

often demonstrated an enterprising spirit, initiating many activities of common benefit to the community. *African governments should identify these local initiatives, which represent true community participation, and support them without, however, altering them.*

The financial and logistical requirements of such an approach are minimal compared with the recurrent costs of the top-down strategies that have predominated until recently. Most important, this approach requires an awareness of the situation in the OCP areas and the political will to support the capacity of the communities to organize themselves and successfully carry out development activities that do not destroy the environment.

The role of nongovernmental organizations

There are many national NGOs that could contribute to the sustainable development of the OCP areas if they received the necessary material, financial, and technical support. To avoid aggravating conflict between the administrative authorities and the NGOs, donors could encourage governments to rely more on these organizations. But the most sustainable and least costly solution would be to support the traditional (or modern) forms of community organizations.

Environmental education

Stories about the origin of a village almost always reveal that the people settled at the site because it was rich in natural resources. The difference between the initial conditions and those that currently prevail often is clear to everyone in the community. But that awareness does not necessarily mean that the community will take actions to protect and preserve its resources. Environmental education—combined with income generating activities, particularly for the poorest—is critical to the sustainable settlement of the OCP areas.

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Capitalizing on Diversity: Women's Issues and Sustainable Development in the OCP River Basins

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Little has been written on women's issues in development planning under the Onchocerciasis Control Programme. Those studies that do exist focus on new settlers still in the initial stages of frontier development (Conti 1979; Guissou 1977; Phillott-Almeida 1985). One result has been a strong tendency for researchers to support Rogers' argument (1980) that the overall effects of new lands settlement and resettlement on women are quite negative (Guissou 1977; Murphy and Sprey 1980; Reyna 1983, 1986). But recent research by the Institute for Development Anthropology at the sixteen sites included in the OCP Land Settlement Review (figure 1; table 1) suggests that the situation is far more complex.¹ The case studies of these sites support Koenig's conclusion that in at least some cases, women are better off when the entire household is better off, even when their access to pre-resettlement resources and occupations has been compromised (forthcoming, p.21).

Although it is important to emphasize that not all new-lands settlement in the OCP river basins affects women negatively and that some new-lands settlement can affect them quite positively, it is equally important to counsel caution. That is because the shift from subsistence to more dynamic patterns of household income growth occurred at only six of the sixteen study sites: the Mo Plain and FED (Fonds Européens du Développement)-Agbassa settlements in Togo, the Autorité d'aménagement des vallées des Voltas (AVV), Komienga, and Solenzo settlements in Burkina Faso, and the Dioila settlement in Mali. Each of these sites involved an area in which donor and government policies had—either intentionally or unintentionally—provided basic services and infrastructure for the settlers moving in. Even then, the resulting development was not always sustainable. In each case in which this occurred, however, the early increase and then decline in women's income and living standards had less to do with their being women than with the overall effects of resettlement and new lands settlement on women.

Sites showing little evidence of growth in agricultural income for smallholders

The Ghana study sites

At none of the four study sites in Ghana (Red Volta Valley and Plateau, the Fumbisi Yagoba-Soo or "Over-

seas" region, the Damongo Planned Settlements, and the Tono Irrigation Scheme) in 1988 did the Ghana team find a single group of settlers that appeared to be increasing agricultural income through the use of either extensive or intensive cultivation methods. The chief reason was the extremely unfavorable policy environment in the decade before 1988 (Akwabi-Ameyaw 1990). With almost no access to improved technology or fertilizer, outside the Tono scheme, farmers attained very low yields and net agricultural incomes, and few households were able to move beyond basic subsistence.

Although the Tono settlers could purchase inputs like fertilizer through the parastatal FASCOM (Farmers Services Company), access to these inputs was constrained. All credit was tied to the Social Security Bank's assessment of the settlers' previous performance in the scheme. This credit assessment was made by the Social Security Bank in collaboration with the scheme management, ICOUR (the Irrigation Company of the Upper East Region). Since farmers were forced to reimburse their credits just after harvest, when farm gate prices were at their lowest, they could never be certain about how much they would earn. This insecure market made it risky for the average farm family to undertake a credit.

In the one major case in which the government attempted to aid spontaneous settlement in the Fumbisi Valley during the 1970s, unrealistic policies subsidized the crops of a small elite at the expense of the local population. The result was an increase in conflict, including the burning of crops. Then, when subsidies ended, the economic viability of these crops was undercut (Akwabi-Ameyaw 1990, pp. 67-68; McMillan, Painter, and Scudder 1992, p.26).

In certain ethnic groups, such as the Mamprussi and Dagomba, who cultivate only bush fields, women did not farm at all and did not even go to the bush to collect fuelwood for household use, these being men's responsibilities. Where women participated physically in the field operations, as in the Red Volta Valley, their activities focused on planting, weeding, and threshing. The chief exception was Frafra immigrant women around Bolgatanga and Damongo, who constituted the main agricultural work force for the urban-based commercial farmers (Akwabi-Ameyaw 1990, pp 91-92).

At all of the study sites in Ghana, women concentrated on domestic chores and developing what meager returns they could from trade. Trade was especially important at the research sites located near the trade centers of Fumbisi, "Overseas" and Damongo. Akwabi-Ameyaw argued that the strong emphasis on trade reflected the complete lack of opportunity for income growth in agriculture (personal communication, 1994). He stated that if opportunities were available, many women would take a

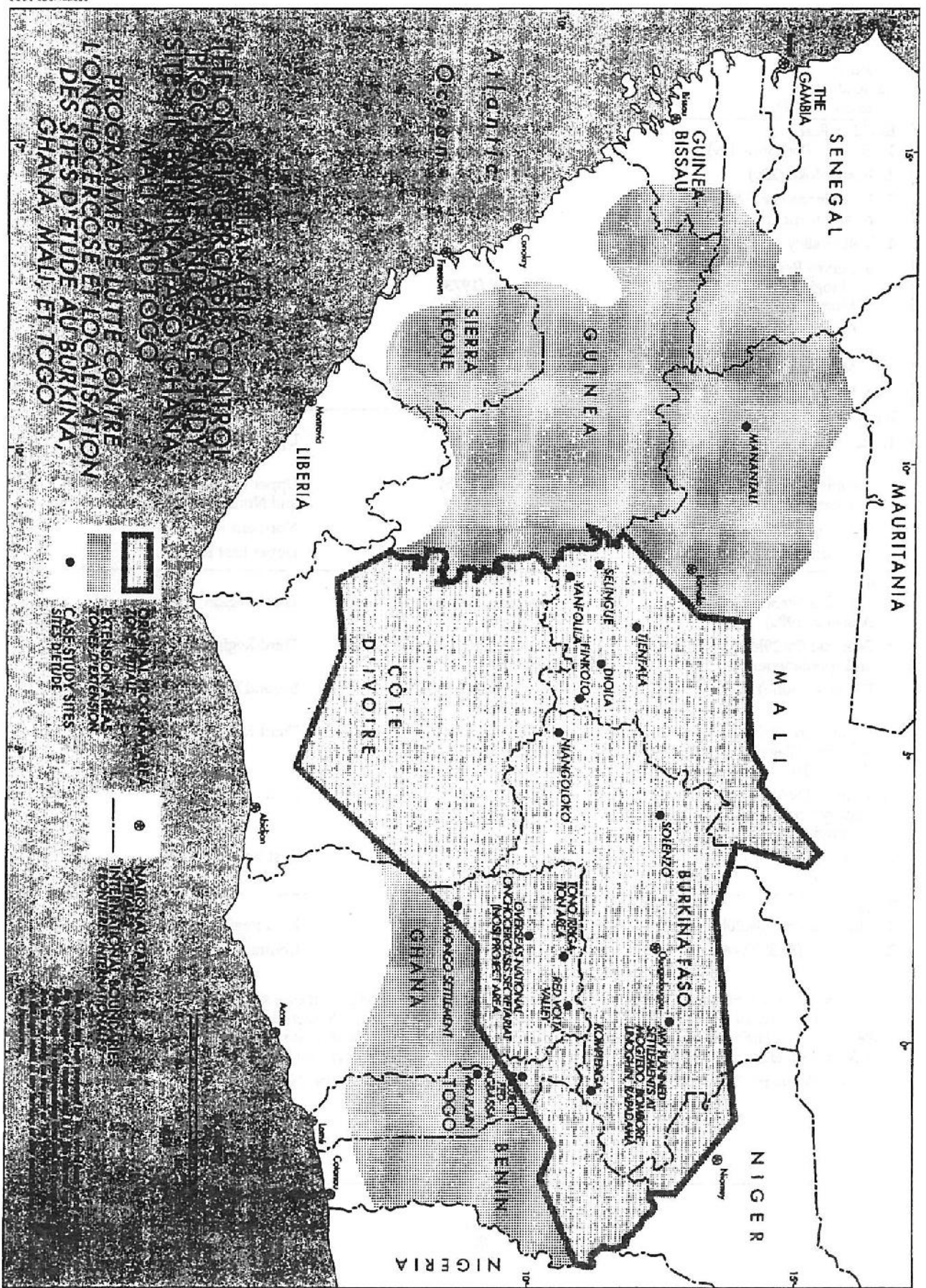


Table 1 The Land Settlement Review Case Studies

Country; name of site; nature of sample	Settlement type; approx. date of settlement onset	Location in country
Burkina Faso		
1. Solenzo (3v:36hh+19v)	Spontaneous (1960s)	Kossi Province
2. Niangoloko (22v)	Spontaneous (1982)	Comoe Province
3. Kompienga (1v:35hh) resettlement and spontaneous (1983)	Dam-related planned	Gourma Province
4. Volta Valley Authority (AVV-UP1)		
a. Survey Restudy		
Linoghin (6v:20hh)	Planned (1973)	Oubritenga Province
Mogtedo-Bombore (7v:20hh)	Planned (1979)	Ganzourgou Province
Mogtedo (6v:40hh)	Planned (1974)	Ganzourgou Province
b. Case Study Restudy		
Mogtedo V3 (1v:20hh)	Planned (1975)	Ganzourgou Province
c. Rapadama (+7)		
	Assisted (1987)	Ganzourgou Province
Ghana		
1. Red Volta Valley and Plateau (2v:30hh)	Cyclical, spont. (late 19th cent.)	Upper East Region
2. Fumbisi-Yagoba-Soo Mankarigu ("Overseas") (4v:30hh)	Assisted (1985)	Upper West, Upper East, and Northern Regions
3. Damongo Settlements (3v:30hh)	Planned (1950s)	Northern Region
4. Tono Irrigation Scheme (2v:30hh)	Planned (1980s)	Upper East Region
Mali		
1. Yanfolila (5v:30hh) Assisted (1985)	Spontaneous (1970s) (Sikasso)	Third Region
2. Selingue (3v:29hh) (late 1970s) and spontaneous	Dam-related planned (Sikasso)	Third Region
3. Dioila (4v:30hh)	Spontaneous (1960s) (Koulikoro)	Second Region
4. Finkolo (3v:30hh) workers' villages at tea plantation (late 1960s)	Wage workers in (Sikasso)	Third Region
5. Tienfala (3v:9hh) railway workers (from early 1900s; continuing)	Spontaneous, by (Koulikoro)	Second Region
6. Manantali (14v:70hh) (1986/87)	Dam-related planned (Kayes)	First Region
Togo		
1. FED-Agbassa (3v:30hh)	Planned (1972)	Kara Region
2. Mo Plain (3v:30hh+6v)	Spontaneous (1970s)	Central Region

Note: Numbers in parentheses that follow site names denote the number of villages at each site where household interviews were conducted, followed by the number of households in the site sample. Numbers preceded by a plus sign denote the number of additional villages at the site where leaders and other community members were interviewed. Information on Manantali was drawn from another IDA contract dealing with that project. (Horowitz, Grim and Konate 1993)

Source: McMillan, Painter and Scudder, 1992, and Koenig, personal communication 1994.

more active role in the household's farm activities. He qualified his statement, however, by saying that it is unlikely that women in certain ethnic groups like the Mamprussi and Dagomba would participate in crop production. Their more likely role would be in food processing and trade. The situation might be quite different, however, in other ethnic groups like the Frafra, where women have traditionally been more active in local farm production.

