International Science and Technology Institute, Inc.

ENVIRONMENTAL SECTOR ASSESSMENT

UPPER VOLTA

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By:

International Science and Technology Institute, Inc.
2033 M Street, N.W., Suite 300
Washington, D.C. 20036

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OVERVIEW

The environmental quality of Upper Volta and her agricultural productive capacity are threatened by serious soil erosion. Degradation and decreased production are most seriously felt in regions with high rural population densities. Base on field work in September and October of 1981, this environmental sector assessment identifies examples of serious degradation of environment in terms of soil erosion, deforestation and range degradation. While it is impossible to quantify the degree of degradation due to insufficient baseline data, examples of each type are provided and the major processes and trends involved are described.

Traditional land use systems are adapted to cope with the environmental variability which characterizes Upper Volta and the Sahel. Farmers have numerous traditional varieties of sorghum to plant depending on the location of their fields and the year's precipitation pattern. Herders move seasonally to use grazing lands when and where they are available. Unfortunately, traditional systems have not coped well with high levels of population density and increased demands for commercial crop and animal production.

The major constraint to solving environmental problems has been the tendancy for all agencies; governmental, non-governmental, and donor; to try to find relatively simple technical solutions to environmental problems. In the case of anti-erosion programs, a single technical package with minimal initial in-country testing and infrequent modifications has been used since the early 1970's. This system yields little to no immediate benefit to the farmers. Similar simple approaches have been used in tree planting with emphasis on plantations of non-native tree species. On-going range management programs involve sedentarization of herding populations in previously

unoccupied zones and are not testing management practices which might be applicable to the majority of animal producers, either semi-sedentary or nomadic.

The general recommendation of this assessment is that all environmental programs and projects adopt an 'adaptive research' approach. Adaptive research recognizes the inherent complexity of the environment by acknowledging the need to test a variety of management techniques in particular local situations. Each technique whether they be erosion control, reforestation or range management, needs to be evaluated and adapted. Such a widespread program of testing and evaluation can only be feasible if it involves the voluntary participation of the local farmers and herder. This approach is compatible with current Voltaic policy to encourage 'self-development'. An example of the successful use of adaptive research in soil and water conservation is found in the Oxfam project in the Ouahigouya area.

Local farmers are using local materials and tolls to install barriers to sheet erosion which increase water infiltration. The top priority assistance strategy recommended by this assessment combines the adaptive research approach with regional and national level expertise in soil and water conservation. Renewed efforts in soil and water conservation, in coordination with other donors, will have positive results both in the environmental sector and the agricultural sector.

Secondary priority is given to continuing support of th on-going AID-sponsored forestry training program at Dinderesso and to support of the procedures committees and maintenance of the exclosures established during the AID Village Livestock Project.

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The USAID Mission made the Assessment a possible assignment by laying the groundwork before the team arrived and continuing support and feedback during the team's visit. Special thanks are due to Gordon Bertolin for his supervision of the team and to Kifle Negash for accumulation of background information prior to the team's arrival. The team received considerable assistance from Samir Zogby, E.G. Van Voortheuizen, Bob Winterbottom, Jay Smith and George Taylor. Cecil Dalebroux provided the crucial linkages between typists and facilities necessary for producing the draft report. In the U.S., Willie Saulters, Jim Hester and Dave Dawson of AID/Washington and ISTI staff contributed a great deal to the initiation of the assessment and its completion.

The Assessment team consisted of Steve Evett, soil scientist; Dean Treadwell, range ecologist; Franz Reuter, forester; and Nancy Ferguson, ecologist and Team Leader. In Upper Volta, the team was joined by Fred Sowers, geographer and social scientist, and Kifle Negash, rural economist. The team not only coped well with a hectic schedule and the complexities of their assignments, but also worked well as a group with much useful sharing of ideas. Previous long-term experience in Upper Volta on the part of Evett and Sowers contributed much to the team's successes.

Washington, D.C.

Nihal W. Goonewardene
Vice President
International Science and
Technology Institute, Inc.

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I. DESCRIPTION OF ENVIRONMENT AND PROBLEMS

A. Description of the Environment

The environment is neither an abstract concept nor a political statement in Upper Volta. Over 90% of the population is rural and makes its living by using the natural resources of the country and being active agents in modifying the environment. The Government of Upper Volta has identified food self-sufficiency as a major national goal. To meet this goal, farmers and herders and their families must use vegetation, soil and water resources to produce more food for the growing population of the country. Environmental degradation through soil erosion and nutrient loss, through deforestation and through range degradation will decrease the productivity of the country's natural resources. This in turn will make it increasingly more difficult to meet the food needs.

The economy of Upper Volta is based on its natural resources: an agricultural economy. The livelihood of the majority of the population is made by managing the solar energy which falls on the land's surface. With rainfall, photosynthesis forms the basis of crop production, animal production and wood/fuel production.

The amount of land available to a farmer or a herder is directly related to the amount of solar energy and to the amount of water available to produce a livelihood. In arid and semiarid regions, the rate at which solar energy can be converted into plant biomass is controlled by the amount of water available to the photosynthetic process. Since land is a critical element in the availability of natural resources, land ownership or use rights become important factors in environmental management.

1. Population Density

The population of Upper Volta was estimated to be 6.7 million persons in 1980. The country's area is 274,000 square kilometers (km^2), giving an average population density of 25 persons per km^2. Regions to the southwest, south, east and north are less densely populated than the average while the central Mossi Plateau has rural densities of from 40 to 70 persons per km^2.

2. Climate

The climate of Upper Volta is characterized by a single rainy season which is longest in the southwest and shortest in the north. A twenty-five year average of annual precipitation ranges from over 1400 mm/year in the southwestern forests to less than 500 mm/year in the Sahel where Upper Volta is bordered by Mali and Niger. The densely populated Mossi Plateau region receives between 600 and 1100 mm/year (about 24-43 inches/year). The length of the rainy season varies from 5 months in the southwest to 3 months in the north. Individual storms are intense (high volumes of rain per unit time) and thus more likely to cause erosion, especially at the beginning of the rainy season when many soils are bare. Highest temperatures (over 40° C) occur at the end of the dry season. Lowest temperatures occur in December and January.

3. Soils

The soils of Upper Volta are highly weathered, highly leached, tropical soils which have evolved from granites and metamorphic bedrocks of the Precambrian shield that underlies most of the country and from sedimentary formations in the west. Limited areas of more fertile hydromorphic soils have formed on floodplains of major water courses, especially the Volta Noire. The soils formed on the gently undulating Precambrian shield are characterized and by high erodibility, and by low fertility especially in phosphorus and potassium. The majority of soils on the Central Plateau, where erosion is more marked, are ferruginous tropical soils with combinations of fine sand, silt, kaolinite, and lack of organic matter. This composition leads to quick crusting under the intense rainfalls. A variety of factors characteristic of traditional Voltaic agriculture favor denudation of the soil surface, crusting, sheet erosion and general soil degradation. These factors include deforestation and devegetation, as well as overgrazing of bushes and grasses; removal of crop residues for forage, fuel and artisans' use; burning of crop residues; fallow fields and grass lands; and the destruction of soil surface structure by passing or grazing animals.

The soils of the Central Plateau are mostly formed from the already highly weathered and leached remains of lateritic shields and other parent materials which are themselves low in essential nutrients. Overall 85 percent of Voltaic soils are very poor in phosphorus, 28 percent of soils are very poor in potassium, and 55 percent of soils are very poor in organic matter. Organic matter is the main source of nitrogen and possibly of phosphorus in these soils. Along with potassium, these make up the three most highly needed plant nturients.

4. Vegetation

The vegetation of Upper Volta is a result of the climate, the soils and human management. Three major vegetation zones are defined from south to north: The Sudano-Guinean, the Sudan and the Sahel. The Sudano-Guinean zone is found in areas receiving more than 1000 mm of precipitation per year and is characterized by woody species in dense populations. Forests of this zone have canopies, a woody under story and a herbaceous understory. Trees, in general, are taller than those found in the Sudan zone.

The Sudan zone, found between the 600 and 1000 mm isohyets, is the most extensive zone in Upper Volta. It is a mosaic of open forests, savannas and grasslands. Human managed landscapes characterize the Sudanian zone, especially on the Mossi Plateau where population densities are higher. The trees and shrubs which remain are those which are protected and used by the local people.

The Sahel zone is found in northern regions receiving less than 600 mm of rain annually. It is characterized by a mixture of grasses, bushes and widely spaced trees with larger trees along the water courses. Annual grasses are abundant during the rainy season and provide seasonal feed for livestock. They emerge and mature quickly after the rains, seed abundantly and rapidly lose nutrient quality and palatability. Trees and bushes are major sources of forage for animals during the dry season.

B. Identification of Environmental Problems

Population density, soils, climate and vegetation, are major elements of the Voltaic environment. When seen from a use-oriented point of view, natural resources provide the population with fuels, building materials, and food. When an imbalance exists between availability of resources and the rates of their use, environmental problems become obvious. Three major interrelated environmental problems are evident in Upper Volta: soil degradation, deforestation and range degradation.

1. Soil Degradation

Soil is the substrate for plant growth. Soil properties, along with climate and man, define the limits of the productivity of the earth's land surfaces. What follows is a description of how interactions of and trends in the above factors have caused or are causing environmental problems in Upper Volta.

a. Erosion. Due to low relief, soil erosion in Upper Volta tends to occur as sheet erosion during runoff events and tends to be exacerbated by the following conditions:

- bare soil surfaces due to human population and their animals, as described elsewhere;
- poor soil structure due to low organic matter, animal movement, and cropping practices;
- crusting type soils that have low infiltration rates and high coefficients of runoff;
- high intensity rainfall; and
- long unbroken slopes.

Bare soils result from deforestation and devegetation due to overgrazing of bushes and grasses; lopping of tree limbs for forage; removal of crop residues for forage, fuel and artisanal use; and burning of crop residues, fallow fields and grass lands. Crop residues are burned in order to clear the fields for easier planting and to provide a salt, high in potassium, prepared from the ashes and preferred for cooking sorghum and millet. Fallow field and grass lands are often burned as a traditional practice related to the local culture.

Crusting type soils exist over large areas of the Precambrian shield - most of Upper Volta - and long, though shallow, slopes are common over the very low relief. Crusting is enhanced by the low organic matter content of most soils. In densely populated areas, the organic matter content is further decreased by land and plant residue use practices. Surface soil structure is altered by animal movement over the field and pasture further decreasing infiltration of water and increasing runoff.

Rainfall tends to come from convective type storms exhibiting high rainfall intensities (especially in the early rains), intensities are much

higher in the northern parts of the country, roughly north of the 900 mm isohyete, decreasing south of Ouagadougou.

Potential evapotranspiration is higher than average rainfall in all parts of the country, and as much as 3 to 4 times higher in the Central Plateau. The dry season is 8 months or longer as one moves north. This precludes any regeneration of plant cover until well after the first rains of the rainy season.

Seasonal effects of human and animal pressure are more likely to result in bare soil surfaces in the grassy savanna with isolated trees, which occur north of Fada N'Gourma, Tenkodogo, Toesse (about 65 km south of Ouagadougou), Koudougou and Nouna, than in the more forested lands to the south.

Long slopes are characteristic of Voltaic topography but, under shifting agriculture associated with low population densities, bare fields have tended to be separated from one another by buffer zones of brush or revegetated fallow fields, effectively reducing slope lengths. In areas of high population density fallow is eliminated or reduced and brush and trees are cleared or overgrazed creating large contiguous cultivated or other areas where unbroken bare slopes tend to be very long.

Runoff, as sheet flow, may be 5 to 20% of rainfall under savanna conditions, increasing to from 20 to 50% under traditional agriculture, and may increase to as high as 60 to 80% of rainfall on bare soil or soil impoverished by cultivation.

Considering the above factors in conjunction with population density, one would expect to find the greatest erosion problems on the crusting soils of the Central Plateau in the ORDs of Ouagadougou, Kaya, Ouahigouya, the northern part of the Koudougou ORD, the northeastern part of the Dedougou ORD, and some parts of the Koupéla ORD. This is indeed the case. The severe erosion in the Ouahigouya areas has been recognized since the early 1950's; and the Ministry of Rural Development has concentrated its anti-erosion work in the ORDs mentioned above, except for the Koupéla ORD, since 1976.

b. Soil moisture/induced drought. As indicated above, environmental degradation coupled with the crusting nature of most Voltaic soils leads to greatly increased runoff compared to that occurring under natural savanna conditions, with the secondary result of reduced infiltration of water into the soil profile. This can cause a fundamental change in the soil-plant ecosystem that may well be irreversible without heavy investment for physical and social changes.

