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New Land is Not Enough: Agricultural Performance of New Lands Settlement in West Africa

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Summary. — For centuries onchocerciasis, or river blindness, has contributed to the underpopulation of fertile river basins in much of the West African savanna. For this reason, an 11-country program initiated in 1974 to control river blindness disease was expected to increase total crop production and improve living standards. Farm management data from 15 sites show that despite the control program's success in opening up new land, the farmers moving back into these areas were successful in increasing and stabilizing their incomes at only five of the 15 sites. Two of the major factors that explained these low success rates were the highly negative policy environment and lack of appropriate technology and supports for intensive cereal production in the drier semi-arid basins. © 1998 Published by Elsevier Science Ltd. All rights reserved

Key words — West Africa, onchocerciasis, disease control, settlement, agricultural development, crop technology

1. INTRODUCTION

In 1974, the World Health Organization (WHO) launched phase one of a massive $56 million program to control onchocerciasis (river blindness disease).[1] Today, more than two decades after control began, the 11-country Onchocerciasis Control Programme (OCP) is widely heralded as one of the most successful health projects ever launched in sub-Saharan Africa. Onchocerciasis is no longer a public health threat and large areas are being resettled at accelerated rates.

Although the principal justification for the OCP was to facilitate economic development of the infected river basins, the program has limited its activities to disease control. Each affected country was responsible for the settlement and development of its own river basin areas. In six of the seven

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countries covered by phase one (Benin, Côte d'Ivoire, Ghana, Mali, Niger, Togo), government programs provided basic infrastructure and social services for settlers who were expected to move into the river basins on their own, as well as for a few more specialized planned settlement projects (Akwabi-Ameyaw, 1990; Buursink and Painter, 1990; Hunting Technical Services Ltd., 1988; Koenig, 1990; McMillan *et al.*, 1992b; OCP, 1986; Painter, 1990). Burkina Faso (Upper Volta) was the only country to designate development planning for the OCP river basins as a national priority.

This article describes the agricultural performance of new lands settlement at 15 sites in four countries (Burkina Faso, Ghana, Mali, Togo) chosen to represent the broad types of settlement and follow-up planning that occurred during the first two decades of control. Since the river basins tend to be the best available lands within a given region, we are specifically concerned with evaluating the success of the resulting new lands settlement in raising agricultural output and incomes and in maintaining these at higher levels over time. The principal thesis of this paper is that to date the impact of all types of institutional models for development planning—capital intensive as well as less capital intensive—have been hampered by the unfavorable macro-policy environment for agriculture and insufficient investments in adaptive regional research and infrastructure.

Section 2 provides a brief overview of constraints to agricultural development in West Africa and the more specific constraints that affect new lands settlements. This is followed in Section 3 by a description of the data collection process and the definition of success used in this review of agricultural performance at the 15 sites. Section 4 groups the 15 research sites into five broad categories of growth experiences and analyzes the factors that contributed to or detracted from agricultural success. Section 5 summarizes the relative importance of different factors outlined in Section 2 in determining agricultural success at the study sites. The conclusions consider the overall effects of the OCP program and make specific policy recommendations for improving success rates.

2. BACKGROUND

(a) *The Onchocerciasis Control Programme (OCP)*

The high incidence of onchocerciasis has been one of the principal reasons that most river basins in West Africa's semi-arid zones have remained sparsely inhabited despite high population pressure in adjacent zones. The inhabitants of the most severely infected river basins followed a cyclical migration pattern, leaving the valleys in response to the disease, then returning again when the poor inland soils could no longer support their numbers (Hervouet, 1977, 1978; Hunter, 1966; Marchal, 1978).

Since these river basins have greater agricultural potential than surrounding areas and include much of the land suitable for irrigation, this lack of settlement has been a major constraint to agricultural development. For this reason, national governments and foreign donors who supported the agricultural development and drought relief programs in the mid-1970s anticipated that an international program to control onchocerciasis would create new settlement opportunities for limited resource farmers from more drought prone ecological zones, and that the associated increase in rain-fed and irrigated crops could help reduce trade imbalances and foster food security (OCP, 1985; PAG, 1973). In sum, what donors envisioned was a wide range of "forward and backward linkages" (Hirschman, 1958) resulting from a single investment in control.

When the Onchocerciasis Control Programme (OCP) began in 1974, there was no acceptable mass prophylactic or treatment for the disease. Consequently, the early program focused on controlling the blackfly vector by repeatedly spraying the infected river basins with biodegradable insecticides to destroy the fly's larvae. The original sphere of operation covered 764,000 km^2 in seven countries—Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, Niger, and Togo (Figure 1). In 1986, the control zone was expanded to cover four more countries—Guinea, Guinea-Bissau, Sierra Leone, and Senegal—for a total area of 1.3 million km^2 (Figure 1).

Today, more than two decades after control began, the 11-country OCP is considered to be a development "success." The World Bank estimates that the control program has created new settlement opportunities on 25 million hectares of potentially highly productive land (Kim and Benton, 1995, p.9). An estimated 30 million people are no longer at risk, and more than 1.5 million people, who once had impaired vision, have fully recovered and suffer no trace of the disease (Kim and Benton, 1995, p. ii). In a recent cost-benefit analysis of the program, researchers calculated that the OCP had "some of the best economic returns [18–20% over a 29 or 39-year project horizon] among Bank projects... in virtually any sector" when the benefits gained were "represented by the additional agricultural output produced as a result of the extra labor force and agricultural land made available through the control of river blindness" (Kim and Benton, 1995, p. vii, viii).[2] This high level of success has encouraged

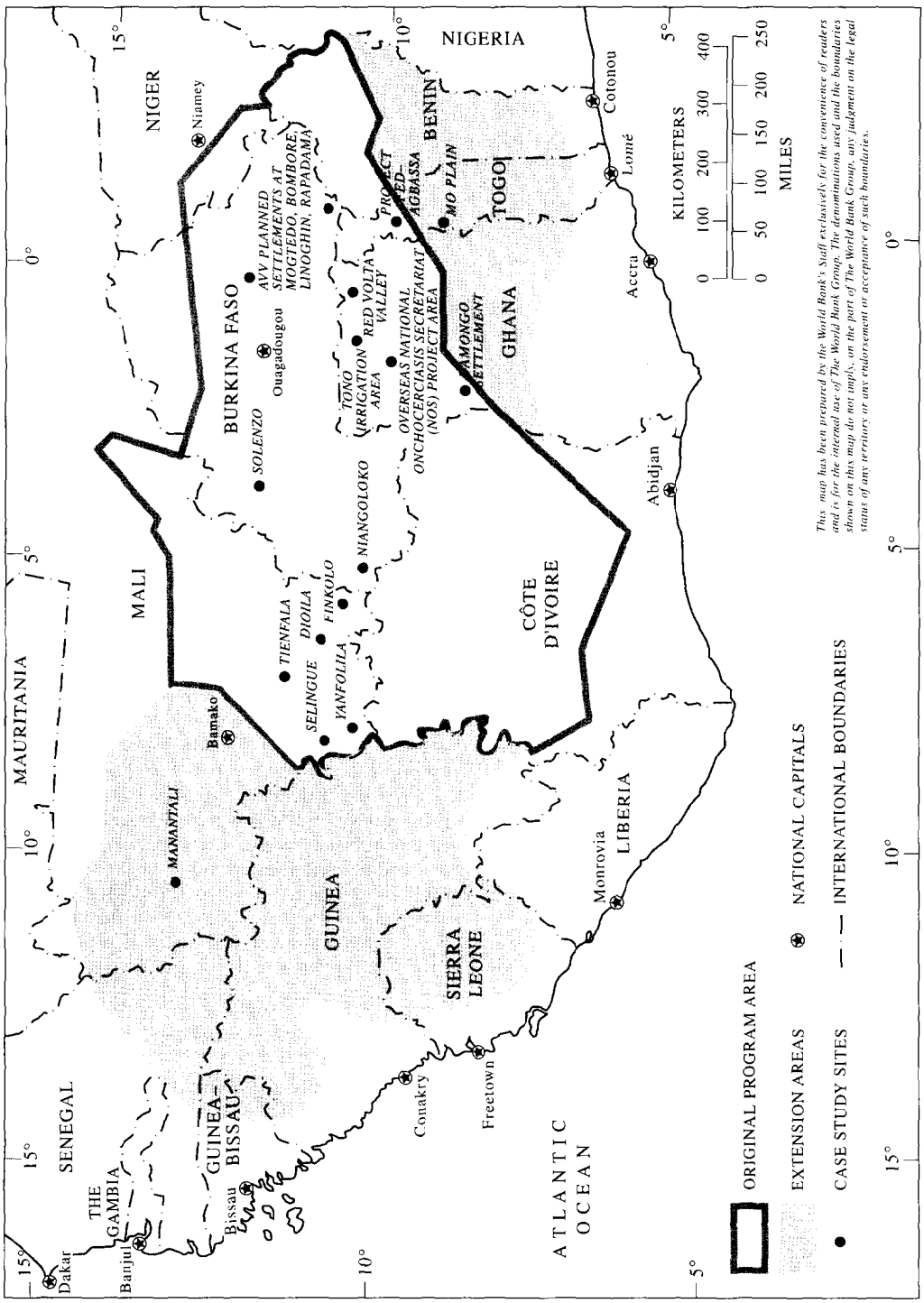

Figure 1. *The Onchocerciasis Control Programme and case study sites in Burkina Faso, Ghana, Mali and Togo.*

foreign donors to fund a new program to extend river blindness control into another 16 countries in East and Central Africa.