Selingue (Mali)

Selingue is another case. The original irrigation effort was designed to benefit the indigenous Malinke inhabitants who were displaced by the dam. In an effort to increase the irrigated perimeter's productivity, the management started to encourage the Dogon immigrants who had immigrated on their own into the surrounding zone to join the project (Koenig 1990: 35). It was also decided that the perimeter would be a good place to locate young school leavers. These extra farmers reduced the size of all plots and decreased the amount of land allocated to individual households from between 0.5 to 1.2 hectares in 1984-85 to 0.25 hectares for a household with one to eight economically active individuals and 0.5 hectares for households with nine to sixteen active individuals in 1988. This meager plot size compares with the Office du Niger's policy of allocating 1 hectare of irrigated rice land per person in 1979 (CILSS 1978: 39 in Koenig 1990: 35). Few families could provide for themselves on what they earned from these small plots even with above-average yields of two tons per hectare. Settler insecurity increased further by the management's policy of constantly redistributing parcels. The indigenous farmers compensated by clearing private maize and millet fields in the surrounding zone. As a result, their average food grain production (232 kilograms per person) was much higher than that of the Dogon migrants (29-141 kilograms per person) who had difficulty getting permission to clear and farm in the surrounding dryland zone (Koenig 1990: 39).

Sites where the initial rise in agricultural income growth was unsustainable

In an attempt to circumvent the multiple macro- and micro-level constraints to development at the sites, the AVV, and FED-Agbassa projects provided settlers with a planned settlement package to develop basic infrastructure (schools, health facilities, roads, and wells) and to support intensive farming (Koenig 1990; Painter 1990; McMillan, Nana, and Savadogo 1993). In the more isolated OCP river basins, like the Manantali Dam resettlement, elements of development planning—access to new land, supplementary food aid, wage labor on project construction sites, subsidized extension services—combined

to help raise settlers' incomes (Diarra and others 1994; McMillan 1983; McMillan, Nana, and Savadogo 1993; Painter 1990). In each case, however, the resulting increases in crop and non-crop incomes were not sustainable due to various market, policy, climatological and other conditions.

The Manantali sponsored settlements (Mali)

Once crop productivity in the Manantali settlements deteriorated to the point at which the women were forced to depend on their private fields for basic subsistence, the settlers reduced the amount of time they worked on the collective household fields.² By 1994, only 18 percent of the women reported that they worked on collective fields (down from 42 percent in 1988). But women's efforts to develop private crop production were thwarted by the same overcultivation problems that plagued the main household fields. Women were able to obtain larger plots in the less circumscribed planned villages but, because of the isolation of these villages, received lower prices for their crops (Diarra and others 1994, p. 37). Efforts to develop irrigated gardening, which traditionally had been a major source of off-season employment, were thwarted by the lack of appropriate sites. Once dam construction ended, there were few opportunities to engage in trade. With less uncultivated bush, the women not only were unable to engage in many of their traditional gathering activities, but also were forced to buy some of the products that these activities had once provided, such as shea nut butter, fruits, and soap (Diarra and others 1994). With few opportunities to develop trade based on their production, the women turned to exploiting wood.

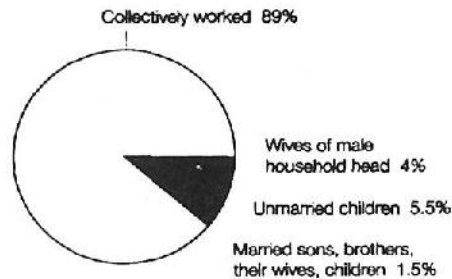
Thus, despite the project's efforts to provide women with land, the lack of a profitable extension package combined with the limited opportunities to develop livestock or nonfarm employment left women worse off than before resettlement. Moreover, they were worse off, but in a situation in which they were still expected to provide for a large share of the household's basic food and condiments. In 1993-94, the male household head helped provide sauce ingredients for the family's meals in only 14.3 percent of the survey households during the dry season and only 23.2 percent of the households during the rainy season (Diarra and others 1994). In addition to providing most of the purchased food, the women were responsible for much of the clothing for themselves and their children (Diarra and others 1994).

The AVV sponsored settlements at Mogtêdo and Mogtêdo-Bomboré (Burkina Faso)

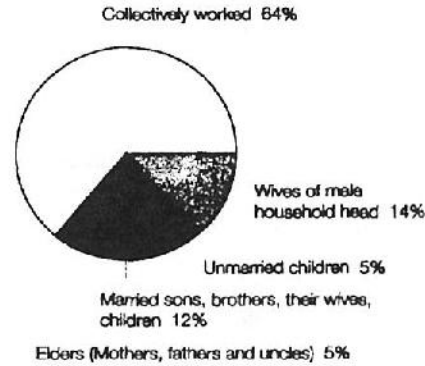
In response to the huge labor demands for cotton, rising production costs (due to lower subsidies), and experience with unreliable yields with the proposed technology

Figure 2 Subdivision of net crop value of income per household, the AVV sponsored settlements, 1979-1989

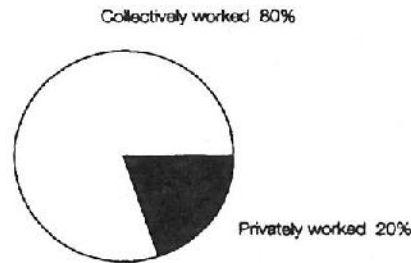
AVV sponsored settlements, 1979



Settlers' home village in Kaya area, 1979



AVV sponsored settlements, 1988



Sources: McMillan 1983.
Savadogo, Sanders and McMillan 1990.

package,³ the AVV project farmers gradually reduced the area planted to high input cotton production and increased the area planted to the less intensive sorghum and millet.⁴ The increased production they achieved was not, however, associated with higher cash income. Indeed, the settlers' average income, calculated using the median price at which crops were sold, was 10 percent less in 1988 than in 1979. When this nominal net income was adjusted for inflation using the International Monetary Fund price index, average income per labor unit (adult labor equivalent, or ALE⁵) on the official household fields was 40 to 50 percent lower in 1988 than in 1979 (McMillan, Nana, and Savadogo 1993, p. 34).

During their first years in the AVV sponsored settlements, the settlers were involved in the heavy work of clearing fields, their families were small, and they had little time or money for noncrop activities, such as livestock or trade. By 1979, three to five years after settlement, most households had established small private plots. Although

the women's private fields represented a smaller share of the total planted area than the share in their home villages (8 percent of total area in 1979, compared with 24 percent in the home village; McMillan 1983, pp. 158 and 388), the income women earned from their private fields was supplemented by gifts of cash from their husbands and gifts of grain from their husbands' friends. In contrast to the home area, where women often were forced to rely on their private production to supplement the household's food during the dry season, in the settlements they usually sold these food crops. In addition, in 1979, many of the expenses that women had traditionally borne in the home area (for example, condiments, school fees, medicines, and family clothing) were being shouldered by the male household heads.

As households shifted away from the earlier "intensive" model, however, they reverted to the "traditional" pattern in which women were responsible for a higher share of the household expenses. By 1988, when the ten-

Table 2 Average Non-farm Income from Different Sources for Individuals Reporting Income from the Source, 1988-1989.

A. Male Head of Household

	Linoghin	Bombore	Mogtedo	Mogtedo V3	Solenzo	Kompienga
1. Unprocessed agric. products	64,120(1)	■	42,000(1)	■	■	23,167(3)
2. Processed agric. products	■	■	■	■	24,000(1)	8,425(2)
3. Forest and water products	■	■	■	■	■	87,000(1)
4. Meat and animal by-products	28,500(1)	122,500(2)	38,650(3)	25,000	■	107,667(3)
5. Commerce	300,000(1)	■	50,250(2)	14,000(3)	■	81,000(3)
6. Handicrafts	21,300(2)	6,070(6)	1,950(1)	6,950(2)	■	53,167(3)
7. Gold	■	2,000(1)	36,166(3)	27,721(7)	■	■
8. Services	4,000(1)	■	5,000(1)	23,700(2)	41,250(2)	50,000(1)
9. Agric. Labor	■	■	20,000(1)	■	■	■
10. Nonagric. Labor	450,000(1)	■	■	250,000	■	■
11. Mill	■	■	■	■	■	550,000(1)

B. One Woman per Family

1. Unprocessed agric. products	9,050(2)	■	■	74,200(2)	■	10,437(10)
2. Processed agric. products	26,043(13)	3,833(5)	3,186(7)	6,642(14)	29,300(6)	6,361(11)
3. Forest and water products	30,050(2)	■	■	■	■	3,000(1)
4. Meat and animal by-products	■	■	37,500(1)	■	■	■
5. Commerce	2,200(1)	6,000(1)	■	■	350(1)	■
6. Handicrafts	7,650(1)	8,150(1)	■	■	■	17,000(1)
7. Gold	■	500(1)	19,691(12)	13,914(16)	■	■
8. Services	■	■	■	3,500(1)	■	■

() indicates how many men and women provided non-zero numbers.

Twenty men and twenty women were interviewed in each of the AVV planned settlements; 36 men and 36 women were interviewed at Solenzo. Means are taken over these numbers.

Source: Savadogo 1989a in McMillan, Nana and Savadogo 1993:52.

year restudy was conducted (ten to thirteen years after the settlements were created), husbands no longer gave cash "harvest presents" to their wives, and the earlier practice of giving large, lavish gifts to friends' wives (an important source of income for women in 1979) had died out. With fewer and less lucrative opportunities in trade than a decade earlier, both men and women farmed more land as private fields. In 1988, private fields accounted for about 20 percent of net agricultural income. Although a larger share than ten years earlier, when it had been 11 percent (before subtracting the costs of animal traction), the income from private fields was still less than it had been in the settlers' home village, where it had accounted

for 36 percent of the total CFA franc (CFAF) value of production or gross income in 1979 (McMillan, Nana, and Savadogo 1993, p. 47, figure 2).

These changes do not appear to have had much effect on women's labor time during the main agricultural season, because cotton requires a high percentage of women's labor during harvests (which occur in the lull after the rains). White sorghum, in contrast (which has a much smaller total labor requirement—394 weighted hours per hectare compared with 1,520 weighted hours for cotton), requires about the same amount of labor as cotton for soil preparation and weeding (see McMillan 1983, pp. 397-99).

Table 3 Percent of women indicating income from off-farm employment and livestock production and average income from these sources for the entire sample, 1988/89 (per woman)

	Sample Size	Off-Farm Income		Net Livestock Income ^a	
		%	CFA	%	CFA
Linoghun	(20)	80	21,331	20	201
Bombore	(20)	35	1,690	45	486
Mogtedo	(20)	60	14,805	45	1,887
Mogtedo V3	(20)	95	23,392	55	3,865
Solenzo	(36)	17	6,833	0	0
Kompienga	(25)	64	9,774	8	442

^a Net income on livestock includes deductions for animal losses by death and theft. The low figures reflect both this and the fact that only a few women in each sample had sold livestock at the time this initial analysis (August 1989) was conducted.

Source: Savadogo 1989a,c in McMillan, Nana and Savadogo 1993:52.

By 1988, the settlers were experiencing growing problems with basic infrastructure because of their inability to manage user fees in ways that allowed them to make repairs and to replenish stocks of drugs and basic equipment. The erratic operation of the groupement-managed grain mill during the preceding five years meant that most women had to revert to the "traditional" (preresettlement) pattern of devoting two to three hours a day to grinding sorghum and millet. Some men would occasionally transport the family grain to a gas-powered mill in Mogtédó, but they were an exception. The same period (1988) was characterized by growing problems with the first generation of bore hole pumps. Pumps sometimes would remain broken for one to two weeks, forcing women to seek water in neighboring villages or to rely on streams or stagnant pools. A similar pattern of early success followed by decline characterized women's health facilities. By 1988, most of the village maternities that UNICEF had stocked with an initial supply of drugs had been abandoned.

In late 1987, gold was discovered near the AVV planned settlements at Mogtédó. The net result was a substantial increase in the income and welfare of female and male farmers near the mining sites (table 2). But the settlers were not optimistic that gold revenues would be reinvested in ways that would improve nonfarm employment in the long run.

