Public Disclosure Authorized

Public Disclosure Authorized

9117

McNamara Fellowships Program

The Effects of River Blindness and Migration on Rural Agriculture

The Case of Some Onchocerciasis Control Programs in Burkina Faso

Clement Ahiadeke

FILE COPY

Economic Development Institute of the World Bank

THE EFFECTS OF RIVER BLINDNESS AND MIGRATION ON RURAL AGRICULTURE

THE CASE OF SOME ONCHOCERCIASIS CONTROL PROGRAM AREAS IN BURKINA FASO

Clement Ahiadeke

(This paper is part of a series of papers by McNamara Fellows, and is, at this time, intended for internal Bank circulation for preliminary review and comments. If you have comments on this paper, please forward them to The Coordinator, McNamara Fellowships Program, Room M-4031.)

The Robert S. McNamara Fellowships Program
The World Bank
Washington, D.C.

Copyright © 1989
The International Bank for Reconstruction and Development/THE WORLD BANK
The Robert S. McNamara Fellowships Program
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.

All rights reserved

The Robert S. McNamara Fellowships Program was established in 1982 to honor the former President of the World Bank. Fellowships are awarded each year to outstanding scholars from developed and developing member countries of the Bank who wish to carry out research activities in the area of economic development. The program is administered by the Economic Development Institute of the World Bank.

About the Author

Mr. Clement Ahiadeke, a national of Ghana, holds a Master of Arts degree from the University of Ghana in Demography. He was researcher and instructor at the university's Institute of Statistical, Social and Economic Research, specializing in onchocerciasis. Mr. Ahiadeke was awarded a McNamara Fellowship in 1987 to carry out research in Burkina Faso on the effects of river blindness and migration on rural agriculture. Currently, Mr. Ahiadeke is enrolled in the doctoral program at Johns Hopkins University, Baltimore, Maryland.

The findings, interpretations, and conclusions expressed in this document are entirely those of the author(s) and should not be attributed in any manner to the Robert S. McNamara Fellowships Program, the World Bank, to its affiliated organizations, or the members of its Board of Executive Directors or the countries they represent.

CONTENTS

I Introduction

The Onchocerciasis Control Programme (OCP)[1] in the Volta River basin area has been operational in the savanna areas of seven West African countries since 1975. Its objective has been to put an end to onchocerciasis as a disease of public health and to prevent it from being an obstacle to settlement and agricultural development of an area covering some 700,000 km^2 of relatively well-watered land (WHO, 1976). Epidemiological studies conducted in the savanna regions of the Programme area have shown that onchocerciasis is most prevalent in rural areas; and that the blackfly has a flight range of up to some 80 km per day, either side of the water courses where the vector flies develop (Cooter, 1983). The disease affects primarily small, isolated and remote communities, (Vajime and Quillévéré, 1978). Studies show also that individuals and communities living under apparently similar conditions of transmission exhibit different clinical manifestations according to the location of the village, its size, the density of population and the pattern of housing, agricultural practices and occupational activities (Prost et al., 1983).

Efforts in controlling the disease over the past ten years are now yielding results, with over 90 per cent of the Programme area under effective control (Samba, 1985). What this means is that the dreadful cycle of infection has been interrupted, and lands bordering the river systems are safe for resettlement and farming activities. However, winning one major battle does not mean the war is won with onchocerciasis control. The challenge now facing OCP, unlike the development and application of vaccine against the spread of the disease, is one of socioeconomic development of the region. While an epidemiological model of a straightforward application of medical technology may be complex, yet it may not be in dispute. The issue of socioeconomic development on the other hand depends on a different combination of cultural, social, ecological and political determinants specific to a particular region, which in many cases have proved to be very costly.

In the present African economic and demographic context, for example, it is important to understand the direction, significance, intensity and motivation for population movement in the region as this is one of the major side effects of the

disease control programme (WHO, 1986). In addition, it is important to know how population movement in the region is affecting indigenous agriculture, which is the main economic activity of the OCP region. Despite recent attention by the Socioeconomic Development Unit of OCP to clarify issues about population movement and the kind of agricultural development taking place in the region, there is still not much information available. However, in 1985 the first major and detailed evaluation project on the socioeconomic development and impact on the region was carried out for the Joint Programme Committee (JPC) of OCP in all the initial seven-member countries. The resulting document has again mentioned the issue of the problem posed by population movement (JPC,1986).

Although demographic data for the region are inadequate, the impact study tends to suggest that household size averages 7 persons, and that families with fewer members (i.e., 7 persons or less) tend to migrate while larger families (e.i., more than 7 persons) tend to stay behind. The study also suggests that factors other than onchocerciasis influence the decision to migrate. It is also known through epidemiological studies that while onchocerciasis has no direct effect on fertility behaviour, it tends to correlate positively with mortality.

According to the impact study, agricultural production, has also increased with the increasing protection given to the region by means of the Control Programme started in 1974. For almost all the seven participating countries for which data are available, animal husbandry has been found to double in the Programme Zone, using 1974 as a base line. Food crop production has also increased in output, being almost 30 percentage points above the pre-onchocerciasis control level. The 1985 socioeconomic impact study attributes increased output and expansion in land under cultivation to natural conditions like abundant pasture, watering-places, and relatively low population density of 2.8 per cent as against over 3 per cent found in the West African region as a whole. The survey indeed demonstrates a modest programme impact, but it concludes, however, that the net migration gain for most of the OCP areas was too high for the level of agricultural production achieved so far. The suggestion implied is that there is the need to do further studies on the influence of migration on economic activity in the region.

The research reported here is, therefore, an attempt to clarify some of the migration issues. In particular, emphasis is given to rural-rural type of migration, since this has a lot of implications for the region's agriculture[2]. In effect since previous research shows that the nature of the impact of onchocerciasis eradication depends on the context within which migration is taking place and on the particular dimension of rural development projects of interest, the factor of migration is treated here as an independent variable. Organization of the paper falls into six sections, with Section I providing the introduction. In Section II, the data source and the methods of data collection are descrived. Section III develops the conceptual framework employed for the analysis, while section IV provides a descriptive overview of the survey results. Section V employs more analytical tools to study the effects of migration on agriculture in the region. The last section then provides some disccusions and suggestions for policy options.

II. Sources of Data and Methods of Data collection

In planning for a long-term strategy, the measures to be taken in the various OCP areas are conditioned by the problems encountered in vector control. In an effort, therefore, to provide continuity and for the purposes of comparison communities sampled by OCP during the 1985 socioeconomic impact survey provided the sampling frame for the 1987 sociodemographic survey.

Yet the socioeconomic elements from the 1985 survey upon which the sampling frame for this study was constructed cannot be a substitude for a real socioeconomic impact study of OCP. A real impact study programme should have had its foundation in the coming into being of OCP in 1974. Alternatively, an imperfect substitute would have been for the 1985 survey to carry out a statistically significant and comparable study between a sample of former onchocerciasis villages covered by OCP activities since 1974 on one hand and a sample of villages (grouped along the basis of a minimum of variables (e.g.ethnic group, type of farming, demographic characteristics, etc) which have never been subjected to the ravages of onchocerciasis on the other hand. Because this was not done and since this study was limited financially, our sampling

frame could only be based on the frame provided by the 1985 survey.

As such questions as to whether or not onchocerciasis affects human fertility or whether or not it affects working capacity may not be adequately addressed by this study.

Geographically, the current project like the 1985 survey, falls into the general area defined as the West African Region. This West African Region, defined as the environment capable of influencing the entomological results (particularly reinvasion) and the future development of the Programme is an integral part of the geographical block commonly called West Africa.

Each member country has approached the development of the zones under OCP control according to the dynamics of its own economy. Some countries have launched specific settlement campaigns while others have included the zones in broader projects, either regional or national.

In 1974, Burkina Faso set up the Volta Valleys Development Authority (AVV), a public industrial and commercial body with legal status and financial autonomy to exploit the natural resources of the river valleys under control. Most of the activities launched relate to resettlement of migrants, agricultural development, road systems, water resources, and the organization of the living environment which is mainly village housing facilities, health care network and adults literacy centres. The AVV villages are grouped into 10 blocks situated along the Red Volta (one block), the White Volta (eight blocks) and the Bougouriba (one block).

The project on which data is reported here was a field interview carried out in two AVV settlement areas and two Non-AVV settlement areas. In all, 12 villages were selected for the field survey and these were made up of two Non-AVV villages (Nokuy and Barakuy) in the Mou-Houn and Kossi Provinces along the upper reaches of the Black Volta river; and ten AVV villages, five in Mogtedo (Ganzourgou Province) along the Red Volta river; and the rest in Diebougou (Bougouriba Province) along the Bougouriba rive, (see Figure 1). The original field interview was conducted between the months of November and December 1987. The sample consists of 463 families made up of a total sampled population of 3,905 people. Of this 475 were family heads (or households heads) 919 women in the age group 15-49 years and with almost 46 per cent

of the total sampled population constituting dependant children aged 0 to 14 years and adults aged 65 or more years.

Procedure for sample selection

a) Criteria

In selecting Burkina Faso for this study, the following factors were given pride of place: (1) Burkina Faso has most of its land area (about 90 percent) in the OCP zone; (2) Ouagadougou, the national capital is also the headquarters of the Onchocerciasis Control Programme in West Africa; and (3) Burkina Faso above all, is the only original member country with a planned programme to resettle migrants in her OCP zones.

Procedure

A complet list of communities along the Black, White, Red and Bougouriba river valleys was drawn up from previous OCP documents. Three strata were defined: the first comprising of communities classified into areas of hyperendemic, mesoendemic, and hypoendemic in the epidemiological sense of onchocerciasis infection. Communities were then regrouped into whether they have rates of population growth exceeding or equal to 6 percent (high growth rate) less than 6 percent but more or equal to 2 percent (medium growth rate) and rates of growth less than 2 per cent (negative or low growth rate) in comparison to the national growth rate of Burkina Faso. The third stratum consists of selecting communities that have all the characteristics of stages 1 and 2 above. This, therefore, involves rearranging communities and then using the method of systematic randown sampling to select three communities from the various Strata.

The eco-regions selected were mainly rural as onchocerciasis is mainly a rural phenomenon. Considering the high cost of making a survey, it was only possible to do a total count of 12 villages in the three communities selected. The initial aim was to interview every family head in the six villages each of Mogtedo and Diebougou and three villages in Dedougou and Nouna respectively, so a sample of 500 families could be reached. It turned out that only five villages each in Mogtedo and Diebougou and one each in Dedougou and Nouna could be reached as a result of the problem of

accessibility.

The way the interviewers were received in each village was one of a cordial and co-operative reception. The time chosen for the visits was between six in the morning to about six in the evening, since there were no good lights to use in the night. Harvests were just getting over and some families could not be found at home during most of the day. These were the first people to be interviewed early in the morning of the following day. Because many of the questions in the survey had a bearing on their personal and family welfare matters or on economic and social problems, most of the interviewees were very much delighted at having to respond to the issues raised. This gave a high response rate to the sample.

The questionnaire was prepared in four parts: family and background history; migration history; social, demographic and economic characteristics of women aged 15-49 years in each family; and a section on general social, economic, political and health issues affecting the Community. A team of 12 people conducted the house to house interview which lasted about two hours on the average.

According to the size of the village this team was divided either into 4 groups each consisting of 3 people or into 3 or 2 groups with 4 or 6 interviewers respectively. The team members were people who have had two or three years of University education or have completed Six Form and were preparing through evening classes to enter the University. They were mostly students of sociology or social science related and were people who had had previous field experience. They were given a thorough training in the use of the questionnaire before a five-day pre-test survey was carried out to select the best team.