The availability of this land creates a host of new planning opportunities and constraints. Most of the new lands settlement is spontaneous, with little or no access to government services or basic infrastructure (Hervouet *et al.*, 1984; OCP, 1986; Elder and Cooley, 1996). By far the major criticism of unassisted, spontaneous settlement in the OCP, as well as other areas of Africa, is that unassisted settlers tend to cultivate the largest area possible, giving little attention to conservation of the new area's soil, forest, or water resources.

When new lands settlement is beginning, it is still easy to acquire new fields so there is little incentive to invest in more cash and labor intensive crop production and conservation practices. As population pressure increases and the new frontier disappears, farmers mine the soils and begin to exhaust the crop nutrients. At this point the initial gains afforded by clearing and colonizing new land begin to deteriorate.

Settlers then respond with one of four strategies:

—intensify their existing livestock and cropping systems;

—diversify with increased nonfarm employment that enables them to compensate for low production levels;

—relocate (extensify); or

—experience further soil mining and deteriorating living standards.

Only the first and second agricultural strategies are "successful." We have avoided the often ambiguous term "sustainable"[3] here and define agricultural success as a strategy that allows sufficient natural resource maintenance to enable continued settlement without income decline. Strategy three tends to repeat the same cycle of extensive field clearance, soil mining, and outmigration to another zone (Scudder, 1981, 1984; Angel, 1985; Van Raay and Hilhorst, 1981). While strategy four may delay migration temporarily, it usually results in declining incomes and soil fertility depletion. Thus a key issue is the need to identify which factors are most likely to contribute to settlers' making the shift from extensive land practices toward greater intensification (strategy one) or diversification (strategy two).

(b) *Constraints to agricultural development*

Three of the most important constraints to agricultural development in West Africa (Sanders *et al.*, 1996, pp. 14; 200–223) are:

—inadequate adaptation and diffusion of the substantial achievements of public investment in agricultural technology research over the last 20 years;

—the failure of economic policies to encourage output and investment in the agricultural sector; and

—the inability of farmers to acquire capital either from their own savings or from the private or public sectors to finance the increased input purchases necessary for technological change in agriculture.

Technological change to augment land productivity is the principal method of increasing output once the agricultural frontier has been exhausted. In addition to the technologies that are already being adopted, including contour dikes and new cultivars of maize, cowpeas, and cotton, a number of more complicated or more expensive technologies including tied ridges and the more generalized use of inorganic fertilizer have proven to be successful in field and experiment station trials (Matlon, 1990; Sanders *et al.*, 1996, pp. 84–88; 100). More widespread dissemination of these new technologies will require scientists to adjust them for different soil characteristics and to combine them with new cultivars. These adjustments require well-trained scientists, experimentation, a regional experiment station network, time, and money.

Even if a new technology tests well for regional adaptation, it will not be widely adopted unless farmers are able to acquire the necessary inputs and to sell the crop at a remunerative price. Prior to the January 1994 devaluation of the FCFA for the 14 countries in the French Economic Union, economic policies in most of the countries affected by control penalized the agricultural sector in order to benefit urban workers by keeping food prices low. This urban bias resulted principally from overvaluation of the domestic currencies and other import substitution policies to promote industrialization. One result of these price distortions, rising urban incomes, and deteriorating rural-urban terms of trade was a shift in urban food preferences to imported cereals, wheat and rice,[4] away from the domestically produced staples of sorghum and millet in the semi-arid regions, and maize and root crops in the higher rainfall zones.

To offset these distortions, which reduce the profitability of agriculture, many countries subsidized imported chemical inputs, especially inorganic fertilizers and pesticides. In the mid to late-1980s, the World Bank began pressing developing country governments to eliminate input subsidies. The most visible short-term impact of these policies was a dramatic increase in the prices paid for fertilizer in the late 1980s that outstripped the increase in food prices and the administered price for exports such as cotton. The 1994 devaluation caused an additional increase in the price of inorganic fertilizer and other

imported chemicals (Coulibaly, 1995). Hence the initial effects of recent economic policy have been to further reduce the profitability of agriculture.

In the longer run, the same policies that increased the prices of imported inputs should put upward price pressure on domestic food substitutes, encourage the use of more inorganic fertilizer, and make agriculture more profitable. In fact, recent research in southern Mali—an area which was once highly endemic for onchocerciasis—shows a jump in domestic cereal prices relative to inorganic fertilizers in 1996, once the favorable cereal stock position in 1994 was exhausted (Kebe, cited in Coulibaly, Vitale and Sanders, forthcoming).

Finally, the shift to more intensive agricultural systems requires farmers to spend more on inputs, specifically improved seeds, inorganic fertilizers, other chemicals, and animal traction. Where does this capital formation come from to allow the farmers to make these investments? Farmers' access to formal credit is almost exclusively linked to the sale of export crops such as cotton and peanuts. Farmers can also generate their own savings internally from the sale of cash crops as well as local wage labor, migrant labor remittances, and other sources of nonfarm employment (Matlon, 1988; Reardon *et al.*, 1992; Savadogo *et al.*, 1994).

The above three constraints are interrelated. To increase yields, higher input levels are required. For farmers to be able to purchase more inputs, they require an economic environment in which profits can be made at an acceptable level of risk, the provision of adapted agricultural technologies, and the evolution of input and product marketing systems.

While these three constraints apply to agricultural development in general, their impact is accentuated by a fourth constraint specific to the isolated river basins. Historically, almost all the affected river basins have had low population densities and been poorly integrated with national markets. Hence, both administrative and social services, ranging from physical infrastructure (roads, bridges) to health care, education, and extension are generally sparse (McMillan *et al.*, 1992b, p. 14). Even when agricultural extension services are provided, they are not always appropriate given the lack of data on which to base recommendations.

3. ANALYZING SETTLEMENT PERFORMANCE

This article evaluates the agricultural performance of new lands settlement at 15 sites in four countries (Burkina Faso, Ghana, Mali, Togo) that were judged to be representative of the major types of settlement and planning interventions taking place in the OCP river basins during the late 1980s (Figure 1). More specifically, the article groups data from the 15 sites into five broad categories of growth experiences and analyzes the relative importance of the different factors outlined in Section 2 in determining the shift toward more intensive or diversified crop production systems. An intensive crop production system is defined as one in which farmers invest labor and cash in technologies that facilitate increasing yields. A successful diversified system is defined as one in which settlers earn money from nonfarm employment, a portion of which is being reinvested in more intensive crop production practices.

The research was undertaken as part of an 11-country survey of settlement and development in the OCP river basins funded by the United Nations Development Program and executed by the World Bank through the Institute for Development Anthropology (McMillan *et al.*, 1992b).[5] The 15 sites that provide the focus of this paper were chosen to represent the broad categories of settlement taking place in the valley as a result of the OCP. Background information (Hunting Technical Services Ltd., 1988; OCP, 1985, 1986) available at the time showed important differences in oncho-related settlement patterns between and within agro-ecological regions.[6]

The new settlements could be further distinguished by the overall level of government and other agency assistance in the settlement process. In planned settlements such as the Volta Valley Authority (AVV) in Burkina Faso or the FED-Agbassa Project in Togo, some agency was involved in almost every phase of the development program, including: surveying and preparing the land; transferring and installing settlers and providing them with initial support; formulating and introducing specific production regimes and input packages; and implementing major technical innovations such as irrigation and animal traction. In assisted settlements, one or more agencies and/or nongovernmental organizations (NGOs) provided basic agricultural services and, in a few cases, basic infrastructure such as roads, warehouses, and extension worker housing to areas of spontaneous settlement. Spontaneous, unassisted settlement refers to immigration and settlement by families without the benefit of formal sponsorship, support, or guidance, such as in the Mo Plain (Togo) and the Red Volta Valley (Ghana).

Few of the 15 sites considered here can be neatly pegged into a single category of sponsored, assisted spontaneous, or unassisted spontaneous settlement. Sponsored settlements such as the AVV, for example, often catalysed a surrounding swath of unassisted spontaneous settlement into the surrounding area so that what we usually found was a mixture of settlement types and government interventions. The final choice of three to four study sites per

Table 1. *The land settlement review case studies*[a]

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 (1983)	Comoe province
3. Kompienga (1v:35hh)	Dam-related planned resettlement and spontaneous (1986–90)	Gourma province
4. Volta Valley Authority (AVV-UPI)		
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 (7v:6hh)	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 Region
3. Damongo Settlements (3v:30hh)	Planned (1952–74) Spontaneous (1955–88)	Northern Region
4. Tono Irrigation Scheme (2v:30hh)	Planned (1980s)	Upper East Region
Mali		
1. Selingue (3v:29hh)	Dam-related planned and spontaneous (early 1980s)	Third Region (Sikasso)
2. Diofila (3v:30hh)	Spontaneous (1960s)	Second Region (Koulikoro)
3. Finkolo (3v:30hh)	Wage workers in workers'villages at tea plantation (late 1960s)	Third Region (Sikasso)
4. Tienfala (3v:9hh)	Spontaneous (from early 1900s to present)	Second Region (Koulikoro)
5. Manantali (14v:70hh)	Dam-related planned (1986–87)	First Region (Kayes)
Togo		
1. FED-Agbassa (3v:30hh)	Planned (1972)	Kara Region
2. Mo Plain (3v:30hh+6v)	Spontaneous (1983)	Central Region

[a]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.
Source: McMillan *et al.* (1992b).

country was based on the research team's assessment that the sites represented important categories of single type and/or mixed settlement taking place on a large scale within that country (Table 1).

The four countries surveyed—Ghana, Burkina Faso, Togo, and Mali—were selected based on the significance of oncho-related settlement within the country both in absolute numbers and the extent of the geographical area affected by the original OCP. In general, macroeconomic policies (structural adjustment) of removing the subsidies on inputs were very similar in the 1980s. Ghana had earlier devaluations with the devaluation of the FCFA for the other three countries only in January 1994, after this study.