Frustrated by the lack of long-term prospects for improving their income and living standards, twenty-one registered households, and ten people from households that did not move (as a group), left Mogtédó; another eight households left Mogtédó-Bomboré just as suddenly.

All relocated to Kompienga, the site of Burkina Faso's first hydroelectric dam, in the extreme southeast of the country. The settlers' main motivation for leaving was to find an area with greater opportunities for dry-season irrigated farming and trade. Some of the strongest advocates of the move were senior wives.

"Step" agricultural migration, like that of the AVV farmers from the home village to the AVV settlements (1975-78) and then to Kompienga (1988), is not new. This sort of serial agricultural migration has been practiced on the Mossi Plateau for centuries. The Kompienga census identified fifty-five male household heads who were former AVV settlers from the planned settlements at Mogtédó, Mogtédó-Bomboré, Rapadama, and Mankarga. As many as half of the Mossi living in Kompienga in 1989 had probably lived for two to ten years in other areas of the OCP valleys or the plateau before migrating to the town.

This kind of step migration has costs—not only economic, but also institutional and environmental. At Mogtédó and in certain villages at Rapadama, the out-migration of wealthier farmers meant the loss of income earned during the early period of colonizing the new settlement sites, when crop production was highest. These cash resources could have been reinvested in the development of more intensive, sustainable environmental management—for example, in the construction of stone diguettes (small dikes). Another incalculable cost is the loss of a first generation of settlement leadership. The commercial farmers who left Mogtédó for Kompienga included some of the most ambitious leaders who had worked most closely with the AVV administration in finding practical solutions to the settlers' problems.

Sites with Limited Opportunities for Agricultural Income Growth but Opportunities to Develop Off-farm Employment

A third category of case study sites includes those where greater opportunities to develop off-farm employment made it possible for male and female settlers to raise their living standards despite the areas' limited potential for agricultural income growth.

The AVV planned settlements at Linoghin (Burkina Faso)

In contrast to the AVV planned settlements at Mogtédó and Mogtédó-Bomboré, no settler households immigrated to Kompienga from the AVV planned settlements at Linoghin. Yet the Linoghin farmers confronted the same stagnant prospects for growth in agricultural income as the settlers living in the thirteen neighboring AVV settlements at Mogtédó and Mogtédó-Bomboré described above. The key difference seems to have been the much greater opportunity to develop trade at Linoghin, where one of the settlements was located along the paved highway linking Ouagadougou to eastern Burkina Faso, Togo, Niger, Benin, and Ghana. Eighty percent of the women interviewed at Linoghin recorded income from off-farm employment, none of it from gold (tables 2 and 3). Most was from cooked food, homemade beer, and gathered forest products. The average nonfarm income for the women interviewed at Linoghin was about the same as that recorded at Mogtédó V3, the village where women gained the most from the 1987-88 gold rush.

The greater success of the Linoghin farmers in developing nonfarm, income-earning opportunities seems to be the main factor in their willingness to invest in a new generation of cash and labor-intensive crop production techniques. Ten years ago, there was no visible difference among Linoghin, Mogtédó, and Mogtédó-Bomboré in input use or net productivity per worker (Murphy and Sprey 1980, p. 69). By 1988, however, the net CFAF value of crop production per labor unit (ALE) for the study farmers at Linoghin was 12 percent higher than for those at Bomboré, and 20 percent higher than for those at Mogtédó (McMillan, Nana, and Savadogo 1993, p. 65). In 1988, production expenses (in cash and in kind) for study farmers at Linoghin were 24 percent higher than at Mogtédó and more than 200 percent greater than at Mogtédó-Bomboré and Mogtédó V3 (Savadogo, Sanders, and McMillan 1989, p. 40). Seventy-nine percent of the study farmers used some compound fertilizer on their fields at Linoghin, 85 percent did at Mogtédó, but only 45 percent did at Mogtédó-Bomboré (Savadogo, Sanders, and McMillan 1989, p. 34). The Linoghin settlers also showed the greatest interest in investing in the more

labor-intensive soil conservation measures, such as building diguettes and manure pits. This, along with the almost nonexistent out-migration from the site, reflected their greater interest in investing in long-term settlement. In contrast, the more isolated, less diversified neighboring blocs of Mogtédó and Mogtédó-Bomboré experienced high rates of settler dropout. Of the 255 households acquiring AVV farms at Mogtédó between 1974 and 1978, only 58 percent (148) were still living there in 1989. Out-migration was much lower but still substantial (19 percent) at Mogtédó-Bomboré.

The greater dynamism of the Linoghin settlers manifested itself in other ways as well. For example, an operating mill was run by a private entrepreneur. Although data are incomplete, it seems that the villages at Linoghin have been more successful in pooling funds to replace worn-out pumps. One settler, a pensioned French military veteran, had opened a small private pharmacy in his home. The women had started a small weaving cooperative to profit from the increased urban demand for hand-woven cloth. In contrast to neighboring blocs, in Linoghin the female literacy programs have been popular and well attended. Especially remarkable was the Linoghin group's development of the first kindergarten, reflecting the higher overall spending on education (primary and secondary) in Linoghin observed in the consumption survey.

Finkolo and Tienfala (Mali)

Most of the study households at the Finkolo study site had immigrated to work as wage laborers on a commercial tea plantation that was established in 1967 (Koenig 1990). It was like most plantations in Africa, and provided the workers with an income insufficient to satisfy all their household needs. The ability of tea plantation workers to supplement their income through part-time farming was hampered by lack of inputs and extension advice; the government agency charged with agricultural extension for the zone did not recognize part-time farming, even though, after retiring, many of the workers remained on the small farms that they had cultivated (Koenig 1990, pp. 30-59). Not surprising, average food grain production was low (119 kilograms per person) (Koenig 1990, p. 39 and personal communication 1994). Few settlers owned animal traction equipment or livestock. The small amount of land made available for household fields at Finkolo left none for women's private fields. Despite these constraints, the combination of crop and income earned on the tea plantation allowed farmers to improve their living standards. School attendance, for example, was the highest at all of the study sites.

A similar situation was observed at Tienfala, located in the peri-urban area along the railway line between Bamako and Koulikoro with easy access to the Bamako

market (20-30 kilometers). Although there were no obvious cases of landlessness in Tienfala, it was becoming more and more difficult for small farmers to support themselves on the available land and to maintain adequate fallow periods (Koenig, 1990, p. 34). Average food grain production was also low (177 kg per person) (Koenig 1990, p. 39 and personal communication, 1994). Despite these constraints, thirty-five percent of the recorded fields belonged to women (personal communication, 1994). In addition, women entered into a variety of non-farm enterprises. Several of the migrant women in the sample worked as maids, something the local women would not do (Koenig 1990, p. 54). Other women sold wood.

Sites with successful intensive commercial crop production packages

The best example of a crop production package that can be characterized as sustainable is the intensive commercial cotton package promoted in southern Mali and western Burkina Faso (Koenig 1990; McMillan, Nana, and Savadogo 1992). Average annual food grain production for the study farmers at Dioila was 394 kg per person, more than twice the yearly requirement of 180 kg per person (Koenig 1990, p. 38 and personal communication 1994). In addition, the sample households produced an average of 1,817 kg of cotton per household (Koenig 1990). Average cereal (sorghum, millet, and maize) production for animal traction households at Solenzo was a whopping 567 kg per person (if the inflated production figures for the small number of farmers with mini-tractors are included) and 361 kg per person for manual farmers (Savadogo, Sanders, and McMillan 1989, p. 5; McMillan, Nana, and Savadogo 1993, p. 66). Total cotton production averaged 372 kg for manual farmers, 2,202 kg for households with animal traction, and 22,252 kg for the nine households with mini-tractors.

These higher yields, involving a much larger cultivation area for cotton, were associated with much higher demands for household and women's labor.⁶ Indeed, the Institut d'économie rurale (IER) research in the Bougouni region argued that the women's willingness to circumvent the traditional prohibition on women working in the fields alongside their husbands by participating in all-female groups that hired themselves out to work on one another's fields was a major factor in the households' ability to meet the much higher labor demands of the new crop technology (IER 1981, p. 25). Conversely, they argued that no such innovative "social" pattern existed in the semi-intensive or traditional villages, where adoption rates and productivity were lower than in the third village which was characterized as "intensive".

The impact of these higher labor demands on women's private production varied widely between sites. Although

women reduced the time that they devoted to their private rice fields in the intensive IER villages, the average area that they cultivated and the average income that they earned from their rice fields were about the same as in the semi-intensive and traditional village (IER 1981, p. 42). That is because, in contrast to the other two villages, in the village that adopted intensive cultivation the male household heads plowed their fields. A similar pattern of male aid on women's private fields was observed in the early AVV settlements (McMillan 1983). Whatever the motivation for the men contributing their labor on the women's private fields, the net result was to enable women to concentrate their labor on the household's enlarged cotton fields while still retaining their 'right' to private fields.

In contrast, in two of the three Dioila study villages in the Land Settlement Review, the women reported having few private fields (Koenig 1990, p. 52). Unfortunately, the team was unable to measure the percentage of land area or production that these fields represented. In addition, the women in the Yantolila region (near the IER Bougouni study sites), where *Compagnie malienne pour le développement des textiles* (CMDT) had just begun working, reported having great difficulty acquiring fields (Koenig 1990, pp. 53-54). Qualitative interviews in Burkina and at other sites show that women immigrating to an uncleared area in the OCP river basins depended on their husbands to clear the new fields. For that reason, the first fields invariably were created alongside the household's main fields. The lesser access to cleared land, combined with the higher labor demands of building a house and routine domestic chores, explains why nonsponsored immigrants typically had little time, energy, or land for private crop production.

In the Dioila, Solenzo, and IER intensive cultivation villages, the observed increase in women's labor obligations on the collectively worked household fields and their reduced income from private sources were accompanied by a "renegotiation" of the distribution of resources from the collective household fields. In the middle- and upper-income households that grew the most cotton, the male household heads appeared to be making cash payments to the women and married sons who helped them on the fields as well as providing all the basic food and condiments (Koenig 1990; Lichte, personal communication, 1994). A similar phenomenon was observed at the AVV settlements in 1979, when farmers still had 30 percent of the total land area planted in cotton (McMillan 1983). Besides assuming greater responsibility for household expenses, the early AVV settlers gave gifts of 5,000 to as much as 20,000 CFAF to their wives and older sons and brothers. Indeed, the high cost of these "gifts" was one of the main reasons given for the farmers' unwillingness to

Table 4 CFA Value of Production per Household and for One Woman per Household

Site:	Sample Size	CFA Value of Production (per household)		CFA Value of Production from Private Income Producing Activities (for 1 Woman per Household)			
		From Household Fields	From All Women's Fields	Crop	Livestock	Nonfarm	Total
AVV Linoghin	20	233,762	31,092	19,336	201	21,331	71,960
Bombore	20	237,137	30,594	11,145	486	1,690	13,321
Mogtedo	20	220,242	37,699	16,976	1,887	14,805	33,668
MogtedoV3	20	192,854	36,457	17,385	3,865	23,392	65,892
Solenzo-All	(36)	1,065,185	22,203	12,687	0	6,833	19,520
Manual	13	86,340	■	■	■	■	■
Animal Traction	14	354,231	■	■	■	■	■
Mini-Tractors	9	3,627,438	■	■	■	■	■
Kompienga	25	409,732	33,505	12,633	-442	9,774	21,965

■ indicates data not available.

Sources: Savadogo 1989a: 17-19; McMillan, Nana, and Savadogo 1993: 62, 66.

accept the cotton parastatal's proposal to split the cotton market into two days. They argued that the split market would eliminate any profit because it would obligate them to make two sets of intrahousehold gifts (McMillan 1983).