Examples of such ecosystem changes are especially common around Ouahigouya, Djibo and Dori, and further north. The very gently rolling topography exhibits some low rises or slightly elevated sloping plains which are covered with dead (not deciduous) bush and trees, and are stripped of topsoil in most cases with isolated platforms of grass testifying to the great erosion that has taken place. The surface is mostly bare subsoil covered with a 1/8- to 1/4-inch thick crust underlain by very gravelly subsoil or kaolinitic clay, depending on the site. North of Djibo the soils are more sandy. These sites are examples of induced dought due to overgrazing during and after dought periods.

In periods of exteme drought, as occurred in Upper Volta in the early 70's, some vegetation will die out in even an undisturbed "natural" ecosystem. Die-out can be much more extensive and severe when heavy overgrazing strips entire surfaces of grassy vegetation for several years in a row. The crusting bare soil surface increases runoff and accelerates erosion. Annual grass seeds are washed away and the soil crust inhibits germination of remaining seeds. Infiltration and deep percolation of rain water is minimized, and trees and shrubs die of the resultant induced dought. The limited grassy revegetation that does occur becomes the focus for grazing in an otherwise degraded landscape in which the percentage of grass covered pastureland is now greatly reduced.

Adequate soil water is an important part of overall soil fertility. Without moisture plant nutrients (N, P, K and trace elements) cannot be effectively used by the plant. Four major factors determine the amount of soil water available to plants in the extensive tropical ferruginous soils: soil texture; soil depth, which over large areas is more or less limited by the presence of a lateritic pan; infiltration rate of surface water into the soil; and length of time that surface water is present on the soil. Time and infiltration rates are those most easily affected by farming practices. The factors of soil texture and depth are, for practical purposes, unchangeable. It should be recognized that shallow soils are a major limitation to storage of rainfall in the soil profile over much of the Central Plateau.

c. Fertility. When soil moisture is adequate, phosphorus is the nutrient that most commonly limits productivity in traditional agriculture. This is one reason why traditional farmers have not discovered the burning of plant residues to be deleterious. The nitrogen that is thereby lost is not limiting and by itself would not significantly increase yields over the long term in most soils, even if it were somehow saved (e.g. by plowing under plant residues). Also it has been found that increasing soil moisture levels alone is not enough for sustained crop yield increases since phosphorus is or will become limiting.

Low soil fertility goes hand in hand with soil erosion. There is much evidence to indicate that the most severe form of erosion in Upper Volta, sheet erosion, acts to selectively remove the finer soil partides and organic matter which are the basis of good fertility.

Fournier estimates that values of erosion loss from a continuous cropping of a non-protective plant (i.e., sorghum or millet) must be comparable to the erosion on the country's most erodible soils (as much as 6 or 7.5 cm per year). Roose gives figures of yearly erosion loss as being 35 tons/ha on bare soil and 5 to 15 tons/ha under sorghum on ferruginous tropical soils near Saria. Roose warns that while the latter losses might be tolerable on a deep topsoil, they are dangerous on the shallow ferruginous tropical soils common to the Central Plateau. He further states that the loss of soil fertility due to erosion under sorghum cultivation equals the loss due to those nutrients carried away in the grain and panicles (not considering the loss of nutrients when leaves and stalks are removed from the fields).

It has been shown that removal of vegetation from West African savanna soils causes a relatively rapid loss of soil organic matter through the mineralization of humus. There is continuing debate about the possible valuable

or deleterious effects of plowing soils in the savanna, with some saying that plowing causes further oxidation and loss of soil organic matter due to the resultant aeration of the soil. Others claim that organic matter can be built up through plowing under of plant residues thus improving soil structure and fertility. This question is closely linked to the problem of removal of plant residues from the field. Present farmer practice is to remove stalks for artisanal or fuel use and to allow grazing animals to eat the rest. Most often, remaining plant residues will be burned before the next rainy season. There is a serious conflict between traditional uses of crop residues and their use as mulches for soil and water conservation or plowing them under to act as a stubble mulch.

Overall, soil fertility as reflected by average crop yields is lowest on the Central Plateau, especially around Ouahigouya. By comparison, yields are 50 to 100% higher in the Bobo-Dioulasso-Dédougou region than on the Central Plateau.

Problems of low soil fertility in the past have been traditionally overcome by abandoning fields and clearing new areas in a shifting cultivation pattern (centered around a village). This process guaranteed sufficient yields to meet the population's needs as long as the population remained small. With small percentages of total land surface under cultivation, the resulting long periods of fallow allowed some build up of soil organic matter and essential nutrients which effectively maintained a sustained productivity. The fallow fields would revegetate and the resulting ecosystem would accumulate and recycle nutrients, rebuilding the fertility in the surface and subsoil. This is a process that the farmers themselves are able to duplicate only in fields immediately surrounding their concessions.

To the extent that population pressure of man and his animals was below the carrying capacity of the ecosystem in the past, there was little concern for the negative effects of traditional land use practices. To the extent that in a large part of the country (Central Plateau) the population pressure now exceeds the carrying capacity of the land, and little or no fallow exists, we are witness to an acceleration of the consequences of traditional land use practices.

d. Animal traction. The effects of plowing on runoff rates and therefore erosion are not yet known. So far, research results are contradictory and confusing. IRAT tests show runoff to be practically identical under either traditional or animal tradition tillage when no plant residues are incorporated, but runoff was about 1/4 less under both systems when crop residues were turned under. The argument is made that plant residues are more likely to be turned under if animal traction is used. IRAT-CIEH research shows runoff to be 150 percent higher under continuous oxen cultivation compared to manual cultivation after fallow.

Other CIEH-IRAT research shows runoff to be practically identical under different cultural practices except for being slightly worse under oxen cultivation if plant residues are not plowed in. Later IRAT research indicates that animal traction plowing increases erosion over hoe cultivation by about 0.4 metric tons/ha/year, but incorporation of residues under either system can reduce erosion by 1.8 metric tons/ha/year.

The proposition that animal traction is likely to result in lower soil erosion than hoe cultivation, because plant residues are more likely to be incorporated into the soil under the former practice rather than the latter, is fairly ridiculous in the context of traditional land use practices that leave the fields essentially devoid of plant residues.

e. Social factors. There are a number of social and political factors which may exacerbate erosion and associated land degradation problems in the future.

1) Migration. There is a great deal of spontaneous migration of the Mossi from the Central Plateau to the Dédougou and Bobo-Dioulasso regions where they continue their previous farming methods including removal of undergrowth and shifting agriculture. While the indigenous populations of those areas have developed farming methods that allowed survival and an accepted yield when population pressure was low, it is probable that increased immigration in the areas will increase the pressure on the land and change the pattern of cultivation. Small separated plots will be combined with fewer buffering fallow or savanna areas in between. As this happens uninterrupted slope lengths will increase erosion. This is a trend which has already reached its limits in the Ouahigouya area with resultant high erosion. Increasing population in all areas of the country will work towards the same effect.

2) Repopulation of the Oncho free zones by AVV is starting to concentrate farming on soils, 70% of which are the same tropical ferruginous soils found on the Central Plateau, which are so sensitive to erosion.

3) Rural mechanization is being encouraged through agricultural credit, animal traction centers, and regional animal traction equipment centers operating in conjuction with ORD extension personnel. IRAT continues to recommend plowing before seeding even through research results are far from encouraging and at least one SAFGRAD researcher recommends the use of animal traction mainly for weeding and not plowing.

4) Anti-erosion projects are likely to receive increased support even though the FDR system is far from proven. This trend may end with a backlash from the farming populace for two reasons: i) Yield increases may not be forthcoming and farmers' faith in the system will be shaken. Improved yields depend on concurrent inputs of fertilizers (manure or chemical), animal traction and improved soil moisture (not proven to be a result of the system). Credit may not be available and the farmer may not possess the management skills necessary to use the various inputs wisely. Without improved water control, use of these inputs remains a risky gamble. ii) Yield increases seen by farmers in the first years due to improved soil moisture without fertilizer application may rapidly drop when available soil nutrients are used up. This scenario is especially likely to happen when available soil phosphorus is used up. Traditional farming practices kept yields at a low level in accord with the low level of release of available phosphorus in the soil. Dr. Paul Christenson, SAGFRAD Researcher, states that recent research indicates that continued higher yields will upset the balance between release of available phosphorus in the soil and the exportation of phosphorus and other nutrients in the form of panicles and plant residues. The FDR program seems to be gambling largely with the idea that this drop in yields will be averted by increased use of fertilizers although promotion of fertilizer use is not an integral part of that program.

5) Sedentarization of the nomadic herders is increasing with consequent cropping increases on soils in the very fragile soils of northern Upper Volta. At the same time, traditionally sedentary farmers like the Mossi and Gourmantché are becoming raisers of animals, especially goats and sheep. These changes make it increasingly probable that fields in the areas will be completely stripped of crop residues by the animals without even the guaranteed benefit of return of animal droppings to the fields.

It is important to note that the focus has been on soil and water conservation and soil fertility problems. No attempt has been made to address other possible problems, three of which are i) misuse and adverse environmental effect of pesticide use, ii) disease and water quality problems related to the creation of surface water reservoirs, and iii) continued drop in local water tables as more soils are degraded and infiltration rates of rainfall are drastically decreased.

6) Ground water. Dropping water tables occur wherever the soil surface is laid bare. There are already serious problems in the Ouahigouya area where it is said that the water table is dropping by as much as a meter a year. Many villages rely on shallow wells in bottom lands fed by perched water tables which are limited in volume and significantly recharged by subsurface flow from surrounding slopes. When those slopes are bared, decreasing infiltration, less water reaches the water table as subsurface flow and more water reaches the bottom land. Some of this surface water is immediately lost as temporary stream flow and the rest is likely to be returned to the atmosphere through evapotranspiration. Little is able to infiltrate to the water table because the layered clays, silts and sands of the bottom land soils (different from the ferruginous tropical soils on the slopes) effectively act to severely limit infiltration. The ponded water remains at the surface until evaporated.

The net result is the lowering of the perched water tables many of which were already insufficient to supply local water needs throughout the dry season. Wells must be deepened, sometimes in vain, and the quality of life worsens. It was not possible to investigate the extent to which this phenomenon is occurring in Upper Volta. One can only guess that it must be widespread on the Mossi Plateau.

2. Deforestation

The deforestation crisis in Upper Volta is the result of the imbalance between the rate of use of forest products and their rate of growth. The problem is symptomatic of the stresses in the subsistence of many rural and urban poor households and cannot be isolated or approached sorely as a technical problem. The "other energy crisis" as it has been called by Eckholm is socio-economic in nature.

The exploitation of Upper Volta's forest and wood products can be broken down into three major categories: land clearing, fuel wood cutting and grazing (browsing) pressure. These elements all interact to place a growing burden on the savanna's limited vegetation resources and its regenerative capacity.

The removal of woody vegetation is a crucial aspect of clearing land for crop production. This is an important and often insufficiently considered aspect of the wood crisis. Because of increased clearing, resources formerly abundant in inter-village bush zones are becoming increasingly scarce. For example, sauce ingredients growing without cultivation and once given freely between households have now become items of commercial exchange. The increasing opportunity costs of obtaining firewood, medicines, and foodstuffs, taken together, have already had a significant impact on the social organization of rural households. The impacts of scarcity of forest resources are more severe in densely populated zones. In regions such as Yatenga, Kaya, and Koupéla the cultivated areas are nearly contiguous and products are imported from outlying areas.

The increasing lack of alternative forage for animals, especially during the dry season, is placing an increased demand on tree resources as well as crop residues. Domestic animals browse the palatable species. In addition, the herders may lop off branches to make leaves accessible to the animals. This pressure is greatest during the dry season when the trees have most limited reserves and the mortality rate is high. The number of dead trees whose branches have been cut attrests to the severity of this problem.

The problem most typically linked with deforestation is firewood cutting. The increasing rate of cutting is a function of population growth. This problem is serious for both rural and urban populations as will be discussed in detail in following sections.

A variety of products for non-cultivated lands make a major contribution to the lifestyles of the people of Upper Volta. Important foodstuffs are in widespread use; local medicines are derived from wild plants; and browse is used by domestic animals. There are a number of structural and construction needs which are met with non-cultivated resources: tree trunks for buildings, thorn bush for fences and shade trees as important elements of the living space.

The contribution of certain trees to the rural diet can not be underestimated. The importance of these 'wild' trees is so much a part of the culture that the present species composition of woodlands is largely a result of anthropogenic factors, such as selective planting and protection of desired species. The protection of these food resources is a component of the overall subsistence strategy and provides a margin of survival in drought years. Dominant trees on the Mossi Plateau are karité (shea butter, Butyrospermum paradoxam) and néré (locust bean, Parkia biglobosa). Other important species include baobab (Adansonia digitata), tamarind (Tamarindus indica) and wild figs. Only as one moves away from villages and into the bush do a number of non-food trees enter the plant community. One study of trees in a noncultivated bottom land indicated that 26% of the trees produced edible foodstuffs (CID, 1980). When clearly to their advantage, Voltaics go to considerable trouble to plant and protect young trees. The fencing and watering of young mango trees is a case in point. Mango trees provide shade, an edible fruit and a marketable fruit.