The completed questionnaires were checked every day and where necessary corrected. A meeting of all members was held at the end of each day to study problems and issues arising out of the days' work, so the interviewing methods and approaches were progressively improved.

To test for the overall effect of the sampling procedure, the 1987 selected villages were weighted according to village data obtained from the 1985 data. Thus to obtain the appropriate weight, the population of all villages in 1985 with 300 or more persons was divided by 75 and those with less than 300 people by 50. Then in

order to correct for community bias, the weights were multiplied by the inverse of the probality of a village being selected in each community (i.e. number of villages in the community divided by the number of villages selected). These final weights were normalized to obtain a mean value of approximately one. The test for the effects of differential population growth between 1985 and 1987, 1985-1987 village growth rates were used to estimate village population size in 1987. This procedure led to weights virtually being identical to those derived from using the 1985 data.

III THEORETICAL FRAMEWORK

Onchocerciasis and human ecology

Although concern for the secondary factors affecting population movement in the OCP region is of prime importance to this study, it is necessary to begin with perspectives on human ecology and onchocerciasis.

Epidemiological studies conducted in the savanna areas of OCP have shown that individuals and communities living under apparently similar conditions of onchocerciasis transmission exhibit different clinical manifestations, according to the location of the village, its size, density, and the pattern of housing, as well as agricultural practices and the occupational activities of the people (WHO,1976). Settlements in the region can, therefore, be classified into three levels of endemicity, according to whether a community is hyperendemic, mesoendemic, or hypoendemic. Hyperendemic areas are characterized by the presence of over 60 per cent onchocerca volvulus carriers in the population, and an average of more than 15 filariae in skin snips. In savanna areas, this percentage is further inflated by a 20 per cent for patients with ocular onchocerciasis and hence a blindness rate which can exceed 10 per cent. This, in effect, constitutes some 50 per cent of the male adult population (aged over 40 years) in a particular community. In situations of this sort, the very survival of the community is at stake and the river valleys are often deserted. In almost all communities where prevalence rate is below 40 per cent, the disease has no social effect and this situation is described as hypoendemic. In a hypoendemic community, therefore, fewer than 10 per cent of the population have ocular lesions caused by onchocerciasis and fewer that 2.5 per cent

have irreversible eye lesions. The blindness rate here due to onchocerciasis is generally below one per cent.

Between the two limits of over 40 per cent and less than 60 per cent onchocerca volvulus carriers, there are different kinds of situations which together, is referred to as mesoendemic. Here, factors associated with human ecology may substantially modify the impact of the disease. It is essentially a situation where the disease is socially recognizable but has not yet reached a level that is intolerable to the community.

It had been observed in Burkina Faso before the programme of eradication that the level of endemicity in a village depended on the proximity of the blackfly breeding site. Yet, two communities located at an equal distance from a breeding site could display very different levels of endemicity according to whether they were in the front line village or whether or not other settlements came between the community and a breeding site[3]. In other words, since the blackfly has a flight range of up to 80 km per day either side of a river valley, and since settlements are located mostly along river basins, the severity of blackfly infection decreases with distance from the river basin. Studies in Ghana and Mali have shown that communities moved away from the rivers when the intensity of onchocerciasis infection increased, and then moved back whenever the situation became less serious (Hunter, 1966; Lefait, 1976). Also studies on village size in Ghana and Burkina Faso show that blindness rates of over 10 per cent (very high) are associated with population densities of less than 200 inhabitants, whereas densities of 500 or more experience lower levels of blindness. In addition, population growth ceased whenever a community experienced a blindness rate that exceeded 10 per cent (Hughes, 1949).

These findings seem, therefore, to suggest two related things: (1) that the risk of blindness reduces the size of population through death and/or migration of the ablebodied persons; and (2), alternatively, there appears to be a critical level of population density which when attained makes onchocerciasis transmission less effective. This hypothesis would seem to explain why for example, onchocerciasis is more of a rural phenomenon than an urban problem.

There is also evidence from work done by Hervouet and Prost (1979) and Prost,

Hervouet and Thylefors (1979) that the pattern of land occupancy is an important factor in explaining the relationship between onchocerciasis infection and population movement. Their data suggest that blindness rate varies among ethnic groups like the Lobi, Dagara, and Birifor who live side by side but practice different space occupation. Prost, Prescott and Le Berre (1983) have found that the settlement pattern among these ethnic groups follow two lines of economic activity; with one correlating inversely with onchocerciasis infection and the other varying directly with infection. First, there is the peridomestic area comprising of residential space, permanent fields and watering points. Here the degradation of plant cover and the elimination of forest gallery for the laying out of cultivated plots, often contiguous, tends to militate against the dispersal of the blackfly vector. In addition, the concentration of population into a limited space, tends to reduce individual contact with the vector. Second there is the external agricultural area which comprises of the more distant fields, lands left fallow, ground traversed in stock herding, and the woods. Maintenance of the plant cover here is made more conducive to the dispersal of the blackfly vector, thus resulting in easy contact with man.

The movement and the distribution of population between the two types of areas are therefore, influenced by the blackfly disease. For example, the Lobi live in scattered dwellings, often on low-lying grounds, which make direct contact with the blackfly very easy. They also practice extensive farming in the external agricultural area. The sum effect is that blindness rate among the Lobi ethnic groups runs high, often above the critical 10 per cent level. The Birifor and the Dagara, on the other hand, settle in groups of compact nature in villages on hillsides. They practice intensive agriculture in the peridomestic areas and work communally; the sum effect is a reduction in the time they have to spend in the fields. The low grounds on which they settle are also parcelled out neatly into rice paddies thus eliminating the plant cover and the galleries. Under these conditions, the Birifor and the Dagara are found to have a much lower blindness rate than the Lobi even though they all live in the same environment. Thus while one community may be said to be doing things that directly welcome the blackfly vector, the other may

be said to have developed an ecological mechanism for resistance against onchocerciasis.

Occupational activities are also found to be connected with oncherciasis infection. Because they work near rivers, people like fishermen, rice growers, and ferrymen run the risk of contracting the blackfly disease. Due also to the division of labour between women and men the latter are also found to be more heavily infected than the former. This is born out among the Lobi and Birifor whose women farm only the peridomestic areas (Prost and Paris, 1983)[4]. On the whole, the risk of exposure to the bites of an infected blackfly is highest for families who live or work near river banks, and is also dependent on the location of a village, the pattern of land distribution, and the availability of, and access to alternative sources of water.

Onchocerciasis and population movement

While evidence supporting fertility behaviour and onchocerciasis would seem indirect, the relationship between migration (or mortality as a demographic behaviour) and river blindness is quite direct. Studies have shown that population movement in localised sectors of the programme area reveal a pattern of heavy migration loss which is related to the situation of onchocerciasis infection. For example, calculations of trends in the hyperendemic districts of Bawku, Bolgatanga and Navorongo all in the north-east of Ghana show an overall net migration loss per district of up to 3 per cent per annum (Sawadogo, 1976).

The pattern of migration is one of heaviest decline in riverine locations and movements of people to upland, watershed areas. Infectivity gradients of onchocerciasis and prevalence of nodules also reveal the disease to be a prime cause of retreat; while the geographic patterns of onchocerciasis and blindness also strongly correlate with the patterns of abandonment. (WHO, 1973). Similar patterns of emigration and movement back from riverine areas are observable in Burkina Faso where the process of "starving out" of villages in hyperendemic areas is graphically demonstrable. This process follws a number of stages, starting with the retreat from peripheral compounds, then a slow movement off-river to the interior territory of the river basin and then a gradual abandonment and movement to upland areas (Prost et al. 1983).

Sex ratios for the economically active age-groups (15-44 years) in the hyperendemic areas of Ghana and Burkina Faso have also show a deficit of young males in comparison to their female counterparts.

In Ghana the ratio averages 65 males per 100 females in most hyperendemic districts in comparison with a national figure of 93 males per 100 females, using 1970 census data. In Burkina Faso, the ratio falls to 40 males per 100 females in the hyperendemic areas as compared to a national average of 52 males per 100 females, using 1975 census data. The low sex ratios reflect the general out-migration of young males when faced with insufficient land with which to support a family, even at subsistence levels.

At the start of the programme of eradication, it was realized that over cultivation of upland areas and population pressure on the limited unaffected upland areas were due to the movement of people out of the more fertile but onchocerciasis infested riverine areas (WHO, 1973). Migration studies in Burkina Faso during the mid-1970s also confirm that after three years of absence from a village, some 50 per cent of the natives would return to begin a new economic venture (Andre, 1980). There were also extreme cases of long absence of up to about 10 years before a total of 844 migrants out of 1,000 would return, while the remaining would migrate for good not to return (Paris, 1983).

The pre-1974 major determinant of migration in the OCP region, no doubt, was the causative effects of the river blindness diseas (WHO, 1986): It directly motivated migration and with its eradication, secondary factors have also become important determinants of population movement in the region. The secondary determinants are those contextual forces and development strategies that distribute land, jobs as well as other such factors as weather failure[5] which cause people to move in search of watering places. Three different approaches to the materialistic basis of migration may, therefore, be noted briefly. There are those writers, who in the neo-classical tradition, tend to view migration as a king of profit-maximization activity in the sense that geographical movement contributes to the social mobility of the migrants, and indirectly to the economic growth of a nation and of its rural areas. This approach, as has been formulated by Todaro (1969, 1976, 1981) for example, has tended

to ignore short-term circulation within rural areas and instead emphasises permanent rural-urban population transfers. This approach as in its various forms (Lipton, 1980; Findley, 1981; Brown and Lawson, 1985) is not sufficient for the analysis of migration in the OCP region.

A second approach is adopted by researchers who are more interested in circulation. They have tended to emphasise risk minimization rather than profit maximization in explaining migratory behaviour (Stark, 1981; Chapman and Prothero, 1982). They argue that migration is often a way of diversifying economic options. Here, the emphasis shifts from migration as induvidual behaviour to migration as household or family behaviour. This view has relevance for the OCP situation, because migration is often the result of decisions made by families as part of an overall risk-aversion or labour allocation strategy (WHO, 1986).

Finally there are reseachers who take a structural perspective and, therefore, interpret migration as a household survival strategy. The concept of survival emerges within this approach as a way of focusing attention on the poverty of many migrants, and on the fact that their movements often result from deteriorating employment and income conditions in the rural communities affected by some structural changes (like land concentration, farm mechanization, and low prices for peasant crops). Migration is, therefore, a response to and a strategy for managing the decline in opportunities (Arizpe, 1981). This view is also worth considering, especially in view of the fact that in the OCP regions of Burkina Faso, migratory movements can either be spontaneous (unsupervised) or planned and sponsored by the state.

Onchocerciasis and agriculture

The concentration of people on the upland soils in the savanna zone where conditions are inherently unfavourable has had specific direct effects on food production in the OCP region. These include (a) reduction in farm size per family; (b) reduction in work capacity of the affected families; and (c) lowering of yields due to overcropping.

The average size of farm (i.e., cultivated land only) has, in the pre-control

period, been found to be much smaller in the densely populated zones than where a more favourable land/man ratio existed. For instance, studies carried out for the Food and Agricultural Organization (FAO, 1979) show that in the Korhogo region of the Ivory Coast, 56 per cent of farms were of less than three hectares. In the north-east of Ghana, average farm size fell to 1.28 hectares for a family of 6.8 people (or 0.2 hectares per person) having previously stood at between 3-4 hectares per person. Similarly in Burkina Faso, farm size in the densely populated Zorgho area averaged 2.8 hectares for a family of 5.7 people. In sum, these levels represent between 0.20 to 0.45 hectares per person active or only some 20-45 per cent of the capacity of the individual farmer under normal traditonal agricultural systems.