The same case studies caution against focusing exclusively on the ideal or "modal" pattern of intensive cotton production to avoid overlooking wide differences at a site in household patterns of production (table 4). In particular, it is very easy to overlook the fact that not all households have the cash, land, or labor to adopt new intensive crop production technologies (Koenig 1990, p. 42; IER 1981, 1982; McMillan, Nana, and Savadogo 1993, pp. 62-68). Key factors influencing the ability of farmers to adopt the proposed intensive crop packages include household size, capital, experience with animal traction, and quality of landholdings, as shown in table 5. These same factors account for at least some of the wide variation observed among households in average yields and income (IER 1981, p. 9; Koenig 1990, p. 30).⁷ In many cases, these differences correlate with differences in levels of and dependence on private crop production. For example, women's production accounted for 25 percent of the net value of production for the Solenzo households that farmed manually, but only 6 percent for the households that farmed with animal traction and less than 1 percent for households that owned mini-tractors (McMillan, Nana, and Savadogo 1993, p. 66; Savadogo 1989a, p. 17). This wide variation was obscured by the overall sample average of 2 percent (Savadogo 1989a, p. 17). The same average fig-

ures can mask wide variation between technology groups in women's role in food grain production (table 6).

Koenig observed that, at all of the Mali study sites, women in the poorest households engaged in a wider range of nonfarm activities than women in the middle- and upper-income strata (Koenig 1990, pp. 42-43). In addition, the households in the lower-income strata were much more dependent on the women's nonfarm income to purchase food and satisfy basic needs. Koenig observed a similar phenomenon at Kita, another area in Mali with a successful intensive peanut package (Koenig in Koenig forthcoming). At Kita, women in the lowest-income stratum produced a much greater share of household income than those in the other two income groups (about a third, compared with a tenth or less), and their income was necessary to cover basic household expenses (Koenig in Koenig forthcoming). The IER survey of three CMDT villages near Bougouni (near Yanfolila) found that the poorest households usually had the most diversified sources of income (IER 1981, pp. 42-46). Nonfarm income was especially critical in the low-income households, which used it to purchase food.

A key lesson to be learned from these "successful" study sites is the flexibility of traditional patterns of intrahousehold production in adapting to new, more labor-intensive cash crops. Equally important is that not all households are willing or able to absorb the labor demands and risk associated with this type of high input cultivation package. It is not surprising, therefore, that

Table 5 Crop and Livestock Production per Adult Labor Equivalent (ALE Solenzo 1988/89)

	Dar/Kie			Daboura			All		
	Manual	Animal Traction	Tractor	Manual	Animal Traction	Tractor	Manual	Animal Traction	Tractor
Average family size (no. residents)	8.0 (6)	13.5 (8)	29.5 (5)	8.0 (7)	7.5 (6)	37.0 (4)	■	■	■
Average family labor force (ALE ^a)	2.8	5.3	10.9	2.6	2.5	13.8	2.7 (13)	4.1 (14)	12.2 (9)
Collective Field Area (per farm ^b)	4.4 (6)	7.0 (9)	37.7 (5)	2.7 (7)	5.8 (6)	29.9 (4)	3.5 (13)	6.5 (14)	34.5 (9)
Collective Field Area (ALE)	1.4	1.6	3.4	1.5	1.9	2.2	1.4	1.7	2.8
Cotton (Kg. per ALE)	148	548	2,789	133	513	869	138	537	1,824
Sorghum-Millet (kg. per ALE)	422	694	808	411	1,252	737	410	838	771
Maize (Kg. per ALE)	42	135	4,292	132	94	1,448	88	124	2,864
Net Crop Income all Fields (CFA per ALE)	24,416	79,821	521,167	39,134	104,988	182,850	31,978	86,398	297,331
Annual Livestock Income (CFA per ALE) for Male Household Heads	1,000	11,200	71,907	3,737	-4,911	10,921	■	■	■

() indicates number of households.

■ indicates data not available.

^a Weights used to derive ALE are based on study calculations.

^b Measurements for the fields of the household head and one wife were estimated by crude calculations of length and width. A subsample of fields was subjected to more rigorous field measurements in order to verify the accuracy of our estimates.

Sources: Savadogo, Sanders, and McMillan 1989 and McMillan calculations.

Table 6 Division of Cereal Production between Privately and Cooperatively Worked Fields, Solenzo 1988/1989 (in percent)

Village and technology type	Cooperative	Private Fields		
		All	Men's	Women's
Dar-es-Salaam/Kie				
Manual	100	0	0	0
Animal traction	79	21	10.5	10.5
Tractor	100	0	0	0
Daboura				
Manual	95	5	0	5
Animal traction	98	2	0	2
Tractor	100	0	0	0

Source: Savadogo 1989d.

households in different income and technology groups vary widely in their organization of household and private crop production.

Conclusion

The Land Settlement Review confirms the observation based on comparative research that women were generally worse off, at least initially, in areas of new-lands settlement (Koenig forthcoming; Scudder 1981, 1984; Sequeira 1993). One reason for this is the substantial increase in demand for women's labor for domestic and agricultural chores. The initial transition period also was associated with women's loss of their traditional sources of independent income from private fields, irrigated gardening, and nonfarm employment—not just in the AVV settlements but in sponsored and spontaneous settlements worldwide (Koenig forthcoming; Scudder 1981, 1984; Sequeira 1993).

The river basins' isolation and their greater distance from markets increased the amount of time spent in transporting crop and forest products to markets. Women's loss of access to the gas-powered mills that many had used in their home areas led to a dramatic increase in the time spent in processing food. With few permanent water points, the average time required to get water also increased, by several hours a day. As a result, women often obtained water from lakes and stagnant sources, which contributed to an increase in guinea worm and infant diarrheal disease at some of the study sites (Painter 1990). When combined with the backbreaking work of clearing and planting new fields, the increased labor associated with routine domestic tasks meant that female settlers had little time for their independent social and economic activities during the early years. Burdened with higher labor demands and less familiar with their new environment, the women often decreased their use of gathered foods and forest products (McMillan 1983; Diarra and others 1994). Colson observed a similar result at Kariba, where it had a serious effect on infant and child nutrition (Colson 1971).

A central theme in the resettlement literature is that female settlers usually lose their inherited rights to land when they move (Colson 1971; Koenig forthcoming; Salem-Murdock 1989; Sequeira 1993). The loss of inherited land tenure rights is especially disruptive in matrilineal societies (Kiste 1972; Koenig forthcoming). Studies emphasize that the lack of inherited rights, fewer sources of independent income, and distance from their natal families increase women's vulnerability in the event of a divorce or the husband's death (Brain 1976; Koenig forthcoming; Sequeira 1993).

When the women settlers immigrated to the OCP areas, they also lost their traditional rights to crop and grazing land. Their acquisition of new land in the river basins was complicated by their dependence on men to clear the

land. Since rights to land are usually held by the person who clears it, the women generally became more dependent on their husbands for land than they had been before moving. Over the long term, most women did acquire private fields, even in planned settlement projects, such as the AVV and FED-Agbassa projects, that made no provision for private fields (McMillan, Nana, and Savadogo 1993; Painter 1990). The chief exceptions occurred where the amount of land given to the recognized male household head was considered inadequate to farm—for example, Finkolo, Tienfala, Selingué, and a village in Manantali (Koenig 1990, p. 43, and forthcoming, p. 11).

Koenig (forthcoming) points out that women generally were less concerned about the loss of land rights per se than about the consequences. She observed that where resettlement resulted in a higher standard of living and men were willing to share the higher income with their wives, women had a more positive perception of the move. Two of the best-documented examples of this are the Zimbabwe schemes studied by Jacobs (1989) and the Shukriya tenants in Sudan's New Halfa scheme (Salem-Murdock 1989). Studies emphasize that women can compensate for a loss of rights in agriculture if they can find other, nonagricultural sources of income (Koenig forthcoming, p. 18). At New Halfa, for example, many women began to trade, and they thus approved of the resettlement despite their loss of "traditional" occupations (Salem-Murdock 1989). In the more isolated Kariba villages that were far from beer halls, women were able to increase their incomes by making beer when the harvests were good (Colson 1971, pp. 130-32).

Similar patterns were observed at the Land Settlement Review study sites, but the resulting income increases were not always sustainable. In each case, however, the early increase and then subsequent decline in women's income had less to do with their being women than with the overall failure to generate sustainable opportunities for increasing agricultural income at the study sites.

When profitable technologies were available, women showed their willingness to forego the land rights and income earning opportunities they had enjoyed before immigration. Women thus contributed to the adoption and productivity of new technologies and land management practices. In the absence of profitable activities, the income earned from women's crop, livestock, and nonfarm activities helped the families to survive.

Recommendations

1. Support adaptive, gender-sensitive, on-farm research and extension

The intensive cotton package implemented in southern Mali and western Burkina Faso has been the only crop technology package promoted in the OCP river basins that

approximates the popular definitions of environmental sustainability. This package builds on more than fifty years of consistent support for action-oriented research and extension by the French and national governments. Its development was further supported by the existence of strong, well-organized rural development organizations such as the CMDT and Société des fibres textiles (SOFITEX), which offered agricultural credit, improved inputs, and advice to farmers growing new crops on new lands (Koenig 1990, p. 64; McMillan, Nana, and Savadogo 1993).

Few such technologies exist for the other Sudano-Sahelian zones. Moreover, in these zones the "normal" problems of technology development were complicated by the lack of established cropping systems or research data on which to base extension recommendations and advice. The river basins' sparse population means that they often lacked the basic infrastructure (roads, bridges, schools, markets, and administrative centers) that supports development. Some of the reasons that an area may have remained uninhabited, such as human or animal diseases, or unhealthy drinking water, also pose problems, as does insecure land tenure. For all these reasons, technology development in the less privileged zones is likely to be a long process of trial and error.

There is a critical need for donors, nongovernmental organizations (NGOs), and governments to support research to develop the technology and policies necessary to support higher-yielding, sustainable crop production practices. Planners recognize the need to support agricultural development. All too often, however, the follow-up planning has focused on preliminary surveys designed to measure arbitrary levels of success, basic infrastructure, and extension. In the early AVV project, for example, there was almost no attempt before 1986 to link the results of the project's farm monitoring program to modification of the recommended package (see Murphy and Sprey 1980). A similar pattern of "top-down" extension was observed at most of the other sites. Indeed, no evidence of on-farm adaptive crop or livestock research was found at any of the study sites in 1988 except in the CMDT and SOFITEX cotton zones.

This finding is consistent with Scudder's observation, based on a comparative review of more than 100 new-lands settlement projects in Africa, Asia, and Latin America, that extension services were either nonexistent or minimal in 53 percent of the government-sponsored settlements and of good to excellent quality in only 11 percent (Scudder 1984, p. 33). Of the ten spontaneous settlements on which he had data, nine either had no extension services or had only minimal extension services.

The recommendation to support adaptive, gender-sensitive, on-farm research should not be interpreted as suggesting that conventional crop research should be

de-emphasized. Rather, echoing Scudder's global recommendation, it is clear that every research station that serves a specific agro-ecological or political zone "should include an area which simulates in size and other conditions the different kinds of settler holdings in that zone" (Scudder 1984, p. 24).

As part of this process, there is a critical need to reinforce and expand existing efforts to promote the full participation of women in the identification, testing, and dissemination of new technologies. There are several practical reasons for this. One has to do with the fact that women's knowledge of the environment is not the same as men's. Drawing on women's knowledge can help prevent costly mistakes, such as investing in seed varieties, field layout patterns, roads, or road networks that are not adapted to the needs of rural farm families. Another practical reason for ensuring women's participation is that it helps improve the chances that both male and female farmers can accommodate the new labor and production demands by adjusting intrahousehold patterns of production and consumption.

2. Anticipate and reinforce the evolving patterns of income diversification at the sites

In the short run, even the most seasoned planners are unlikely to be able to predict all of the factors that will affect the development of commercial farming in the OCP river basins. For that reason, the planners' goal should be to develop a diversified production system, rather than a system focused on the intensive production of one or two commercial crops, such as the early programs advocated at the AVV, FED-Agbassa, and Manantali projects (McMillan 1993). A diversified economic system that includes possibilities for earning income from irrigated dry-season farming, livestock, forestry, trade, and rainfed agriculture offers both men and women the greatest freedom to develop innovative responses to new constraints and opportunities.