The popularity of the neem tree among villagers can be attributed to the shade it provides and its rapid rate of growth. In dry areas it cannot survive with out the protection of the concession or an urban area, yet it is popular. Shade trees have a powerful status among village groups. The presence or absence of a good shade tree may have much to do with the influence of a village chief within his village. Village collective groups almost always meet under the dominant shade tree.

Combinations of trees and crops, agro-forestry, are part of the traditional milieu of Upper Volta. Selective planting and protection of tree crops in conjunction with field crops have been cited. Species chosen to plant or leave in a field have little apparent negative effect on crop yields and in some cases may be an asset to the field crop. Palm, a valuable constructive wood, is interplanted with crops in southwestern Upper Volta. Acacia albida provides nutrients to the field by dropping its leaves just before the cropping season thereby providing fertilizer and permitting full sunlight to the crops. In the dry season, its shade and forage attract grazing animals whose droppings further enhance the soil fertility.

Firewood collection places the heaviest burden on Upper Volta's limited forest resources. While large areas still exist where wood production exceeds demands, such zones are becoming less common. The per capita consumption of firewood averages 1.0 cubic meters per year (FAO, 1981). In addition, 0.05 cubic meters per person per year of construction wood is used. For the whole country, with a population of approximately 6.7 million, the wood consumption is estimated at 7 million cubic meters per year.

The comparison of demand for firewood to its availability must take into account a number of factors. It is important to distinguish between the wood that exists at any point in time, 'standing biomass', and that which is being produced, 'annual increment'. Macro-level estimations must make assumptions about average standing biomass and average annual increment in an environment which is characterized by its variability in space.

FAO (1981) estimated a total of 13 million hectares of forest area in Upper Volta. This includes only part of the Sahel and excludes wildlife reserves and scattered trees growing in agricultural fields. The volume of standing woody biomass is estimated at 18 m^3 per hectare for a total of 234 million cubic meters. The annual rate of growth is estimated at 5.4 million cubic meters per year. The estimated annual consumption rate is 7 million cubic meters a year, giving an estimated deficit of 1.6 million cubic meters a year which must be harvested from the standing biomass. An environmentally sound goal is to have annual production rates exceed annual consumption.

Beyond the whole country overview, it is important to note that forests and population are unevenly distributed. Over 50% of the population live in the center of the country (on the Mossi Plateau), which is no longer well forested. The majority of the forests, including the government controlled forest reserves (forêts classées), are in the south and southwest and are not easily accessible.

Demand for wood is particularly heavy in and around urban areas, in intensively cultivated and densely settled zones and in overgrazed areas. Excessive offtake has produced local shortages. The irregular distribution

of wood has produced a price differential and an incentive to commercialize firewood. Isolated village or bush locations are being transformed into major sources of wood in order to serve urban based demand. Farmers are undertaking the gathering, cutting and bundling of firewood, which is then purchased and transported by merchants to final markets in the urban areas. Many people have come to depend on the income thus produced as a means of reducing exposure to risk and to compensate for declining agricultural yields. An example of this economy was studied by the Village Livestock Project (CID, 1980)., in which an average addition of income of at least 18000 F.CFA per family was obtained from wood sales and that income was produced during the particularly vulnerable period at the end of the dry season. Wood selling had spread in five years from one household to over twenty-five households in an area over 200 km from Ouagadougou. While the concentric rings of deforestation around the city are widely documented, this export of ecological pressure to outlying regions is less well recognized.

In urban areas an average family may spend 20-30% of their total income on firewood (Ouedraogo, 1974). In the last few years, the price of firewood has been rising at an annual rate of 15%. For low income families in the cities of Ouagadougou, Bobo-Dioulasso, etc., firewood for food preparation is becoming unafforable.

3. Range Degradation

It is a mistake to simply equate rangeland deterioration with overgrazing. The current status of range is an outcome of a number of changes taking place within the context of a tradition of complex interactions between herders and farmers, patterns of seasonal animal movement and range availability, peace vs. warfare, as well as numbers of animals vs. the forage available.

Livestock raising takes place throughout Upper Volta. In the north herders are the majority of the population. Herds are moved seasonally between Upper Volta and Mali and between the north and more southern rangeland in Upper Volta. Further south in the savanna semi-sedentary herders live in the bush zones between sedentary villages. The animals are moved relatively short distances seasonally to make use of forage as it is available. Bush areas are grazed during the rainy season and often animals graze in fields after harvest. All animals within a herd do not belong to the herder. Herds are usually a mixture of the herder's personal and family animals and animals owned by farmers and being herded as a result of a mutual agreement between the farmer and the herder.

Livestock raising is not solely or even principally for meat production in West Africa. A major economic benefit from herds is their milk production in the late rainy season and early dry period. Milk and milk products belong to the women in herding groups. Milk produced in addition to needs for feeding calves and the herders themselves is sold, enabling women to contribute their necessary share of cash and goods to the herding economy.

Numerous changes in Upper Volta are having profound effects on the nature and viability of the herding economy. There are changes in security of land tenure, in relationships between farmers and herders, as well as changes in the range itself.

Herders in much of Upper Volta experience an insecurity with regard to their continuing access to rangeland resources. Land in the customary system belongs to no one; however, the usufruct rights are allocated and administered by the dominant agricultural group for a given region. In this context, predominantly herding groups are displaced whenever the land they occupy is reallocated for agricultural purposes. This makes herders reluctant to support programs which require long range inputs into improving their habitat (range management schemes, reforestation and rangeland rehabilitation interventions, animal health infrastructures). Only in the Sahel and in a few places on the Mossi Plateau have herding ethnic groups (most commonly the Fulani) managed to acquire land security through establishing ordinary chiefs (their own 'chefs de terre'). However, their ability to move frequently has proved adaptive in many ways and has allowed the Fulani to extend their geographic range with the result that they use resources that would otherwise be wasted.

The colonization of the West African region led to abolition of slavery and cessation of local warfare. The advantages of pacification of the countryside and elimination of slavery certainly outweigh their negative consequences. However, their impact on the ecology of livestock herding requires consideration. The breakdown of ethnic division of labor has permitted a greater proportion of the total population to own animals with relative security from theft. Raiding once served as a mechanism for insuring the redistribution of animal wealth and restricted animal ownership to a specialized minority. Disparities in wealth and herding are now more firmly entrenched. Buffer areas between settled zones were once avoided but have now become incorporated into agricultural and herding land uses. As a result former grazing reserve areas are now overgrazed. The expansion of cultivated areas within the grazing zone is a major problem. Inter-ethnic tension and mistrust grow from incidents involving crop damage or loss of animals entrusted to the Fulani by the sedentary agriculturalists. As the human population density increases, herding in the Sudan zone is becoming less viable as an economic basis for the sustained production of the household.

Normally, symbiotic exchanges (crop residues for fertilizer, herding services for rights to dairy production) between herders and farmers provide a basis for complementary social relationships, but with increasing pressure on resources conflicts are becoming more common.

The tendency to maximize herd size is a strategy to minimize risk and counter insecurity. The uncertainty of environmental extremes such as drought periods, the high incidence of disease- and parasite-caused morbidity, and low fecundity of the herd, all necessitate keeping the maximum number of animals in order to survive high mortality periods. A herder losing 50% of 100 animals can rebuild his herd as well as pay for his basic needs much better than a herder losing 50% of 20 animals. This logic also justifies retaining old and relatively unproductive animals. Their very age is testimony to their survival capacity and probable immunity to diseases.

The vegetation of the northern range lands is dominated by annual grass species and shrubs. The traditional use strategy of annual grasses in Upper Volta is to graze the vegetation heavily while it is palatable and to move animals out of the region when the grasses dry at the end of the rainy season. From the northern part of Upper Volta, herders have traditionally moved in

two directions. By moving north into Mali, the herds enter the grasslands flooded by the Niger River finding range which sustains the herd during the dry season. By moving south herders move into the more humid zones of Upper Volta and have traditionally grazed in brushlands between cultivated fields and in the fields after harvest. While this pattern continues to be well adapted to the environment, it is hindered by the international border and the intensification of land use to the south.

The subsistence system of the herder interacts with the commercial system of the West African region. There is a demand for meat in the large coastal cities. During the 1970's the exportation of cattle and meat represented 50% of the total value of exports for Upper Volta. The importance of meat for export reinforces the tendency for the Livestock Service and donors to view the livestock system and its supporting range lands as a meat production system. This is in contrast and may be at cross purposes to the herders subsistance logic of producing milk, meat and live animals.

The actual conditions of West African rangelands is subject to heated debate (AID, 1980). A data base for the quantitative assessment of range conditions in Upper Volta does not exist. Typical range management approaches have been developed for management of perennial grasslands. Techniques for management of annual grasses and shrubs are less well known. Some strategies suggest maximum grazing of annuals while they are palatable. However grazing to the bare ground in Upper Volta can cause the soil surface in many areas to form a crust. The crust increases runoff, decreasing the available soil moisture and often washing away the seeds for the following year's crop of annual grasses. The result are large areas bare of vegetation even during the rainy season. Many such areas were observed by this team north of Dori.

There is a growing literature which is beginning to provide clearer descriptions of the existing livestock system in Upper Volta as a preface for understanding the nature and importance of range degradation in the country. The following are recommended for a more detailed understanding than can be included here: AID (1980) Workshop on Pastoralism and African Livestock Development; Horowitz (1976) Effects of Drought on the Productive Strategies of Soudano-Sahelian Herdsmen and Farmers; Brokensha (1977) Anthropology of Rural Development in the Sahel; Riesman (1978) Fulani in a Development Context; AID (1979) Sociology of Pastoralism and African Livestock Projects; Delgado (1977) Economic Interactions Between Peasants and Herders in the West African Savannah; Delgado (1979) Livestock versus Food grain Production in Southeast Upper Volta; Herman (1977) Cattle and Meat Marketing in Upper Volta; CID (1980) Final Report of Upper Volta Village Livestock Project; Gallais (1977) Stratégies Pastorales et Agricoles des Sahelien durant la Sécheresse 1969-1974; Benoit (1977) Introduction a la Géographie des Peuls de Boobola; and Barral (1974) Mobileté et Cloisonne chez les Eleveurs du Nord de la Haute Volta. Several international organizations, notably the International Livestock Center of Africa and the FAO have undertaken major studies of both the environmental and cultural aspects of livestock production in the Sahel.

4. Fire

Fires during the dry season in Upper Volta are seen as a major environmental problem. Recent legislation has been passed to outlaw burning

and to fine people convicted of starting fires. From an environmental point of view, burning is a complicated subject and can neither be evaluated as detrimental nor beneficial. Cultural practices are well established: annual grass range fires in the Sahel are vigorously fought by the Fulani, while Sudanian perennial grass ranges are periodically burned by the Fulani to decrease unpalatable dry matter and stimulate regrowth, and sedentary farmers burn vast areas every dry season for various reasons. Timing of burns is also important. The advantages of early burns are that grass is not all burned; fires are not so hot nor destructive; protection in the traditional milieu is easier; or remaining soil moisture fosters regrowth of palatable herbage. Very late burns preserve standing biomass as forage reserve and soil protection. They foster nutrient flush as grasses begin regrowth, but damage young tree seedlings.

Examples of damage by fire are readily available. Fires in forest reserves and reforestation project areas kill newly planted trees, limit natural reseeding of certain species, and damage and slow the growth rate of larger trees. Range ecologists believe that many of the annual grasses which are burned could be used as animal feed under modified management practices. They contend that doing so would limit grazing pressure on dry season range lands.

Research related to the ecology of fire is just beginning in Upper Volta. Remote sensing imagery has been used to define patterns and annual differences in burning are the stimulation of herbaceous regrowth, decrease in coarse unpalatable material and nutrient recycling of the ash.

In general, world wide, many semi-arid vegetation types are well adapted to periodic fires. In many areas in the United States fire supression is seen as an environmental problem. It is considered good management to ensure relatively frequent, low temperature burns to prevent build up of dead vegetation which fuel destructive, high temperature burns at some later time. In some ecosystems, fire plays a major positive role in succession and nutrient recycling.

Given the environmental variability of Upper Volta fire can not be revaluated as a clear cut environmental problem. It must be seen as one of many factors to be considered in natural resource management.