When the Land Settlement Review started, there was almost no census data on settlement locations or composition. For this reason, the Land Settlement Review methodology used a combination of intensive case studies of individual settlement sites and literature review. Repeated field studies were undertaken in the AVV and Manantali sponsored settlements during 1978–1989.[7] To gather comparative data on other 13 sites we designed a farm monitoring survey to elicit comparable information on the 1988–89 crop production year. The farm families included in the survey were identified by local leaders. Whenever possible, we attempted to choose a representative sample of the major socioeconomic groups living at a site. Ultimately the research included indepth, frequent visitation interviews with 485 households in 66 villages. Leaders and other community members, including members of the indigenous host populations not included in the survey, were interviewed in an additional 48 villages (Table 1).[8]

4. REVIEW OF THE SITES

(a) *Type I Sites: No evidence of agricultural income growth*

The first five sites (four in Ghana and one in Mali) are grouped into Type I because we found no evidence that the majority of study households had ever been able to move beyond basic subsistence in the 1980s (Table 2). Instead the outside settlers and indigenous host's recolonization of the valleys was reinstating the same low living standards that characterized their "home" areas before they moved. At Selingue, the situation of the settlers who immigrated from outside the region was even worse than that of farm families who had not moved.

In Ghana, this widespread lack of success was attributed to the extremely negative national policy environment in the decade before 1988, which was further complicated by a 200-fold increase in the price of fertilizers due to lower subsidies for imported inputs and the repeated devaluation of the cedi in the 1980s (Akwabi-Ameyaw, 1990). With almost no access to improved technology or fertilizer, farmers attained very low yields and low net agricultural incomes. Few smallholder households were able to move beyond basic subsistence. Although the sponsored settlers living in the Tono irrigation project site benefited from a special program which allowed them to purchase inputs such as fertilizer through the parastatal FASCOM (Farmers Services Company), access to these inputs was constrained by other project policies which required farmers to reimburse their credits just after harvest. Since this was the period when farmgate prices were at their lowest, profitability was often low. The resulting high level of uncertainty discouraged farm families from using inputs or investing in the agricultural sector.

Also important in the north of Ghana was the lack of well maintained roads. While this applied to the north in general, it was especially severe in the sparsely populated river basins. This isolation translated into lower crop prices and lower levels of social infrastructure. Despite the extremely negative situation at the sites, there was little evidence of large-scale emigration. The chief reason seems to be the lack of more attractive alternatives.

In the one major case in which there was an attempt to aid spontaneous settlement in Ghana's affected river basins, the government built roads and subsidized extension and marketing services at Fumbisi in the late 1970s. Unfortunately, the terms of access to the new assisted settlement program excluded all but a small non-local, non-resident elite at the expense of the indigenous population. The result was an increase in land tenure conflicts including burning crops (Akwabi-Ameyaw, 1990; Goody, 1980). Little emigration took place, so this was a case of soil degradation and declining living standards.

Selingue (Mali) provides another case in which there was no observed increase in settler income or welfare. The original irrigation project was designed in part to compensate for land loss among the indigenous Malinke displaced by construction of the Selingue dam. To increase the perimeter's productivity, the management encouraged additional immigration and decreased the amount of land allocated to individual households to 0.25 ha for households with 1–8 economically active individuals and 0.5 ha for households with 9–16 active individuals. Despite above-average yields, few of the non-indigenous settler households could be self-sufficient based on an average rice production of only 114–160 kg/person from the official project fields (Koenig, 1990, pp. 38–39; Koenig, Diarra and Sow, forthcoming). Chronic land shortages made it

Table 2. *Type I: Sites showing no agricultural income growth due to inappropriate technology and extremely negative micro and macro-policy environment for agriculture*

Site, settlement type and period, crop research and extension	Identified constraints/opportunities to higher yielding crop production systems
Red Volta Valley (Ghana) —Circular spontaneous immigration in and out of valleys; —Cotton Development Company (parastatal)	—Limited supplies good land —Limited access markets —Acute shortage secondary access roads —Limited access to technology, credit, fertilizer, and extension cotton only
Fumbisi/Overseas (Ghana) —Assisted Spontaneous; —Large scale rice farming with tractors and subsidized inputs (1970s) aimed at large commercial farmers	—Abundant supplies good land —Very limited access markets —Acute shortage primary and secondary access roads —Inappropriate technology —No access to credit or fertilizer except for large commercial farmers —Difficult access to reliable drinking water —Vulnerability to periodic flooding and drought
Damongo (Ghana) —Sponsored (Frafra ethnic group) (1952–74) Spontaneous (Konkomba ethnic group) (1955–88) —Mechanized farming	—Abundant supplies good land —Soils suitable for yam production —No access credit, fertilizer or extension —Differential access to land depending on when settlers arrived —Conflicts between indigenous hosts and settlers —No research or extension on the dominant yam crop production system
Tono (ICOUR) (Ghana) —Sponsored (1975–present) —Mechanized farming (irrigated and dryland)	—Appropriate technology —Easy access extension for rice and tomatoes —Limited access to credit and fertilizer due to project market policies —Unexploited opportunities for irrigated and rainfed agriculture —Inappropriate policies for marketing rice —Strong local demand but poor prices for highly seasonal, perishable tomato crop
Selingue (Mali) —Sponsored (early 1980s); Spontaneous (1980s) —Irrigated rice for sponsored settlers expanded to include spontaneous	—Good market access —Good primary access roads —Insufficient supplies of arable rainfed land that were exacerbated by dam construction —Inappropriate, insecure land tenure policies —Circumscribed access rainfed land outside scheme —Land tenure conflicts with indigenous population

Sources: Akwabi-Ameyaw (1990); Koenig (1990); Koenig, Diarra and Sow (forthcoming).

virtually impossible for the non-indigenous settlers to obtain rainfed fields outside the scheme. Although production was much higher for the indigenous Selingue inhabitants (300 kg/person), who had greater access to non-project rainfed fields, the high potential for soil degradation in these areas made it unlikely that this level of production could be sustained over the long term. This impoverished agriculture plus a small administrative zone produced a few nonfarm employment opportunities for the lucky indigenous Selingue inhabitants with social networks or cash but almost none for the non-indigenous settlers. Not one immigrant farmer reported earning any nonfarm income at all.[9] As at the Ghana sites, the difficulty of acquiring new land rights in other regions seems to have stemmed massive out-migration and thus soil degradation was proceeding.

(b) *Type II Sites: Increased agricultural income based on extensive cultivation*

A very different scenario was observed at the Type II sites which had experienced high rates of recent new lands settlement (Table 3). The key difference here was that there was strong market demand for locally produced crops. This combination of strong market demand and the natural fertility of the new soils increased total production and catalysed a wider process of regional economic growth.

Cotton production in the Niangoloko subsector (Burkina Faso) increased tenfold (from 50 to 500 mt) in just three years (1985–88) due to Burkinabè labor migrants returning home from Côte d'Ivoire and settling in the once highly infected Comoe and Leraba river basins on the Burkina-Côte d'Ivoire border (Nana, 1989). By 1988, less than five years after the completion of the first bridge linking the isolated Mo Plain (Togo) with nearby population centers, the Mo Plain had become Togo's prime yam-producing area (Painter, 1990). High market demand for the yams in addition to relatively easy access to regional markets meant that this increased production translated into higher incomes. In 1988, the combination of high production and high demand for the products of the spontaneous settlers living at Kompienga meant that their recorded mean productivity per worker in terms of Adult Labor Equivalents (ALE)[10] was one of the highest averages at all of the Burkina sites (McMillan *et al.*, 1993).[11]

New land was still available in the Mo plain and Niangoloko sector although various pockets of population pressure were already occurring near the major market and administrative centers (Painter, 1990; Nana, 1989). This was not the case, however, at Kompienga where the high rates of new lands settlement had already occupied almost all areas with even medium potential for crop production near the town. One response, after 1990, was a second generation of out-migration to create small cultivation hamlets, 15 to 25 km from Kompienga.[12] Researchers predicted a similar pattern of out-migration would occur from the more densely settled areas of the Mo Plain and the Niangoloko subsector unless there were major changes in crop technology and extension to enable the successful shift to intensive production techniques (Nana, 1989; Painter, 1990). Thus although the Type II settlements were successful, the long-term prospects for maintaining this success were not at all clear.

(c) *Type III Sites: Early increases in agricultural income not maintained*

In an attempt to circumvent the multiple macro- and micro-level constraints to development, the AVV (Burkina), FED (European Development Fund)-Agbassa, (Togo), and Manantali (Mali) projects provided settlers with a planned settlement package to develop basic infrastructure and services (Table 4). Certain aspects of the resettlement program, such as greater access to new, uncleared land and, in the case of FED-Agbassa and the AVV, a prescribed extension package, created a short-term agricultural success by increasing crop and nonfarm employment.

At Manantali (Mali), the state withdrew its support for credit and other inputs for peanuts as part of the national plan for structural adjustment in 1987, just one year after the resettlement program began (Diarra *et al.*, 1994; Koenig, 1990). Despite these problems, the settlers were able to reestablish basic food self-sufficiency as early as 1989 in large part due to the natural fertility of the heretofore uncultivated soils (Diarra *et al.*, 1990). The settlers also were able to supplement their income with money received from relocation payments and construction work, much of which was invested in livestock and small-scale trade.[13] Based on these positive trends, the project was judged a "qualified success in terms of the ability of individuals to at least sustain their standard of living" (Koenig, 1990, p. vii).