While diversification is important in all systems, it is especially important in areas that lack established commercial crop production packages such as those supported by the CMDT in Mali and SOFITEX in Burkina Faso. In these areas, the availability and profitability of nonfarm income earning opportunities (for men and women) are likely to influence reinvestment patterns. Some of our best evidence for this comes from the AVV planned settlements at Linoghin. Plentiful nonfarm employment gave the Linoghin settlers the means to invest in a new generation of crop technology and land management practices. Higher cash income due to plentiful off-farm employment gave the Linoghin settlers the means and the motivation to invest in a new generation of crop technology and land management practices that would allow them to increase or at least

stabilize agricultural production at the site. In much the same way, the high potential for developing irrigation and trade at the Kompienga study site seems to account for the low rates of farmer out-migration despite declining yields and the lack of government support for agriculture.⁵

Diversification is likely to be relatively unimportant in the initial development of areas with intensive commercial packages such as the CMDT cotton package. But over the long run the development of diverse commercial food and cash crop production helps to buffer the impact of a collapse in the price or subsidies for a single dominant cash crop. A dramatic drop in the profitability of a dominant cash crop affects both rich and poor, but wealthier households have a greater ability to move on to an area offering new opportunities.

A diversified package of income earning opportunities based on several crops, livestock, and nonfarm employment improves the chances that new immigrants, who often have less labor and cash than established farmers, will be able to absorb the cash costs and higher risk of moving into new, higher-yielding crop production technologies. The same "bank" of more diversified income earning opportunities provides a cushion for smaller households that may be forced to abandon more labor-intensive, high-risk technologies because of illness, old age, or the out-migration of a key worker.

These findings corroborate other research showing that increased economic diversification need not be at the expense of additional investment in intensive farming or higher crop productivity (Scudder 1981, 1984). Indeed, there is little evidence from successful settlements throughout the tropics of significant numbers of wealthier farmers withdrawing entirely from agriculture as long as appropriate agricultural markets exist (Scudder 1981, 1984). In terms of environmental sustainability, crop productivity, and positive regional development, one of the most successful settlements in the tropics is Minneriya, established in the dry zone of Sri Lanka in the 1980's (Scudder and Wimaladharma 1985, 1990). Wimaladharma found that over 90 percent of holdings in the early 1980's were still controlled by the same families—including now adult children to whom parents had handed over management (Scudder and Wimaladharma 1990). High rates of settler turnover in Africa, Asia, and Latin America are associated with a lack of opportunity as well as insecure tenure and unfavorable project and macro-level prices and/or price policies that deflate the returns to sustainable cropping (Scudder 1981, 1984; Painter and others 1984).

There is a need to increase the awareness of governments, NGOs, and donors about the vital link between farm and nonfarm employment in the OCP and at older settlement sites worldwide. This is a theme that was examined for agriculture in general and for new-land set-

tlements in particular during the 1970s (Haggblade, Hazell, and Brown 1987, 1989; Johnston and Kilby 1975, p. 301; World Bank 1978; Weitz, Pelley, and Applebaum 1978; van Raay and Hilhorst 1981). But it seems to have been lost during the 1980s, as the emphasis shifted to macroeconomic policy reform and reinforcing national research institutions and regional research networks.

For more decentralized, diversified income earning opportunities to develop, they need to be reinforced by new technology. There is an immediate need for research to identify promising technologies that could improve the returns to women's manufacturing and food processing activities, for wider dissemination of information on existing food processing technologies. Another priority need is for national initiatives to decentralize food processing and to expand markets for nontraditional, locally manufactured products.

In view of the importance that settlers attach to developing diversified sources of income, policymakers should concentrate, at least initially, on less isolated areas where opportunities for diversification are greater. The chief exception should be isolated areas with considerable natural resource or economic potential, such as areas near dams and protected (or classified) forests.

If the first generation settlers in an area are successful in development efforts, that success is likely to attract additional settlers. Therefore, it is important for policymakers to phase development investments over a long period. Growth of a settlement normally results in the creation of new markets and in the expansion of existing markets and administrative centers. These expanded markets tend to increase women's nonfarm employment by creating new market opportunities and reducing input and labor costs. The AVV's many futile attempts to develop markets show that it is not always easy to predict where new market centers will develop. Nevertheless, government investment in roads and infrastructure that facilitates the development of market centers increases the profitability of local agricultural and nonfarm enterprises. Donors might therefore plan a second generation of funding to support the development of market and administrative centers that emerge during the first phase of an intervention and whose continued success is critical to the attainment of longer-term project goals of sustainable development.

3. Link basic literacy training to the development of better models for funding and managing labor-saving technology and social infrastructure

There is clear evidence that women suffer disproportionately from the lack of infrastructure in the sparsely settled river basins, since this increases the labor involved in time consuming activities like carrying water, processing food, and raising healthy children, transporting crops

and trade. To remedy this, a large number of research and planning documents emphasize the need to develop health and education infrastructure, as well as labor-saving technology for domestic tasks, as a "women's issue" (see Phillott-Almeida 1985).

But no model has yet demonstrated the best means to support these types of project. In one model the new infrastructure was provided by a development authority similar to the AVV or FED-Agbassa. Invariably, however, these projects ran into trouble when it came time to hand over management of the infrastructure to the settlers (McMillan, Nana, and Savadogo 1993; Painter 1990; Koenig 1990). An important problem was the settlers' low level of education. For this reason, some of the more recent programs emphasize the need to link infrastructure development programs with programs to teach the basic literacy and accounting skills necessary to manage this infrastructure. Policymakers would benefit from a critical analysis of the factors that have contributed to (or detracted from) the success of group-managed infrastructure such as wells, mills, village pharmacies, and schools in the older areas of new-lands settlement or in particular countries.

Far less attention has been focused on the issue of privately managed mills, clinics, and village pharmacies. Although the Land Settlement Review did not examine this issue, a high percentage of the mills operating in successful zones of spontaneous in-migration seemed to be privately owned. The high failure rates for group-managed enterprises suggests that more attention needs to be paid to the relative merits of private sector management. Few women care who operates a mill or dispensary; they care only that it is open and capable of delivering the required services.

4. Develop income earning opportunities based on renewable forest products

Given the heavy concentration of protected and natural forests in the OCP river basins, priority should be given to NGO and government efforts to develop income earning opportunities based on renewable forest products. The genius of this type of project is that it creates a group of people with a vested interest in regulating those who attempt to exploit the forests. And since women typically are the primary gatherers and processors of forest products (firewood, charcoal, honey), they often are the major participants in and beneficiaries of such projects.

5. Analyze women's issues and strategies to address these issues within a wider systems context

A final recommendation concerns the need for planners to analyze gender issues within a wider systems context. Failure to do so can lead policymakers:

- To overestimate or underestimate the impact of gen-

der-related factors on a household's willingness and ability to adopt new technology and land management practices⁹

- To misidentify the major sources of household income and to estimate incorrectly the size of household income
- To overestimate the impact of gender-specific constraints relative to that of broader system constraints
- To exclude women from the design of crop and livestock extension programs by focusing attention instead on gender-specific infrastructure and income earning projects.

The call for a broader systems approach is similar to a recent shift in thinking about women in developing country agriculture toward the concept of "gender planning," which, in taking account of the fact that women and men play different roles in Third World societies and therefore often have different needs, provides both the conceptual framework and the methodological tools for incorporating gender into planning (Moser 1989: 1799).

6. Need for a longitudinal perspective on women's issues

An important weakness of OCP planning and evaluation documents, however, has been their strong tendency to consider household and intrahousehold opportunities, constraints, and goals as if they are static. This stems in part from the difficulty of quantifying and verifying the reliability of information on intrahousehold labor and commodity flows and in part from the need to simplify interview forms to ease data collection and comparative analysis (McMillan 1987).

A promising methodology for developing comparative, longitudinal research on settlement trends is to incorporate intensive, micro-level studies of intrahousehold change and diversification in a more broadly based farm monitoring survey. This methodology was used in the longitudinal case studies of the AVV and the Manantali sponsored settlements (see Diarra and others 1994; Koenig 1990; McMillan 1983, 1987; McMillan, Nana, and Savadogo 1993). A longitudinal approach is important for development research in general, but it is especially important for analyzing new-lands settlements because of the high demands for labor and investment during the early years and the significant stress of adjusting to new social and production environments (Scudder 1984).

Whenever possible, studies should strive to be longitudinal—that is, they should reexamine the same group of households at different points in the project cycle. If longitudinal research is not possible, careful attention should be given to distinguishing between households at different stages in adopting a new technology package. This approach allows researchers and policymakers to distin-

guish between long- and short-term effects of technical innovation and resettlement. It can also increase appreciation of the fact that the issue of women's roles in OCP development is not only—or even primarily—about equity. Rather, general differences in development are fundamentally economic, and, as such, have significant implications for the current and long-term sustainability of specific sites and of the entire OCP zone.

Notes

1. The research was conducted in 1989 by four country teams that comprised a mix of national and international consultants. The teams conducted interviews in 114 villages and several cooperatives. The household surveys included 485 settler households in 66 villages (see McMillan, Painter, and Scudder 1992, pp. 5-6). Questions asked of household members at each study site concerned household migration histories; patterns of production, consumption, and investment; the nature and uses made of returns on production; off-farm activities; and natural resource management. In most cases, though not all, only one man and one woman were interviewed in each study household. Community leaders and other individuals were asked questions about village history, migration, and settlement in the area, land use and land conflict, the presence of social services, infrastructure, markets, and the like. Regional-level information on settlement and development was obtained through interviews with representatives of government and nongovernmental organizations and projects and through a review of government documents (McMillan, Painter, and Scudder 1992). Although gender issues were addressed for each topical area, they were not the primary focus of the study.

2. Like the AVV and FED-Agbassa plans, the project plan for the Manantali Dam resettlement scheme included the expectation that settlers would continue to use the high input package suggested by ODIPAC (Opération de Développement Intégré des Productions Arachidières et Céréalières) that would have allowed the settlers to grow a mix of cash and subsistence crops on a fixed area of land that was more circumscribed than that to which they had been accustomed (see Horowitz, Koenig, Grimm, and Konate 1993; Diarra and others 1994).

3. The success of the intensive cotton production model in western Burkina Faso led the AVV to advocate a similar model for the planned settlements along the Nakambe (formerly the White Volta).

4. The AVV farmers reduced cotton cultivation from 38-42 percent of the planted area in household fields in 1978 to 20 percent in 1988, and increased the area planted to the less intensive sorghum and millet from 33-48 percent of the household field area to 60 percent (McMillan, Nana, and Savadogo 1993, p. 64).

5. The AVV uses a system of labor equivalents to determine the amount of land a household receives and a similar system to determine the distribution of supplementary food during the first year. A household's potential labor is measured by a labor index that assigns weights to persons according to sex and age. Since an adult male is considered to have the work capacity most readily transferred to a variety of tasks, adult males are the standard unit and are assigned a value of one. Women and children are assigned lesser values (0.75 for adult women, 0.50 for teenage boys, 0.25 for a woman over age 55). The use of labor and consumption equivalents to standardize the units of comparative analysis (so that one does not calculate the "average" household income based on units that may range in size from three to thirty-five people and one to twelve workers) is a hotly debated topic in farm management research.

6. In 1979, the recorded rainy season labor time for Kaya settlers who had lived in the AVV planned settlements for three to five years was twice the recorded figure for the home village (1,200 weighted hours per labor unit compared with 600), due in large part to the fact that 30 percent of the total area was planted in cotton.

7. The IER research in the most intensive CMDT village showed that cotton yields ranged from 747 to 2,346 kg/ha and averaged 1,091 kg/ha (IER 1981, p. 9). Sorghum yields ranged from 736 to 2,369 kg/ha and averaged 1,380 kg/ha.

8. The reinstatement of women's private fields and off-farm employment at Kompienga was very rapid due in large part to the strong base of existing social infrastructure associated with the dam, such as housing, wells, roads, and health care facilities, as well as the fact that some of the fields were all or partially cleared by the first generation of spontaneous settlers before the former AVV settlers arrived.

9. One of the best examples of this was the fear that a strong tradition of "private" fields would reduce settlers' willingness to adopt more labor-intensive crop technologies. Instead, the case studies note several instances in which the women were willing to forgo certain "traditional" prerogatives as long as there were sufficient economic incentives. Moreover, in the absence of strong economic incentives, the case studies showed that nothing could prevent the women from reinstating private income earning opportunities even when these were not specified in the project plan (AVV and FED-Agbassa).

