	4.50	10.50	34.25	7.50		10.00	104.25
9/10			14.50		4.00	3.75	8.00	13.00		4.00	47.25
9/20	3.00	7.50	6.00					26.50	15.00	15.00	73.00
9/30	18.50					5.00	20.00		5.50	20.00	69.00
10/10		28.75				4.00	6.50		4.00	32.75	76.00
10/20						6.00	12.75	7.75	21.25	9.75	57.50
10/31	5.00					8.00	11.25	29.25		8.25	61.75
11/10	3.00					8.75	7.75	20.00		10.75	50.25
11/20						3.75	10.00	8.00			21.75
Total	16.00	78.00	62.00	9.50	25.00	63.50	110.50	117.25	45.75	110.50	638.00

As we see in the Table 10.5, the evolution of the quantity of fish caught corresponds perfectly with the regime of the Diamel. It was during the last 10 days of August that the fish catch was at its maximum

(104.25 kg). It was also during this period that the largest group of village fishermen decided to become part of the monitored group (9 out of 10).

(2) Fishing in a Year of Average Flood

Please see Chapter 4.

(3) Household Revenues from Fishing Activities

Please see Chapter 8.

c. Herding

Here, access to animals was determined in the same manner as access to land. Hence, access refers to all animals managed, whether owned or consigned by others to be managed. According to the classification of the PSs, as with the analysis of access to land, we note the following in the animal domain:

- In areas dominated exclusively by recession cultivation and irrigation, access to animals is weak, compared to the overall average of 4 cows and 11 small ruminants per households.

- In areas that practices mixed agriculture, herding of small ruminants is preponderant.

- In the areas where irrigation and recession cultivation is weak, the level of access to animal is very high. In these area, partially to compensate for low agricultural revenues, cattle herding is very important.

Table 10.6. Access to Livestock, by PS

PS	Number of Households	Number of Bovines	Bovines per Household	Number of Small Ruminants	Small Ruminants per Household
1	32	142	4	299	9
2	25	42	2	302	12
3	37	114	3	561	15
4	32	67	2	675	21
5	37	273	7	677	18
6	34	68	2	222	7
7	53	172	3	496	9
8	38	52	1	226	6
9	47	293	6	285	6
Total	335	1,223	4	3,743	11

Herding of small ruminants, especially of ovines, easily commercialized in the course of ceremonies such as Tabaski, seem to be particularly adapted to a situation of diversified agriculture. Even in stalling animals, households can find pretty good forage throughout the year: green forage in the rainy season and jeeri harvest residues in October, canal herbs and grasses and irrigated perimeter harvest residues between November and January, and waalo and falo harvest residues between February and April and at the beginning of the rainy season. It is perhaps for these reasons that herding of small ruminants is more active in the PSs that enjoy a more diversified production system.

d. Irrigation as a Limited Alternative

In the aftermath of the absence of flood in 1990 and the rumors that this fact generated, OMVS issued a note to appease the anxieties of people, suggesting that off-season irrigation would compensate for earnings lost from the absence of flood. Comparing waalo and irrigation average production per hectare on the basis of 400 kg of sorghum for waalo, as opposed to 4,000 kg of paddy rice for irrigation—in other words, a 1 to 10 ratio—that note estimates that the 50,000 ha of waalo that would have been inundated were they able to have a type "A" flood (2,500 m^3/s) could be compensated by 1,000 ha under irrigation. Since the rainy irrigation season was already too far along to absorb this, these "1,000" ha would have to be cultivated in the off-season.

In addition to the interannual adjustments that households make between recession cultivation, rainfed farming, and irrigation, one supposes that the failure of traditional agriculture is translated automatically into a serious effort to compensate for cereal deficits created by a failed season by increasing the off-season hectarage cultivated, especially in the hot off-season. The note that was written by the OMVS following the decision not to release from Manantali enough water to inundate part of the waalo lands, might explain how easily managers arrived at this decision, thinking that the lack of flood would be easily compensated for by off-season cultivation. The OMVS departs from the assumption that, had water been released, it would have been for the generation of a type "A" flood that corresponds to a hectarage of 50,000 for an estimated harvest of 400 kg per hectare, and assumes that another 5,000 supplementary ha of rice, with an average production of 4,000 kg of paddy per hectare, be put under cultivation in the off-dry season to compensate for lost earnings. Even though all evidence (awaiting the statistics of SAED), indicate that the area cultivated that year in the hot off-season appears to have been higher than in the two preceding years, a number of observations can be made in terms of the possibility of adopting this measure as a solution.