Labour productivity on the other hand has been known to be seriously cripped. A family's productive capacity was reduced not only because of land shortage and declining yields which follow overcropping, but more so because the blackfly disease induced various stages of physical debility in addition to the direct nuisance effects of the blackfly attacks. It has been estimated, for example, that the average loss of productive capacity due to the disease or the nuisance effect of blackfly attacks is about 5 per cent of the capacity of the exposed work force (Joint Programme Committee, 1986). This in practical terms means that the equivalent of a production loss of about 10,000 tones of food grain per planting season was experienced as a result of onchocerciasis infection.

In consequence, the motivation and energy required to stimulate the production of cash crops was virtually lost. Marketing activities fell off from even their traditional levels, while basic infrastructure in the form of road networks and health services had deteriorated, often to the state of complete uselessness. Income under the circumstance was very low thus paving the way for most of the family members to migrate.

Thanks to OCP activity, things have changed over the past ten years. The pre-1974 obsessive fear of onchocerciasis and the dread of the "cursed valleys" are now disappearing in several river basins, and in the next section we report on the extent of this.

IV OVERVIEW

Table 1 presents information on certain basic characteristics of the three communities studied. Contrasts are evident particularly with respect to the physical and social development of the villages. The major contrast is that communities are either AVV or non-AVV. The AVV villages as mentioned in section II are mainly settlements established by the state for sponsored migrants, although 12 out of the 153 families interviewed in Mogtedo and 8 out of the 232 in Diebougou were enumerated as non-AVV settlers. The AVV villages have access to modern technology in the form of improved seeds, the plough and credit facilities. They also have access to schools for their children, dispensaries for the sick, and cooperatives to buy and store their produce. In contrast, children in Nokuy and Barakuy for example, need to walk a distance of between 4 to 7 km each day to attend school and then do the same distance back home. There are no cooperative shops and no medical facilities. There are also differences in settlement and housing patterns. In the AVV villages the settlement pattern is dispersed with each family living and cultivating the peridomestic area of some 3 hectares of land while in non-AVV villages the pattern is nuclear with houses and huts clustered together.

Yet there are many important similarities between the AVV and non-AVV villages. All the villages studied are thoroughly agrarian as indicated by the percentage of land-operating families (almost 100 per cent in each village). Given the focus on land assets, this is an important point. In these villages, land remains the dominant repository of wealth, the dominant means of production, and hence the main economic endeavour. Also in all villages, owner-operation of land is the rule, although the percentage of total cultivated area under tenancy is quite high in the Non-AVV villages, ranging between 19 percent in Barakuy to about 23 per cent in Nokuy. All villages face the threat of natural disaster such as blackfly reinvasion[6] or drought which is mainly the case these days.

Although there appears to be no serious threat of the blackfly to the communities, respondents in some of the villages (of Barakuy and Diebougou in particular) complained of the nuisance attacks of the blackfly. In AVV5 of the

Diebougou settlements for example, the villagers complaind bitterly of the blackfly attacks. Because the simulium fly bites outside dwellings from sunrise to sunset and is particularly active in the mornings and evennings, in cloudy weather and in shady spots, farming activities are slowed down or may be completely disrupted during most of the year as the villagers have to stay indoors.

On the other hand, agricultural production in the sahel region involves substantial year-to-year variations in yields. Of primary concern here is the frequency of weather failure. While the most severe and extended drought in recent times in the region occurred in the 1971-1972 and 1983-1984 periods, the complaint in 1987 was "that the rains came rather late so our crop yield fell below the previous year's harvest level". The effect of this late rains to many of the farmers is not quite different from the experience of 1983-1984. Late rains have seem to become the major source of disaster to farming communities in the region. This would seem particularly so in view of the fact that even in normal rainfall times, most of the 500 to the 920 mm of the rainfall comes during the months of July, August and September. The periodicity of rainfall may be more important than its abundance in the Sahel. The duration of a shower, which is rarely more than 2 hours, the rate of fall, and the time between rainfalls is of critical importance to both soil fertility and crop production. For example, because the growing season is short, there is incentive to plant early, but there is greater risk involved. The early rains are irregular; if after seed is planted there is no more rain for two or three weeks, the seed stock is lost. Similarly, there is a special time constraint in the utilisation of the soils: the period when the soils are workable and planting can occur is very restricted. Thus without a change in farming systems it is extremely difficult to extract acceptable yiels from the heavier soils.

Most farmers interviewed complained about the lack of such institutional sources of insurance as a well-functioning capital market which can even out consuption streams in periods of adversity. Thus in the absence of a modern sturcture of this sort, the mechanisms for adjustment to drought become progressively, bleak and costly perhaps. Alternatively, the other source of insurance against risk may lie in traditional systems of support, either kin-based systems or patron-client networks.

However, because the extended kinship networks are unlikely to function well in times of widespread natural disaster, many families resort to the demographic option - migration- which is a major issue we now focus on.

Table 2 presents data on certain basic characteristics like education, relationship, activity and age distribution of the study population. As is typical of the patriarchal system, men and women have unequal roles in the family. Among the families covered in the study, only 7 women were said to be heads of family (i.e. 1.4 percent of the sample) althought the proportions of males and females in the sample are just about even (50.5 percent males and 49.5 percent females). In all cases, the woman only became head of the family after the death or absence from home of her husband and when there was no male member of the family of the right age or occupational status. In fact during the field exercise, some women whose husbands had migrated refused to be called family heads.

Information regarding the age distribution shows that the young population (0-14 years) is a little less than one half (45.9 percent) of the total sample while those in the adult age group (15-59 years) constitute 50.4 percent. There are few people who have had some schooling before and there appears to be little desire for people to go to school, since children currently enrolled in school constitute just under 8 percent of the total sample. If one removes the 1.6 percent non-kin members from the sample one is left with 98.4 percent as kin members thus giving the sample a very solid homogeneous character, with the majority of the active labour force engaged in crop farming.

Migration

For the study area as a whole Table 3 shows that out of the total sampled population of 3,905 people, more than half the number (i.e. 59.6 percent) were identified as migrants. Of this figure 49.7 percent were males in comparison with 50.3 percent females. For the study communities the number of migrants reflects the size of the sample size, hence Diebougou with the largest sample size has more migrants than any other community then followed by Mogtedo and Dedougou respectively. What is worth observing, however, is the near identical male-female proportion of migrants found in Diebougou and Mogtedo, being in the ratios of 1.07 and 1.06

respectively for the two communities. This is in sharp contrast with the same ratio for the nom-AVV villages, being only 0.35. Thus in effect, it is only in Mogtedo and Diebougou, typical AVV settlements that males predominate as migrants while the opposite seems true for the non-AVV settlements. A look at the non-migrant column of Table 3 also reveals an even parity between the male-female proportion of non-migrants for the AVV villages while in the case of the non-AVV villages, the gab between male- female non-migrant proportions is as much as 4.5 percent.

Under normal assumptions of migration theory the larger male proportion relative to the female non-migrant population in the non-AVV villages could be considered as an indication of in-migration on the part of males. However, detailed examination of the data in addition to actual field experience indicate a massive out-migration of males in the Dedougou communities. Tables prepared separately for each of the various communities (see Appendix Tables 1, 2, and 3) suggest the same conclusion. In fact, the 1985 OCP Census count of the two villages of Nokuy and Barakuy put the total population of each village at 317 and 243 respectively (JPC 1986). The total count of the same villages two years later found the total population figures to be 287 and 247 respectively. In effect, the relatively high proportion of female migrants found in the Dedougou villages would seem more suggestive of marriage migration than anything else. On the other hand, the near equal proportions of male and female migrants found in the other communities would seem to reinforce the point made earlier that OCP migration is mostly a family affair.

To examine the issue of family oriented migration further, we look at Table 4 which documents migrants by their age groups and length of stay. Broadly, the table shows for both male and female migrants that most of those in the age segments 30-59, 18-29 and 10-17 have stayed for at least 6 years in the survey areas. The proportions are 15.8 percent and 15.0 percent respectively for men and women aged 30-59 years; 12.4 percent and 10.3 percent for males and females aged 18-29 years; and 14.1 percent and 12.8 percent for males and females aged 10-17 years. Most migrants in the oldest age category (60 years and over) have stayed in the survey areas for more than 10 years. Migrant sex ratios in the age segment 10-59 for AVV and non-AVV settlements are also found to be 1.05 and 0.34 respectively. One

therefore infers that female migrants out-number male migrants by far in the non-AVV villages as compared to the situation found in the AVV settlements. The abnormal sex ratio found in the non-AVV villages is further supportive of a massive out-migration process by the male settlers. Indeed, field evidence confirms this suggestion. There is a general movement of people from the two non-AVV villages towards the main Black Volta River basin area. In fact, using 1974, 1984 and 1987 data, it is estimated that the population growth rates of Nokuy and Barakuy were respectively -3.26 and -0.55 percentage points for the period 1974-87. Most of the people interviewed in these villages complained about the lack of drinking water in addition to poor harvests due to inadequate rainfall. They also complained about poor and overcultivated soils, which coupled with poor rainfall has led to very poor harvests in the past three years. It is therefore not just a design or accident that these two communities, situated some 15 kilometers away from the left and right banks of the Black Volta River have identical migratory patterns and also complained about the same problems. The lack of water is really a threat to their survival and rather than walk a distance of 15 kilometers to get water during the dry season, they perfer to move closer to the water source.

In contrast, the undistorted sex ratio for migrants in the AVV settlements is once more supportive of the fact that migration in these communities is a family affair. Of the number interviewed in these communities, 56.8 percent said they came to their present settlement in groups of four or more people, while 32.2 percent came in groups of 2-3 members. Only 11 percent came first as individuals to prepare their new homes. Table 4 also shows this pattern even in terms of the lenght of stay. For each period of stay in the community the male-female parity appears evenly distributed, especially for the age segments 30-39 and 18-29, although there is the tendency for females to predominate. This is quite normal especially in a culture where the practice of polygyny is an accepted norm.

Table 4 again shows that most migrants arrived in the survey areas more than five years ago. Thus taking into account the fact that both the AVV villages of Mogtedo and Diebougou were established in the period 1974-75, the conclusion may be drawn that most of those who have stayed in these villages for less than six years

are not sponsorded migrants. The same argument can be made for some of the migrants who have stayed for 6 to 10 years in the AVV communities; so leaving out the bulk of the more than 10-year stayers as purely supervised migrants. Cross-tabalating migrants by place of origin and age of migrants on the assumption that the AVV villages were found more than then years ago, Table 5 also would seem to suggest that between 15-20 percent of migration into the AVV villages is not supervised. Thus added to the fact that some 8 to 12 families interviewed in the AVV villges were classified as non-AVV settlers, evidence can be built to the effect that spontaneous migration into the AVV settlements constitutes some 12 to 15 percent of the migrant settlers[7].

Table 6 shows the age at entry, kin tie and place of origin of the migrants found in the study areas. Looking first at the age composition of the migrants, one finds the expected association of less selective nature of rural-rural migration with age: 25.3 percent in the age group 10-17, 29.2 percent aged 18-29, and 34.1 percent aged 30-59. Also recorded in the table is the relation of the migrant to the head of the family at the time of entry. It is easily seen that children constitute the majority,

being 45.2 percent of all migrants. This is followed by spouses who make up 25.2 percent in comparison with 16.8 percent for family heads. The significance of the kin tie at entry is to underscore the fact that population movement here is family oriented. A typical pattern is that the family head sets out with his eldest wife and a few of his children to establish their new home; then the rest of the family members move in to join them. Those who come along with the other wives and children include other kin members like brothers, sisters, cousins, father, mother, uncles and aunts. Others who come in to join the family are people like in-laws servants and visitors who together constitute 2.5 percent of the migrants and are labelled as non-kin in the table.