By 1993, however, the settlers were experiencing increased problems with soil fertility and plant disease, and a consequent decline in yields. Peanut and millet yields were 1,107 kg/ha and 934 kg/ha respectively in 1988–90 but only 900 kg/ha and 700 kg/ha in 1993–94 (Diarra *et al.*, 1994, p. 18). Efforts to offset the steady decline in crop productivity by investing in livestock were thwarted by the dense project-mandated settlement pattern which made it difficult to obtain sufficient

Table 3. *Type II: Sites showing increased agricultural income growth based on extensive cultivation methods*

Site, settlement type and period, crop research and extension	Identified constraints/opportunities to higher yielding crop production systems
Niangoloko (BF) —Spontaneous (1982) —Regional Development Organization (no special donor funding to reinforce). Support targeted: cotton and small number of irrigated rice schemes	—Good markets on international border —Abundant undeveloped natural potential for irrigation and tree crops —Highest concentration of protected forests of any province in Burkina —Increased in-migration seasonal pastoralists —Few primary or secondary access roads —Limited research smallholder agriculture —Limited access to improved technology, credit, or fertilizer —Low extension ratio
Mo Plain (Togo) —Spontaneous (1983); —SOTOCO (cotton parastatal); No extension focus on the dominant yam production system	—Strong urban demand and indigenous marketing system for yams (border location) —Good primary limited secondary access roads —Good access extension for cotton only —No research or extension focus on economically dominant yams —Limited access to technology, credit or fertilizer
Kompienga (BF) —Spontaneous(1986) and Sponsored(1990); —Regional Development Organization. Special project funded through ONAT (ex-AVV) to support improved technology, extension, credit, and inputs for dryland farming in villages displaced by dam	—Good markets on international border —Spontaneous exploitation of small-scale irrigation in connection with manmade dam —Good dam-created primary and secondary access roads —High initial infusion of cash from dam construction —High concentration of protected forest and wildlife —Sudden dramatic increase spontaneous ag. and pastoralist immigration —Conflict with pastoralists; growing land tenure conflicts with indigenous inhabitants —Limited research smallholder agriculture and livestock —Limited access to improved technology, credit, or fertilizer —Extension nonexistent except in resettled villages

Sources: McMillan *et al.* (1993); McMillan *et al.* (1992b, p. 59); Nana (1989); Painter (1990).

Table 4. *Type III: Sites where the initial rise in agricultural income growth was not maintained due to the lack of supporting economic policies and inappropriate production options*

Site, settlement type and period, crop research and extension	Identified constraints/opportunities to higher yielding sustainable crop production systems
Manantall (Mali) —Sponsored Resettlement related to dam relocation (1986–87) —Regional Development Organization (ODIPAC) No special funding to reinforce. Extension targeted commercial peanut production.	—Settler participation site and farm layout —Initial Infusion of cash through resettlement payments and hired labor —Good primary and secondary access roads within settlement area —Good access extension —Extremely isolated from major markets and urban centers —Appropriate crop technology options but not supports —Limited access to and use of improved technology, credit, and fertilizer once subsidies for peanut production removed —Circumscribed access to rainfed and pasture land outside settlement area
FED-Agbassa (Togo) —Sponsored (1972–81) —Prescribed project-administered and funded program to promote intensive commercial farming	—Easy access technology and fertilizer on credit for cotton and for cash for maize —Guaranteed market for cotton —Strong local market demand for maize —Dense network of extension (1:59) —Good primary and secondary access roads —Evidence for declining soil fertility attributed to insufficient fallowing and fertilizer use —Land tenure disputes with indigenous population —No settler participation sites, farm layout or design of extension program
AVV-Mogtedo and Mogtedo-Bombore (BF) —Sponsored (1974–80) —Prescribed project-administered and funded program to promote intensive commercial farming	—Easy access technology, credit and fertilizer —Good primary and secondary access roads —Guaranteed market and price cotton —High extension ratio (1:25–50) during first five years of a settlement gradually reduced to (1:100–200) by 1988–89 —Early infusion of cash from construction and illegal wood cutting —Technology not fully adapted to soils and climate —Initial reluctance to fully adopt more cash and labor intensive soil conservation measures —Land tenure conflicts with indigenous inhabitants and pastoralists —Limited social access (due to land tenure conflicts) to regional markets

Sources: Diarra *et al.* (1994); Koenig (1990); McMillan *et al.* (1993); Painter (1990); Koenig, Diarra and Sow (forthcoming).

areas for grazing. Moreover, the early increase in nonfarm employment catalysed by the outside infusion of cash from relocation payments and construction labor was not maintained once these outside sources of income dried up and the settlers were forced to rely on local market demand at the isolated dam site. Settlers responded to this deteriorating situation by selling cattle to purchase food. Another response was to relocate part of their families to agricultural hamlets outside the project area where new land was more easily acquired (Diarra *et al.*, 1994, pp. 13–16).

A similar pattern was observed in the FED-Agbassa Project (Togo) where certain aspects of the project (easy access to fertilizer, new fertile fields, and guaranteed markets for certain products) enabled settlers to achieve higher than average yields and to create a regional food surplus. Contrary to the expectations of the planners, however, this additional income was not invested in the development of more intensive cultivation practices. Instead, most settlers followed a pattern of partial adoption, using animal traction year after year and using levels of fertilizer well below the recommended rates (Painter, 1990, p. ix). Researchers attributed this lower fertilizer use to the steady increase in expenses for fertilizer and animal traction due to a decline in government subsidies.[14] Moreover, the proposed package was not well adapted to the area's climate and soils. Settlers' frustration with the high financial costs and associated risks of cultivation in the scheme, combined with the project's unclear land tenure policies, contributed to high rates of out-migration, estimated at 10% a year (Painter, 1990, pp. xi, xv, 50, 59).

The case studies showed many similarities between crop production patterns in the FED-Agbassa scheme and the AVV sponsored settlements in Burkina. Early planning for the AVV was hampered by the lack of a strong base of agronomic research in the affected region, so the project borrowed many of its recommendations from the high-performing cotton programs in Burkina's southwest. A series of farm monitoring surveys conducted in 1978 and 1979, when the study households had been living at the project for periods of one to five years, showed that settlers were earning higher incomes and producing more food per capita than sample farmers studied in one of the major "home" recruitment zones (McMillan, 1983; Murphy and Sprey, 1980). These increases resulted from the expansion of the total area cultivated and the natural fertility of the new soils, rather than the successful introduction of the proposed technology package. Specifically, settlers who had been at the project for shorter periods of time followed the prescribed extension package more closely than those who had been there longer (Murphy and Sprey, 1980). In addition, cotton was the only crop on which the recommended package of intensive cultivation techniques was applied consistently. Later research demonstrated that rainfall in the northern Nakambe (former White Volta) basin where the three groups of planned settlements in the 1988–89 re-study were located was in fact marginal for cotton. Under these conditions there was little return to fertilizer use unless it was combined with either new or traditional water retention technologies such as stone dikes, tied ridges, or cross plowing (Nagy *et al.*, 1988; Sanders *et al.*, 1990).

Faced with high labor demands for cotton, rising production costs due to lower input subsidies,[15] and increasingly unreliable yields with the proposed technology package, the settlers gradually reduced the area planted to cotton and increased the area planted to sorghum and millet. This increased production, however, was not associated with a higher cash value of production. Indeed, the settlers' net value of production, calculated using the median price at which crops were sold, was 10% less in 1988 than in 1979. When this nominal net income was adjusted for inflation using the International Monetary Fund price index, average real income per unit of labor (ALE) on the household fields was 40% to 50% lower in 1988–89 than in 1979–80 (McMillan, 1995; McMillan *et al.*, 1993). This decline was attributed to a number of factors: (i) a significant decrease in the median price of sorghum (when adjusted for inflation); (ii) lower returns for cotton because higher input prices were not offset by the increase in the amount paid to farmers; (iii) the project's decision to restrict settlers' main crop activities to a 10–20 hectare project farm with only limited opportunities for area expansion; and (iv) a slight increase in average family size. Livestock production was more risky and higher in cost than once thought (Savadogo, 1989c), and efforts to diversify into regional trade were thwarted by the indigenous people's hostility toward the project's land tenure policies (McMillan, 1993).

Frustrated by the lack of long-term prospects for improving their income and thus their living standards, 21 entire households, and a substantial number of people from another 10 households, left Mogtedo in 1988 (11–13 years after first arriving there). Another eight households from the seven settlements of Mogtedo-Bombore left at the same time. All relocated to Kompienga, the site of Burkina Faso's first hydroelectric dam in another OCP river basin in the extreme southeast of the country. The settlers who immigrated to Kompienga had been the AVV success stories. They included some of the most ambitious leaders who had worked closest with the AVV administration and a high percentage of the top producers and leaders in technology change and nonfarm employment (McMillan, 1993, 1995). Many of these people had accumulated considerable

investments which they used to rent trucks to transport their families and possessions as well as to purchase housing and hire labor at the new site. Their main motivation for leaving was to find an area with greater opportunities for counter-season irrigation and trade as well as rainfed farming.

In spite of the accumulation of wealth by these successful migrants, they left the region without shifting to permanent settlement with intensive cultivation. For that reason we do not include them in our definition of success.

(d) *Type IV Sites: Limited opportunities for agricultural growth but opportunities for nonfarm employment*

A fourth more successful category includes three sites where greater opportunities to develop nonfarm employment made it possible for male and female settlers to raise their living standards despite the areas' limited potential for agricultural income growth (Table 5). This increased nonfarm activity was not necessarily at the expense of additional investment in farming. Instead, the greater opportunities for nonfarm employment increased settlers' willingness and ability to use soil conservation measures to increase crop productivity.