C. Extant Institutions Dealing with Environmental Problems

Managing natural resources is the direct or indirect concern of numerous institutions in Upper Volta. In the process of trying to manage natural resources to meet their various institutional goals these groups encounter the country's environmental problems and respond to them. The following discussion provides an overview of the major institutions dealing with environmental problems. The major types of institutions treated are elements of the government of Upper Volta, donor agencies and examples of local, rural groups. Appendix IV.A. provides a more detailed listing of institutions.

1. Government of Upper Volta

The multi-disciplinary nature of environmental concerns is reflected in the diversity of governmental agencies working on environmental management. While the Ministry of Environment and Tourism has titular responsibility for the environment, the Ministry of Rural Development has the responsibility for agricultural development within Upper Volta and is of necessity involved in environmental issues. The Ministry of Plan and Cooperation is evolving in directions which may increase its ability to contribute to solutions of environmental problems.

The Ministry of Environment and Tourism is a relatively recently organized ministry with a relatively small share (1.14%) of the national budget (see section II.C. Financial Constraints). It is subdivided into twelve Directorates, four of which have major roles in environmental management: Direction de l'Aménagement Forestier et du Reboisement; Direction des Parcs Nationaux et des Réserves, des Faunes et Chasses; Direction de la Pêche et de la Pisiculture and Direction de l'Environment Urbain. In addition, the Direction des Etudes et Programmes has a potential role in the coordination of environmental research activities in cooperation with the Centre National de la Recherche Scientifique et Technologique as discussed in the strategy section (III.C.1.b).

The Direction de l'Aménagement Forestier et du Reboisement is responsible for the forest reserve system (fôrets classées) and reforestation. This Service includes a recently appointed national coordinator for "Foyer Amélioré" to coordinate the efforts of the various donor agencies involved in the development and dissemination of improved wood stoves. The Service plans to initiate work to prevent fires and soil erosion. Forest Service policy is implemented at the local level through forest agents acting to enforce forest regulations.

The Ministry of Rural Development is the major agricultural agency for Upper Volta. As such, its policies and programs have a major role in national environment management. It is a relatively large organization receiving 6.5% of the proposed national budget for 1981. The Ministry is divided into the Direction des Services Agricoles (DSA), Direction de la Formation des Jeunes Agricultures, Direction de l'Hydraulique et de l'Equipement Rural (HER), and Direction des Services de l'Elevage et des Industries Animales. The Ministry operates throughout the country through Regional Development Organizations (Organisme Regional de Dévelopment, ORD).

ORD's often function as decentralized organizations for coordination and implementation of projects of the Ministry of Rural Development. In

some regions they have coordinated local activities for other Ministries as well. ORD's are the administrative structure for the network of agricultural extension workers. Under their leadership numerous village level groups have been established to interact with a variety of government projects including credit, animal traction, bottom land development and reforestation programs.

The Direction de l'Hydraulique et de l'Equipement Rural (HER) is in charge of the technical aspects of the Ministry's anti-erosion program. A Soils Service has recently been set up within the Agriculture Service (Direction des Services Agricoles, DSA) and it is still under development.

Among its other official responsibilities, the Livestock Service (Direction des Services de l'Elevage et des Industries Animales) is charged with carrying out the necessary studies to formulate a livestock development policy and with the preparation and implementation of national livestock programs. In response to a number of factors including USAID funding, the Service has reoriented to include a range resource management component in its program. More than a dozen livestock specialists have been trained and are being stationed in rural locations throughout the country to carry out the Services range management programs.

The National Office for the Exploitation of Animal Resources (ONERA) was established in 1975. It is charged with commercializing and modernizing the livestock industry in Upper Volta. The organization has effectively assumed the activities formerly under the Animal Industries Service of the National Livestock Service. The Livestock Service retains technical advisory functions although, in practice, ONERA has operated relatively independently. Activities directly related to the environmental sector have until recently remained largely a matter of discussion. ONERA, nonetheless, has administrative responsibility in the following potentially relevant areas:

- work in rural development to increase livestock production
- assist in the professional organization of livestock producers
- develop animal marketing and transportation programs
- cooperate with the ORD's and the A.V.V. to achieve these aims.

The Ministry of Plan is charged with coordination of all development projects undertaken in Upper Volta including those pertaining to the environment. Its budget was 0.57% of the proposed 1981 national budget. Within the Ministry a Regional Planning Service (Service Départemental de Planification, SDP) has recently been established. Four SDP's have been established in four of the country's eleven administrative Departments with support from the United Nations and EuroAction Accord. SDP's have a potential coordinating role in environmental activities at the regional level. Also within the Ministry is the newly established Direction de l'Amenagement du Territoire (DAT). Its charge to coordinate the spatial aspects of national planning should be investigated in the project planning process of environmental activities.

2. Non-Voltaic Agencies

A number of agencies working in Upper Volta on environmental problems are not parts of the Voltaic government. Those agencies include the Comité Inter-Etate de Lutte contre la Sécheresse dans la Sahel, the Centre Régional de Télédétection de Ouagadougou, the Comité Interafricain d'Etudes Hydrauliques, the World Bank, the Office de la Recherche Scientifique et Technique d'Outre-Mer, the Institut de Recherches Agronomiques Tropicales and the Centre Technique Forestier Tropical. All are working on topics of major environmental interest and have potential roles to plan in projects being developed by USAID. A resume of their activities is included in Appendix IV.A.

3. Local and Village Level Groups

Current national policy in Upper Volta emphasizes food self-sufficiency and self-development. These twin goals mean that much emphasis will be placed on the participation of local, rural groups in a variety of development activities. Since neither goal is attainable without solution of the major environmental problems, local groups must be considered crucial elements in development and implementation of environmental projects.

The USAID Village Livestock Project successfully organized and worked with a number of village-level livestock producers committees. Sedentary agriculturalists and semi-sedentary herders met together to consider range management proposals from the AID team. Such organizations replicated on a broader scale could be important in the local enforcement of any forthcoming range management legislation.

Groups of ranchers within the Projet Elevage Ouest-Volta have formed economic and social organizations which are responsible for the collective management of grazing resources. Family groups of herders within the AVV Sondré-Est experimental area participate in a program of ecological management of the areas range resources.

Some village leaders have organized residents into local fire control committees.

There are numerous village-level groups in Upper Volta. A few have been formed through actions taken by the villagers themselves, but most have been organized by outside agents from the ORD's or non-governmental organizations such as OXFAM and missionaries. Groups are active in obtaining rural credit, controlling range fires, reforestation, and erosion control. Some local groups are encouraged and sponsored by people who are from the village but now reside elsewhere. Examples are known in Yako and Tenkodogo.

D. Current Interventions

This section provides an overview of the environmental actions currently in process in Upper Volta. Donor involvement is specified in reference to specific projects. More detailed descriptions are included in Appendix IV.B. To provide coherence, these projects are grouped by subject area: soils, forestry and range management.

1. Soils Interventions

Numerous projects in the past and at the present have concentrated on improving Voltaic soils. Major emphasis has been on soil and water conservation. As mentioned in Section I.C.1. a National Soils Service has recently been set up within the Direction des Services Agricoles of the Ministry of Rural Development. Service capabilities are described in Section IV.A.1.b.3. The history of anti-erosion projects in Upper Volta and more detailed descriptions of on-going projects are included in Appendix IV.B.

Serious problems of soil erosion have been evident in Upper Volta for many years. A number of current projects are working to counter the degradation. Funding is being made available by the World Bank, OXFAM and USAID as well as through Belgian and German volunteers. The Ministry of Rural Development established the Rural Development Fund (FDR) in the early 1970's with World Bank support. An anti-erosion project, FDR I, covered about 1,000 hectares with a system of closed dikes designed to cause total infiltration of rainwater. FDR I was completed in 1976 and followed by second phase, FDR II, which finished in 1981. In the first year of FDR II, the total infiltration system was abandoned due to widespread failures and the project turned to a system of open-ended level terraces which channel water to both ends of the terraces where water exits into a drainage way. This system improved upon the previous large-scale closed terrace system only by being less susceptible to broken terraces. During FDR II 9,200 hectares of terraces were installed. Unfortunately this system has little effect on rain water infiltration or on increasing crop yields. In spite of this, demand for terraces has almost doubled yearly. This demand may be related to the food aid being given in conjunction with some of the FDR projects. A third phase of this work is planned by the World Bank. It will use the same technical design but will emphasize stabilization of terraces with plants. The terrace system being installed was designed to be used in conjunction with contour plowing. However, use of animal traction has lagged far behind the installation of terraces. The use of chemical fertilizers are not being advised because it is felt that organic matter must first build up in the soil.

The OXFAM project in the Ouahigouya area began with an emphasis on reforestation oriented toward using local plant resources and the voluntary participation of local farmers. Farmer interest has outdistanced the project staff's ability to respond and has reoriented the project toward water harvesting and soil and water conservation for agricultural purposes. Numerous techniques have evolved from farmer participation. One successful design involves the construction of a grid system, perpendicular and parallel to the slope, with about 10 meter intervals between parallel lines. The grid is constructed from rocks and/or bundles of millet and sorghum stalks staked to the soil. Areas which were unproductive have been reclaimed for crop production using this system. Project success is attributed to continuing

experimentation and evaluation of the systems by the farmers, to voluntary participation without incentives, to use of local tools and resources, to a system with short term benefits to the farmers (soil build up and increased soil moisture), and to a system designed on a small enough scale that it can be constructed with available labor and tools and can fail in one part without causing widespread failure in other parts. The project is coordinated through the ORD and works with German and Belgian volunteers in Djibo and Yako, respectively.

The Farming System Unit of SAFGRAD, with support from the Africa Regional Affairs Office of USAID is working on problems of soil and water conservation and soil fertility. A four year study of zero runoff techniques in conjunction with animal traction is being conducted on three small watersheds. Controlled plot studies of various soil and water conservation systems are being carried out at the Kamboinsé research station. A soil physics and chemistry laboratory are planned for Kamboinsé. Another SAFGRAD study involves an analysis of precipitation data for the whole country which will contribute to efforts in soil and water conservation.

The German Government has provided technical and funding support for the creation of a mine and mill for Upper Volta's rock phosphate reserves. Although this mill is operational, rock phosphate is not yet becoming an important phosphate source due to problems with production policy, distribution, agricultural extension and pricing for rock phosphate and other agricultural inputs.

A number of agencies have been involved in rock phosphate trials including IRAT experiments at the Saria Research Station between 1976 and 1979, and trials by the Dédougou ORD in 1977. There was a Phosphate Project in 1978 which carried out trials. ICRISAT/SAFGRAD started experiments in 1979 which are continuing. Although results are not conclusive, a preliminary report from SAFGRAD indicates that responses to rock phosphate applications on many soils in Upper Volta would justify the expense of phosphate production and distribution.

2. Forestry Interventions

A broad spectrum of activities is being carried out in Upper Volta aimed at reversing the trend of using forest and fuel resources of the country faster than they are being produced. The Direction de l'Aménagement Forestier et de Reboisement is in charge of a system of forest reserves most of which were set aside during colonial times. These reserves are currently policed by forest agents to try to control the more blatant forms of misuse. The Direction acknowledges the need for better management of these resources to produce both larger quantities of firewood and construction wood. Protection of forest reserves against encroachment, wood harvesting, fires and squatters is seen as a major management goal according to the 1981 outline on Forest Management Policy from the Direction.

Major changes are being made in the training of forest agents and of professional foresters and forestry technicians. With USAID funding, the

Forestry Education and Development Project (686-0235) is developing new courses for forest agents in forest management techniques and, in conjunction with training, developing the Dinderésso Forest Reserve as a demonstration of progressive and productive forest management. Refresher courses will be offered for experienced forest agents. In a second USAID funded project, Agricultural Human Resources Development (686-0221), higher level technical personnel and administrators are being trained at the Institut Superieur Polytechnique in Ouagadougou. The South East Consortium for International Development provides a professor in forestry as well as a livestock specialist and a soil scientist. Forestry experiments are being carried out at the Gampela Experiment Station with student participation. Students from this program are being rapidly incorporated into the Ministry of Environment and Tourism.