Turning to the place of origin, Table 6 shows that the largest proportion of migrants are people who come from within the province of survey. They constitute 41.4 percent of all migration streams. The second largest stream of about 33 percent are moves originating from rural communities in other provinces. Together, migrants

with rural background constitute 74.0 percent of all documented migrations which leaves 26 percent as migrants with urban background. Evidently, migration has become a more common phenomenon as the development process in the OCP regions accelerates and as pressure resulting from rapid population growth rates mounts, especially in the Mossi provinces of Yatenga, Sanmatenga, Baam and Kouritenga from where most of the migrants came. The move toward the river basin areas is particularly noteworthy, it not only suggests that economic change due to onchocerciasis eradication is stimulating movement of people into the river basin areas but also a movement caused by frequent drought. Equally important is the fact that most of the migrants with urban background came from no less urban provinces with the most urbanized cities of Ouagadougou and Bobo-Dioulasso. To the extent that more and more rural land is available for settlement and to the degree that rural development efforts have met with some success, more opportunity or incentive may exist for the unemployed urban population to move into the OCP areas. The 7.0 percent migration stream whose origin is another country is also of particular interest. This stream is due to international labour migration from Burkina Faso to Cote d'Ivoire and Ghana, the origins of the stream, and as such is a return migration stream.

As with migration patterns elsewhere, every migration stream has its counter stream. To some extent, counterstreams reflect return migration. Counterstreams largely reflect migrants' preferences and perceptions based on their own characteristics and needs. As a result what attracts one family to a given locaction may be the very factor which stimulates another to leave the place. It is therefore necessary to further ascertain the extent of return migration, and to do this we cross-tabulate long term and recent migration information by origin and destination of each move made by family heads. Available information show that there is a substantial amount of repeat migration. The data show that of the 391 family heads who were migrants, only 19.9 percent had made their first move. Of the remaining 80.1 percent, 28.4 percent had moved twice, 11.2 percent three times, 22.8 percent four times, and the remaining 17.7 percent had moved five or more times. Repeat migration involving onward movement or relocating at other places is quite a common feature and therefore another important factor in OCP migration.

A pertinent question then is why this apparent low retention rate among migrants into the zone. To be able to address the issue of frequent movement on the part of migrants, it becomes necessary to detail the nature of agricultural production in the survey areas, including the crops grown and marketed, techniques adopted, and the level of farm income.

Economic activity

Although agriculture is the main economic activity in all the villages studied, the situation differes slightly from one community to another. The relative importance of secondary economic activities to boost income is however not very clear in most cases of the field survey. There are about 12 percent indeterminate cases in Mogtedo, 7 percent in Diebougou and 4 percent in Dedougou. Where information is available, there are more references to migration in Dedougou, fishing and animal rearing in Mogtedo and crafts in Diebougou. Information with regard to crops points to sorghum, millet, groundnut, cotton and in a few cases, tobacco in Dedougou as being the main ones in the various communities studies.

As can be seen from table 7 live stock breeding includes both small and large animals. On average, there are 2.6 cattle per family of 7.8 members, although this average varies from 3.4 in Mogtedo to 1.8 in Dedougou. There are also 2.9 sheep and 4.5 goats per family with variation being highest for Diebougou and lowest for Mogtedo. Goats predominate as the favoured livestock in all communities, although beef herding is the sole economic activity for 10 families in Mogtedo. In terms of feeding pattern, sheep are herded with cattle during the day. Goats are thethered during the growing season, but are allowed to roam and graze freely at other times. Donkeys (and in a few cases horses) are also important as they are mostly used as a means of transport in situations where bicycles are not available.

All residents of a family work on the farm, and all share equally from the granary, though the male head controls its distribution. Most of the land preparation is done by men; planting is done by women and children. Weeding is the main labour bottleneck in this system; labour seems to be allocated to weeding in a variety of ways, including reciprocal communal workcrews. Harvesting is done by everyone, although particular chores are age and sex specific. By January when all

but the major streams are dry, women who are not using borehole water get water from holes dug into dry stream beds. The most difficult dry-season task for men is clearing the bush for new farms. Most people also have dry season work with which they earn cash income, although the activities are specific to each locality. From some villages, women headload firewood to the nearby urban place where there is market for it. Villages that are close to roads or markets specialize in local foods and drinks, the sale of which bring some income to the family. In areas where the soils are appropriate villagers specialize in clay pots and vegetable farming.

These economic activities do not appear to enable the population to achieve food self-sufficiency though. In nearly all the villages, negative answers were received in reply to the question "Have the recent harvest been large enough to meet the food requirements of the majority of the inhabitants?" and "Have you been able to satisfy your own food needs?" The main reason given by 83 percent of the communities studied was the lack of water; and in addition, five settlements complained of the blackfly attacks which occur mostly during the main farming season. Furthermore, the non-AVV villages complained of lack of agricultural inputs like high yielding seeds, fertilizer and even land to make a farm. On their part, the AVV settelers in Mogtedo and Diebougou believed that the irregular nature of the rainfall during the planting season was the major cause of insufficient food production.

The effect of drought which has come on and off since 1972 would seem incalculable to agriculture in these zones. It is to be feared that this effect is now irreversible and that there is now a veritable desertification and thus frequent population movement particularly in the Dedougou villages. Most water sources are seasonal, in the form of temporary rainfed streams and pools, as rainfall in the region is characterized by extreme irregularity both in terms of time and distribution. Water supply for ordinary consumption and for both cattle and crops is therefore not ensured even in the AVV settlements. It depends either on wells and rivers (most of which become dried up for eight months in the year) and occasionally on boreholes. All these sources may dry up at any time throughout the year but especially between October and May when there is very little rainfall. There are no irrigation facilities, not even in the AVV settlements. In additon to the water

problem, the threat of spontaneous disasters caused by onchocerciasis reinvasion and bush fires cannot really be guaranteed. The major effect of the poor rainfall pattern is that on the whole, whether it is the compound farm, bush farms or in the degraded grass lands, soils are mostly bare during the dry season. The lack of vegetative cover exposes the ground surface to direct sunlight and, at the beginning of the rainy season, the direct impact of rain drops. This exposure to sun and rain causes deterioration of the soil structure, which reduces the absorptive capacity of the soil. Thus not only do the soils hold less water for newly planted crops and sprouting grasses, but there is reduced percolation of rain into the subsoil, and consequently none into the aquifer.

In essence the greater attraction of the AVV areas reflects not only their relatively better agricultural potentials compared with other regions of the country, but also infrastructure in the form of feeder roads, watering facilities and the use of modern technology. Between 1974 and 1982 the AVV constructed road network linking up the national network rose to 192 km of main tracks and 91 km of secondary tracks. AVV founded 58 villages with 152 water-supply points equiped with pumps, 9 dispensaries, 28 schools, 68 stores and 216 houses for extension workers. These infrastructures are of benefit not only to the organized settlers but also to spontaneous migrants. The unsupervised cow Fulani- found in the Mogtedo settlements for example, prefer AVV3 because this village provides him a guaranteed semi-permanent water supply.

The structure of agriculture

Table 8 summarizes the major agricultural characteristics of the survey areas. Together, they span the major forms of agriculture found in Burkina Faso (except areas under plantation and irrigation). By almost any measure of development, the non-AVV areas occupy the lower end of the socioeconomic spectrum. Transportation within this areas and to other parts of the country is severely limited by poor roads. While it may be true that the bicycle and the motor cycle are abundant in other parts of the country, this is not the case here. There are few local opportunities for non-agricultural labour, as farm techniques remain substantially as they were in pre-onchocerciasis control period; no fertilizer, no improved seeds and

no machinery rental. Agriculture is practised in small parcels of land as most of the farming is under a collective system, in which land belongs collectively to the members of the communitiy and cannot be sold. Under this system, the land is divided into individual plots that are farmed year after year by the same family. Perhaps because of this practice, the soil quickly becomes exhausted and the land must be left fallow for a long period of time. As a result the family or the individual members must move or relocate to a new land in order to subsist.

The average farm in these communities consist of 3.8 hectares of which at least 65.8 percent are planted during one planting season. Low values of net production combined with the small size of the average plot proceduce annual farm incomes averaging 129,309 CFA francs. There is a high family labour input to which women and children contribute equally with men. As a result an average family of 5.9 persons work 207 person-days per year on their land, representing one-third of total family labour input on and off the farm.

The AVV villages occupy the other end of the spectrum, having undergone significant agricultural modernization since their establisment and the accompanying infrastructure. Cotton, the main commercial crop, relying heavily on fertilizer and other pruchased inputs, now dominate agriculture in this zone. A linear progression form traditional to commercial agriculture is, however, not implied in the above contrast. Both the AVV and non-AVV communities exhibit many aspects of traditional agriculture, with reliance on family labour and traditional inputs. However, agriculture in the AVV communities is quite mechanized with the one major commercial crops cotton. Agricultural income here is therefore higher, being at least 35,755 CFA francs higher than the average in the non-AVV villages.

Each settlement in the AVV communities contains two areas of economic activity (1), a peridomestic area which comprises of residential space, permanent field for subsistence agriculture and water points (2), and external agricultural area which is made up of the more distant temporary fields, fallow land, and the ground traversed in stock herding and wood collection. The peridomestic plot which is about 30 percent of the total land area owned in Mogtedo and 44 percent in Diebougou is farmed year after year by the same family; and as long as it is cultivated regularly,

the land can be passed down to children, though not sold or legally divided into smaller plots. This is the plot normally used for subsistence cropping as opposed to the more distant field which are normally planted with cotton for sale to the state. The more distant fields have the disadvantage that they are subjected to occupation by spontaneous migrants. Perharps the decrease in the average land holding by a settled family from 10 to 8 hectares in Diebougou and 10 to 6.4 hectares in Mogtedo would seem to suggest the extent to which land has been taken away from the settled migrants[8].

The Diebougou communities are a more prosperous agricultural zone than the other zones. Agricultural income here is the highest, being 28.2 percent higher than the average income in the second most properous community of Mogtedo. Compared with Mogtedo, agriculture is less of subsistence farming since only 20 percent of cultivated land is devoted to this purpose. On the whole agriculture as practised here may be described as moving away from traditional, employing relatively good quantity of purchased inputs and devoting relatively large percentage of cultivated land to commercial production.

Agriculture and population movement

As might be expected in a region with limited income-earning opportunities permanent out-migration is a fairly regular feature in the non-AVV communities. Perhaps because of this, family size is smaller here than can be found in the AVV settlements (5.9 as compared to nearly 9). Table 8 also shows that in the non-AVV villages while one family can own as much as 20 hectares of land, another is entitled to less than one hectare. Thus in a zone where land is very inequitably distributed and most farms are very small (average holding is 3.8 hectares per family of 5.9), the demand for hired labour would seem very mcuh limited. Simultaneously, small farmers would be forced to compete with the landless for off-farm work if it existed at all. In effect, small farms with low productivity only increase the likelihood of out-migration either by the landless or by the small farmers who cannot supplement their farm earnings in their home communities. This assertion is quite evident in Table 8 where only 207 person days of farming work is done here (and there is little evidence of off-farm work as compared to 60 person-days of off-farm work in the AVV

villages.)