(i) *The AVV sponsored settlements at Linoghin (Burkina)*

In 1989, the settlers living in the six AVV sponsored settlements at Linoghin were confronted with the same stagnant prospects for agricultural income growth as the settlers living in the 13 neighboring settlements at Mogtedo and Mogtedo-Bombore described in Type III. The key difference was a much greater opportunity to develop trade at a settler created market located on the adjacent highway linking nearby Ouagadougou (less than 50 km away) to eastern Burkina, Togo, Niger, and Benin.

The greater success of the Linoghin farmers in developing nonfarm, income-earning opportunities also explains their greater willingness to invest in a new generation of more cash- and labor-intensive soil conservation technology that the project advocated after 1986 (McMillan *et al.*, 1993, p. 65). This new technology adoption, along with the almost nonexistent emigration from the site, reflected the Linoghin settlers' greater interest in long-term settlement. In contrast, the more isolated, less diversified neighboring blocs of Mogtedo and Mogtedo-Bombore experienced high rates of settler dropout and lower rates of technological innovation. Of the 255 households acquiring AVV farms at Mogtedo during 1974–1978, only 58% (148) were still living there in 1989. Out-migration was much lower but still substantial (19%) at Mogtedo-Bombore.

(ii) *Finkolo and Tienfala (Mali)*

A similar pattern of heavy involvement in nonfarm employment was observed at the peri-urban sites of Finkolo and Tienfala in Mali.[16] The majority of the study households at the Finkolo site immigrated to work as wage laborers on a commercial tea plantation established in 1967 (Koenig, 1990; Koenig, Diarra and Sow, forthcoming).[17] Adult men were the most likely to be permanent employees. Most households, however, included several other male and female members who worked as seasonal employees on the tea plantations. In addition the workers supplemented their income through crop production on the small fields in adjacent zones allocated by the tea plantation.

Most households at Tienfala (20–30 km from Bamako) had at least one family member employed full-time in informal wage labor, trade, or manufacturing. The best returns to nonfarm employment came to those who had skills (e.g., jewelers, blacksmiths) and working capital. Nevertheless, even those with only everyday skills and little to invest could find work, because of the area's proximity to the large Bamako market. Many of the women were hired as domestic servants for wealthier civil servant and merchant households, earning minimal wages (an average of 3000–4000 FCFA/month or US$ 9–12). As in Finkolo, the Tienfala households created acceptable economic strategies when multiple members had different activities. In this context, farming was an essential secondary occupation, the relative importance of which often changed over time. As people became more settled, for example, women of new immigrant families worked less for other families, and concentrated more on production on their own farms (Koenig, Diarra and Sow, forthcoming).

Despite the inhabitants' heavy dependence on farming for food and retirement income at both Finkolo and Tienfala, the government extension service refused to recognize part-time farming (Koenig, 1990, pp. 30–59). Thus settlers had little or no access to inputs or extension advice, and few households owned animal traction equipment or livestock. It is not surprising then that average food grain production was low (90–119 kg/person at Finkolo and 140–170 kg/person at Tienfala; Koenig, Diarra and Sow, forthcoming) although there was significant variation between households. While there were no obvious cases of landlessness in Tienfala in 1989, it was becoming more difficult for small farmers to support themselves on the available land and still maintain adequate fallow periods.

Table 5. *Type IV: Sites with limited opportunities for agricultural growth due to inadequate or inappropriate crop production options but opportunities to develop nonfarm employment*

Sites, settlement type and period, crop research and extension	Identified constraints/opportunities to higher yielding crop production systems
AVV-Linoghin (BF) —Sponsored Settlement (1973–77) —Prescribed project-administered program to promote intensive commercial farming	—Easy access technology, credit and fertilizer —Good primary and secondary access roads —Guaranteed market and price cotton —Dense extension (1:25–50) during first five years of a settlement gradually reduced to (1:100–200) by 1988–89 —Early infusion of cash from construction and illegal wood cutting —Good social access (despite land tenure conflicts) to AVV settler-created market that became a major market center —Technology not full adapted to soils and climate —Strong willingness to experiment with more cash and labor intensive soil conservation measures —Land tenure conflicts with indigenous inhabitants and pastoralists
Finkolo (Mali) —Spontaneous (late 1960s) to work on tea plantation —CMDT activities restricted to full-time commercial cotton farmers	—Easy access nonfarm employment on tea plantation —Easy access urban market at Sikasso —Good primary and secondary access roads —Use of manure on fields —Circumscribed access non-plantation land —No research, technology, or extension aimed at part-time smallholder agriculture
Tienfala (Mali) —Spontaneous (1900s-present) —Plantation and Urban Nonfarm Employment; Regional Development Organization ignored part-time farmers	—Easy access urban nonfarm employment and markets in Bamako —Opportunities for employment on plantations owned by elite Malians —Good primary and secondary access roads —Good access to health facilities —Use of manure on fields —Short supply of good, arable land exacerbated by plantation development —No research, technology, or extension aimed at part-time smallholder agriculture

Sources: McMillan (1995); McMillan *et al.* (1993); Koenig (1990); Koenig, Diarra and Sow (forthcoming); Savadogo (1989a, 1989b, 1989c, 1989d).

Even with low levels of food production, the combination of crop income and income earned on the tea plantation at Finkolo and through different types of nonfarm employment at Tienfala enabled the average farm family to improve its living standards (Koenig, Diarra and Sow, forthcoming). School attendance, for example, was the highest at all of the Mali study sites. Many people sent money to families in their home areas, something they could not have done if their incomes were insufficient. Settlers' dependence on continuing this "diversified" lifestyle, combining nonfarm employment with subsistence crop production, was reflected in their willingness to invest labor in the use of soil conservation practices such as manure and intercropping; the only other Mali site practicing this was in the high-yielding cotton belt near Dioíla (Koenig, Diarra and Sow, forthcoming).

(e) *Type V Sites: Shift to successful intensive crop production*

Only two of the study sites—Dioíla in Mali and Solenzo in Burkina—showed evidence that large numbers of farm families were adopting more intensive crop production practices. A key to the success of the intensive cotton package in both areas was the existence of a strong, well-organized network of parastatal organizations which offered agricultural credit, inputs, and advice (Table 6) (Koenig, 1990; McMillan *et al.*, 1993).

The cotton package and the supporting services were developed over several decades—first by the French colonial government and later by national parastatals. One result of this investment was a steady increase in average cotton yields (from 544 kg/ha in 1972–73 to 1,043 kg/ha in 1982–83 and 1,598 kg/ha in 1987–88) (CRPA du Mouhoun, 1988, 1989a, 1989b, 1989c; Nana, 1989), fertilizer use, animal traction equipment, and most recently, mini-tractors throughout the Solenzo region. The 50-fold increase in total cotton production that occurred at Solenzo over 1971–88 (from 801 mt to 41,500 mt) contrasts sharply with the early rise and decline of cotton production in the lower rainfall Type III AVV sponsored settlements.

Both Solenzo (Burkina) and Dioíla (Mali) were located in or adjacent to the higher rainfall Sudano-Guinean zone while the AVV sites were in the lower rainfall Sudanian zone. Fertilizer use at Solenzo and Dioíla was highest on cotton and corn, with lower amounts used on red and white sorghum in rotation. Solenzo and Dioíla were the only sites in the entire study where rotations were practiced regularly (Koenig, Diarra and Sow, forthcoming; McMillan *et al.*, 1993).[18] The Dioíla farmers also showed the greatest willingness to use manure of any of the study farmers in Mali and had the highest use of commercial inputs, both in terms of number of users and quantity used (Koenig, Diarra and Sow, forthcoming). Dioíla was the only one of the Mali sites where farmers regularly practiced field rotations.

Average annual food grain production for all study households at Dioíla and for the animal traction study households at Solenzo was more than twice (394 kg/person and 361 kg/person respectively) the FAO's estimated minimum requirement of 180 kg/person (Koenig, Diarra and Sow, forthcoming; Savadogo *et al.*, 1989, p. 5; McMillan *et al.*, 1993, p. 66). This figure rose to over 567 kg/person, over three times the FAO minimum requirement, when the extremely high production figures of the nine study households using tractors at Solenzo were combined with the 26 study households farming manually and with animal traction.

The case studies showed substantial differences between net crop revenues for farmers at different levels of technology (McMillan *et al.*, 1993, p. 66). At Dioíla, cotton production averaged 1933 kg/household in 1988 and 1576 kg/household in 1987, with the quantities produced ranging from 490 kg/household to 8000. The household revenue earned from all agricultural sales (cotton plus other crops) ranged from a low of 38,250 FCFA (US$116) to a high of 1,530,900 FCFA (US$4639) (Koenig, Diarra and Sow, forthcoming). The median was 167,080 FCFA (US$506), below the mean of 246,797 FCFA (US$748) due to the disproportionate influence of three big producers (out of 30 in the sample) who had sales superior to 500,000 FCFA (US$1515).