Two major strategies are being followed in the Voltaic reforestation program: large-scale plantations and village-level projects. Major funding for large-scale plantations is being provided by the German Forestry Mission, the Food and Agriculture Organization of the United Nations, and the World Bank. The Germans have established a green belt plantation around Ouagadougou consisting of 750 planted hectares of a number of non-native species of trees. The project goal is to protect the lakes which are the source of drinking water for the city and to provide recreational space. The firewood plantation of 3100 hectares in the Gonsé Forest Reserve is also under German leadership. Non-native species (Eucalyptus camaldulensis, Gmelina arborea and Cassia siamea) are producing about 3 cubic meters of wood per hectare per year at a production cost of 7500 F. CFA per cubic meter at roadside excluding overhead. The UNDP/FAO project has plantations of non-native species of 1,110 hectares between Ouagadougou and Pô and 540 hectares at Dinderésso near Bobo-Dioulasso. The World Bank Forestry Project (IDA 982 UV) plans to invest $14.5 million in forestry activities between 1980 and 1984 to maintain 16,400 hectares of plantation established by UNDP/FAO, to establish a new plantation of 1,600 hectares of non-native species in the Maro Forest Reserve and to experimentally manage 1,000 hectares of native species in the Maro Reserve, as well as to provide administrative and technical support for the Ministry of Environment and Tourism. Outside the Ministry of Environment and Tourism, the Authorité de l'Aménagement des Vallées des Voltas (AVV) has planted 3,500 hectares of plantations in the Wazen Forest Reserve, east of Ouagadougou.

Village-level woodlots are being funded by a combination of Swiss, Dutch, German and World Bank assistance. Donor agencies have been given geographical zones to work within: the Swiss work in three departments: Center, Est and Nord (Yatenga); the Dutch, in Centre-Nord and Volta Noire; and the Germans, in the Sahel. Private Voluntary Organizations are also active in reforestation at the village level. OXFAM is active in agro-forestry projects in the Ouahigouya area. The USAID Integrated Rural Development projects in the Seguenega area has a reforestation component. The World Council of Churches has channeled funds through the ORD of Yatenga for village reforestation projects.

Improved cooking stoves have been an additional concern of donor agencies in hopes that wide scale acceptance of more fuel efficient stoves would slow the consumption of fire wood. The German Forestry Mission builds improved stoves of concrete for 5,000 F. CFA and 7,5000 F. CFA in Ouagadougou

($25 - $35) in cooperation with the Ministry of Environment and Tourism. The Ministry for Social and Women's Affairs is developing improved stoves through the Association International de Développement Rural with funding from Belgium and the World Bank. There are stove demonstration centers at Kaya, Koudougou and Nouna with Peace Corps staffing. CILSS is beginning its work on improved stoves by evaluation the various stoves already on the market. A local blacksmith in the Ouahigouya area makes fired clay stove tops which can be installed on an adobe firebox and chimney which sell for 250 to 300 F. CFA ($1-2). Even the Voltaic Boy Scouts have been involved in stove promotion. Experiments with solar cookers and biogas generation have not been successful.

3. Range Interventions

There are numerous on-going or recently completed projects which are related to the use of range vegetation. They may be categorized into three groups by the approaches they take: organization of groups of herders to use improved range management techniques and animal health techniques; focus of improved breeds of livestock; and production of forage to supplement range vegetation.

a. Herder organizations. Three projects currently focus on organizing groups of herders to use specific sites for animal production: Project Elevage Ouest Volta, Projet Aménagement Zone Pastorale de Sondré-Est, and Projet Aménagement Zone Pastorale de Léo. These projects are being developed in areas which formerly had low population densities of people and animals due to onchocerciasis and/or trypanosomiasis. Projet Elevage Ouest Volta is administered by the Service de l'Elevage with World Bank support. It was started in 1975 to establish a private ranch operated by sedentarized Fulani herders. The Government of Upper Volta provided a 99-year lease on 300,000 hectares northwest of Bobo-Dioulasso. Three ranches for three groups of herders have been organized. Physical improvements include a road system, headquarters buildings, vaccination corrals, tick dips, fire breaks and improved water point distribution. Grazing distribution and animal control is accomplished by herding; there are no fences. A legal code governing the ranch operation has been negotiated between the herders and the government. It provides tenure security to the participants. The program poses problems for the herders' wives who have traditional rights to the milk from the herds but have no market since the project is located too far from other villages for daily commerce.

Project Aménagement Zone Pastorale de Sondré-Est is one element of the extensive resettlement program administered by the Autorité des Aménagements des Vallées des Voltas (AVV). The Sondré-Est project is funded by Holland. The project area is 16,000 hectares unsuited to commercial agriculture. Fulani herders were attracted to the area by guaranteed land tenure, adequate water and a livestock health program. Animal stocking rates are to be controlled. There are a fire control program, plans for forage cultivation, animal selection for disease resistance, and supplementary feeding; and an animal health program (AVV, 1981).

Projet Aménagement Zone Pastorale de Léo is also funded by Holland but is administered by ONERA (National Office for the Exploitation of Animal Resources). Plans are to provide participating herders with 500 hectare

ranches from a zone of 40,000 hectares. Water, animal health, animal selection and forage crop assistance will be provided. A system of pasture rotation will be designed and animal numbers controlled. A use fee is planned based on the number of animals using the zone.

In contrast to the three projects described above, the recently completed USAID Village Livestock Project worked with established communities. Committees of livestock producers, often including both herders and farmers, were organized to participate in animal health programs and to help in the design of improved range management systems appropriate to their local situations. Intensive range vegetation surveys were made and two inclosure/exclosure plots were established to demonstrate the benefits of controlling numbers of animals to the local participants. This project also contributed to the growing awareness within the Livestock Service of the necessity of range management in meeting its organizational goals.

b. Improved breeds and forage. Animal selection programs aim to improve the production and survival characteristics of livestock to increase off-take while, in theory, decreasing the pressure on grazing resources by having fewer, more productive animals. As mentioned above the Ouest-Volta, Sondré-Est and Leo projects all have elements of animal selection built into their plans. The Livestock Service operates a breeding ranch (Centre d'Elevage et de Formation d'Oudalan) for Zebu Azaouak cattle at Markoye in the Sahel zone. Established with USAID funding in 1965, the ranch maintains a breeding herd of about 300 head. Approximately 60 bulls 2 1/2 to 3 years old are sold each year. Purchasers are primarily civil servants. The ranch is 1200 hectares with numerous corrals and housing for the staff and herders. Although the ranch managers are plagued by local herders cutting the fences to use the vegetation, the ranch is still visible in recent satellite imagery.

A number of projects are working to provide supplementary feed to livestock during the dry season. Canadian aid is involved in a quasi-commercial venture to provide cotton seed and cut grasses to herders in the Gorum-Gorum area in cooperation with the ORD administration. In Dori grasses are harvested from a tree plantation by paid laborers to protect it from fire. These grasses are sold to entrepreneurs who resell it to herders. A CILSS sponsored program in Dori has successfully produced two to three cuttings of Andropogon gayanus and stored it without termite damage.

II. IDENTIFICATION OF CONSTRAINTS

Major constraints to resolving environmental problems are obvious at numerous levels throughout Upper Volta. This chapter presents them in a tactical order; those which can be dealt with most successfully first.

A. Technical Constraints

The most persistent technical problem is the recurrent notion that there is one or a few technical solutions to environmental problems. World Bank foresters have talked of developing a technical package for reforestation in the Sahel. FDR has spent 6-7 years in 6 ORD's in the Central Plateau using a single technical package, developed at a research station, that is not refined for use in local situation.

Many environmental projects are constrained by the failure of institutions to recognize when a particular technique is not working, failure to change techniques in a timely way in response to such recognition, and the institutional tendency, probably due to lack of time, personnel, and organizational ability, to provide a single technical solution to be applied over a large geographic area with no organizational mechanism for adapting the technique to the highly variable ecological, topographic and socio-economic circumstances of particular sites. This situation exists with reforestation and range management projects as well as with soil and water conservation efforts.

From the discussions on problems and interventions, it is obvious that soil and water conservation techniques in Upper Volta have slowly evolved from little research and, in the case of responses to failure as in 1977, no research at all. Attempts to scientifically justify the techniques have come after the fact of their dissemination and have been few and inconclusive. Also as discussed in the problems section, results of research on farming systems to be used in conjunction with terracing (e.g., contour plowing) are inconclusive and subject to variable interpretation.

Fauck, Inspector General of ORSTOM (Office de la Recherche Scientifique et Technique Outre-Mer), in 1977 reviewed the research on soil erosion and conservation systems in the Sahel and concluded that terracing could not be recommended. He acknowledges that contour plowing can increase erosion. Admitting that the quantitative analysis of the dual effects of erosion and loss of soil water through runoff is not possible due to lack of basic research, he concludes that most of the decline in primary production is related to the loss of water. Fauck recommends biologic methods such as mulching with crop residues in preference to mechanized methods such as plowing, but recognized that crop residues may have other uses. He, therefore, counsels study of technical solutions adapted to local socio-economic conditions and to a wide range of soil types, ecosystems and geomorphologic situations. He concludes: "...we need to develop an integrated agriculture/cattle-raising system stemming from a basic principle, improvement of the seepage of runoff waters in the soils...". The strategy developed by this assessment concurs with Fauck's analysis and notes that little has been accomplished towards developing such a system.

Little adaptive field research has been done, although SAFGRAD and IRAT have begun some efforts in field work. Most field research to date has focused on justifying the FDR system or trying to see if it will work. Few attempts are being made to come up with soil and water conservation systems that are better adapted to Voltaic conditions. It may be that since there is no administrative mechanism for evaluating current soil and water conservation programs, there are no calls for development of new systems to improve upon the inadequacies of the current system.

The Institut Panafricain du Développement (IPD) in coordination with IRAT and the ORD at Ouahigouya began in 1981 some adaptive research in farmers fields and training of ORD herds of services and sector chiefs. The research and training centers on farming systems are to be used in conjunction with the FDR/HER anti-erosion project. However, results of this project's experimentation, view by the assessment team were inconclusive. HER completed a runoff/erosion study on FDR anti-erosion works compared to traditional farming practices, but was unable to prove the advantage of the FDR system. (The study report was published in April, 1981.) Research into conservation and related farming systems suffer from the same lack of direction and duplication of effort evident in agricultural research in general (World Bank, 1981.)

B. Policy Constraints

Although national policy places food self-sufficiency as the first priority no link is made between the attainment of this goal and soil and water conservation. Without adequate policies to encourage soil and water conservation, national goals for food self-sufficiency will be unattainable. New national policies also emphasize "self-development". This approach will also prove to be fruitless unless it is interpreted to mean the large scale participation of rural people in development.

Such participation can only be guaranteed if leadership and expertise is available at the national, regional and local levels; if techniques developed are demonstrated to increase yields; and if the pricing and availability of inputs necessary to the success of the techniques and of the increased production resulting from the techniques are assured.

Government tradition for the last 80 plus years in Upper Volta has been one of centralization. This is a tradition inherited from outside the region and an approach currently being re-evaluated in its native European context. Centralization of technical expertise and direction of actions to solve environmental problems is not well matched to the evolution of solutions of site specific problems of erosion, reforestation and range management.

National policies dealing with natural resources are almost exclusively inherited from Upper Volta's colonial tradition. Forestry codes evolved in Europe's moist forests are hardly related to the realities of fuel and other wood needs in semiarid West Africa. The lack of policies related to range management and soil conservation contribute to the continuing degradation of the natural resource base in Upper Volta.

Traditional top-down approaches have frequently been pursued in Forest Service Programs. Villagers sense that the resulting trees, woodlot, associated nursery, and infrastructure do not belong to them. This limits villagers' willingness to participate without monetary compensation in community programs. The traditional policing role vested in the forestry agent vis à vis the rural villager reinforces the gap in understanding between the two.

Top-down approaches have proven excessively expensive relative to their productivity. Multi-use aspects such as forage production, soil and watershed enhancement have not been considered. Frequently such efforts involve a paid team coming in, establishing a plantation then moving on. Local interests are inadequately incorporated into project design. Insufficient aftercare and the absence of a clearly defined harvesting program all serve to reduce the benefits of these efforts to the rural population.

Even peri-urban industrial plantations are not well integrated into the environment in which they are placed. Near Yalogo in the Center-North Department, an industrial plantation was established at great cost in an area that included an important traditional animal trekking route. Fines, upsetting to the local population, were imposed on villagers whose animals were caught in the plantation. No provision was made for herd passage; further, the fines were higher for cattle than for goats, even though the latter pose a greater threat to the seedlings. Grazing by the cattle may help seedling survival by reducing the competition from grasses. The lack of multi-use management policies, both for plantations as well as for classified forests, reduces their cost effectiveness and utility.

Forestry policy as outlined in the new (1981) Forest Management Policy of MET is extremely limited. There is no mention made of multiple land use and it suggests that people be evicted from the forest reserves. Given the serverity of forestry problems, restrictive policies are a constraint to solving environmental problems. The importance of wood and forest products in the village economy is often poorly recognized by policy makers. As a result, forestry programs tend to be singularly oriented to increasing the production of firewood. Viewed as such, the problem becomes a technical one with the result being a proliferation of expansive "plantation type" projects whether at the village woodlot or "industrial" level. Too often, such programs are conceived, implemented and policed by outside authorities and involve very little consultation with the villagers whom they ostensibly benefit. The diverse uses of tree and other bush products are poorly incorporated into the design of reforestation projects.