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Settlement and Development of Onchocerciasis-Freed Areas in Mali

Ministry of Rural Development and the Environment, Mali

Development of onchocerciasis-freed areas

For a very long time, onchocerciasis (or river blindness) has been the main constraint on the development of vast areas of high productivity in Mali. Indeed, the area of prevalence of this serious endemic disease covers 350,472 square kilometers, or 28 percent of the national territory (five regions out of eight, and twenty-seven cercles—local administrative units—out of forty-six). Often, more than 90 percent of the economically active rural population in these areas was affected.

The government of Mali not only launched a program to combat the disease, it also planned for the economic development of the areas freed from onchocerciasis. In December 1974, therefore, an Onchocerciasis Unit was created at the level of the Ministry of Planning with the support of the UNDP, the FAO, and the World Bank. Since then, major successes have been achieved with regard to the endemic disease, and the populations are flowing back into formerly deserted areas.

The global strategy of combating desertification favors developing more fertile areas before already desertified areas. For this reason, areas freed of onchocerciasis were given priority for agricultural extension and the establishment of technical structures.

Characteristics of the area

The onchocerciasis area extends across the Sudanese-Guinean and Sudanese savannas and the Sahelian-Sudanese steppe. Rainfall there ranges from 1,300 millimeters per year in the south to 400 millimeters per year in the north. According to the 1987 census, the area had 5,189,417 inhabitants—or more than 65 percent of the total population of the country. The density there is 21.97 inhabitants per square kilometer, compared with a national average of 7 inhabitants per square kilometer. This population is 90 percent rural and is divided among small villages. The formerly infested region is largely farmland and pasture area with immense economic potential.

The current economic activities there are farming, fishing, stock raising, and forestry. It can be safely said that the onchocerciasis area is the breadbasket of the country. It furnishes:

- More than half of Mali's millet and sorghum
- All cotton produced for export
- More than 20 percent of the production

of paddy and groundnuts.

It is also the foremost mining area of the country, combining the gold mines of SIAMA I and II, Kalana, and Sadiola and all the diamond mines, marble quarries, and other mineral works. The hydroelectric dams of Sélingué and Manantali—with their high potential for increasing agricultural and electrical production—are major industrial assets of the onchocerciasis area.

The onchocerciasis area is also rich in natural resources:

- The area's agricultural land reserves are estimated at 7,168,768 hectares. The rate of land use is 36.25 percent. The area farmed per number of inhabitants gives the ratio of 0.94 hectares per capita. The land reserves are estimated at about 100 years.
- The pasture resources consist of natural forests, cropland after the harvest, harvest residues, and agro-industrial by-products. Forage resources reportedly fall far short of the needs of the animals using the area.
- The forest resources (now receding rapidly under pressure of the drought and wood cutting) are expected to provide the area with a reserve of firewood for about 150 years.
- The wildlife and fish resources, formerly considerable, are rapidly receding despite the existence in the onchocerciasis area of Mali's only national park as well as wildlife reserves, numerous watercourses, and large reservoirs of water in the Sélingué and Manantali dams.
- The area's water resources are considerable and make it possible not only to develop the lands but also to replenish underground springs and meet human and animal consumption needs. Nevertheless, a perceptible and continuous decline in rainfall has been noted in the area since 1950.

Extension services in the area are provided by the major development offices and operations, a large number of nongovernmental organizations, and other national and international projects—including the Onchocerciasis Control Programme.

In the onchocerciasis area, mechanization is furthest advanced in the country, and the rural areas are well organized into village associations, village tons, and women's groups. In the CMDT area, an experiment with rural savings-and-loan banks is in progress.

Since the drought of 1973, the western, southern, and eastern edges of the onchocerciasis area have experienced heavy immigration of populations and their cattle fleeing particularly harsh climatic conditions, especially from the Mopti Region and regions of the north.

Major health control efforts in the area include:

- A devolution plan for the Onchocerciasis Control

Programme, begun in 1989 and updated in 1993, which covers not only onchocerciasis but also African human trypanosomiasis and schistosomiasis.

- A program for combating any new or more serious outbreak of onchocerciasis through information, education, communication (IEC); epidemiological surveillance of sentinel villages; and ivermectin treatment for already infected settlers, for populations especially at risk, and for new onchocerciasis victims detected at health facilities.
- Surveillance for trypanosomiasis will entail educating the population about the disease; conducting immunological tests of at-risk populations; testing for parasites, if necessary, by means of cercle health services; and having villagers combat disease vectors with the help of traps and screens impregnated with insecticides.
- Combating schistosomiasis will entail parasitological surveillance; installation of clean water sources; treatment of known cases with praziquantel (biltricide); and informing communities about the dangers, the symptoms, the transmission method, and preventive measures.

Whether combating onchocerciasis, trypanosomiasis, or schistosomiasis, disease control requires a comprehensive community and health development policy. All health control activities should be decentralized to community health structures and given support at the regional and central levels. Backed by sufficient political will, Mali's health authorities can establish a program of training and refresher courses for staff members at all levels, strengthen and equip the existing community health infrastructure, and promote active participation by the rural communities. Such a program would be coordinated by the Comité national de dévolution and monitored by regional and local committees. Mali's health sector can look to Belgium, the European Development Fund, the Netherlands, and the World Bank as partners in development.

Development of Mali's onchocerciasis-freed areas

There is no lack of development experience within the designated area. The OCP has already helped resettle areas and has a data bank that is indispensable to development planning. With the OCP having now largely achieved its objectives, Mali must adopt a ten-year development plan to resettle cleared areas that reflects its new-found democratization, administrative decentralization, and accountability of the population. This plan must be in

accordance with the government's March 1992 Strategic Guidelines for Rural Development.

To develop these areas' enormous agricultural, livestock, and mineral resources, the government must continue its efforts to eradicate disease, actively combating infestation by blackflies and tsetse and implementing follow-up investment programs in health control.

OCP gains must be enhanced throughout the onchocerciasis-freed areas and complemented by a bold policy on land use and village development (*gestion des terroirs*). Mali's economic situation suggests that the support of its partners in development will also be required. Combating poverty is the ultimate objective of all these development activities, which must therefore be in accord with their ecological setting to be sustainable.

Sustainable development depends upon combating such problems as Mali's low education and literacy levels, inadequate farm equipment, poor health services and potable water coverage, the after-effects of onchocerciasis, the pressure of tsetse, the schistosomiasis in the dam areas of Sélingué and Manantali, restricted access to farm credit, climate constraints, degradation of the environment, isolation of villages, low-performing rural production systems, populations that move about in search of cash income, unequal rural and urban development, inadequate recognition of rural women's economic contributions, and a traditionally centralist approach to development.

Mali's democratization has created a new socio-economic situation. The government has now hired macro- and microeconomic planners. Populations are now being given responsibility for development of villages, thereby assuring more secure land tenure. There are real assets for the development of onchocerciasis-freed areas.

Devaluation has also helped increase the export of agricultural products and therefore increased producers' income—an additional advantage in accelerating Mali's agricultural and pastoral production. Mining, too, is increasing rapidly and should soon provide income that will improve the standard of living of rural people.

But the precondition to all rural activities in the onchocerciasis-freed areas is maintaining their freedom from disease. Control activities therefore must be integral to the primary health care system, and rural communities must take part in carrying them out. Combating onchocerciasis and developing areas freed of the disease both require financial efforts that exceed the capacity of the Malian government, however, and will require the support of all partners in development.

Discussion

The discussion centered primarily on the need to ensure the participation of settlers—particularly women—in the settlement process. Participants stressed the difficulties that women face because of their low levels of education, their lack of marketable skills, and the heavy demands on their time.

Comments

"The onchocerciasis-freed areas have fantastic potential. We need to go to these areas and discover the needs. Then we need to support these areas with infrastructure such as roads, health centers, water points, and improved communication. We must create enough incentives so that people will stay and not move to the cities."

"The presentations have spoken of the negative aspects of settlement for women as well as examples of successful women. What is the percentage of these cases? The general situation of women in Africa is disastrous. We need to work swiftly. Where are we going to be in ten years?"

"There cannot be just one model for settlement, since the situations in our respective countries are diverse. For example, Ghana saw displacement from overpopulated to underpopulated areas. In Niger and Mali the underpopulated areas are desert, and people are leaving and going to the overpopulated cities. We must try to change this by studying the sending areas and finding out how to retain people. We must be careful to avoid overpopulation in the settlement areas. Africans must be involved in the design of projects from the outset because, whatever the good intentions of outside organizations or individuals, they do not understand or sense the situation in the same way as those of us who live in the region. Therefore, sometimes they do not understand why certain changes are resisted by the countries in the region. If this meeting allows the expression of African opinions, then it is a step in the right direction. We must be mindful of the past history of ethnic

groups to facilitate cohabitation in settlement areas."

"Women are not participants at all levels. We must safeguard the gains already achieved by women. In our village committees at least two of the five members should be women, but this is not always done. Women still have a long way to go. Even at this conference we are a minority. Education and information are fundamental to improving women's position, but a change in mentality is also needed in order for women themselves to change. It should be emphasized that we are striving for complementarity with men, not competing with them. Participation of women at all levels is important and this is true with respect to development in the onchocerciasis-freed zones, where women should be able to participate in the planning, implementation, and use of all resources."

"Returning to the question of participation, coordination of efforts is needed such as is found in the OMVG (Organisation pour la mise en valeur du fleuve Gambie). Environmental studies are an important part of these efforts, and similar things should be done in the onchocerciasis areas. From a historical perspective, this area flourished before colonialism. Grain was exported to North Africa. However, colonial policy was to push farmers not to plant millet, but to plant peanuts instead. The local population switched to imported rice for food. Farmers participated in the shift to cash crop production, but was this good? For most Sahelian countries, the level of importation is high, and this is an aberration. There is a need to diversify the production system with the primary goal being to meet the needs of the people. We need to reorient, diversify, and open the markets. But if you open the markets, will this create development? NGOs can help facilitate settlement, but the settlers themselves must be the motor for change. To do this, they must be partners when we define the policies. We need to take into account their hopes and aspirations, otherwise nothing we do here will matter."



Sustainable Agricultural Production

Sustainable, diversified production systems are key to the success of settlement in the OCP area. Initially, settlers produce mainly for subsistence. Once convinced that subsistence production is assured, they diversify rapidly into other crops and, just as important, into other income-generating activities. This means that extension messages must shift over time. Agricultural extension systems need to understand the role that diversification plays in household income-generating strategies. And they need to be able to provide advice on sustainable production systems that are financially viable for small farmers.

For their part, governments need to set appropriate policies to promote sustainable production in settlement areas, policies that will accelerate production while at the same time protect the environment (recommendations 10, 11, 12). To do so, they must understand the farming systems in the surrounding areas from which most settlers will come. They also need to be aware of the fragility of the natural resource base with which they are working—to know its potential carrying capacity for both human and livestock populations. Production systems must be seen as a continuum—from production to farm and village processing to markets, with a counterflow of income for household needs, including inputs for the next production season.

The FAO paper, "Sustainable Agricultural Production: Issues and Policy Requirements in the Onchocerciasis Control Programme Area," reviews the current state of agriculture and the different farming systems in the OCP areas. It describes production systems that allow intensive

cultivation without endangering the environment and outlines steps for creating and supporting such systems.

The paper by Roberto Cugno, of the French Ministry of Cooperation, "Settlement and Development in Ganzourgou Province, Burkina Faso," examines the agricultural issues discussed by the FAO, as well as broader rural development issues, in the context of Ganzourgou Province in Burkina Faso. This area has experienced considerable settlement, both spontaneous and organized, in the past twenty years. The paper details the agronomic, socioeconomic, and ecological impact of settlement in the area, analyzes the cost to the government of planned settlement and makes recommendations on how to promote sustainable agricultural and nonagricultural production in the area.

In a similar vein, the paper by Guinea's Ministry of Agriculture and Animal Resources, "Strategic Guidelines for Sustainable Resettlement of Onchocerciasis-Free Areas," examines the situation in the formerly hyperendemic part of the country where considerable settlement is now occurring. The paper describes the current land tenure rules, the agricultural production systems, and the potential for settlement. It also looks at problems associated with settlement and makes recommendations on how to overcome these problems and promote increased agricultural production and sustainable settlement.