A similar pattern was observed at Solenzo where per household production of cotton ranged from 372 kg for households farming manually, to 2,202 kg for households using animal traction, and 22,252 kg for households with mini-tractors. The study households cultivating with animal traction at Solenzo had net crop income level that was 2.5 times as high as manual traction farmers (McMillan *et al.*, 1993, p. 66). There was another big jump in productivity per active worker between animal traction and motorized tractor farmers. Even deducting the substantial costs of mechanized cultivation (estimated at 650,000 FCFA per family per year) and the high costs of fertilizer, net crop income for the tractor households was three times as great as for households using animal traction (McMillan *et al.*, 1993, p. 66). Although there were reports that prosperous merchants sometimes invested in tractors, many of the farmers appear to have "worked their way" up the technology ladder by progressive investment in technology and labor. The average household size of the farm family in the two

Table 6. *Type V: Sites with successful intensive crop production options*

Site, immigration type and period, crop research and extension	Identified constraints/opportunities to higher yielding crop production systems
Solenzo (BF) —Spontaneous (1960s–present) —SOFITEX (cotton parastatal) + series of donor funded projects to strengthen the research and extension capacity of the regional development organizations	—Strong tradition of crop research to improve cotton yields —Good soils and higher rainfall climate adapted to cotton production —Targeted donor support to strengthen research and extension —Easy access to technology, fertilizer, extension and credit for cotton (all) and maize (tractor only) —Guaranteed market for cotton -Strong tradition of farmer organizations and farmer-managed markets —Poor access to markets and low prices for crops other than cotton —Poorly developed primary and secondary access roads —Increasingly circumscribed access to new land —Gradual increase in land tenure disputes
Diofla (Mali) —Spontaneous (1960s–present) —CMDT (cotton parastatal) + series of donor funded projects to strengthen the research and extension capacity of the regional development organizations	—Strong tradition of crop research to improve cotton yields —Good soils and higher rainfall climate adapted to cotton —Targeted donor support to strengthen research and extension —Good access to extension (1:77) through well developed regional development organization —Easy access to technology, fertilizer, extension, and credit for cotton Guaranteed market for cotton —Strong tradition of farmer organizations and farmer-managed markets —High use of manure to complement high use of purchased fertilizer —Poor access to markets and low prices for crops other than cotton —Poorly developed primary and secondary access roads —Insufficient access to schools and wells

Sources: Koenig (1990); Koenig, Diarra and Sow (forthcoming); McMillan *et al.* (1993).

Solenzo, villages was 30–37 persons (12.2 adult labor equivalents) for households with motorized cultivation versus 7.5 and 13.5 persons (2.5–5.3 adult labor equivalents) for farm families using manual and animal traction.

Although certain of the Dioíla groups were obviously much wealthier than others, more people at Dioíla had measurable wealth in terms of income, livestock, and equipment than at the other Mali sites.[19] The high profitability of the cotton package combined with flexible land tenure arrangements with easy access to uncleared land seems to have militated against the formation of fixed social categories at both Solenzo and Dioíla.

The long-term decline in soil organic matter is a matter of increasing concern at both sites but these are second generation problems of a successful intensive technology rather than problems that threaten to undermine the long-term profitability of the technology itself (Koenig, 1990; McMillan and Savadogo, 1996). The research and development agencies' responses have been to promote zoned land use, improved rotations, and greater use of organic fertilizer to complement the high levels of mineral fertilizers already in use.

The existence of several privately owned grain mills, well-stocked, sturdily built boutiques, and thriving village markets in the two Solenzo study villages suggests that part of the high income from crop production is being reinvested in commercial enterprises. In general, however, the relative importance of nonfarm income (as a percentage of total income) was lower than at the other Burkina sites (Kompienga and AVV; see Table 7).[20] Many settlers and extension workers believe that some of the large disparity in net crop production per unit labor between farm families with manual technology and those with animal traction and tractors is being offset by the manual farmers' greater earnings from nonfarm employment (McMillan *et al.*, 1993, pp. 54–55).

Although the amount of earnings reported from nonfarm activities at Dioíla was small,[21] there was a wide range. Most Dioíla farmers who entered nonfarm activities did so to diversify income sources (and hence reduce dependency on weather, price vacillations and other risks in agriculture) and to improve living standards (Koenig, Diarra and Sow, forthcoming). A few recent migrants worked as wage laborers for wealthier farmers or engaged in other types of wage labor, petty trade, or manufacturing. The kinds of nonfarm activities found in the zone (tractor rentals, animal traction rentals, blacksmithing, farm labor, transporting cotton, food processing, weaving, masonry, and wood sales) stemmed directly from agriculture and/or the area's agricultural success (Koenig, Diarra and Sow, forthcoming).

5. FACTORS AFFECTING AGRICULTURAL SUCCESS

By far the leading factor that influenced the outcome of new land settlement in the study sites was the macro-policy environment for agriculture during the preceding 15 years (1974–88). A combination of government policies contributed to this. Among these were: explicit and implicit taxes on export crops; cheap food imports; government prohibitions on grain exports by private parties; and parastatal marketing boards that gave producers a small percentage (in some cases less than one-third) of world market prices for their produce (McMillan *et al.*, 1992b, p. 34). Since the mid-1980s, most countries have instituted a series of economic reforms to provide smallholders with more incentive to produce and invest in agriculture. Structural adjustment is endeavoring to do this by changing the prices of agricultural goods relative to nonagricultural goods in West African countries.[22] Over the long term, these policies should result in a net transfer of income from urban areas to the rural sector.

Unfortunately, the first result of these structural adjustment reforms in the river basins was to increase substantially the price of already difficult to acquire inputs such as fertilizer. Inorganic fertilizer still is principally employed on cotton and irrigated rice in semi-arid West Africa. Over the long run, the 50% devaluation of the FCFA, announced on January 1, 1994, will make it more expensive to import cereals and thereby increase domestic as well as imported cereal prices.[23] With increasing prices for domestic foodstuffs over time, inorganic fertilizer use is expected to become more profitable for cereals and tubers (Sanders *et al.*, 1996).

It would be a mistake, however, to attribute the lack of fertilizer use on cereals during the 1988 and 1989 cropping season only to the higher prices of inputs. In the absence of more stable annual and intra-annual prices for cereal crops, it is unlikely that much inorganic fertilizer would be applied to these crops. Mid-1980's research demonstrated that the lack of roads linking high potential river basins with major urban markets was a primary factor accounting for the much lower farmgate prices in these areas (Dejou, 1987; Sherman *et al.*, 1987). Examples of this can be seen in the Burkina case study where the median farmgate price for white sorghum ranged from 28 to 40 FCFA/kg (US$0.09-$0.13/kg) at the isolated but high potential Solenzo study sites to 44–55 FCFA/kg (US$0.13-$0.17/kg) at the less isolated, lower potential AVV, and 50–70 FCFA/kg (US$0.16-$0.22/kg) at the small urban "boom" town of Kompienga (McMillan *et al.*, 1993).

Even the less isolated areas, which had easy access to urban markets (and higher median cereal

Table 7. *Average income by income source for male heads of household and women in the study sample,[a] 1988–89 (FCFA)*

Site	Net crop production (per ALE)	Net livestock production (per ALE)	Net off-farm (without secondary occupations)	Total
Male head of household				
AVV Linoghin	61,315	21,897[b]	9,461	92,673
AVV Bombore	54,988	6,797[c]	1,921	63,706
AVV Mogtedo	51,072	14,764	19,695	85,531
AVV Mogtedo V3	55,101	5,415[d]	18,118	78,634
Solenzo				
manual	30,965	2,445	2,958[e]	36,368
animal traction	78,784	8,494	2,958[e]	90,236
tractor	294,422	44,802	2,958[e]	342,182
Kompienga	78,784	8,522	39,495	126,801
One Woman per Family				
AVV Linoghin	19,336	201	21,331	40,868
AVV Bombore	11,145	486	1,690	13,321
AVV Mogtedo	16,976	1,887	14,805	33,668
AVV Mogtedo V3	17,385	3,865	23,392	44,642
Solenzo	12,687	0	6,833	19,520
Kompienga[f]	12,633	−422	9,774	21,965

[a]Net crop and livestock production are calculated per ALE (adult labor equivalent) for the collectively worked fields and supervised livestock under the responsibility of the male household heads. These herds and fields are generally used for the main food and cash needs of the family unit.
[b]Does not include nonfarm income earned from one soldier's military pension and the estimated annual income from one farmer's successful boutique (450,000 FCFA and 300,000 FCFA respectively).
[c]Does not include nonfarm income earned by two butchers (122,500 FCFA each).
[d] Does not include nonfarm income earned by one male head of household from his religious activities (250,000 FCFA).
[e] The study did not distinguish nonfarm income by groups with different technologies.
[f] Ethnic groups differed substantially in terms of women's economic activities.
Sources: Savadogo (1989c); Savadogo *et al.* (1989); McMillan *et al.* (1993, p. 53).

prices), were vulnerable to the low market prices that follow bumper crop years. In years such as 1989, high prices for inorganic fertilizer and low average selling prices due to high production resulting from the previous season's abundant rainfall, give farmers little incentive to invest in yield increasing technologies. Measures to moderate these price collapses (such as using traditional cereals in new foods such as bread and beer and encouraging grain-fed livestock) need to be considered.

Substantial long-term yield and income gains were observed at only two of the 15 sites; both sites were located in the higher rainfall Sudano-Guinean zone. These gains were based upon previous research principally on cotton and maize (Sanders *et al.*, 1996, pp. 54–61; 187–190; see Table 16). In several cases in other regions (AVV, FED-Agbassa), lack of research led policy makers to endorse extension programs that were not fully adapted to either area climates or soils.

When formal credit programs were available, they were invariably linked to major cash crops such as cotton, peanuts, or rice. A farmer's willingness, therefore, to acquire formal credit was directly linked to the ability to market these cash crops at a guaranteed remunerative price. There are many cases, however, where farmers were able to generate their own capital. The spontaneous settlers moving into high potential areas such as the Mo Plain (Togo) and Kompienga (Burkina) brought substantial savings with them which they used for hiring labor to assist with field clearance and cultivation. Farmer savings from successful nonfarm employment were the major source of capitalizing a new generation of soil conservation measures in the peri-urban AVV sponsored settlements in Burkina and at Finkolo and Tienfala in Mali. Further, a high percentage of the animal traction equipment at Solenzo and Dioíla appears to have been purchased from farmer savings or migrant remittances (see also Savadogo *et al.*, 1994). Thus the issue of access to credit as a constraint on local agricultural development appears to have been less important than the constraints of policy unfavorable to crop profitability and the insufficient transportation infrastructure.