C. Institutional Constraints

The lack of a strong soil and water conservation service with capable field personnel has worked to maintain the status quo of all soil and water conservation work. Projects are directed by a small cadre of expatriate personnel using a single technique and working out of Ouagadougou. This has worked against the evolution of an adaptive research approach to insure that soil and water conservation techniques and programs are appropriate to the various Voltaic environmental and social contexts. It has also worked against the recognition of soil and water conservation as an essential part of Voltaic efforts not only to protect the environment but to ensure and increase agricultural productivity in both the short and long terms. With a large percentage of agriculture now, and assuredly in the future, being totally

dependent on rainfall for water, there is no way to assure rises in productivity and maintenance of those rises without soil and water conservation being made an integral institutional part of almost all Voltaic agriculture.

Institutional responsibility for soil and water conservaton is vested in Direction de l'Hydraulique et de l'Equipement Rural (HER) within the Ministry of Rural Development. However, HER's main expertise lies in the areas of building and hydraulic engineering. In addition, HER's responsibilities were limited when the National Office for Dams and Irrigation (ONBI) was created in the mid-seventies. At the local or regional level there is no permanent institutional base for anti-erosion work. An ORD may have an office for anti-erosion work, an office for bottom land water-spreading work or an office for construction depending on the extent to which the ORD is receiving donor funds for a particular project. Offices tend to be reorganized or created anew to receive the benefits of each new project as it comes along. Often the office established serves mainly as a base of operations for an expatriate technician with little interaction with the ORD technicians.

At present there is no national service with regionally based agents that has the technical competence or authority to focus and organize efforts in soil and water conservation. Nor is there a governmental institution which regularly interacts in more than limited circumstances directly with herders. This is a constraint in technology dissemination, feedback and acceptance of projects by the target populations.

The major use of natural resources in Upper Volta is the production of food and fuel. Until recently this unity and interrelationship were reflected in the Government structure by having most non-research environmental activities located in the Ministry of Rural Development (MDR). The creation of a separate Ministry of Tourism and Environment has separated the forestrty aspects of natural resource utilization from crop production, animal production, soil conservation and range management. MDR has trained a corps of extension agents to educate farmers in the production of certain crops. This division of environmental interventions between two ministries makes it more difficult to devise and implement multiple-use solutions to environmental problems.

For example, many promising ideas and techniques of soil and water conservation involve the use of trees and bushes as integral parts of conservation systems. Given the fact and attitude of separation of personnel and expertise, it is hard to envisage effective adaptive or basic research efforts or effective field work taking place.

The Forestry and Reforestation Service of the Ministry of Environment and Tourism is aware of the need to incorporate soil and water conservaton in tree growing efforts. The Service has recently accepted technical responsibility for the "Pilot Project for Protection and Restoration of Soils" in the Kaya ORD. This directly involves MET in soil conservation work which is the institutional responsibility of the HER within the Ministry of Rural Development. This illustrates the problems created when institutional configurations do not fit with practical approaches to problem solving.

D. Human Resources/Training Constraints

The country of Upper Volta is rich in human resources. The population knows how to produce its own food from the existing natural resources base. People however do not know the scientific complexities of range-management, forestry and soil conservation techniques. However, they are willing to learn and ready to discuss local realities with technicians as evidenced by interactions between village livestock committees and range managers (CID, 1980).

Despite ten years of technical responsibility for anti-erosion work, HER remains weak in personnel trained in soil and water conservation. The main training effort was in topographic surveying and hydraulic engineering. The FDR (Rural Development Fund) projects rely almost totally on expatriate technicians for design and design changes in the anti-erosion system.

In the past little training of ORD agents has occurred often because 1) the financial motivating forces working on the ORD's focused on completion of physical project infrastrucuture, not an accomplishment of training which is left to occur spontaneously through homologue interactions, and 2) the expatriat technicians had no real competence in soil and water conservation work being hydraulic engineers with little or no field experience (Dutch volunteers), or surveyors (Peace Corps volunteers). Thus, the ORD's have no particular competence in or understanding of soil and water conservation efforts.

Centre d'Etudes Economiques et Sociales de l'Afrique de l'Ouest (CESAO) which trains ORD extension agents apparently does not have much competence in, nor does it place much emphasis on, training in soil and water conservation. This is a deduction from observations that ORD agricultural extension workers who are charged with on site surveillance of construction, maintenance and use of the FDR anti-erosion works generally have little understanding of how the system is supposed to work or of the principles of soil and water conservation work and erosion processes.

Within the Forest Service, the fact that not enough well trained technical people are available is compounded by the amount of paper work and the attitude that foresters belong to an office not in the field. Although there is a definite need for administrative leadership, there is an equally urgent need to first have sound field experience as a basis for planning and policy decisions. The University of Ouagadougou (forest engineers) and the school of Dinderesso (forest technicians) are producing well trained foresters. However, recent graduates do not receive field experience before being assigned to administrative positions.

E. Social Aspects

A variety of the characteristics of the social system in Upper Volta can act as constraints to the solution of environmental problems when project planning and implementation does not take them into acccount. It is frequently assumed that the rural milieu into which these efforts are introduced are homogeneous. They are not. Cohesion and sense of community vary greatly from village to village even within the same region. Thomson's studies of

the acceptance of reforestation efforts clearly reveal the degree of inter-village variation (Thomson, 1980) that exists in the Ouahigouya area. In some villages ethnic, religious and interlineage factors preclude harmonious, community-based programs. In others, traditions of self-help and cooperation can sustain and foster community-based programs. Attempts to find a simple, replicable social package for environmental programs are a constraint to the development of widespread, successful projects.

There are a number of inequalities in social status which constrain project implementation. For example, popular support for reforestation activities is not equally divided among different members of the community. Often it is not the women, who stand to benefit, but the men who are consulted in the decision to set up reforestation programs. Also there is often poor communication across between different ethnic groups. This dissonance renders the resolution of land use conflicts more difficult. In discussing the crop/range land use conflicts in the West Volta range project, the Fulani expressed surprise bordering on disbelief that the Livestock Producers Committees which worked with the AID Village Livestock Project included representatives of all resident ethnic groups and met regularly to discuss land use conflicts. The idea of working out a mutual solution with the farming population had never occurred to them.

Rights to land and land resources are not equally distributed among the rural population. New migrants to a region are often given land to use but have none of the security accorded to the villagers whose usufruct rights extend back several generations. This situation poses a constraint to reforestation projects which are based on the assumption that all villagers are equally capable of participating in tree planting activities.

A particularly clear case of unequal use rights arises when considering the Fulani inhabitants of the predominantly agricultural zones. The Fulani normally inhabit the peripheral zone between the settled village and the surrounding bush areas. Land use rights are vested in the sedentary chiefs who often favor the agriculturalist's interests. This often means, as the rural population grows and soil fertility declines, that the Fulani are displaced as the area under cultivation expands. This situation constrains the design of projects to regulate grazing rights.

Mobility is a principal characteristic of livestock management in Upper Volta. In earlier times grazing rights were negotiated collectively among the herding populations. With the distruction of herders' ability to regulate their grazing lands, herders have been incorrectly perceived as lacking a conservation ethic. Mobility remains an important component of the Voltaic livestock system. Patterns of movement and their rationale to the herder are seldom fully investigated before changes are suggested or imposed. Sedentarization of herders is still a stated goal of the Livestock Service. Programs which plan stabilization of livestock production system in the southern part of the country may constrain the availability of southern range lands for northern pastoralists during times of drought.

F. Economic/Ecologic Constraints

Many techniques suggested for increasing productivity of land on a per hectare basis require substantial investments of labor and materials. It is not logical to expect people to make investments if they will not stand to profit from them. To date the standard approach of most farmers to increase their production is to increase the amount of land under cultivation. Herders follow a similar logic by increasing the number of animals they own. Collection of wood spreads over increasingly larger areas. The easily seen solutions are extensive not intensive. The primary economic constraint in Upper Volta is that there is a real and finite limit to the amount of land available. There are already zones of conflict between crop production and animal production and these zones will increase as the extensive approach is followed.

From an individual's point of view, the important economic factor is per capita production not production per unit of land area (productivity). When one considers the relatively high population densities of Upper Volta and the steady rate of population growth, the problems of agro-sylvo-pastoral production on limited land have become obvious and accute. One response of the Voltaic population to the local limitations of production, in addition to extensive exploitation of resources, is high rates of out-migration, especially to the South. High rates of emigration by young men from rural areas has the ironic impact of limiting agricultural production. If the situation is such that the young men who migrate cannot return home to help with planting, weeding and harvesting crops, labor shortages may in many cases be acute enough to decrease the agricultural production.

Opportunity costs of labor may also constrain environmental projects. Villagers who choose to spend time involved with reforestation activities are not spending that time elsewhere. Timing in reforestation programs is important not only for the successful survival of seedlings, but in gaining the necessary participation of local residents. Most programs do and should require voluntary labor inputs from the potential beneficiaries. Labor demands may include site preparation, planting, weeding, watering, recurrent maintenance (firebreak, fence repairs). It is important to distinguish between those activities that coincide with peak season agricultural or herding labor demands and those that can be programmed during the off season. Labor bottlenecks during the planting season can inhibit the villagers' willingness to volunteer their labor in reforestation programs. A villager's perception of his priorities are as important in this regard as are economic calculations of the opportunity costs. Although effective extension efforts can help, it may be difficult, for example, to convince the farmer that he will compensate for lost agricultural labor by a reduction in the time spent in gathering wood. This is especially true since wood gathering is usually the responsibility of women. An understanding of household labor division would clarify the challenge to successful extension efforts. Farm survey studies in Upper Volta have revealed widely varying labor input to agricultural production from region to region thus making generalization about available labor during the cropping season a dangerous undertaking. Again this suggests a flexible approach need be taken at the village level.

Opportunity costs of land are related to, but distinct from, land tenure insecurity. Village reforestation programs often assume all villagers

are in an equal position to provide land upon which to plant trees. This, in fact, is not the case. Historical, economic and demographic factors have resulted in an unequal distribution of land rights. Many families simply do not have sufficient agricultural land available to fulfill their subsistence needs. There may be no room for expansion. To ask that this farmer relinquish even less than one hectare for tree planting imposes an unrealistic burden on these land poor households. At the same time, many families have an excess of land, some members may have urban, off-farm incomes. Hence transferring some of their land to reforestation development poses no problem.

G. Financial Constraints

As with all sectors of the Voltaic economy, there are limited monetary resources available to the Environmental Sector. The 1981 National Budget is just over 29 billion francs CFA ($103.6 million). Over 78% of the national budget is allocated to cover personnel costs. In addition revenues are collected at departmental and village levels for use at the local level. External financing is the major financial resource for carrying out field activities. The extent of financial resource availability for the operation of the environmental sector in Upper Volta can be better understood by examining the current fund flow situation from three possible financial sources: the National Budget, external funding and local community resources.

In Upper Volta two ministries have direct involvement in interventions related to the environment. The Ministry of Environment and Tourism (MET) and the Ministry of Rural Development (MDR). MET is primarily responsible for reforestation activities while MDR includes range management and soil and water actions as well as salaries for extension agents.

1. The National Budget. According to the 1981 State budget, the allocation for the Ministry of Environment and Tourism amounts to 331,597,000 CFA ($ 1,184,000/280 CFA/$). This represents 1.14% of the total allocated for Government operations. The current allocation to MET is an improvement at least in nominal terms from the 1980 budget which was 0.79% of the overall government operation expenditure. Out of the 1981 allocation for MET, 72% is destined to be expended on wages and salaries leaving the balance of 28% for other operational costs.

Within the Ministry of Environment and Tourism the operation budgets for the directorate's action in environmental interventions are

	10^3F CFA	$
Environment urbain	2,400	8,600
Peche et Pisciculture	3,600	12,900
Parcs Nationaux	4,300	15,400
Amenagement Forestiers et reboisement	9,400	33,600
Services Forestiers - Inspections Departementales	16,000	57,100

The MET budget for forestry is so limited that field staff are sometimes unable to drive to the forests and plantations due to the lack of funds to pay for gasoline. At present it is not reasonable to assume that

MET itself could finance the establishment and maintenance of industrial plantations which cost between 200,000 - 250,000 francs CFA/ha.

The Ministry of Rural Development (MDR) is allocated 1,902,830,000 CFA ($ 6,796,000/280 CFA/$) which represents 6.51% of the 1981 the Government of Upper Volta's operating budget. In MDR 92.46% of this amount is targeted for wages and salaries while only 7.54% is left for other operating expenses.