- to become an acceptable alternative to the absence of flood, off-season irrigation has to be able to compensate all households who lose earning because of the absence of flood, including fishermen, and at all levels: the region, the PS, the village, and the household.

- For households with access to irrigated parcels to be able to adopt this strategy, it is important that offseason irrigation does not conflict with the fashion in which

household labor is managed, including the ability to migrate, at least without interfering too much in migration behavior, especially long-term migration.

In 1991-1992, it appears that the ratio of hot off-season irrigation hectarage, compared to that on the waalo, was very low throughout the area (see Table 10.7). The only exceptions are PSs 1 and 2, which did not cultivate the waalo. For this idea of compensation to work in reality, the area under hot off-season irrigation has to be increased to 10 percent of that under waalo, which does not seem very likely.

Table 10.7. Ratio of Off-Season (Hot) Irrigation to (1) Waalo; (2) Total Recession

PS	Ratio of Off-Season Hot ha to Waalo ha	Recession 1991-92	Ratio of Off-Season Hot ha to Recession ha
1	0.00	NA	NA
2	37.21	NA	NA
3	0.00	NA	NA
4	0.10	NA	NA
5	0.00	NA	NA
6	0.00	NA	NA
7	2.81	NA	NA
8	0.00	NA	NA
9	0.00	NA	NA
Total	0.78	NA	NA

In all cases where the CSC (off-season [hot]) area in 1992 did not compensate for waalo or recession cultivation, we assume that an adequate compensation must be at least 10 percent:

(1) 1 ha CSC compensates for 10 ha waalo;

(2) 1 ha falo equals 10 ha waalo.

n.b.: In PS 5, recession agriculture is insignificant, even though not only CSC irrigated culture is practiced there.

G. Conclusions

The impact of the rainfall deficit and the absence of flood on households, despite their very responsive diversification of the sources of their revenues, is explained by the constraints imposed by the agricultural calendar. The margin for manoeuvering that farmers have is very narrow. At the same time, the fragility of the household economy partly stems from the strong inter-dependence among local sources of revenue: agriculture, fishing, and herding. This is perhaps the reason why migration becomes an obligatory strategy for all domestic units. Because of communication problems between decision makers and beneficiaries, the dams have served to increase and multiply uncertainties in a milieu where nature is already capricious enough.

Emigration remains the most important recourse that the population can follow when faced with disaster. Creating heavy demographic losses, emigration is a common characteristic throughout the entire Middle Valley. Contrary to appearances, the rate of emigration in the Department of Matam is not higher than that in Podor. Both departments suffer in the same degree from painful labor shortages, especially shortages of men.

It is rather the typology of migration that distinguishes the downstream Middle Valley from the upstream area. In Podor, emigration is national while in Matam it is instead international: directed toward other parts of Africa and Europe. This difference in the destination of migrants is combined with a difference in the economic status of migrants. Migrants established outside of Senegal suffer much less pressure than those who live in the country. The infrastructural transformations that one sees in Fuuta villages is come from the migrants referred to as "Afriquenaabe," or migrants to other African countries, or "France-naabe," migrants to France, other European countries, and the United States. These infrastructural transformations, especially with regard to social investments such as health centers, schools, markets, and deep wells and buildings are far more numerous in the Department of Matam than in Podor.

National migration is frequently a seasonal movement that is controlled by the agricultural calendar in the Valley. The outflow and inflow of seasonal labor varies, depending on locality. Moreover, their periodicity and volume is, in general, a function of agricultural labor demands, the need to satisfy basic needs at the local level, and the need to control the pressure on households' cereal reserves. The only justification that permits keeping active labor in the village throughout the year is strong agricultural diversification between irrigation and recession cultivation.

Irrigation that can be called upon to reduce risks related to deficit rainfall or flood does not yet play a role comparable to that of migration. Identifying different types of average farms shows that the idea of compensating for the loss of potential revenues from recession cultivation by resorting to irrigation, particularly in the off-season, is difficult to translate into reality. Because of their varied locations, upstream or downstream from the river, in the waalo or in the jeeri, households and farms have unequal access to waalo and falo cultivation. Their access to irrigation is regulated also by these same factors, in addition to other economic and sociological considerations.