On the other hand, the pattern of labour allocation that emerges in the AVV communities is one that is heavily weighted toward intensive use of on-farm labour with less permanent out-migration but more regional circular and repeat migration. This argument is born out by the fact that apart from Yatenga the most distant migrant supply province for the study areas, all other supply provinces border around the study regions. Perhaps earning off-farm income is less critical to most families in the AVV communities, where farm incomes are relatively high and purchased inputs are regularly delivered. Most families are able to earn enough cash to meet minimum needs by growing millet, sorghum, groundnut as well as rearing animals and birds as supplements to cotton cultivation. Because rainfall in the region is characterized by extreme irregularity both in terms of time and distribution, most families are forced to hire labour during the period of high farm labour inputs to enable them plant and, therefore, harvest in good time to avoid the risks that accompany late planting and hervesting. This process, therefore, encourages other relatives elsewhere to join the settler farmer during periods of planting and harvesting. In fact, farmers interviewed never made a secret of this point: they considered it a blessing. It may therefore, be postulated that the larger family size in the AVV villages is conducive to making high farm income which in turn makes it possible for more members to share in the income from farm production. This perhaps explains why extended members of the family move in from time to time.

Agricultural commercialization, defined here as the substitution of purchased inputs, commercial crops, and marketed production for traditional farming would seem to define the AVV villages in contrast to the non-AVV villages. Also, agricultural development, through its potential impact on farm income and the commercialization of agriculture would appear to have different effects on the types of risks associated with family income and therefore on the allocation of family labour to various types of farm activities. Higher levels of purchased inputs and the subsistence production link the family closely to the market economy, thus increasing the fixed monetary variability of farm income. One would want to explain population movement here in terms of these concepts. In the non-AVV communities, inadequate techniques employed

on limited land for long periods of time yield poor soils giving rise to indequate farm incomes for the bare necessities of the family, and with few local opportunities for wage labour, some members often migrate seasonally or relocate permanently. In the relatively better-off AVV communities, opportunities exist to expand farm and hence increase farm income thus permitting in-migration especially by relatives.

One other cause of frequent relocation of migrants is due to what one may call "seasonal vegetable farming". Between the months of October and April when most of the country is dried up of water, there still can be found watering land scattered over the region which, during the rainy season are inaccessible farming lands, but gradually become very suitable agricultural land as the dry season dips into the December-March period. Most farmers quickly relocate around these fertile lands in order to cultivate vegetables like tomatoe, okro, gardenegg and salad. Because of the season involved (dry all over the sub-region) these vegetables have ready markets in the neighbouring coastal countries like Ghana, Cote d'Ivoire and Togo. As such both urban and rural farmers are encouraged to find land to grow vegetables. Because this type of land cuts-across the whole contry, farmers could be seen moving from one place to another during the dry season.

On the whole evidence on migration suggests more arrivals in the AVV communities and out-migration from the non-AVV villages. Typically, migration is family oriented and is led by family heads mostly uneducated and normally aged above 30 years. Arrivals in the AVV communities can take one of the following forms: in a situation where the male family head dies and the woman and children elect to go back to their original home a new family may move in to take over the deceased's land. This study documented five cases of this sort during the field study. There is also the case of outright spontaneous migration by families who move into the AVV settlements and live off portions of AVV fallow or pasture land. This would seem to be proceeding at the rate of 5.2 percent per every three years. The other type of unsupervised migration into AVV communities is rather subtle and may not appear to catch the eyes of the officials. It involves a situation where an AVV settler invites close relatives to join him on his piece of land which is shared unofficially between them. Evidence on this is based on the fact that some family units have expanded to contain two or more

households usually headed by migrants who are either the eldest son or a close relative of the initial settler. This would seem to be growing at the rate of 7.8 percent per every five years.

The question we have been exploring thus far is how beneficial is the onchocerciasis eradication programme. We can summarize by saying that the benefits of onchocerciasis eradicaton are of two kinds: there are those benefits related to increases in labour productivity; and there are others that derive from the opening up of new lands for agricultural settlement. In the case of the former, there are four separate labour-related benefits including reduced debility (i.e., lower level of physical performance caused by the parasite); of the bites of the blackfly; and the reduced blindness experienced by the post-control population of OCP regions. In principle, these benefits can be measured in terms of the estimated output losses involved; in practice, however, the data required for this exercise are lacking due to the nature of the sample (see Section II).

On the more positive side it is well known that the main economic benefits of OCP come from its contribution to the opening up of new lands. Thus to better understand the potentials of these new lands one would like to establish whether or not obstacles other than onchocerciasis have hindered progress in agricultural production. For example, evidence has tended to suggest that unavailability of water, uncertainty over land rights, the juxtaposition of traditional techniques over poor soils and the prevelance of other health hazards do stand in the way of productive utilization of the OCP lands. These obstacles not withstanding onchocerciasis control has helped open up large new areas of agricultural land. The question may then be asked how much use is being made of the new lands? In other words, we wish to determine the extent to which onchocerciasis control and the concomitant population movement in the region is affecting agricultural production.

V REGRESSION ANALYSIS

Since no general theory of mobility transition can be applied to a region without an examination of its agrarian structure, it is now logical that we specify the impact of agricultural production upon selected variables depicting agranian structure. This is useful in order to better understand the emerging responses.

Variables and measures

As indicator of the structure of agricultural organization, we employ tenurial arrangements. The type of land tenure arrangements that charaterize a family's farm have autonomy and stability of these families. The extent to which members of the family have the opportunity to engage in productive labour will vary with land tenure system. Both autonomy and stability and children's likely employment opportunities can also be expected to influence family-level decisions about the future movement of the family. This is so in view of the fact that the land tenure system defines the rights and obligations with respect to acquisition and use of land and is a critical determinant of the size and distribution of farm income. The ideal tenure system is alos the one that provides adequate incentives to produce, to adopt improved techniques, and to invest. It should, therefore, afford reasonable security to those who till the land and give them the opportunity for meaningful participation in public decisions which afffect their welfare. Under these conditions, output will increase giving rise to higher incomces and hence a disincentive to relocating by the settler (but an incentive to the would-be migrant).

For each of the study area the following categories of tenure were identified: (1) AVV settelement type which is characterized by owner operated[9] tenure and non-AVV settlement types characterized by skin, communal, rental, and pledged as security for loan ownerships. To oprationalize, we hypothesize that family farming (owner operated) would be more positively related to output than the other types of tenure. The AVV system satisfies this. A dummy is therefore, created where tenure = 0 if land ownership is AVV type and = 1 for all other categories.

In our model, population pressure variables assume that people move from low to high wage areas and from fewer to more numerous employment opportunity regions. More central to this research are two measures of population pressure, migration and land/man ratio. Migration has many consequences for the social organization of the place of origin, for the destination, and for the migrants themselves. As a policy oriented research, interest is in the consequences and implications of migration, redistribution of population, and economic adjustment. In particular, we want to understand the relevance of intra-rural migration to agricultural productivity.

Theoretically, availability of arable land should exert a positive influence on the desire to migrate into the OCP regions. It has been argued elsewhere in this paper that the two basic factors that would seem attractive to migrants are the agricultural potentialities and the relatively low population density found throughout the OCP areas. If so then our basic premise is that the nature of productive organization in the places of origin has conditioned the cost, use, availability, and the development of land to the extent that social and economic opportunities for the majority in the sending areas have been stifled. Accordingly, it is argued that long-term internal migratory streams into the OCP region are important as a mechanism for obtaining efficient population redistribution in response to structural changes in the production system accompanying a modern economic growth process. Again, the migration variable measured in terms of length of stay in an area is expected to be positively related to agricultural production if current land/man ratios are inducive to agriculture, and negative otherwise.

Because of the problem of reinvasion (i.e. the arrival of migrant blackflies from bredding places outside the treated zone) and also because of the fact that onchocerciasis has only been controlled and not completely eradicated, it is hypothesized that agricultural productivity will seriously be affected by the presence of the blackfly since the nuisance attack by the simulium fly can result in below average utilization of the land. The effect of the blackfly is, therefeore, measured by a dummy variable which is equal to one if respondents complained about the presence of the blackfly and zero otherwise.

Throughout this study it has been found that rainfall is one singular factor that exerts tremendous influence on agriculture and population movement. Recent OCP research also shows that although the onchocerciasis disease may have contributed to the kind of agrarian structure found in the region, the pattern of rainfall has tended to have a very significant impact, having contributed in no small way to soil structure (Hervouet et al. 1984). It has also been observed above that the periodicity of rainfall may be more important than its abundance as far as yield is concerned. The duration of a shower and the time between rainfalls are, therefore, not only of critical importance to crop production, but are of equal significance to

the behaviour of the overall growing season which has substantial influence on labour mobility in the region. Therefore for the purposes of this analysis, the influence of rain is measured by the pattern of rainfall prevalent in the study areas; and is grouped into high, medium, and low categories. A good pattern is assumed to have a positive effect on land utilization.

Variables of background interest are education and the age of the farmer. Quite apart from general education which has been universally found to be an important factor in raising the level of agricultural productivity, it is expected here that the formal training received by the AVV settlers coupled with their general educational background should have a more positive influence on the level of productivity than found among the less educated non-AVV farmers. It is also expected that the age of a farmer should have a more positive influence on land cultivation the more mature a family head is, than would have been the case if he were a young family head.

Procedure

Because the annual amount of land cultivated each planting season could be equal to or less than the actual amount of cultivable land available to each family, logit regression is employed for the anlysis. That is, it is the natural logarithm of the odds of the proportion of land cultivated in a year that is assumed to be linearly related to the set of factors affecting agricultural production. In precise terms we want to determine the log odds of the equation;

$$\lambda_i = \log \{ \theta_i / (1 - \theta_i) \} = \Sigma \beta_i X_i$$

where the Xi's are independent variables and the β_i's their logistic regression. θ_i denote the proportion computed as the amount of land planted in a year divided by the total amount of cultivable land available to the family.

For the purpose of this study, substantial interest lies in the null hypothesis that the proportion of land cultivated each year is a constant. The maximum likelihood technique employed, therefore, expresses the proportion of area planted per year as a linear function of a constant term and a set of additive parameters, indicating the incremental impact of the independent variables on the logarithm of the odds of the amount of agricultural land cultivated relative to the total amount

of cultivable land available to the individual family.

To facilitate the interpretation of the results, we compute the first-order partial derivative of each estimated parameter, computed as $b_i P'(1-P')$ where $\hat{b_i}$ is the logit coefficient of the relevant independent variable, and P' is the sample proportion employed. This derivative is therefore, interpretable as the increment to the actual proportion of land cultivation associated with a unit increase in an independent continuous variable, or belonging to the relevant category of a discrete variable. The sample proportion for the dependent variable is a realistic representation of the actual overall amount of land cultivated, but the derivatives would be different if computed at different levels of P'.

Results

The coefficient from the more complete model converted into probability increments are presented in Table 9 for easier interpretation and analysis.

To begin with, one observes that all the variables of interest are properly signed as predicted, except the land tenure variable. In addition, the improvement chi-square testing the hypothesis about the term entered at various steps significantly improves prediction as is the goodness-of-fit test comparing the fit of data to the logistic model (Dixon et al. 1985). That the impact of tenurial arrangement should be negative with statistical significance is no surprise in this context. This only reinforces the fact that the relationship between migration and the land tenure system is complex, to say the least. The existence of supervised and unsupervised migrants who are all cutlivating the land simultaneously, but with different technologies underscores this complexity. When settlers belonging to different levels of technical knowhow settle on the same land, it is expected that land would tend to be unequally distributed thus increasing disparities in the colonization process. It is tempting to conclude that inappropriate utilization of land by spontaneous migrants has created the negative effects so far. However, it could also be argued that settlement opportunities such as the one offered by Government through the AVV frequently mask general problems, the best example being the confrontational attitudes between new settlers and traditional claimnants. In fact, apart from the negative impact argument of the cultivation of marginal lands

and the use of ineffective technology against spontaneous settlers, all other negative arguments like deforestation, uncontrolled bush fires, overgrazing of land by animals,etc. can be made against the AVV settlers found in this study. There is, therefore, substantial reason to doubt the effectiveness of the current settlement programme, even though its existence has loudable consequences for the future agricultural development of the region. There is, therefore, the need to work toward converting the negative impact of 11 percent to a positive effect by rethinking and redefining the status of spontaneous settlers once they find themselves in AVV areas.