In the absence of profitable opportunities in crop production or the existence of nonfarm enterprises, a

Table 8. *Categories of agricultural systems at the 15 sites included in the analysis*[a]

	Period of increased new lands settlement	Prospects for increased ag. income	Prospects for ag. income increases over time	Declining soil fertility &/or yields	Basic living standard depends heavily on nonfarm income	Prospects for growth in nonfarm employment
Type I: No Agricultural Income Growth						
1.Red Volta-G	19th century	no	no	yes	no	no
2.Overseas-G	1985	no	no	yes	no	no
3.Damongo-G	1950–74	no	no	yes	no	no
4.Tono-G	1980s	no	no	yes	no	no
5.Selingue-M	early 1980s	no	no	yes	yes	no
Type II: Agricultural Growth Based on Extensive Cultivation Techniques						
1.Mo Plain-T	1983	yes	short-term	pockets	no	yes
2.Niangoloko-B	1983	yes	short-term	pockets	no	yes
3.Kompienga-B	1986	yes	no	widespread	yes	yes
Type III: Initial Agricultural Growth Not Sustainable						
1.Manantali-M	1986–87	yes	no	yes	yes	no
2.FED-Agbassa-T	1972–81	yes	no	yes	yes	no
3.AVV-B:						
a.Mogtedo	1974–78	yes	no	yes	yes	no
b.Mogtedo-Bombore	1979–81	yes	no	yes	yes	no
Type IV: Limited Agricultural Growth but Nonfarm Employment						
c.Linoghin	1973–77	yes	no	yes	yes	yes
4.Tienfala-M	1900s–present	no	no	yes	yes	yes
5.Finkolo-M	late 1960s	no	no	yes	yes	yes
Type V: Successful, Intensive Crop Production Technologies						
1.Solenzo-B	1960s–present	yes	yes	pockets	no	yes
2.Dioila-M	1960s–present	yes	yes	pockets	no	yes

B = Burkina; G = Gliana; M = Mali; T = Togo.
[a]One of the 16 sites in the Land Settlement Review, Yanfolila, was excluded due to difficulties with analysis of the data.

majority of farmers living in the more established new settlements (three-fifths of the sites) were pushed to mine the soil or move. This emigration was typically to the same or another river basin covered by control. Although the extensive practices used by farmers at the two Type II sites (Mo Plain and Niangoloko) resulted in soil mining, they were still able to rely on long fallows and additional land clearance to restore soil fertility. This pattern is the classic extensive growth pattern which becomes inviable with increasing population pressure. Unless there is increased investment in adaptive research and extension or a substantial increase in nonfarm employment opportunities, we would expect these areas to begin to show declining yields and increasing problems with soil degradation as in Kompienga (Type II) after 1990.

A more stable pattern of income growth and permanent settlement was achieved in five of the 15 sites (two in Type V and three in Type IV) that benefited from successful crop technologies or profitable activities outside agriculture. Farmers at only two of the sites (Type V) had shifted to intensive agriculture. Farm families at three other sites (Type IV) were able to offset the impact of limited opportunities for crop income growth by relying on nonfarm opportunities from manufacturing, wage labor, and trade. The availability of outside nonfarm employment accounts for the Linoghin settlers' (Type IV) greater ability to invest

in a new generation of labor intensive yield-increasing measures including stone dikes, intercropping, and manure pits. At Tienfala and Finkolo it was necessary to supplement the households' primary source of income with nonfarm employment since limited crop areas available provided minimal incomes. In summary, in spite of the large investment in controlling onchocerciasis, the settlers moving into the affected river basins were able to intensify or diversify at only one-third of the study sites.

6. CONCLUSIONS

Various aspects of the structural adjustment policies embarked upon in the late 1980s should make food production more profitable. These same policies should increase the incentives for settlers to adopt more intensive crop production practices. The Solenzo and Dioíla successes were based upon the profitability of cotton which has enjoyed excellent agricultural policy and support. The new price environment should extend these successes into cereals especially as new cereal production technologies are introduced for the semi-arid areas.

One way to insure that settlers will shift to more intensive crop production systems is to encourage more research, extension, and market (input and product) development to support higher yielding crop extension activities for the lower-rainfall Sudanian zones (600–800 mm at 90% probability) in general and for the lower rainfall OCP river basins in particular. At present only the higher rainfall river basins in the Sudano-Guinean (800–1,200 mm rainfall at 90% probability) areas in the francophone countries benefit from an established extension package for a major cash crop (cotton). Current efforts to promote the combined effects of water harvesting technologies and soil fertility improvements are particularly important for the semi-arid agroclimatic zones (Sanders *et al.*, 1996). Although the river basins in these zones generally have higher soil fertility and water retention capability than adjacent plateau areas, they share many of the same soil characteristics and experience the same low, irregular rainfall.

River basin research and extension efforts should build on the preexisting base of national research and extension programs. A high percentage of the most visible and costly first generation projects created separate planned settlements and river basin authorities like the AVV (Burkina), FED-Agbassa (Togo), Manantali (Mali), Damongo and Tono (Ghana). While many of these projects were successful in the short run, they were less successful once project funding decreased and the farmers' crop production systems were no longer buffered from the effects of adverse price policies, degraded roads, and distant markets.

More likely to be effective over the long term will be government planning which assists settlers in areas where there is already an appropriate technology package and good economic environment such as occurred at Dioíla and Solenzo. This approach, which is similar to the concept of "assisted" spontaneous settlement (Scudder, 1981, 1984; Van Raay and Hilhorst, 1981; Angel, 1985) allows planners to build on the recognized strengths (entrepreneurial ability, cash resources, strong community ties, familiarity with the region or good relationships with indigenous groups) of spontaneous settlement and to avoid some of the better documented social, ecological, and economic problems that usually accompany unassisted settlement.

In the absence of a good crop technology package combined with economic incentives for profitable agriculture, nonfarm opportunities for supplementing income will be critical. These same nonfarm opportunities are needed to cushion the variability of cereal prices and yields, even with the introduction of higher yielding cereal production technologies into the semi-arid zones. Nonfarm income is also likely to play a role in capitalizing settlers' investment in inorganic fertilizer and water retention technologies.

Given the critical role that nonfarm employment plays in reducing risk as well as capitalizing technological change in the semi-arid regions, the assisted settlement for these areas should focus on sites which have greater short-term opportunities for nonfarm employment (McMillan *et al.*, 1992b, pp. 44–50; see also Reardon *et al.*, 1992; Savadogo *et al.*, 1994). This recommendation runs counter to many government plans to focus follow-up planning and investment on the river basins' more isolated zones (see Hunting Technical Services Ltd., 1988; Ministry of Food and Agriculture, 1995; Elder and Cooley, 1995).

NOTES

1. Onchocerciasis is caused by the threadlike worm *Onchocerca volvulus*. The adult worms have an estimated life of 14 years in the human body, where they inhabit the subcutaneous tissues of the skin, causing raised nodules. Each female worm produces millions of microscopic microfilaria which live for about two years. These microfilaria migrate in the epidermis of the skin, causing itching, skin depigmentation, and eventually eye lesions

that can result in blindness. The disease is transmitted to humans by the bites of the female blackfly of the *Simulium* genus. The flies breed only in fast flowing streams or rivers. As a result, the highest incidence of onchocerciasis occurs among people who live in river valleys hence the name river blindness.

2. The World Bank is one of over 20 donors that have consistently supported the OCP since its inception. The activities of the program continue to be overseen by a Committee of Sponsoring Agencies that includes the United Nations Development Programme, the Food and Agriculture Organization, the World Health Organization, and the World Bank (Kim and Benton, 1995, p. 2; Liese *et al.*, 1991).

3. In a recent review of different paradigms of sustainability in African agriculture, Goldman (1995, p. 192–193) identified three main conceptual strands in most of the current notions of sustainability that were first identified by Douglass (1984):

> The first is primarily ecological in inspiration, the second derives from economic thought and the third from sociology and associated fields. The main proponents of the concept are probably those who view sustainability in terms of stewardship and preservation of resources and ecosystem, with maintenance of "sustained yield capacity" of agricultural and other resources as primary objectives....The social norm often associated with this theme involves preservation of resource potential for future generations....

Although many articles and books on West Africa and the OCP discuss the issue of "sustainable" river basin development, they rarely define the concept (Flack and Swaze, 1996; Sirleaf, 1995, p. 3; Liese, 1995, pp. 11–18; Traore, 1995, pp. 72–77). Most studies emphasize the creation of land use patterns "achieving optimum utilization of important natural resources" for managed forestry, wildlife, and livestock grazing, as well as farm production (Lewis *et al.*, 1995, p. 20). An explicit assumption shared by most planners associated with these as well as other definitions of sustainable OCP development (see McMillan *et al.*, 1992b, pp. 69–77) is that new settlers will have neither the willingness nor the ability to preserve large areas of land for alternative environmental uses (as forests, wildlife reserves, and grazing) unless they can obtain stable income increases from more sendentarized intensive crop production. This assumption is at the core of the current emphasis on community-based land management as the best model for follow-up development in the zone (Painter, 1993; McMillan *et al.*, 1992b, p. 72; Elder and Cooley, 1995, p. 128; Lewis *et al.*, 1995, pp. 20–29).

The concept of community-based land management is premised on the idea of village land management associations managing the multiple resources to which they have access. Although planning models vary, they typically involve a three to four-stage process that includes the election of a village land management committee, and delineation of the village boundaries and the land use rights of different socioeconomic groups (pastoralists, agriculturalists, recent immigrants, and long-term residents). These preliminary phases are then followed by the negotiation of a signed contract between the community (represented by the land management committee) and the state institutions involved in agricultural development and environmental management in a given region. Most contracts specify that the community will agree to respect certain themes for soil and forestry conservation, and improved pasturage and forest management in the areas designated for specific types of land use. In return, the state institutions agree to help the villages with the realization of basic infrastructure and land improvements.