Preliminary analyses of access to land show that recession cultivation remains far from being relegated to secondary importance even though there has been a dazzling development of irrigation in the course of the last few years. The importance of the waalo in village economies explains peoples' attachment to this system of production and the great anxieties they feel about the future, which, in their eyes, has become even more uncertain because of the Manantali Dam.

For the time being and for many years to come, irrigation cannot, for the majority of households in the Middle Valley, compensate for recession cultivation. Future management of the Manantali Dam should take this reality into account.

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GLOSSARY

A:

aada	custom(s)
aalmaami	imam or prayer leader; head of the theocratic state of the Fuuta Tooro after the Tooroodo Revolution of 1776
aawde	to plant
almuudo (pl. almubbe, talibe)	student of a marabout
amo	a heavy flood inundating foonde as well as waalo lands
anja-njaara	a type of hand-held fishing net attached to small poles and manipulated in shallow waters
arano	first weeding
ardo	title held by the chief of certain Fulbe tribes or families
asakal	a religious tithe paid to the joom leydi and given to the poor. This tithe applies also to herds and estates, but the percentage is not the same as for crops
asakal diine	Islamic tithe representing a tenth of the harvest
asbugol	census of goods and, by extension, the portion that is allotted to the person who renders decisions concerning inheritance
askude	giving of tithes and prestations to the poor
awde or awdi	planting

B:

bajaal	cutting tree branches (to feed herds)
ballal	help, in the general sense of the word
ballongiral	reciprocal help

Bambara	Mande peoples from western Mali (Kaarta and Segu)
bammbaado (pl. wammbaabe)	Fulbe griot caste (musicians and genealogists)
barba	title held by the king of the Jolof. It signifies "the king" or "the king of kings" because he rules over other kings
baatu	meeting
baylo (pl. wayilbe)	blacksmith caste
bayti	state lands; "land of the Muslim community"; land located between lands held by two feuding factions of a family and taken over by the joom leydi
bekkugol	covering up; either a young child or an elder places a small handful of sand in a planting hole to protect the seeds from insects
belweldi	kind of grass, good for milk cows
beyaat	second weeding
bidaan	white Moor
biirde	to milk
biir gawoowo	an agricultural week that goes from Saturday to Wednesday
birnajo	gorwori
boowol	open spaces
burnajo (pl. burnaabe)	potter: subgroup of the Sebbe (freemen), specializing in pottery

C:

caambal	gulnet
caangol (pl. caalli)	thalweg, a valley filled only during the flood

cakry	a dish made from samme (sorghum flour), sugar, and sour milk
caatal	gift representing a portion of the harvest given to individuals who have not cultivated
capaato (pl. safalbe)	referring to Moors
ceddo (pl. sebbe)	former warrior caste (free men)
ceedu	the hot, dry season
cengalaal	traditional woven baskets
ceerno	religious teacher/leader; marabout
ciifol	field, plot of land
ciifol bottaari	small plot lent free of charge by the joom ngesa to a sharecropper practicing the rem peccen didabal
coggu	rent paid in kind for land for one to two years in the waalo
cokde	annual closing of fishing rights in the river, which takes place near the end of the cold season, usually in January or February
coktal (pl. cokte)	opening of the period of communal fishing undertaken from luggere to luggere, upstream to downstream along the river
conyal (or cona)	harvest
cootiigu	the right paid by a man to claim his father's right to cultivate a field
cuballo (pl. subalbe)	caste of fishermen (free men)

D:

daande maayo	secondary riverbed, bounded by steep banks

dabbunde	the cold season between December and March
dassiri	to remove weeds and thorny plants
dawol	collective labor; half-day of work (from about 9 AM to 2 PM)
dawol fedde	labor carried out by an age grade
dawol kaaliss	collective labor; a half-day of work (from about 9 AM to 2 PM)
dawol sonnes	collective labor carried out by young people
deedal (pl. deede)	the lowest lands in the waalo
deenal	guarding against predators other than birds (monkeys, wild boars, etc.)
deeniyanke (pl. deeniyankoobe)	family of the former rulers of the Fuuta
demal	general term for weeding
demoowo (pl. remoobe)	farmer
demoowo lubal	cultivator who has been lent a field free of charge by the joom ngesa
demoowo rem peccen	sharecropper
dende	watermelon
der dera	fields situated in the interior of the kolangal
desndaadi	cattle cared for by another member of the family
diacre	sandy-clayey soil of the waalo
dimgal	transport
dimo (pl. rimbe)	noble caste (free men)
diokkere	financial aid practiced within the extended family