Although control programme achieved complete interruption in this region since 1977 (Prost and Prescott, 1984), the decrease in the prevalence of the disease has been gradual because infected people still carry living parasites. The positive effect on land cultivation for those who have stayed for five or less years would, therefore, suggest that there has been considerabble reduction in debility, which is the generally lower level of physical performance caused by the parasite.

In addition to its statistical significance, the length of stay variable has increased land cultivation by 10 percent more for those who have stayed in the communities for a period not exceeding five years. This would in itself suggest extending inviatations to more migrants; however, this would need to be done in full view of more dynamic and a more all embracing settlement programme which can accommodate unsupervised settlers. The positive values of the age variable is also supportive of the fact that land colonizers are economically active, being in the age group 25-45 years. Their participation in the land colonization process increased land cultivation by three percent more than would have been the case if they were not in that age segment. In addition, it may also reflect the fact that as pioneering migrants to a new land, these family heads had the capacity to finance their travel and initial installation costs with minimum impediments. In that sense, the degree to which earlier migrant provided information, temporary housing and financial assistance for younger siblings and other family members who wished to follow has been made very secure; thus creating positive influence for the migration process to continue.

The rainfall and education variable effects are also quite important in terms of their levels of statistical significance. In particular, education, especially the informal training given to the AVV settlers would seem to be yielding the desired results. The increment of 11 percent to the process of land cultivation over what would have been the case if they were not educated, reinforces the need to provide such a facility to more rural dwellers. If anything, these settlers are more likely to understand and cope with weather vagaries and also be better able to adopt new techniques that can lead to efficient use of the land.

In order finally to highlight differences in the extent to which various factors affect agriculture in the AVV and non-AVV settlements, Table 10 is prepared using differences in mean value of variables of common interest. Tests of differences between means show that the two categories of community are significantly different with respect to the major socioeconomic variables of farm size, labour force, farm labour and migrant category except perhaps with farm income, for which the level of significance was raised to 0.4 percent. In particular, it is worth observing that families that entertain temporary migrants have an average labour force (males aged 12 to 60 years) that was 52 percent larger than those that did not; a difference that is statistically significant at the 0.001 level. The implication here is that a larger family labour force permits a diversification of income sources that offests the increased risk of relocation. Therefore, as long as there is room to accommodate friends and relatives and as long as people relocating can find a parcel of land to cultivate, the AVV areas will continue to experience unsupervised migrations contrary to the design of Government.

Finally, that the effect of income is not significant at 0.05 or 0.001 level in no way implies that the influence of this factor is trivial, either substantially or statistically. It could be the reflection of the statistical difficulties of estimating a complex mechanism with a coarsely measured variable. On the other hand it could also be a reflection of what is really happening: that push factors, particularly risk, operating through the impact of weather failure and poor land titles is the driving force behind migration and not a pull factor as such.

VI SUMMARY AND CONCLUSIONS

The study undertaken here shows that on the whole, while some of the communities like the traditional non-AVV villages experience heavy out-migration others, particularly the AVV ones experience in-migration. In the communities of heavy out-migration, there is also a corresponding decline in agricultural production as measured by income levels and the amount of land cultivated. Most moves in the AVV communities in particular are more temporary than permanent as is also the prevalence of family migration over individual movement. In both types of community, migration has direct influence on the size and structure of the labour force, including its age, sex, and occupational characteristics; being positive for the AVV settlements and negative for the non-AVV villages. For the AVV communities, the influence on the available capital is the negative impacts of the indirect invitation extended to close relatives and friends as spontaneous migrants. The fact that non-farm employment has not developed far enough to create jobs outside the family farm would seem to suggest that the kind of technology carried with the migrants is lacking in modernity.

For the non-AVV villages, the deterioration in the land/man ratio would seem to be the major cause of out-migration. It is to be noted that the rural conditions that define underdevelopment and cause migration; a lack of land and capital and the use of traditional techniques of production, resulting in low agricultural yields constitute the major contrast between AVV and non-AVV settlements.

Overall, the dynamics of intra-rural migration in the OCP areas of Burkina Faso are rooted not only in disease environment dominated perhaps by onchocerciasis, but also in the level of agricultural technology, soil type and above all rainfall pattern. The very fact that migrants tend to be attracted to specific locations even within the OCP areas underscores the fact that not all the reclaimed lands are suitable for the kind of rural agriculture taking place in the region. In deed, without giving attention to these other factors, agricultural development may not move further away from what obtained during the pre-onchocerciasis control period. The problems involved would need to be tackled, perhaps as a collectivity and not on isolated basis. To to extent that the availability of unfarmed arable land serves as an absorptive capacity for rural agricultural labour force, there is the need to

encourage migration into these areas. That said, we now turn attention to the likely favourable policy options.

In an attempt to spell out certain policy options, it is observed with emphasis that because the current AVV settlements are patterned and structured to favour an explicit dispersal policy, attempts to isolate the unsupervised migrants may in the long run create a failure out of the whole settlement project. At least, free movememt of unskilled labour is unlikely to have any major effect at this stage since there are manpower surpluses in nearly all other parts of the country. What the planners need to do perhaps is to redefine AVV scope to be more embracing of an integrated rural development programme rather than its current scope of rural population distribution or resettlement scheme which is less tolerating of spontaneous migrants. In essence, the polarization of settlements into spontaneous and supervised strategies need to be relaxed into some other forms of strategy that can accommodate the former. The extent of migration from the plateau areas to the river valleys is determined by the advantages and disadvantages of the different alternatives available to potential migrants. In addition, being spontaneous migrant from the sending regions is not necessarily a resposne to an organized demand for monpower. Hence in terms of policy instruments pull factors would seem less important than the push factors. As such, policies and pratical measures for settlement and socioeconomic development must tackle the migration issue at both the sending and receiving areas simultaneously in order to prevent spontaneous migration into the AVV settlements.

Experiments with less orthodox tenure forms must be encouraged in order to evolve systems which build on indigenous tenure arrangements. Long-term leasehold arrangements for example, may provide a greater degree of flexibility in land management as compared with freehold tenure systems. Where economic efficiency can be ensured, group farming systems, public-sector estates or privately owned estates with smallholder outgrowers could be a good means to introduce efficient cropping systems and technologies and simultaneously satisfy employment and distribution goals. For these to be effective all underutilized lands need to be equipped with basic infrastructure (e.g. roads and water supply sources).

Although the percentage of arable land in the region has increased slightly over the 1977 lvel, emphasis should be on raising crop yiel per hectare, rather than on increasing the amount of land in use. Clearing more land to grouw more food is not the solution because this gives rise to other problems such as deforestation, soil degradation, and erratic rainfall patterns. The technology must be found (if it does not already exist) to raise yields through proper agronomic techniques and the correct inputs at the right time. In this regard it is important to note that what the AVV communities currently have is what the entire farming region needs: efforts to markedly increase yields of the main food crops; sorghum, millet, maize, and groundnuts. This is not only essential in itself; it is a precondition for reallocation of agricultural land and labour to cash crops and other activities, which could significantly raise rural incomes. If farmers everywhere could be shown the advantages of using improved seed, appropriate plant spacing and the importance of proper timing of planting and weeding, output would grow. In addition, relatively simple measures like appropriate ridging, and mulching with a ground cover or crop residue can significantly reduce soil degradation and water loss. These are not new discoveries; they are old techniques which most farmers are still ignorant about.

It would seem that the AVV planners have not given explicit consideration to employment for the current settlers' children as they mature and enter the labour market. An assumption frequently held is that the dependents of the settlers will still carry on with agriculture, especially as rural populations expand and land/man ratios in the settlements deteriorate. A more realistic planning assumption should be that some settlers, and many of their children, will seek livelihoods in non-farm employment. The problem then would be how to design settlements to provide (a), more off-farm employment opportunities to the present and subsequent generations of rural workers and (b), a wider range of social services to the settlement communities at a reasonable cost. Both of these considerations can be viewed in terms of the current pattern and size of the AVV settlements. This is a research issue of great importance and can be pursued using the AVV communities as a case study.

Also, in order to avoid any intensification in rural population pressure in the OCP areas, economic development, although difficult in the rural setting,

particularly in a region where resources are limited is the best option. The establishment of a weaving industry in the settlement communities to make direct use of the cotton that is grown is quite obvious here. In this regard, one needs to consider the relative importance of agricultural and non-agricultural occupation in the settlement zones. Even at the current level of AVV development efforts, there is very little in the form of non-agricultural employment which can easily absorb the second generation offprings of the settlers. Thus locating a weaving factory around the major cotton growing areas will not only absorb second generation settlers, but will also provide the linkage for a complete institutional system to support, market and provide credits, inputs and professional advice on close range.

NOTES

The research on which this paper is based was funded from a grant made from the special Robert S. McNamara Fellowship Programme of the World Bank in 1987. The author is a Research Fellow at the Institute of Statistical, Social, and Economic Research (ISSER), University of Ghana, Legon. His greatest acknowledgement goes to the 1987-88 Fellowship Officials at the World Bank; Dr Ebrahim M. Samba, Director of the Onchocerciasis Control Programme (OCP), Ouagadougou; Mr J.B. Zongo of the Socioeconomic Development Unit of OCP; and Professor Sidney Goldstein of the Population Studies and Training Centre, Brown University, USA. The research could not have been carried out without anyone of them. My special gratitude goes to the OCP Statisticians Messers J.F.H. Remme and E.A. Soumbey.

1. Onchocerciasis or river blindnessis a blinding disease caused by the parasitic worm Onchocerca Volvulus. This filarial worm is transmitted through the bite of a blackfly known as Simulium damnosum. The Onchocerciasis Control Programme in the Volta River Basin area, involving the initial seven West African countries of Benin, Burkina Faso, Ghana, Ivory Coast, Mali, Niger and Togo, was launched in 1974. Because the distribution of the vector has an aquatic stage, which in essentially concentrated in foci alongside fast flowing water courses, the disease is commonly called river blindness.
2. Although the Sahel region has been experiencing vast shifts of population from rural areas toward the urban centres, it is important to note that rural-rural migration is of more relevance to onchocerciasis control than say, rural-urban migration. In addition, it is relevant to the Socioeconomic Edevelopment Unit's singular objective, which is to try to show how this demographic factor can help rehabilitate the OCP zone (see JPC, 1986).
3. Large differences in endemicity levels, in infection intensity and frequency of blindness can be found even between villages that are located only a few kilometers apart. These micro-epidemiological gradients are directly functional to the relative proximity of human settlements close to fast flowing rivers and

streams in which the blackfly vector breeds. Swarms of adult female flies usually seek the nearest source of human blood. Villages that are in the front-line of attack by the vector serve as effective barriers between the breeding site and the other villages in the same direction, thus reducing the number of infections in communities located at greater distance. Based on this observation, communities have been classified as either "1st", "2nd" or "3rd" line villages.