4. There is substantial domestic production of irrigated, swamp, and upland rice in West Africa but demand has been increasing faster than production, hence imports have been increasing. Moreover, the overvalued exchange rates give an advantage to imported rice. In addition, several Asian countries (Thailand, Vietnam) have been very low-cost rice producers. Wheat is more difficult to produce in most of West Africa but is sometimes found in irrigated zones.

5. The objectives of the Land Settlement Review were (McMillan *et al.*, 1992b, p. 1):

> —to describe and evaluate settlement experiences to date, including organized and spontaneous types of settlement in the OCP river basins and, where relevant, selected experiences elsewhere;
>
> —to draw conclusions from these experiences concerning the major factors that promote or detract from) rational settlement-related development, and derive lessons regarding the most effective interventions to influence such factors; and
>
> —to provide recommendations and guidelines (based on the two above) on: (a) how to manage the effects of spontaneous settlements; (b) what types of land use planning or other activities would be needed prior to and in conjunction with spontaneous settlement; and (c) how to plan and implement initiatives in the future to support viable low-cost settlement and settlement-related development in the OCP areas.

6. Other studies (Hervouet *et al.*, 1984) showed major differences in settlement densities and patterns between ethnic groups. Two of the most important factors affecting interregional differences were ethnic traditions regarding settlement design as well as the presence or absence of development projects, towns, and roads.

7. Baseline research for the longitudinal case study of the AVV (Burkina) was conducted in 1978 and 1979 with restudies in 1983, 1987, and 1989 (McMillan, 1983, 1986, 1987, 1993, 1995; McMillan *et al.*, 1993; Murphy and Sprey, 1980). The most recent fieldwork in 1989, funded as part of this project, included a restudy of crop, livestock, and nonfarm employment for 60 of the 114 households that were included in the 1979 farm monitoring survey and were still living in the AVV sponsored settlements at Mogtedo, Mogtedo-Bombore, and Linoghin in 1989 (Table 2). Another 20 households were studied in Village 3 (V3) in the AVV sponsored settlements at Mogtedo that had been the object of a more intensive longitudinal case study (McMillan, 1983, 1995).

The case study of the Manantali sponsored settlements (Mali) builds on Koenig's long-term fieldwork through the Institute for Development Anthropology connected with the design and implementation of the project as well as a longitudinal study of production for a sample of 50 households in multiple villages that was conducted over 1986–89 by a team of researchers from the Malian *Institut des Sciences Humaines* (Diarra *et al.*, 1994, 1990; Horowitz *et al.*, 1993).

8. The case studies described here illustrate how intensive case studies, focused on small numbers of households, can provide policy makers with basic quantitative and qualitative information on important differences within and between settlements (see also McMillan *et al.*, 1992a). It is important, however to stress some of the limitations as well as strengths of this approach. Although the intensive case studies and rapid assessment procedures provided an overview of settlement trends, they told us nothing about the settlers who immigrated to an area, mined the soil and left (McMillan *et al.*, 1992a, p. 163). A second problem with the technique has to do with the limitations of a single interview survey to give accurate information on income trends.

In most cases we found that the information we gathered on the estimated total production for each crop gave a somewhat accurate portrayal of the households' crop production patterns and the subdivision of private and cooperative crop production activities within families. The data on livestock and nonfarm production, however, were extremely unreliable. The most accurate and frank information that we obtained on these and other complex topics such as host-settler and pastoralist-agriculturalist conflicts, was in the villages where team members had worked or lived for many years.

9. Although the town of Kangare, the administrative and dam headquarters, became a small commercial town, the number of people looking for work far outnumbered the number of jobs. Moreover, the many poor people that went to Selingue looking for work had very low consumer demand. The indigenous inhabitants took advantage of their knowledge of the bush and its resources to gather shea nuts and fuelwood which they sold. Other indigenous inhabitants used their social networks to establish small businesses such as tailoring. The indigenous women also did placer mining for gold. This contrasts with the Dogon immigrants who had neither the social networks nor the knowledge of the bush (except to collect fuelwood) that enabled the indigenous inhabitants to earn small amounts of cash to complement their crop production.

10. The AVV used a system of labor equivalents to determine the amount of land a household received and a similar system to determine the distribution of supplementary food aid during the first year. The Adult Labor Equivalent (ALE) 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, this is the standard unit and is assigned a value of one. Women and children are assigned lesser values (0.75 for adult women, 0.50 for teenage boys, and 0.25 for females over 55). This same system was used to standardize analyses across all of the sites in Burkina.

11. In 1988, the per capita cash value of production for a male head of household at Kompienga was 126,801 FCFA (US$402) per ALE versus 63,673–92,673 FCFA/ALE (US$202–294) for the older Volta Valley Authority sponsored settlers, and 36,368 and 90,236 FCFA/ALE (US$115–286) for manual and animal traction farmers at Solenzo (Savadogo, 1989c; Savadogo *et al.*, 1989). The mean productivity of a male household head was calculated as the cash value of production from the collective fields per worker (ALE) and net cash income from private livestock and nonfarm employment accruing to him.

12. In 1992, seven of the 25 households in the 1988 and 1989 farm-monitoring surveys spent all of the rainy season and at least part of the dry season in one of these cultivation hamlets.

The households remaining in Kompienga after 1990, were generally those in which one or more family members were heavily invested in year-round nonfarm employment in the town's active market.

13. Small entrepreneurial activities abounded for those who could provide necessary goods and services to wage-earners. One host village, for example, entered vegetable cultivation on a large scale, selling lettuce and other green vegetables to expatriate and African workers. Women also sold charcoal and sauce ingredients, while some began small restaurants.

14. These expenses increased from 21% to 63% of gross income during 1982–88.

15. In Burkina Faso, the retail price of fertilizer increased from 35 FCFA/kg in 1980 to 96 FCFA/kg in 1988; subsidy levels fell from 63% to zero during the same time period (McMillan *et al.*, 1992b, p. 38).

16. Most of the data on nonfarm activities came from informal interviews. These data illustrated major patterns but did not provide detailed quantitative data on either productivity or income (Koenig, Diarra and Sow, forthcoming).

17. Of the 15 household heads about whom we had information, 10 held permanent positions, two were temporary employees, and the status of the other three was unknown. To increase incomes, household heads encouraged children and wives to work as temporary employees. In one case, up to 10 other family members also worked on the tea plantation. Harvesting income was highly seasonal, and most women were temporary employees, involved in harvesting or sorting. During the rainy season, when harvest income was the highest, a woman could harvest 45 kg. of green leaves per day, earning up to 1125 FCFA/day (US$3.41). This compared favorably to the daily rate for temporary help of 250 FCFA/day (US$0.76) (Koenig, Diarra and Sow, forthcoming). Monthly earnings per female tea worker at the height of the tea harvest season were sometimes over 30,000 FCFA (US$91). Although the daily rate of 250 FCFA for temporary help was quite low

even by Malian standards, many of the tasks given for the "day" did not require a whole day's work.

18. The most common rotation at Dioíla alternated two crops: cotton and a food grain, usually a year of cotton followed by a year of food grains (a direct response to extension recommendations) or multiple years of food grain followed by one year of cotton (Koenig, Diarra and Sow, forthcoming). Dioíla farmers used fertilizers on cotton fields only, but the grain fields planted the following year benefited from residual fertilizer effects.

19. Dioila showed the highest average per person animal ownership; 87% of households had some animals, including draft oxen. Although most livestock was reportedly owned by household heads as part of the household patrimony, several women reported owning sheep, goats and chickens (Koenig, Diarra and Sow, forthcoming). That so many people at Dioíla were able to invest savings in animals is a reflection of the success of their agricultural strategy.

20. Reported nonfarm employment for male heads of household at Solenzo was only 8% of total income for households farming manually, 3% for households farming with animal traction, and 1% for households with tractors (McMillan *et al.*, 1992b, p. 53). In contrast, the average reported nonfarm income for women (6,833 FCFA) constituted 35% of their personal reported income from all sources (Table 7).

21. This observation supports Reardon, Delgado, and Matlon's analysis of income data from four rainfed harvest years (1981–82 to 1984–85) in Burkina. Their research found that while nonfarm activities were important in all cropping systems, they were "most important in the zone with the best agriculture—the Guinean zone" (where Dioíla and Solenzo are located) where such activities as food processing, cottage industry, and commerce constitute 38% of income (1992, p. 4). Care must be taken in the interpretation of these results since our Burkina data shows how one farm family earning an extremely high income can inflate a calculated average for the entire population (McMillan *et al.*, 1993, pp. 51–53; Table 7). Analyses based on averages calculated across the entire sample tend to obscure information on the high percentage of a population that may earn little or any income outside crop production and livestock.

22. Devaluation changes the relative prices of traded to non-traded goods. Most agricultural goods are either exports or they are substitutes for imported goods and hence they can both be considered traded goods. See the succeeding endnote discussing the empirical evidence on the substitution between imported and domestically produced foodstuffs. Structural adjustment has generally included many agricultural-sector reforms to increase the profitability of agriculture.

23. This assumes that domestically produced foodstuffs such as sorghum and millet can substitute for largely imported products such as wheat and rice. Econometric studies (Reardon, 1993; Delgado, 1991) have shown very low cross elasticities in demand, indicating a low substitution potential of the local cereals for the imported cereals. The price distortions against millet and sorghum, however, have existed for a long time, apparently resulting in a change in tastes. Further, the relative difficulty of processing and preparing local as opposed to imported cereals is undoubtedly a factor influencing choice, especially in the urban areas where the opportunity costs of women are higher than in villages. Technologies for reducing processing and household preparation time for domestic cereals are increasingly available.

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