dobale	small measure of the sorghum harvest, apportioned as remuneration for women's field labor and as social prestations
dooftade	plant thinning
doftal	unpaid work day on the land of another farmer
doftal esiraado	help organized by a prospective son-in-law and undertaken by his age grade for his future father-in-law
doftal giyiraabe	help in the form of labor that an entire age grade performs for the family of one of its members (in case of death, for example)
dokkal pandungal	a field (ngesa) given as a permanent gift by the joom leydi
dolinge	fishhooks
donaadi	cattle received as an inheritance
dôoftade	thinning
dôoftagol	thinning
doppere	clay
dowrowal (pl. dowrowe)	lands located at the highest elevations in the waalo
duggitaade	light clearing of land by removing stubble from the previous season
dumel (pl. damel'en)	title held by Sebbe or Subalbe dignitaries
duppude	to burn; burning of light brush
duwaari	benediction
duyru	type of fishing net attached to small poles that are manipulated by hand in shallow waters

E:

elimaan	imam (prayer leader). The term now refers to the temporal title given to certain landowners

F:

falmapel	a kind of fishnet
falo (pl. pale)	agricultural recession lands located on the banks of the river
farba	title held by the chiefs of various Sebbe clans
fedde (pl. perle)	groups of girls or boys of the same age
fela	variety of sorghum
femmbirge	a female animal presented as a gift to a newborn child at its first ritual shaving, when the child is named (a type of preinheritance)
ferlo	land area, used largely as pasture
follere	sorrel
foonde (pl. poode)	river banks traditionally devoted to rainfed agriculture, now often developed as PIVs; foonde soils fall into three groups: foonde rannere, foonde balleere, and foonde wallere
fooyre (pl. pooye)	household
Fulbe Feroobe	Fulbe clan
Fulbe Ururbe	Fulbe clan, especially well-represented in the Fuuta Tooro
Fulbe Yaalalbe	Fulbe clan
Fuuta	a generic term referring to the Fulbe country
Fuuta Jallon	a mountain in Guinea, inhabited by the Fulbe and the Jallonke, site of the sources of the Senegal, Niger, and Gambia Rivers

Fuuta Tooro	Middle Valley of the Senegal River, formerly called the Tekrur
Fuutanke (pl. Fuutankobe)	inhabitant of the Fuuta

G:

gaawgol	planting
galle (pl. galleeji)	all the pooye in a compound; households occupying one fenced-in area; fence surrounding a field
gambol	small dams constructed of layers of mud between which trapped water is bailed out until only fish remain
garbaari tokosiri	bull
gawlo (pl. awlube)	caste of griots, musicians, genealogists, and keepers of the oral tradition
gawoowo (pl. awoobe)	fisherman (freeman)
gawri ndiyamiri	finger millet, including the Suuna and Saanyo varieties
gaylinké	a herder who cares for animals belonging to other people
gaynaako (pl. aynaabe)	herder
geerngal	the bulk of the sorghum harvest, set aside in a large central area of the field, for field owners and cultivators
geernude	placing of sorghum into large mounds for distribution
gesa mangu	field on joowre land taken over by the mawdo lenyol/mawdo galle for cultivation
gedal mangu	the portion of asakal amassed from rented joowre land and given to the mawdo lenyal

goniakie (gawdi; pl. gawduule)	acacia nilotica
gool (pl. gooleeji)	a young unweaned male or female animal (a bull calf or a heifer)
gooyol (pl. gooji)	the stalks and leaves of the cowpea
gorwori	part of a herd belonging to the head of the household
gubbol	gill nets for fishing
gummbaala	a traditional chant or song