Within the Ministry of Rural Development the following allocations are made to the major environmentally active groups:

	Personnel	Operations
	10^3 F.CFA ($)	10^3 F.CFA ($)
Services agricoles	189,576 (677,000)	13,809 (49,300)
Hydraulique et Equipement rural	96,483 (344,600)	16,237 (57,990)
Services de l'Elevage et des Industries animales	333,519 (1,191,000)	22,032 (78,700)

A comparative picture of the allocation to MET and MDR with the other Ministries is presented in Table 1.

In addition to the above allocation for personnel and operating expenses, the Government has also appropriated 3,440,954,000 CFA for contribution to International Organizations and for scholarships. Out of this amount, MET has been allotted 2,403,000 CFA to be used for scholarship purposes. MDR is also allotted 5,417,000 CFA from the same budget category to be used for the Anti-Tse-Tse school program in the Bobo-Dioulasso area. Neither MET nor MDR received an allocation from a third additional budget category of 3,849,547,000 CFA intended for investment for infrastructure development or for contributions to donor financed development projects.

2. External financing is the major financial resource for carrying out field activities designed to improve the use and management of natural resources in Upper Volta. According to the 3rd Development Plan, the activities to be financed by various external donors within the Ministry of Environment and Tourism are indicated in Table 2.

HER within the Ministry of Rural Development is the only Voltaic government service, currently funded and operating, directly responsible for soil conservation activities. The World Bank funds the third phase of the Rural Development Fund (Fond de Developpement Rural III) to continue soil and water conservation activities.

3. Local contributions. Revenue is collected by departments for use at the department level and by village groups for local use. Since these funds are not accounted for in the National Budget, their existence can only be noted.

TABLE 1. UPPER VOLTA GOVERNMENT 1981 OPERATING BUDGET (in 000 CFA)

Ministry	Personnel costs	Operating costs	Total costs	% Total Budget
Environment & Tourism	239,664	91,933	331,597	1.14
Rural Development	1,759,374	143,456	1,902,830	6.51
Supreme Court	15,747	8,714	24,461	.08
Office of Presidency	128,523	216,507	345,030	1.18
Office of General Secretary	22,115	14,443	36,558	.13
National Defense	7,760,000	493,914	8,253,914	28.26
Foreign Affairs	527,567	236,144	763,701	2.61
Interior & Security	2,167,132	327,335	2,494,467	8.54
Economy & Plan	131,311	34,908	166,279	.57
Information, Post & Telephone	303,123	136,150	492,273	1.50
Transport Public Works	292,255	68,572	360,827	1.24
Sports & Arts	176,200	135,146	311,346	1.07
Justice	160,243	34,989	195,232	.67
Finance	1,073,910	251,825	1,325,735	4.54
Commerce, Industry, Mines	143,763	33,520	177,283	.61
Education & Culture	4,034,909	159,908	4,194,817	14.36
Higher Education and Research	241,628	45,690	287,318	.98
Public Health	2,358,680	371,703	2,729,983	9.35
Public Administration and Labor	128,579	30,103	158,682	.54
Social Affairs and Women	301,193	63,616	364,809	1.25
General Expenditures	978,924	3,366,982	4,345,906	14.88
Total	22,944,840	6,265,208	29,210,048	100.00

Source: Ministère des Finances, 31 Dec. 1980, Budget de l'Etat, Exercise 1981, Republique de Haute-Volta.

TABLE 2. IMPLEMENTATION PROGRAM 1977-1981 - (in million francs CFA)

Project Title	YEAR 1977	1978	1979	1980	1981	Total Funding	Fund Source
Village reforestation	5	50	100	50		205	Swiss
Reforestation	96	133	95	76	83	483	RFA
Reforestation support in Sahel zone	27	28	-	-	-	55	FAC
Forestry program	-	80	400	450	140	1070	FAC
Forest and Fauna	-	61	50	50	-	161	PNUD
Bazaga Fishery Center	13	62.5	11.5	-	-	87	USAID
Maintenance and operation tree nursery at Nagbangre Yalgo, Bissiga, Nuise Sapone	82	55	55	55	55	302	BN
Fishing tools	-	5	5	-	-	10	BN
Fishing tools for 40 fishermen in Volta Noire	-	4.5	4.5	-	-	9	BN

RFA : République Federal Alamagne
FAC : Fonds d'Aide et de Cooperation
PNUD : Programme des Nations-Unies pour la Développement
USAID : US Agency for International Development
BN : Budget National

Source: Ministère du Plan et de la Coopération, Direction generale du Plan, 1977, IIIeme Plan de Developpement Economique et Social, Avant-Projet, République de Haute-Volta

On-going environmental programs receive non-monetary contributions from the local participants. While it is not feasible to calculate the value of these contributions, substantial amounts of time, land and organizational efforts are being used. These resources are crucial to the success of any and all environmental projects. They are evidence of local community interest in projects and their continued availability is a prime indicator of project success.

III. ASSISTANCE STRATEGY

This assistance strategy assigns top priority to soil and water conservation. Second priority goes to continuing support of existing or recently completed projects in forestry education and village livestock management. Beyond these high priority activities there are a number of activities and approaches which merit consideration from AID and the Government of Upper Volta.

A. Soil and Water Conservation

Government policy of Upper Volta calls for food self-sufficiency and self-development. USAID supports that call by giving increased food production top priority. This assistance strategy supports oth food self-sufficiency and increased food production by proposing a program of soil and water conservation. Conservation efforts should proceed and accompany USAID programs. To fail to do so is to risk destroying the productive basis of the country's economy, the soil, and to fail to attain either increased food production or food self-sufficiency.

Experience in the United States and elsewhere shows that attempts to conserve soil and water are successful only when they are fully supported by the farmers who are the prime users of the soil and the prime participants in conservation efforts. Acceptance of soil conservation on the part of the farmers is fully tied to motivation through demonstrated higher yields. Thus any successful attempt to protect and enhance soil and water resources must provide short term agricultural results for farmers. Increased yields result only if the conservation systems reduce runoff and increase infiltration of water into the soil (Fauck, 1977). Increase in soil moisture has a multiplier effect on the benefits derived from other inputs such as fertilizers and hybrid seeds.

To be effective conservation programs must be intimately tied to agricultural programs run through the Ministry of Rural Development, Direction des Services Agricoles. Attempts to protect soil and water resources through other institutions will fail to the extent that those institutions cannot tie resource preservation goals to goals of higher productivity and better return to the individual farmer.

Soil and water conservation systems have been touted as a dual solution to the problems of soil erosion and limited soil moisture. A properly designed, constructed and operated system can reduce run off and/or the speed of runoff, enhancing infiltration and reducing erosion. Since soil, topography, rainfall, and vegetation and socio-economic considerations are site specific, it cannot be hoped that a single technical solution will be found. In fact, as argued in Sections I.D.1 and II.A, the uniform technical solutions used in the past and present in Upper Volta are expensive, marginally effective and do not pay for themselves. Also research results to date are limited and inconclusive. They neither allow prediction of the effects of different practices nor do they allow quantitative separation of the detrimental effects of increased runoff from those of soil erosion.

Failure of the present research and extension system to provide effective solutions is largely due to the fact that research efforts have been mostly confined to research stations. Relatively little field research or testing has been done on an interactive and adaptive basis with farmers. Although some limited efforts at field evaluation have been made recently, there is no administrative machinery at the national, regional or local level for evaluation of the effectiveness of the technical solution. The result has been very slow recognition of problems and slow proposition of new methods to solve the problems. Compounding this is the lack of soil and water conservation expertise at the local, regional and national levels. Finally the crucial connection between soil and water conservation and the national goals of improved and sustained agricultural yield to provide food self-sufficiency has not been made.

The major objectives of this soil and water conservation strategy are to set up and test a regional adaptive research program and to establish a Soil and Water Conservation within the National Soils Service. The Soil and Water Conservation Service will provide leadership and expertise to the regional program and coordination with other components of agricultural production within the Ministry of Rural Development. The Service will also be charged with gathering and analyzing information which will lead to a sound rationale for national policies on soil and water conservation as they relate to agricultural production.

A pilot project should be designed to implement an adaptive research program for soil and water conservation. The heart of adaptive research is the interaction between a researcher and farmers. The researcher, who may be an extension agent or a village-level assistant, encourages farmers to use their own initiative in adapting any of a number of soil and water conservation techniques to the farmer's specific site. The researcher's role is to help the farmer to redesign experiments with unsuccessful results and provide feedback to his regional supervisor on which techniques work best in which situations. The Yatenga ORD is a logical location for the pilot program since a regional research substation has been established in Ouahigouya. Ouahigouya was the base of operations for the OXFAM project and the Yatenga region with its high rural population densities is a focal point of agricultural and conservation problems. A supervising researcher trained in soil and water conservation would be attached to the ORD.

The supervising researcher would be responsible for technical communication between the research substation and the National Soil Service in in Ouagadougou. He would provide the necessary feedback on techniques being successfully used by local farmers to conserve soil and water and transmit new ideas developed at the national level to his local researchers to be passed on to farmers for evaluation. He would be responsible for training selected ORD agriculture agents in soil and water conservation and in the adaptive research methodology.

Additional objectives of the pilot project would be 1) to formulate guidelines for soil and water conservation work, 2) to build a data base of local farming techniques, farmers goals and resources available to farmers, especially on local plant varieties and soils, 3) to develop teaching materials and demonstrations of soil and water conservation techniques in coordination

with rural schools, and 4) to develop affordable, simple tools for use in soil and water conservation work in cooperation with the ARCOMA farm machinery center and local farmers.

At the national level creation of a Soil and Water Conservation Service is necessary in order to 1) focus attention on conservation goals and provide a base within the Ministry of Rural Development for the integration of conservation goals into the national policy of food self-sufficiency; 2) provide leadership, expertise and communication with the regional pilot program and to other regional programs to be established modeled on the experience of the pilot project; and 3) help focus national agricultural research on the connection between conservation, farming systems and improved production.

For soil and water conservation programs to become an effective part of the national effort towards sustained food self-sufficiency, the proposed programs must operate within a context of effective and coordinated national policy of agricultural production. These policies will deal with pricing, the availability of agricultural inputs and outputs, and on an emphasis and direction of research and extension programs. As discussed in section I.B.1.c, conservation efforts which enhance available soil moisture may fail to sustain increased production if appropriate fertilizers are not available.

For these reasons this strategy supports the FAO proposal (FAO, 1981) for a three year research activity to be the initial activity of the new Soil and Water Conservation Service. Research activities would include:

1) Inventory and summarize all previous and current research on conservation, agricultural production and resources in Upper Volta and neighboring countries. This has not been done and is an essential step toward creating a data base from which to work.

2) Inventory all existing projects and programs having a conservation component.

3) Analyse all factors affecting the phenomena of degradation, erosion and loss of productivity by agro-ecological zone.

4) And compare the cultivated and cultivable land and present and potential agricultural production by zone under different scenarios of policy interventions.

This four step research process will allow the preparation of a report of the direct and indirect cost of erosion, degradation and desertification processes in economic and other terms. These data could serve as the basis for a national policy on soil and water conservation aimed at preserving the food self-sufficiency of Upper Volta into the future.

Initial personnel needs include two soil and water conservation specialists, one for the pilot project and one at the national level, and a specialist in agricultural production at the national level. Three Voltaics should be trained in the United States in soil and water conservation with an emphasis on agro-ecology. These Voltaics will work along side the three specialists during the third year of the project and then assume their roles.

In-country training should be provided to prepare the regional level soil and water conservation agents. Training would be one of the tasks of the three specialists in the initial phase of the project. Training could take place partly at the national training center and partially at Ouahigouya in conjunction with the ORD's adaptive research activity. In the long term, if the pilot program is successful, the training of extension agents at CESAO will need to be reoriented to include a strong soil and water conservation point of view. This would require long term funding and training support much in the manner in which USAID is already supporting forestry training. Alternatively, training could be through the Martourkou program (also AID supported) for Cadre B extension agents. These supervisory agents could then be active with supervison and training of lower level agents in adaptive research techniques.

For the Soil and Water Conservation project, budget support will be needed for expatriate researcher in Ouahigouya as well as support for the three Voltaic nationals during training in the United States. Beyond the pilot project there will be training needs to disseminate the adaptive research approach into other ORDs by training additional agents. As trained agents begin work, their salaries and expenses related to their work will have to be assured. Since the long range goals of soil and water conservation and agro-ecological education at the farmer level are ones that will take many years to realize, AID should plan to fund a share of the recurring costs to this essential national activity.

Centralization of policy making has been cited as a constraint to the solution of environmental problems. The proposed pilot program is based on the decentralized interactions between field agents and farmers following the adaptive research methodology. It is recognized that programs must be linked into the existing administrative and research structures. This need is met through interaction/supervision between field agents and soil and water conservation agents at the ORD level and interaction between ORD-level agents and the Direction des Services Agricoles and the Soil and Water Conservation component at the Soils Institute at the national level.