4. Epidemiological data also show that usually there are differences between the two sexes in terms of onchocerciasis infection. In males, infections are more intense than among females of corresponding age-groups. Likewise, the prevalence of eye lesions and blindness is higher in males than females. Similar studies show the disease to be more prevalent among adults than the young ones. It would seem therefore that the lenght of exposure is the major determinant of onchocerciasis infection.
5. Rain failure is the major problem. According to the 1987 Joint Programme Committee (JPC) report of 1986, rainfall was below average; and the weather was drier than it was in 1985, but much wetter than the decade 1972-1982 and above all, the period 1983-1984. It observes that although the Central and Eastern sudan savanna regions had satisfactory rainfall for agriculture, all the Guinea savanna zones to the South were in deficit and throughout, the Western areas of OCP, rainfall was similar to that recorded during the decade of drought (1972-1982), (JPC 1987).
6. In 1975 the presence of large numbers of the blackfly was first observed in certain Programme zones despite the highly effective vector control measures taken. It became evident that these flies came from breeding places outside the treated zone and were therefore, immigrants. This phenomenon recurs every year in several zones of the Programme area and has since then been referred to as "reinvasion". The arrival of migrant blackfly starts with and sometimes even before the first rains and conitnues for a good part of the rainy season.
7. The total number of family heads interviewed in the two AVV communities add up to 385. Of this figure only 20 family heads declared openly that they were not supervised migrants. However, checking on information from the kind of land title

held by a family head reveals that as many as 30 families were not entitled to AVV lands. It is therefore estimated that at least 12 percent (i.e. 50/385) of families were spontaneous migrants.

8. The other possibility is that the initial land holders have given portions of the title held to their adult male sons or other close relatives who later on joined in the migration process. Althought settlers were unwilling to give details about land title, information on this is based on the fact that certain families have now split into two separate households instead of one, as is required by law.
9. Strictly speaking, settlers within the AVV settlement blocks do not own the plots they cultivate. Under Burkina Faso laws, title to all lands in the development project areas rests with the state. Settlers do, however, have a form of user rights similar to that in traditional systems operating in the country as a whole.

REFERENCES

Arizpe, L. 1981. Relay migration and the survival of the peasant household, in Jorge Batan (ed.) Why People Move. Paris, UNESCO pp.187-211.

Andre, F. 1980. "Le Statut economique et social des aveugles de Wayen, Village Mossi", Etudes et documents du CERDI, Université de Clermont-Ferrand.

Brown, L. and V.A. Lawson. 1985. "Migration in Third World settings, uneven development, and conventional modeling: a case study of Costa Rica", Annals of the Association of American Geographers 75:29-47.

Chapman, M. and R.M. Prothero. 1982. Themes on circulation in the Third World Working Paper No.26. Hawaii: East-West Population Institute.

Cooter, R.J. 1983. "Studies on the Flight of blackflies (Dipt. Simuliidae) II: Flight performance of three cytospecies in the complex of simulium damnosum". Th. Bull. ent. Res, 73:275-288.

Dixon, W.J. et al. 1985. BMDP Statistical Software, 1985 Printing.Berkeley: University of California Press.

Findley, S.E. 1981. Rural development programmes: planned versus actual migration outcomes, in G.J. Demko and R.J. Fuchs (eds.) Population Distribution Policies in Development Planning, New York: United Nations, Department of International Economic and Social Affairs, Population Studies 75:144-166.

Food and Agricultural Organization, 1979. Rapport sur le projet relatif aux zones agro-écologiques. FAO document. Vol.1; Ouagadougou.

Hervouet, J.P. and A. Prost. 1979. "Organisation de l'espace et épidémiologie de l'onchocercose" in Maîtrise de l'espace agraire et développement en Afrique Tropicale, Mémoire ORSTOM, 89:179-189.

Hervouet, J.P. ; J.C. Clanet; F. Paris and H. Somé. 1984. Peuplement des vallées protégées de l'onchocercose après dix ans de lutte anti-vectorielle au Burkina Faso. OCP/GVA/84.5, Ouagadougou.

Hughes, M.N. 1949. Association of Population changes with blindness rates in the Kassena-Nankanni Division of Navrongo District. Unpublished document, Ghana National Archives Ref. Nealth 34.

Joint Programme Committee, 1986. Report on the Evaluation of the Socioeconomic Impact of the Onchocherciasis Control Programme. JPC 7.3 (OCP/86.7) Accra.

Joint Programme Committee, 1987. Onchocerciasis control Programme in West Africa: Progress Report of World Health Organization for 1987. JPC8.2 (OCP/PR/87) Rome.

Kosinski, L.A; and R.M. Prothero. 1975. People on the Move: Studies on Internal Migration. London: Metheun and company.

Lefait, J.F. 1976. Aspect Clinique, Epidémiologique et Psychosociale de l'onchocercose en zone de savane africaine, dans la Région de Bamako. Ph.D. dissertation held by the University of Marseille.

Lipton M. 1980. "Migration from rural areas of poor countries: the impact on rural productivity and income distribution", World Development 8:1-24.

Paris, F. 1983. L'occupation des vallées de la Bougouriba et de la Volta Noire. Dynamique de l'habitat et des cultures depuis 1974. Internal OCP report.

Pred, A. 1969. Behaviour and Location, Lund Studies in Geography 28B (Lund:Gleerup.)

Prost, A. and N. Prescott, 1984. "Cost-effectiveness of blindness prevention by the Onchocerciasis Control Programme in Burkina Faso", Bulletin of the World Health Organization. 62:795-802.

Prost, A. and Paris, F. 1983. "L'incidence de la cécité et ses aspects épidémiologiques dans une région rurale d'Afrique de l'Ouest." Bulletin of the World Health Organization. 61:491-499.

Prost, A. ;Prescott, N. and Le Berre, R. 1983. The economicis of blindness prevention under Onchocerciasis Control Programme in Upper Volta: A preliminary analysis. Workshop on Economic Aspects of Parasitic Diseases, Janssen Res. Found., Belgium, 10-13 January 1983.

Prost, A. J.P. Hervouet and B. Thylefors. 1979. "Les nveaux d'endémicité dans l'onchocercose"Bulletin of the World Health Organization 57:655-662.

Roberts, K.D. "Agrarian structure and labour mobility in rural Mexico" Population and Development Review. 8:299-322.

Sawadogo, R.C. 1976. Socioeconomic findings of the epidemiological evaluation of the

Onchocerciasis Control Programme in Ghana. World Health Organization Epidemiological Evaluation Unit: Technical document OCP/EP/77.21. Ouagadougou.

Stark. O. 1981. Research on rural-urban migration in LDCs: the confusion frontier and why we should pause to re-think afresh. (David Horrowitz Institute, Tel-Aviv University) Mimoegraphed.

Todaro, M.P. 1981. Economic Development in the Third World. Second Editon, New York and London : Longman.

Todara, M.P. 1976. Internal Migration in Developing Countries: A Review of Theory, Evidence, Methodology and Research Priorities. Geneva: International Labour Office.

Todaro, M.P. 1969. "A model of labour migration and urban unemployment in less developed countries" "American Economic Review 59: 138-148.

Vajime, C.G. and D. Quillevere. 1978. "The distribution of the simulium damnosum complex in West Africa with particular reference to the Onchocerciasis Control Programme area", Tropenmedizin und Parasitologie. 29:473-482.

Samba, E.M. 1985. "Together, we have defeated oncho". World Health. The magazine of the world Health Organizaton. October 1985:pp6-9.

Worlpert, J. 1969. "The basis for stability of inter-regional transaction", Geographical Analysis. 1:152-180.

Worlpert, J. 1965. "Behavioural aspects of the decision to migrate" Papers and Proceedings of the Regional Science Association. 15:159-169.

World Health Organization, 1985. 10 years of Onchocerciasis Control: Review of the Work of the Onchocerciasis Control Programme in the Volta river Basin Area from 1974 to 1984. OCP/GVA/85.1B, WHO, Geneva.

World Health Organization, 1976. Epidemiology of Onchocerciasis: Report of a WHO Expert Committee. Technical report series 597: WHO, Geneva.

World Health Organization, 1973. Onchocerciasis Control in the Volta River Basin Area: Report of the Preparatory Assistance Mission. WHO, Geneva OCP/6-1.

Fig. 1 **A MAP OF BURKINA FASO SHOWING STUDY AREAS**

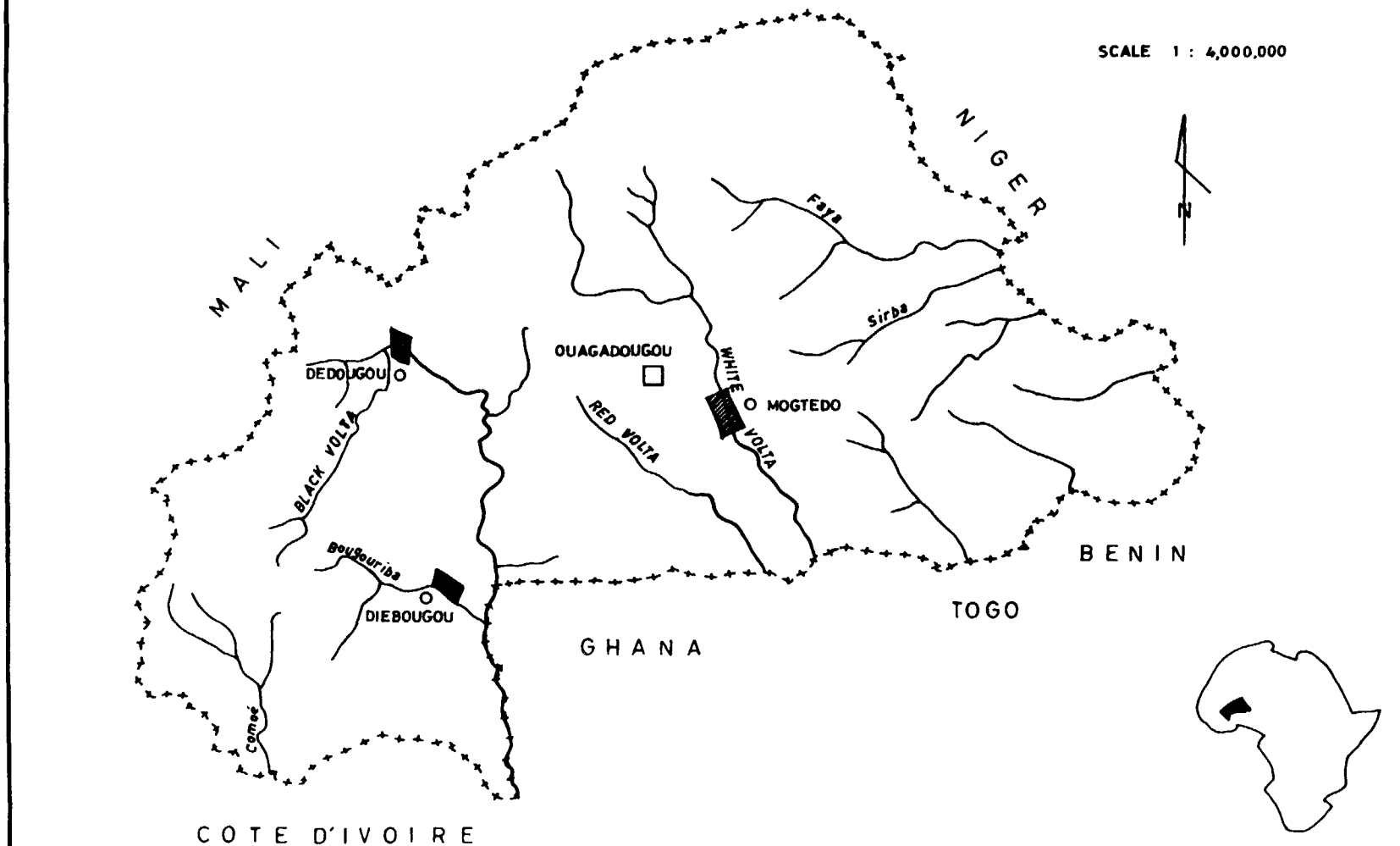

TABLE.1 BASIC CHARACTERISTICS OF COMMUNITIES IN THE SAMPLE

	COMMUNITIES			
	Ganzourougou (Mogtedo villages)1	Bougouriba (Diebougou villages)1	Mou-Houn (Nokuy)2	Kossi (Barakuy)2
Total Population	1,370	2,001	287	247
Number of families	153	232	46	44
Owner Land-operating families (percent)	99.7	99.8	77.0	21.0
Tenant cultivators (percent)	0.3	0.2	23.0	19.0
Average rainfall per year	500 mm	920 mm	650 mm	600 mm
Distance from district capital (km)	25	8	4	9
Distance from provincial capital	50	8	4	9
Distance from national capital (km)	110	293	238	263
Educational facilities	Primary School	Primary School	non	non
Medical facilities	Dispensary	Dispensary	non	non
Frequency of bus service (per day)	non	non	non	non
Road connection	25 km to all weather	Secondary route	Secondary route	Secondary route
Electricity	non	non	non	
Number of shops	One cooperative	One cooperative	non	

Note: 1. AVV villages settled by supervised migrants
2. Non-AVV villages.