H:

haacoonde	a weed found in the waalo
haako	refers to leaves eaten in the form of a sauce (e.g., cowpea leaves)
Haal Pulaar (pl. Haal Pulaaren)	Fulani, a Pulaar speaker
hadday	alm in cash or in kind
hamdar	a measure, about 3 kilograms
haange	cow
haw hawo	weeding undertaken before planting
hinde	a gift, usually to lower castes or neighbor, given during ceremonies
hiwde	frightening of birds by noise
hollalde	very heavy clay soils of the waalo
huudiadi	a sum of money that the groom gives to the age grade of the bride
hurnaade	warding off birds

I:

itita	fields located on the edge of the floodplain

J:

jaagaraaf	traditional collector of land use fees, now tax collector
jaasi	machete
jaawando (pl. jaawambe)	a Torrobbe's political advisor
jabbere	to sow fields; to hoe
jabbube	turning the soil
jacere	a kind of weed that animals cannot digest, found in the kollade after the flood
jagodin (pl. jabodin'en)	title held by Sebbe dignitaries
jaltaabe	chief fisherman (Cuballo), water use administrator
jambere (pl. jambe)	axe
jatiytaade	light weeding by hand
jawli kofe	type of fishing net attached to small poles that are manipulated by hand in shallow waters
jeejegol	intermediate zone between the jeeri and the waalo
jeeri	rainfed agricultural land, usually sandy or clayey-sandy
jeewo	a man's first wife
jeyngol	fire
jiggoore	the acquisition of wholesale grain for food

jiine	spirits
jolirde	cattle paths (on the foonde) that access the river
joltoobe (jolal) waalo	a seasonal migrant who returns to his home region to cultivate the waalo
jomiraabe	parcel owners
jontannde	rotation of cultivation rights on joowre lands
joom (pl. jomiraabe)	master
joom galle	chief of the galle, the family compound
joom ganndal	master of knowledge; land owner through receipt of plots of land donated to him as thanks for services performed
joom jambere	owner of land obtained through clearing by axe
joom jeyngo	owner of land obtained through clearing by fire
joom lewre	owner of land obtained through clearing by machete
joom leydi	master of the land/agriculture/territory
joom ngesa	master of the field (owner)
joom sareet	owner of a (horse-drawn) cart
joom wuro	village chief
joowre	lands held communally
jumtinaadi	part of a woman's herd given to her married son and subtracted from his future inheritance
juurgal	a gift to lower castes
juude	river crossings
juuwde	to cross a river

K:

kawule	the second (short) fishing season in October and November
kirwal	period of guarding against birds, which takes place late in the season when sorghum ripens
kodu	a meal offered by villagers to a passing stranger
kodungu	a celebration, often accompanied by the slaughter of a lamb to honor a visitor to the village
kolangal (pl. kolaade)	recession cuvette/depression
koliyaabe	clan of Sebbe associated with the Deeniyanke family
koolaado (pl. hoolabe)	confidant; refers sometimes to the title held by certain Fulbe dignitaries close to the Ardo
kordo	captive
koreeji	a very intimate term used for close relatives or those persons perceived as such
korite	the feast celebrated at the end of Ramadan
kowgol	construction of a protective fence around a house or a field
kumal	a religious ceremony
kurnal (pl. kuurne)	period of guarding against birds when sorghum matures
kurtordi	a gift of cattle given to a bride by her parents on the occasion of her marriage

L:

labbo (pl. lawbe)	caste of artisans who specialize in woodworking

laamdo fedde	the chief of fedde
lana	dugout canoe
laare	the place were young people gather to eat without age distinctions (fedde)
lappol (pl. lappi)	cattle path located along the cultivated fields
lawake (pl. lawakoobe)	those who exercise or who are called upon to exercise political power; associated with Deeniyanke power
leegal (pl. leede)	neighborhood (of a village)
lelnde	a ceremony organized upon the remarriage of a divorced woman
lembel	a man's second wife
lenyol	lineage, family, tribe
lewre	field preparation; newly cleared land; clearing; machete
lewre bottaari	plot reserved for payment in lieu of food
lewtade	extensive clearing of land formerly in long-term fallow
lewtu ngesa	temporary cultivation rights obtained by clearing a plot of land belonging to another person
leydi (pl. leyde)	agricultural land; landholdings
lirde	drying of sorghum in the fields
lorngo	transplanting
lorwa	guarding against birds that takes place late in the season when sorghum matures
lowre	a plot of land in a field

lotunde	warding off birds with slings
lubal	a loan
luude	placing the hole (during planting on the waalo)
lugal	a pointed stick used to make a hole in the earth in which seeds are planted
luggere (pl. lugge)	area of deep water, good for fishing; fishing hole; a river branch that cannot be forded
lulnde	guarding fields through continual surveillance
luugol	the act of digging a planting hole for seeds