In the final presentation in the session, the Minister of Agriculture of Sierra Leone describes his government's current agricultural policy and its relationship to development in the onchocerciasis zones.

Sustainable Agricultural Production: Issues and Policy Requirements in the Onchocerciasis Control Programme Areas

Food and Agriculture Organization

This paper looks at policies and strategies that would accelerate the adoption, in the areas freed from onchocerciasis, of agricultural production systems that will protect the natural resource base and the environment for the benefit of present and future generations.

Sustainable agricultural and rural development has been defined as follows:

"...the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to assure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable, and socially acceptable."

Sustainable agriculture is inspired by considerations of human needs. It links the protection of resources and the environment to poverty reduction, gender issues, and the creation of production incentives. It recognizes the crucial role of human beings in every sphere of development.

The challenge facing Africa—with widespread poverty, degraded natural resources, high levels of external debt, and a population projected to reach 850 million by 2000 and 1.5 billion by 2025—is to achieve three essential goals:

- Food security
- Employment and income-generating opportunities in rural areas, particularly to eradicate poverty
- Protection of natural resources and the environment.

An effective strategy to meet these goals must extend beyond the purely agricultural sector. It needs to encourage fairer terms of exchange for agriculture in national and international trade, appropriate population policies, adequate financial facilities, measures favoring agriculture and protection of the environment, and a better recognition at the policy level of the need to accord farmers a status commensurate with their role in supplying essential commodities and maintaining the natural resource base.

The implementation of sustainable agricultural and rural development strategies should involve many actors: farmers (many of whom are women and thus still less privileged than most) and other rural dwellers, rural communities, the private sector, government institutions, and intergovernmental and nongovernmental organizations. The success of these strategies will depend largely on

whether a set of broad, mutually acceptable objectives can be established that recognizes and harmonizes the interests of all these actors and the requirements of sustainable development.

The current state of African agriculture

Before taking a closer look at agriculture in West Africa, and in the OCP area in particular, it is worth considering African agriculture in general. Agriculture, including forestry and fisheries, plays a central role in the continent's economy. For many countries, the food and agriculture sector accounts for more than 40 percent of gross national product, and for some of the non-oil-producing countries, 50 to 90 percent of export earnings. In Sub-Saharan Africa, which is particularly dependent on agriculture, the volume of agricultural exports declined by one-third between 1970 and 1980 and had failed to recover by 1990.

If we look at Africa's resource base and its environmental problems, we see that it is a continent of contrasts and extremes, ranging from desert to equatorial forest. Because of this diversity, generalizations are not meaningful. Thus, we normally divide the continent into six major subregions, two of which cover the OCP area—Sudano-Sahelian Africa, and humid and sub-humid West Africa. These subregions accord with national boundaries to benefit from statistical information available at the country level. The land reserves in Sudano-Sahelian Africa (65 million hectares) and in humid and sub-humid West Africa correspond to these subregions' marginally cultivable land; some marginally suitable land in the subregions is already being cultivated.

Natural resources and environmental constraints

Soils. Most parts of Africa suffer from several forms of environmental degradation. Vulnerability to sheet erosion is closely related to slope and vegetation. Soil crusting is a serious physical soil management problem that decreases permeability and increases runoff, thereby causing erosion, and can prevent seedling emergence. Many soils have poor nutrient retention capacity and thus are heavily leached. This is exacerbated by "nutrient mining"—the removal through cropping of more plant nutrients than are returned to the soil by mineral or organic fertilizers or by natural processes. In the more humid areas there are chemical problems—aluminum toxicity and potassium and phosphate deficiency—and many semiarid soils suffer from deficiency in phosphate and organic matter.

Hydrology. Compared with tropical Asia and Latin America, Africa has less surface water and a higher rate of evaporation. The flow of most of its main rivers is markedly seasonal. Irrigation could make a dramatic impact in the drought-prone Sudano-Sahelian region, but only two major rivers—the Senegal and Niger—flow through the OCP area. Both rivers are subject to large

seasonal variation in discharge rates, and would require substantial regulation to supply irrigation water reliably through the dry season. The OCP area contains many small rivers and watercourses, often with only seasonal flow. There is potential in this area for small-scale irrigation using traditional irrigation technologies.

Rangelands. The increase in livestock numbers is placing grazing land under intense pressure. Although livestock is privately owned, property rights controlling access to grazing land often do not exist, so responsibility for land management cannot be allocated. The livestock carrying capacity of the rangelands has already been exceeded in many places, particularly in the Sudano-Sahel. If the present productivity levels were to continue unchanged, the projected livestock population in the year 2010 would require 84 percent of the area of the Sudano-Sahel, clearly an unattainable situation. Much former grazing land is now used for crop production; this often means that adjacent lands are inaccessible for grazing during the cropping season and that access to transhumance routes and water is affected. Large areas could be opened to livestock and would meet future grazing land requirements if water supplies were developed and tsetse infestation eradicated.

Farming systems in West Africa

In West Africa, as elsewhere, the agricultural production systems used by farmers are determined by a unique combination of natural and man-made factors and conditions. Some of these factors and conditions remain constant over long periods, such as climatic and soil conditions; others, such as relative prices and technologies, are subject to more frequent change.

Agricultural production systems in West Africa can be grouped into three types: shifting, fallowing, and permanent. These three types, in that order, also depict the evolutionary progression of agriculture from traditional to modern farming. For the vast majority of farmers in the OCP area, this progression has yet to run its full course.

Shifting systems

Indigenous agriculture occurs in systems characterized by an abundance of land relative to population. Shifting cultivation and grazing practices that use no external inputs predominate under these conditions. The key to sustainability is replenishment of soil nutrients through regrowth of natural vegetation. While this process occurs, the farm population "shifts" its location, returning only after ten to twelve years. At low population densities these systems are productive and can be sustained over long periods with little or no degradation of the natural resource base.

As population densities have increased, farmers using shifting systems have been forced to adjust to the scarcity of land by shortening the fallowing cycle. Mining of soil

nutrients and declining productivity have resulted.

Fallowing systems

In areas with better soils or a longer rainfall period, or both, shifting cultivation systems have evolved into fallowing systems that are applied within a settled environment characterized by permanent field divisions and limited areas for livestock grazing. These systems rely on short fallows of only a few seasons to maintain soil fertility. To minimize risks relating to the climate and pests and to optimize returns from increasingly degraded land, farmers have developed intensive cropping methods that include intercropping and multiple cropping and, when feasible, an integration of crops and livestock and the use of organic fertilizers.

These intensification efforts are not unique to fallowing systems. They have long been used to a lesser degree in most shifting systems and more recently have been used with greater success in permanent systems in areas with higher population density. Such intensification was feasible because farmers gained access to new crops and varieties and to other external inputs, largely through informal channels.

The performance of fallowing systems has been mixed. It depends to a large extent on the natural fertility of the soil, the level and distribution of rainfall, and the population growth rate. In high potential areas with slower population growth, farmers have had sufficient time to develop technologies through trial and error to achieve stable and productive systems. External inputs—higher-yielding and pest-tolerant varieties and limited mineral fertilizers—were important in the development of these systems. Under these conditions productivity has stabilized, but often at levels lower than those realized under the shifting system used earlier.

In areas of rapid population growth farmers have been forced to switch from shifting to fallowing systems while retaining the crops and production methods used in shifting systems. Increased soil degradation and falling crop yields have resulted. In marginal areas productivity has fallen more dramatically as the fallowing cycle has become shorter.

Permanent systems

The shift to permanent agriculture has already occurred over extensive areas of developing countries. A number of variations of the system have developed. More recently, permanent systems based on wheat, maize, and cash crops have emerged in some semiarid upland areas with sufficiently fertile soils and adequate rainfall. Almost all of these systems are monocropped and achieved the significant increases in productivity through green revolution technologies. Mineral fertilizers, fertilizer-responsive

varieties, and, for rice, water control were the key ingredients. Other permanent systems of perennial tree crops have emerged from shifting and fallowing systems, largely in response to increased commercial opportunities.

Agro-climatic environments and sustainability

Knowledge of the sustainability of agricultural production systems is limited. Productivity growth, the best-documented indicator of sustainability, is occurring in the arid irrigation and wet lowland areas where permanent systems are practiced. In the arid dryland, semiarid, semihumid, and humid highland zones, where shifting and fallowing systems predominate, productivity is generally declining or stagnating other than in the permanent wheat- and maize-based systems and permanent tree crop systems.

Indicators of sustainability at the soil system level are the rate of soil and nutrient loss and the level of soil pollution. These indicators are not well documented, nor is the relation between the indicators and productivity well understood, except for macronutrient loss.

Soil pollution is related to the intensity of agrochemical use and improper irrigation practices. Waterlogging, build-up of salinity, and micronutrient deficiencies and toxicities are serious problems in some arid irrigation areas.

Once agricultural production moved beyond extensive shifting cultivation, plant and animal diversity began to decline in all agroclimatic environments. Shifting and fallowing systems pose a threat to indigenous animal and plant species that increases as shifting systems evolve into fallowing and permanent production systems.

Intensification of agricultural production without environmental hazard

Three main strategies have been used to intensify agricultural production: reliance on high levels of external inputs, organic farming, and integrated farming. Each of these strategies can be used as long as the users are aware of the potential environmental hazards involved. But for most situations in Africa the third is the most important.

High external input agriculture

Increasing the use of technology to enhance the productivity of land has allowed many countries to meet or exceed their domestic needs for farm products. Fertilizer and plant protection chemicals have been the main external inputs that have increased yields; plant breeding and improved cultivation techniques have also made a large contribution. In West Africa this strategy has been used in cotton production.

Experience in industrial countries shows that intensification often causes environmental damage. Excessive fertilizer use has caused contamination of water supplies, and

some pesticides are hazardous to humans and to beneficial flora and fauna. The pure stands and monocultures often inherent in high external input systems may exacerbate weed, pest, and soil erosion problems. Although such problems can be minimized through careful management, there is increasing pressure to reduce the use of inputs.

In high external input systems livestock production usually is spatially separated from crop production. This arrangement often precludes the utilization of crop and animal by-products and presents problems of waste disposal.

Organic farming

Organic farming avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. Organic farming systems rely as much as is feasible on crop rotation, crop residues, animal manure, legumes, green manure, off-farm organic wastes, and biological pest control to maintain soil productivity and tilth, to supply plant nutrients, and to control insects, weeds, and other pests. Organic systems are viewed as posing lower environmental risks than systems that rely on high doses of agrochemicals.

Yet organic farming still represents an intensification of land use compared with many farming systems used in West African countries. It aims at maintaining yields at a remunerative level by intensifying internal nutrient cycles and recycling organic material, and at increasing the frequency of crops through mixed cropping and rotation. Because organic systems depend on higher labor inputs, they tend to be competitive only where labor costs are very low or where consumers will pay a premium for organic produce, as in many high-income countries. In most developing countries, labor costs are low but the possibilities for special market outlets are minimal. Moreover, population and income growth may require increases in domestic production beyond the yield potential of organic farming.

Integrated farming systems

Integrated production systems accept moderate and environmentally appropriate use of external inputs—mainly fertilizers and pesticides—in combination with measures to make maximum use of internal nutrient recycling, biological pest control, and complementarity between different crops and between crops and livestock.

Integrated pest management, integrated plant nutrition, soil conservation, and efficient and nonexhaustive use of water are mutually reinforcing measures. They should be applied together in the farming system at the intensity levels appropriate to the physical and socioeconomic conditions; the optimum strategies are highly specific to individual farms.

Socioeconomic policy and environmental management considerations

The socioeconomic policy and environment nexus is crucial in determining sustainable use of natural resources. In Africa development strategies have long given too little attention to agriculture—including the fisheries and forestry—despite its important role in African economies.

Country development strategies may contain an urban, anti-agriculture bias as the result of a concurrence of macroeconomic and sectoral policies that most likely are not intentionally anti-agriculture. But the domestic terms of trade move against agriculture as the prices farmers receive fall relative to those they pay for inputs and consumption goods. At fault are policies that maintain an overvalued exchange rate, that tax export trade, or that protect domestic industry through tariffs or quantitative restrictions, leading to higher prices or short supplies for agricultural inputs and consumption goods.