TABLE 2. BASIC CHARACTERISTICS OF THE STUDY POPULATION

Characteristics	Number	Percent
Total study population	3,905	100.0
Number of males	1,971	50.5
Number of females	1,934	49.5
AGE DISTRIBUTION		
0 - 14 years	1,794	45.9
15 - 59 years	1,966	50.4
60+ years	145	3.7
LEVEL OF SCHOOLING		
No schooling	3,113	79.7
Some schooling	792	20.3
RELATIONSHIP		
Family head	481	12.3
Spouse	638	16.4
Children	2,376	60.8
Other kin	348	8.9
Non-kin	62	1.6
ACTIVITY		
Crop farmer	769	19.7
House wife	793	20.3
Children currently in school	306	7.8
Other dependents	1,961	50.2
Animal breeder	10	0.3
Others	66	1.7

TABLE 3. BREAKDOWN OF THE STUDY POPULATION BY SEX AND MIGRATION STATUS

COMMUNITIES/SEX	Total Population		Migrants		Non-migrants	
	Number	%	Number	%	Number	%
ALL VILLAGES						
Total	3,095	100.0	2,329	100.0	1,576	100.0
Male	1,971	50.5	1,158	49.7	813	51.6
Female	1,934	49.5	1,171	50.3	763	48.4
MOGTEDO VILLAGES						
Total	1,370	35.1	818	35.1	552	35.0
Male	694	17.8	422	18.1	272	17.2
Female	676	17.3	396	17.0	280	17.8
DIEBOUGOU VILLAGES						
Total	2,001	51.2	1,333	57.2	668	42.4
Male	1,011	25.9	691	29.6	320	20.3
Female	990	25.3	642	27.6	348	22.1
DEDOUGOU VILLAGES[1]						
Total	534	13.7	178	7.7	356	22.6
Male	264	6.8	46	2.0	218	13.8
Female	270	6.9	132	5.7	138	8.8

Note 1 : These villages have been grouped under that title for the purpose of analyses.

TABLE 4 PERCENTAGE DISTRIBUTION OF MIGRANTS BY LENGHT OF STAY AND AGE CATEGORY OF MIGRANTS: ALL VILLAGES

Lenght of stay	Broad age segments				
	0 - 9	10 - 17	18 - 29	30 - 59	60 and over
			MALES		
(N)	86	327	312	366	55
<1 year	1.0	0.6	1.1	0.7	0.1
1 - 5 years	5.4	6.6	4.1	4.2	0.4
6 -10 years	1.1	14.1	12.4	15.8	1.7
> 10 years	NA	7.2	9.7	11.3	2.5
			FEMALES		
(N)	70	263	355	416	55
<1 year	0.7	0.9	1.9	0.7	0.1
1 - 5 years	4.5	3.8	10.8	4.2	0.7
6 -10 years	0.8	12.5	10.3	15.0	1.2
> 10 years	NA	5.2	7.7	15.9	2.8

Note: Calculation excludes 124 cases with unknown dates.
NA = not applicable

TABLE 5. CROSSTABULATION OF MIGRANTS BY AGE GROUP AND PLACE OF ORIGIN (PERCENT)

Place of origin	AGE GROUP				
	0 - 9	10 - 17	18 - 29	30 - 59	60+
From urban area in study province (N=103)	0.4	0.8	1.2	1.6	0.5
From rural area in study province (N=964)	3.0	9.6	12.3	15.6	1.7
From urban area in another province (N=298)	0.7	3.4	4.0	4.5	0.4
From rural area in another province (N=760)	2.1	6.8	10.0	12.2	2.2
From another country (N=162)	0.6	1.1	0.7	4.6	-
Total (100.0%)	6.8	21.7	28.2	38.5	4.8

Note: Computation excludes 42 cases with unknown date and origin

TABLE 6: DISTRIBUTION OF MIGRANTS IN THE STUDY COMMUNITIES BY SELECTED CHARACTERISTICS

Characteristics	Distribution	
	Number	Percent
AGE AT ENTRY		
<10	156	6.9
10 - 17	590	23.3
18 - 29	679	29.2
30 - 59	794	34.1
60 and over	110	4.7
Total	2 329	100.0
KIN TIE AT ENTRY		
Head of family	391	16.8
Spouse	588	25.2
Children	1,051	45.2
Other kin	241	10.3
Non-kin	58	2.5
Total (excluding unknown)	2,329	100.0
PLACE OF ORIGIN		
From another rural community in study area	964	41.4
From an urban community in survey province	103	4.4
From a rural community in another province	760	32.6
From an urban community in another province	298	12.8
From another country	162	7.0
Unknown	42	1.8
Total	2,329	100.0

TABLE 7: MAJOR AGRICULTURAL PRODUCE OF THE STUDY COMMUNITIES

	Community		
	Mogtedo	Diebougou	Dedougou
Food and cash crops:			
Cotton (average production in kg)	2,200	2,200	na
Sorghum (average production in kg)	1,650	1,650	na
Millet (average production in kg)	1,700	1,700	na
Dried vegetables (average production in kg)	350	350	na
Animals (production per family):			
Cattle	3.4	2.5	1.8
Sheep	3.5	2.9	2.2
Goats	5.0	4.0	4.5
Donkey	0.05	0.07	0.1

Note: na = estimate is not available

TABLE 8: MAJOR AGRICULTURAL CHARACTERISTICS OF THE SURVEY AREAS

I T E M	Survey areas		
	Mogtedo	Diebougou	Dedougou
AGRICULTURAL PRODUCTION			
Average farm size (hectares)	6.4	9.0	3.9
Minimum holding (hectares)	1.0	1.5	0.5
Maximum holding (hectares)	10.0	10.0	20.0
Cultivated land in subsistence crops (percent)[1]	29.7	20.0	85.8
Cotton production sold (percent)[3]	80.7	80.7	-
Average farm income per year (CFA francs)[2]	165.064	229.893	129.309
Farms with income less than average (percent)	72.9	63.4	73.2
Proposition of farmers receiving extension service (percent)[3]	83.7	92.6	12.7
AGRICULTURAL LABOUR			
Area cultivated by means of animal traction (percent)[3]	19.5	24.4	-
Family farm labour (person-days)[4]	442	472	207
Hired farm labour (person-days)	60.0	60.0	-
Total farm labour (person-days)	502	532	207
Average family size (number)	8.9	8.6	5.9

Notes: 1. The percent of cultivated land in subsistence crops is the proposition of cultivated land in these crops to the total cultivated land for each family, averaged over all families.

2. 1 US$ = 283 CFA francs at the time of the survey.

3. Information was supplied by extension service resident representative in AVV villages.

4. Computation is based on crops and type of farming taking place.

TABLE 9: EFFECTS OF SELECTED VARIABLES ON LAND CULTIVATION IN THE STUDY AREAS.

Selected variables	Logit coefficient	First Derivativea
Tenure	- 0.44*	- 0.106
Rainfall pattern		
High	0.11	0.027
Medium	- 0.17*	0.41
Low	- 0.24*	0.058
Presence of blackfly	0.11	0.027
Lenght of stay	0.43*	0.104
Education	0.40*	0.096
Age	0.13*	0.031
Constant	- 4.536	
-2 log likelihood	-1060.923	
N	1,593	

* P< 0.05

a Figures computed using bi p^1 ($_1$-p^1) where bi is the respective logit coefficient and p^1 = 0.59.

TABLE 10. MEAN VALUES OF SELECTED VARIABLES FOR FAMILIES IN AVV AND NON-AVV VILLAGES

Variable	AVV Families (N = 380)	Non-AVV families (N = 90)	Level of significance of differences in mean value[a]
Farm size (hectares)	7.2	3.8	. 050
Farm income (CFA francs)	197,478	129,309	. 400
Male labour force (persons)	27.8	4.3	. 001
Guest workers (temporary migrants)	4.3	3.8	. 050
Average farm labour (person-days)	266	207	. 001

[a] t-test of pooled variance

APPENDIX TABLE 1. PERCENTAGE DISTRIBUTION OF MIGRANTS BY AGE GROUP AND LENGTH OF STAY: MOGTEDO

Length of stay	Broad age segments				
	0-9	10-17	18-29	30-59	60 and over
		Males			
N	32	121	112	127	26
<1 year	0.7	0.7	0.5	1.0	0.2
1-5 years	6.2	7.7	3.3	5.0	0.2
6-10 years	0.7	5.0	5.0	3.8	0.5
>10 years	NA	15.6	17.9	20.3	
		Females			
N	24	81	106	160	21
<1 year	0.3	-	2.0	1.3	0.3
1-5 years	5.4	4.6	8.3	5.9	1.0
6-10 years	0.5	6.1	5.6	5.4	0.6
>10 years	NA	9.9	11.0	28.3	3.6

APPENDIX TABLE 2. PERCENTAGE DISTRIBUTION OF MIGRANTS BY AGE GROUP AND LENGTH OF STAY: DEDOUGOU

Length of stay	Board age segments				
	0-9	10-17	18-29	30-59	60 and over
	Males				
N	51	200	185	221	26
<1 year	1.0	0.6	1.3	0.4	-
1-5 years	5.0	6.1	4.8	3.8	0.6
6-10 years	1.5	20.7	17.7	24.1	0.6
>10 years	NA	1.9	3.2	4.1	0.6
	Females				
N	42	169	204	201	20
<1 year	0.8	1.4	1.7	0.3	-
1-5 years	4.6	3.5	12.7	3.5	0.6
6-10 years	1.3	19.0	13.5	23.4	1.9
>10 years	NA	2.7	4.1	4.4	0.6

APPENDIX TABLE 3. PERCENTAGE DISTRIBUTION OF MIGRANTS BY AGE GROUP AND LENGHT OF STAY: DEDOUGOU

Lenght of stay	Board age segments				
	0-9	10-17	18-29	30-59	60 and over
	Males				
N	3	6	15	18	3
<1 year	2.2	-	2.2	2.2	-
1-5 years	4.4	4.4	-	2.2	-
6-10 years	-	-	2.2	-	
>10 years	NA	8.9	31.2	33.3	6.8
	Females				
N	4	13	45	55	14
<1 year	1.5	1.5	2.3	0.8	-
1-5 years	1.5	3.1	8.4	3.1	-
6-10 years	-	2.3	8.4	3.1	-
>10 years	NA	3.1	15.2	35.1	10.6