M:

maabo (pl. maabube)	weaver caste
maccudo (pl. maccube)	(former) slave caste
mawdo galle	the oldest member of a galle
mawdo lenyol	the oldest member of a lineage
mbaatu	a disease that causes dwarfing in plants
mbalde	a grass known for its positive milk yields
mballa	rainfed cultivated foonde land
mbargu	a method of constructing dams to catch fish
mbereeji	cattle entrusted to the care of a person who is not a member of the family
mbolo-jofnde	a kind of fishnet

miskiino (pl. miskineebe)	poor people; needy individuals who are given a share of the asakal
mjoldi	a fee paid when work begins in the waalo
munu (pl. munuuji)	river spirit
muudo (pl. muudi)	a measure varying between 3 and 3.5 liters, equivalent to approximately 4 kg of grain
muudo horma	"muudo of protection"; tribute paid in kind by the inhabitants of the Fuuta to the Moorish emirs (Trarza and Brakna), which dates back to the 17th century. This tribute is taken off the asakal.

N:

nafoore	a good deed or large gift given by the prospective groom to his fiancée's mother
nattinde	transport of harvest to the village
nayeeri	old bull
ndennal	a period of general surveillance against such animals as monkeys and wild boars beginning just after the crops have begun to grow
ndiyamiri	millet, finger millet
ndoodi	tribute paid by the joom ngesa to a central power considered to be the eminent master of the land
ndungu	the short and unpredictable rainy season in the middle or at the end of June
nduumtaaji jeeri	migrants returning to cultivate the jeeri
ngaabu (pl. gaabi)	a hole; a very shallow well providing access to the surface water table
ngaari kalhaldi	breeder bull

ngaari tokoriri	young bull
ngedu	a gift of meats offered to close relatives during the feasts of Tabaski and Korite
ngesa (pl. gese)	field
ngesa cukka	in the case of the joowre, a plot allotted to a junior
ngesa laamu	state fields (used for irrigated perimeters)
ngesa mangu	a field taken over by the oldest person in the case of the joowre
ngesa nguurduba (pl. gese guurdude)	a field allotted to the head of a household so that he may provide for his family
ngesa suudeewa	a field that is transferred from the joowre to family use
njaytam	the remounting of the river
njeylaari (pl. jeylaaje)	a waalo field taken from the joowre and allotted to circumcised single men of the lenyol
njiimandi	lands extracted from the large domains of the aimamyat that is managed by the Almamy in the name of the Islamic community and given to those close to the theocratic regime
njinn danngu	long-handled hoe
njobdi	daily wage laborer
niebe	cowpeas
nyaayko	sorghum stalks and leaves
nyaayngal	opening of the waalo to herds after the harvest
nyale	a three-year-old weaned cow

nyeenyo (pl. nyeenybe)	a caste composed of artisans including: maabube (sing. maabo), weavers; wayilbe (sing. baylo), blacksmiths and silversmiths; lawbe (sing. labbo), wood-workers; burbaane (sing. burnajo), potters; awlube (sing. gawlo), griots, musicians, genealogists, and entertainers
nyendiko	a variety of rainfed sorghum
nyippere	a type of weed found in the waalo
nyobdi	salary, payment for work

Q:

P:

pale	falo field
parka	a method of constructing dams in order to catch fish
pullo (pl. fulbe)	Fulani (herder); free caste, descendants of the first inhabitants of the Fuuta
purdi jorngal	large, black-grained sorghum
pusam	a destructive flood

Q:

querool (pl. queeri)	small mounds denoting the boundaries of plots

R:

raddo jooke	communal hunting during flooding
rakal	animal feed purchased by herders during drought years

rasde	gathering and burning of weeds and debris
remde	heavy weeding
rem bamaa = rem nawaa	loan of agricultural lands, or a field lent free of charge
rem itaa giye	see "lewtu ngesa"
remooru (pl. remoobe)	farmer
rem peccen	sharecropping
rem peccen didabal	sharecropping where half of the harvest is paid in rent to the joom ngesa
rem peccen tatabal	sharecropping where a third of the harvest is paid in rent to the joom ngesa
remru	weeding
riginy	old cow
rimbe (sing. dimo)	a caste of free men
robtude	separation of sorghum into small heaps
rumaano (pl. rumaanooji)	seasonal rainy season camp
rumtude jeeri	to return to cultivate the jeeri