Inadequate investment in and poor maintenance of rural physical infrastructure, particularly in transport and communications, result in reduced incentives for farmers and high marketing costs. Inadequate investment can hurt agricultural research and extension, and marketing and credit organizations. And it can contribute to the breakdown of indigenous land and property rights, leading to the creation of open or private access rights, landlessness, and rural poverty.

Many governments have intervened, through subsidies and credit provision, to offset the deteriorating terms of trade for agriculture. But often such interventions are inadequately focused, so that the larger, richer farmers benefit the most and the smaller, poorer farmers not at all. And government interventions, whether in research, extension, credit, access to land, or input supply, have often neglected women farmers, who play critical roles in agricultural production for home provisioning as well as for cash.

The widespread adoption of structural adjustment programs in Africa has led to the phasing out of many of the market interventions and price distortions. The net effect on farm incomes and production incentives has been mixed, depending on the prevailing macroeconomic and market policies. Adjustment programs offer both opportunities and challenges to modify the “urban-biased” development strategies and to support a move toward sustainable agriculture.

Moving toward sustainable agriculture

Whether sustainable agriculture can be achieved ultimately depends on the motivations, perceptions, capabilities, and attitudes of rural dwellers using natural resources. They must feel responsible for the natural resources that they exploit to satisfy their needs. The fundamental prob-

lem arises when resource users upset the balance between the resource base and their needs, by using it inefficiently for their short-term interest alone. Sustainable development can only be achieved by steps that progressively remove the financial, cultural, and institutional constraints, and enhance the knowledge base, that govern the resource users' decisions.

Many environmentally sound agricultural practices have been shown to be technically successful, such as agroforestry, minimum tillage, alleycropping, water harvesting, and water spreading. But, mainly because of social and economic constraints, these practices have not been adopted by the great majority of farmers. Farmers need incentives and assistance to adopt agricultural technology that enhances yield and conserves soil and water.

Limited economic data are available to assess the costs and benefits of alternative ways of exploiting natural resources and to arrive at rational policies for natural resource management. Improved research is needed on the key characteristics of the resources and of their users. Special efforts are needed to fully assess the economic value of the resources and how this value is affected by the manner and degree of their exploitation. Improved research and information are also needed to deal adequately with the potential tradeoffs between different users of a resource.

The move to sustainability in agricultural production must transform traditional agricultural and fisheries exploitation systems into science-based systems, through a combination of strategies and policies adapted to local conditions. In the OCP areas of West Africa, national governments and their development partners should in the first instance *protect, conserve, and sustainably use the natural agricultural resource base* by ensuring that:

- Land clearing practices are appropriate
- Land is used for crops that maintain soil fertility
- Necessary fallow periods are maintained to guard against overexploitation
- Grazing lands are managed at stocking levels that avoid overgrazing
- A protective forest cover is maintained, especially on watersheds
- Harvesting and growth of fuelwood are in balance
- Fisheries resources are not overexploited
- Biological and chemical qualities of water are maintained
- Ecosystems are safeguarded against pollution.

Conclusion

Governments and their development partners should adopt measures to increase farm productivity by elevating the yield thresholds on traditional crops, introducing non-traditional crops and livestock enterprises, developing labor-saving technologies (particularly for women) and improving labor efficiency, identifying alternatives to shifting cultivation, and designing cost-effective techniques for restoring the productive capacity of degraded lands.

Where land resources are limited, expanding productivity will require the improved use of such inputs as water, fertilizers, and high-yielding cultivars and, where feasible and economical, the use of higher levels of inputs. In some instances, the cultivable land area must be expanded through major land improvements such as land reclamation through drainage and flood control. Agricultural research and extension efforts will need to identify techniques and innovations that will lead to sustainable production of locally consumed foods, taking into account that women farmers provide 60 to 80

percent of the labor input for producing these foods.

National policies should aim at increasing social responsibility and environmental awareness. They should create a framework and institutions that help internalize the need for environmental conservation and promote conscious, voluntary participation in decisions on resource use. Decisionmakers should promote research into new systems of relationships between the individual and the community, on one hand, and land, forest, and water resources on the other, and they should adapt resource tenure and management rules and rights to the holistic development needs of societies.

Through these measures governments in the OCP area can address several of the needs mentioned in the guiding principles such as natural resources conservation and management, the provision of essential support services and input supplies, policies to support small farmers, and the promotion of sustainable agricultural production through enlightened planning, appropriate policies, and effective problem-oriented research and extension programs.

Settlement and Development in Ganzourgou Province, Burkina Faso

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Beginning in the 1970s, the government of Burkina Faso (then Upper Volta) and the international donor community, including France, agreed to set up a large-scale model operation combining the health objective of controlling onchocerciasis with the more general objective of opening up for development "new land" throughout the catchment area of the Volta rivers. Progress had been made during the 1950s in identifying the nature and extent of onchocerciasis through health research and other work by organizations such as the Center for Research on Controlling Major Endemic Diseases in Bobo Dioulasso. The methods developed for controlling onchocerciasis were based on eradicating the insects (simuliids) that are the vectors of the disease and, to be effective, had to be applied over vast areas. Between 1968 and 1974, a regional program was developed to eradicate simuliids.

In Burkina Faso a government agency, *Autorité d'aménagement des vallées des Voltas*: (the Volta Valleys Development Authority, AVV), was charged with organizing the settlement of the newly "liberated" lands. The AVV was incorporated in 1974 as an industrial and commercial statutory body with financial autonomy and placed under the supervision of the Ministry of Rural Development. The AVV began preliminary design work for the settlement operation in 1971, with financing from the French development fund, *Fonds d'aide et de coopération* (FAC).

Settlement and development goals

The primary goal was to redirect development efforts toward the "new land" in the river valleys and to decrease the population density on the overpopulated central Mossi Plateau, where pressure on the land was considered excessive. The AVV development scheme, in seeking a more appropriate balance between population distribution and production potential through organized or "directed" initiatives, formed the cornerstone of a voluntary regional development policy designed to achieve a new equilibrium in nationwide rural development.

The measures that the AVV took, from its inception until its reorganization in 1991 as *the Office national d'aménagement des Terroirs* (the National Office for Land Development, ONAT), toward developing the underpopulated areas of the Volta valleys reflect three main objectives. First, the AVV sought to achieve rational land use planning in the Volta valleys. To achieve optimal land use, the AVV gave priority to developing and implementing guidelines

for zoning and distributing land based on the planned development activities. The land previously had been used by groups of transhumant Peuhl pastoralists and seasonally by neighboring villages.

Second, the AVV deemed it necessary to organize a program of planned settlement, as opposed to spontaneous settlement of indigenous or recently arrived groups not sponsored by the AVV. The planning centered on three issues: recruiting migrants from the central Mossi Plateau, settling migrants in the areas identified by the guidelines, and pacing the recruitment and settlement to accord with the ability of the AVV to complete the necessary infrastructure and improvements.

Third, the AVV sought to initiate economic growth in the newly developed valleys through:

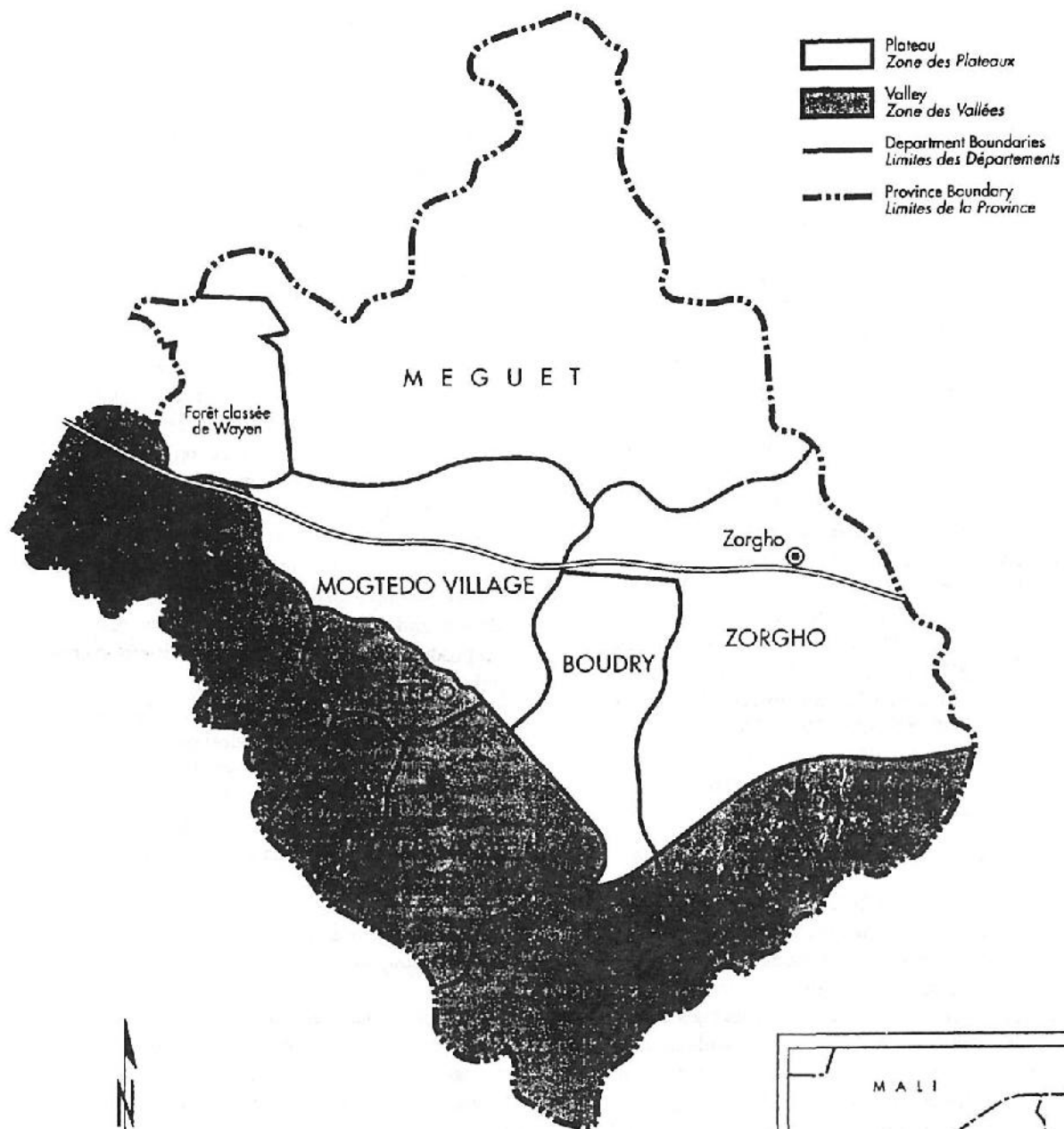
- Increased food self-sufficiency and cash income for the primary participants. The AVV viewed higher cash income for farmers not only as a means to raise their general standard of living and enable them to acquire modern means of production, but also as a deterrent to internal and external migration. Moreover, reducing the chronic shortage of food staples and developing export crops (cotton) would help increase the foreign currency available to purchase imports and finance development.
- Modernization of farming systems, to increase the production and productivity of both food crops and cash crops.
- Preservation of the ecological balance. The challenge of preserving the ecological balance had been raised from the outset, with regard both to maintaining and restoring the fertility of the fragile and depleted soils and to protecting and renewing the forest resources threatened by the cutting of firewood for Ouagadougou.

Development and settlement in Ganzourgou Province

The province is characterized by:

- A Sudano-Sahelian climate that has unreliable rainfall, averaging about 700 millimeters a year, but which sustains cereal, pulse, and cotton crops and stock raising
- A population density of about 55 to 60 people per square kilometer, which leaves little space for traditional cropping systems and contributes to the steadily increasing depletion of the soil
- Excess food production at least three years out of five, which is sent primarily to the markets of Ouagadougou and Pouytenga (Pouytenga is 30 kilometers east of Zorgho)
- A high rate of out-migration. Soil fertility is decreasing, with the possible exception

BURKINA FASO GANZOURGOU PROVINCE PROVINCE DU GANZOURGOU



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