S:

saanyo	a variety of finger millet
saatigi (pl. saatigi'en or saatigeebe)	title given to Deeniyankoobe kings and certain Sayboobe dignitaries
sadaake	segment of the herd belonging to the first wife

sakite	a particular type of caambal (gill nets) that is utilized in the floodplain and at the edge of a marsh where it is set at night and checked the following morning
sakkade	thorn barriers erected during the initial phases of clearing, used only in the kolaade nearest the village; construction of thorn fencing
sakke (pl. sakkeebe)	caste of leather workers
samba remooru	landless farmers; sharecroppers
samme	recession sorghum
samme baleejo	black samme
samme bodeejo	red samme
samme daneejo	white samme
samme sewii	smaller red- or white-grained sorghum whose taste and smell attract birds
samme yaki	another samme variety similar to black samme
samtardi	a grass known for its positive effect on milk yields
sanda	Koranic school pupils
sandareeje	the part of a herd belonging to a man's second wife
satindaade	agricultural labor paid in kind
sawa suuka	a variety of sorghum
sayboobe	class of Fulani warriors. This term is derived from the Arabic "as sahab" (companion) and refers to Fulbe warriors who accompany the saatigi
sebbe (sing. ceddo)	former warrior caste (free men)

seedaano (pl. seedaanooji)	dry-season camp
seeno	sandy land in the jeeri
seno	sand
siiwre	pasture grass found in the falo after the period of recession
sincu	a newly established neighborhood or a new village established with people from another village
soomde	covering of sorghum pinnacles for protection
sonde	removal of sorghum from stalks
sones	youth
soonyo	insufficient or nonexistent flood
soppitaade	annual clearing of light brush
soudure	the period just before harvest when most farm stocks have been exhausted
subalbe (sing. cuballo)	caste of fishermen (free men)
surkinde	smoking out of snakes, wild boars, etc., in waalo fields
suudu	house
suuna	a variety of finger millet

T:

tabaski	the Muslim feast celebrated at the end of the pilgrimage to Mecca
talibe	a Koranic student; follower of a marabout or religious leader
tatabo	third weeding
tati	three

teen (pl. teen'en)	title held by Subalbe dignitaries like those in Dounguel and Kaedi
tengne	dowry
tew	meat
tierno	religious teacher/leader; marabout
tiwaande	period of interdiction lasting until the opening of harvest, fishing, or the entry of herds onto fields. With the lifting of the tiwaande, all of these activities are permitted
tobaani ilaani	"no rain, no flood"
toggere (pl. togge)	elevated zones left unflooded, usually wooded, in the middle of a kolangal
tooroodo (pl. toorobbe)	marabout caste of free men; education specialists who took power in 1776
torndoogam	runoff waters
tuufan	sweetened sour milk
tufnde	access ramp to the river for people as well as cattle; port

U:

uddude	"to close the door": a period of very heavy fishing when villagers occupy strategic positions at the main tributaries on the plain to seine for fish swimming in canals toward the interior plain
uguude	siiwre root, used for incense

V:

W:

waala fenndo	the name used by the Haalpulaar to refer to France in general and to Paris in particular
waalo	recession land in the floodplain
wadde galle	to enclose behind a fence
wafdu	sickle
wallere ballere	very black, heavy clay soils in the most elevated zone of the falo
wallere ceenal	light, alluvial soil found at the lowest elevations in the falo or the waalo
wallere ranene	sandy alluvial soil found in the intermediate zone of the falo
waynaade	weed removal in flood waters
weccu beli	a widespread form of diking and bailing undertaken in drying ponds
weendu (pl. beeli)	pond
wekkude	covering the seed with sand (in waalo fields)
weynude	warding off birds with scarecrows
wiige	a cow older than three years that has not yet reproduced
wodaabe	large Fulbe clan inhabiting the Tooro and the waalo

X:

Y:

yamba	a hallucinogenic weed
yanga	a ceremony that takes place the second day of a marriage
yiyal	bone; part of a sacrificed animal given to the land owner

Z