B. Continuing Support

1. Forestry

A major constraint to successful forestry and reforestation programs is the nature of the current relationship between forestry agents and local farmers and herders. The agent is a law enforcement agent responsible for apprehending violators and collecting fines. This role is not compatible with village level work to encourage farmers and herders to plant more trees. The AID program (686-0235) to train forestry agents and to retrain agents is a prerequisite to any significant change in the forestry situation in Upper Volta. Based on the assessment that adaptive research is most likely to develop technical solutions to the varied environment of Upper Volta, it is suggested that course work be developed for use at Dinderesso and Martourkou to introduce trainees to a collaborative working relation with farmers and herders. With the concurrence of project personnel efforts to do this could begin immediately and would not necessitate additional funding.

2. Village Livestock Management

As described in the Current Interventions section, several major on-going livestock projects are aimed at making use of lands from which onchocerciasis has recently been cleared. In these situations herders are being invited to settle with certain conditions being specified about the number of animals and other range management practices. While these are indeed experiments in sociology and range management, they are unlikely to produce models for range management which will have applicability outside of resettlement zones. The team found no current projects which approached range management in a manner which is likely to evolve into range management systems applicable to settled high population density regions of Upper Volta.

Two elements are considered to be key for the evolution of range conservation in Upper Volta. Methods must be evolved which are specific to small areas and which depend on local populations for their implementation. It is possible that examples exist of locally managed range lands which are successfully conserving grazing resources. The discovery of these situations would provide important information for the design of other range conservation projects. The adaptive research methodology should be applied in a range conservation/management context. Extension agents, working with small groups of livestock producers, could encourage local experiments in range conservation. These experiments could be based on the groups established by the AID sponsored Village Livestock Project. It should be remembered that range strategies may be quite different for semi-sedentary herders and the animal owners than for more mobile populations.

At two Village Livestock Project sites the local committees supported the establishment of exclosure plots and selected locations for the exclosures which were consistent with local land use patterns. These plots at the Tafago and Gnaguedin, if maintained, will have the dual purpose of demonstrating the benefits of controlling the numbers of animals to local livestock producers and of providing critical data points of the production potential of Voltaic range lands for use by the Livestock Service. To avoid the disappearance of the exclosure plots and the disbanding of the producers committees, AID should continue at least minimal support.

C. Additional Activities and Approaches

Beyond these high priority strategies there are a number of additional activities and approaches which will contribute to the improvement of the environment in Upper Volta. These lower priority strategies are organized under three headings: coordination, forestry and range management.

1. Coordination

AID and the Government of Upper Volta should support coordination of projects and research between the Ministry of Environment and Tourism and the Ministry of Rural Development. Failure to establish effective means of coordination will lead to duplication of efforts and/or ineffectiveness. There is a real danger of developing a dual system of extension agents - one group trained in forestry trechniques and the other in other agricultural

techniques. This is most likely to occur if large amounts of new funding become available to the Forestry Service. AID can continually encourage officials in both MDR and MET to work cooperatively and take care that AID funded projects do not contribute to competition between the ministries. The Forestry Service should be encouraged to coordinate its activities at regional levels through department level administrations.

a. Interministerial Council. An Interministerial Council on the Environment has been proposed as an operational framework for coordination of environmental activities within Upper Volta. The ideas for such a Council are in the developmental stage. To the extent that a Council could coordinate interactions between ministries and avoid competition, it will contribute to the solution of environmental problems. On the negative side it risks becoming an ineffective organization which could divert resources from problem-solving activities. Participation in the conceptualization of the Council would contribute to developing the potentially positive aspects of the Council.

b. Research coordination. The National Center for Scientific and Technical Research (CNRST) has recently formed a technical committee to review and coordinate forestry research, the Commission "Sylviculture et Techniques Forestieres." This activity is particularly appropriate in that it will provide the information and evaluation necessary for understanding what research is providing useful results and may result in better integration of research into Voltaic agencies and into donor funded projects. While a modest beginning this Voltaic initiative deserves recognition and support both from the Government of Upper Volta and the donor community.

c. Agro-Sylvo-Pastoral code. Officials within the Livestock Service and the Ministry of Environment and Tourism have articulated the need for national level legislation to secure land use rights for herders and farmers. Lack of secure use rights to land and resources is seen as a major block to the active involvement of rural people in protecting their natural resources. Since a forestry code and a grazing rights code are now under discussion, these two laws should be considered jointly.

Any proposed code should clarify use rights and provide a firm legal basis for land use management by local people at the rural level. The code should be flexible enough to permit enactment of drought crisis strategies as well as those of normal rainfall years. The role of southern Sudanian range lands as drought range for Sahelian livestock production should be incorporated and not overlooked. In considering the Sahel, the code should recognize the breakdown of traditional pasture management practices which has vastly altered the organization of livestock production in that region. Unless the remaining elements of collectively organized management are revitalized and supported through the proposed code, range management interventions are not likely to achieve significant results. A trial program of management under a reestablished range code has been initiated in Mali. The problems and successes of this program should be monitored for possible application in Upper Volta.

There are several potential mismatches between a national code and the solution of environental problems. Both the physical and social environment of Upper Volta is characterized by variability. Solutions to environmental

problems will have to be site specific and therefore can be expected to vary considerably through the country. These solutions may include changes in traditional tenure patterns; however it is unlikely that a single law will be appropriate for the country as a whole. The development of a rigid code could impede local innovation which is central to the adaptive research approach advocated by this assistance strategy. Furthermore, unless constructed with extreme care, it is unlikely that a code will provide regional options and avoid the pitfalls of favoring one group of the population over another, farmers over herders for example. The development of a national code is basically a centralized attempt to solve decentralized problems. Minimal support from AID would seem appropriate.

d. Centralized vs. decentralized approaches. This strategy statement supports decentralized approaches to environmental problems as being the best match with the decentralized nature of the environment itself. The logic of the adaptive research method proposed in the Soil and Water Conservation Strategy is decentralized. There exist several organizations within the Voltaic government which are designed to operate on a decentralized basis: Regional Development Organizations (ORD's) and Departmental Planning Service (SDP's). ORD's are administered through the Ministry of Rural Development. Their role is to coordinate activities at the departmental level for the Ministry. The effectiveness of the ORD structure has been variable with both notable successes and failures. In their role as the administrative structure for extension agents, the ORD is crucial in the evolution of solutions to environmental problems. Support to ORD's, especially in training and retraining agents, could potentially provide a major contribution to the solution of environmental problems.

Departmental Planning Services are new organizations within the Voltaic context. As of the fall of 1981, four services had been established in four of the eleven departmental capitals. Their role in compilation of regionally specific data is complimentary to the evolution of solutions to environmental problems. Much basic information on current land use patterns and the extent of environmental degradation could be gathered by SDP's for use at both the regional and national levels in assigning priorities to conservation activities. Support by AID of extension agents and of department level planning would constitute major support of decentralized approaches.

2. Forestry

There may be two 'energy crises' in Upper Volta not one. The problem section notes that high prices for firewood are problems for urban poor families whereas availability and the time required to collect wood for domestic consumption are problems for rural women. While the two crises are clearly related, strategies for solving them may be more effective if developed in a separate but articulated manner.

Two strategies are appropriate to both urban and rural settings; dissemination of information about improved wood stoves and addition of social science expertise to the capabilities of the Forest Service. Several good wood stoves have been designed and some are available at very low cost. Promotion can be done in the context of existing women's projects and programs. The ORD's have trained female agents whose role in the dissemination of cooking stoves could be expanded. Geographic emphasis of promotion should

fall where wood is already most scarce and this scarcity perceived in terms of increased labor investment or cash expense to meet fuel needs. The Forest Service has no trained social scientists (geographers, anthropologists, rural sociologists) employed among their professional staffs. Given the importance of human/social factors to the resolution of fuel and wood shortages, this strategy advocates the training and placement of policy-oriented social scientists within the Forest Service. Coordination and design of extension activities would be among their duties.

National level research is needed on the characteristics of native bush and tree species to determine the role these species could play in reforestation, erosion control, soil improvement, forage and wood production. This need is recognized by the Forest Service and projects to fill the need should be considered by AID and other donors.

a. Rural strategies. Villages are socially and economically complex. Strategies developed for improving wood and fuel production must deal with the complexity in order to be effective. As pointed out by Thomson (1980) not all villages work well collectively, forestry projects should include a range of social options. Firewood cutting occurs in a number of social and economic contexts and requires a set of technical approaches as well. The inclusion of highly regarded fruit trees along with the more typical firewood species could do much to attract and sustain villager interest in the acquisition and planting of young trees.

Hoskins (1979) points out the need to secure the agreement of all parties involved in a program regardless of their relative positions in the village power structure. This strategy is in contrast to many extension efforts which are focused on key figures in the traditional community. Ironically women are often excluded in planning of forestation projects in spite of the fact that they are traditionally responsible for wood gathering, are major users of fuel wood for food preparation and stand to be major beneficiaries of successful projects.

Villages have their own specific histories which interact with the success or failure of projects. For example, village level groups for reforestation were proposed in the context of the Village Livestock Project to different villages in the Tafogo site. While villagers acknowledged the importance of tree planting, resistance was encountered to the formation of village groups. Following further community development efforts it was discovered that the villagers had strongly opposed their chief during the time of corvée or forced labor, when utimately, they had been conduced against their will to participate. A residual suspicion and resistance to village level programs (particularly those introduced through the chief) precluded their easy acceptance by the villagers. Instead, the villagers expressed a willingness to work together at the neighborhood level where control of the benefits of the labor investment were close at hand and the level of mutual trust higher.

A number of on-going reforestation and forest management projects should be monitored to see if their strategies are proving successful and if they may provide approaches which could be tested beyond their current geographical area. The Dutch village woodlot effort in the Kaya Department operates using ORD extension agents and village groups in cooperation with

the Forest Service. The Forest Service provides infrastructural support by providing seedlings and technical supervision of extension efforts. The ORD agents are responsible for organization of the village level groups. Niger is experimenting with local management of forest reserves. The villagers are encouraged to use the resources of the reserve in a planned manner - through grazing, bee keeping or prescribed wood harvesting.

There is a need for village level assistants as part of the solution of forestry problems. The effectiveness of extension agents would be enhanced if villagers themselves were trained as assistants. They in turn could be responsible for helping implement environmental programs. Someone trained in the repair and maintenance of woodlots and woodlot fencing, working through informal village structures would increase the effectiveness, reduce the recurrent costs, and facilitate the spread potential of pilot activities.

Evaluation measures to determine the opportunity costs of transformation agricultural land into village or family woodlots should be included for each proposed activity site. Such measures should not simply calculate costs in foregone agricultural output but should evaluate such costs relative to household differences in capacity to support such costs. The importance of this factor is heightened by the frequent coincidence of fuelwood deficit areas with areas experiencing a scarcity of agricultural land.

Villagers as far as 200 kilometers from Ouagadougou have responded to the economic opportunities inherent in firewood sales. Families have organized to collect wood, transport it and to man roadside stations to sell it to passing vehicles. While there are limits to the time that this activity can persist by harvesting natural vegetation, this response by rural producers could serve as the basis for developing family-based wood lots.

b. Urban strategies. While Urban needs are not the focus of AID assistance programs, there is an important linkage between the urban demands for fuel wood and the deforestation of the Voltaic countryside. Consideration should be given to strategies for making urban areas self-sufficient in fuel production. Such strategies would probably include tree plantations. Since current plantations are not cost effective, efforts should include the development of cheaper techniques for the establishment and maintenance of plantations. Techniques such as copicing (periodic cuttings followed by resprouting) should be evaluated. In recommending the establishment of plantations for providing urban fuels, this strategy acknowledges potential negative consequences. Often land used for plantations is already in use for agricultural production. By establishing plantations, farmers are potentially deprived of valuable crop land.

3. Range Conservation

This assistance strategy supports the results of the AID Workshop on Pastoralism and African Livestock Development as being compatible with range conservation goals (AID, 1980). The following conclusions and comments from the workshop are particularly relevant to range conservation in Upper Volta:

- "Prime emphasis on livestock sector interventions at this time should be to support the subsistence base of pastoral herding rather than to stress commercial activities."

- "The greatest error would be to rush into a series of actions predicated on the unsubstantiated assumption of widespread, herder-induced degradation."

- "Quantitative data relating to pastoral systems (including human populations, herd demography, giotic composition) are notoriously unreliable."

- "Management units for development interventions in the livestock section should be (a) small-scale and (b) based on existing cultural ecological systems."

- "Various kinds of mobility are both crisis-survival mechanisms and effective strategies for long-term exploitation of the range."

Strategies suggested by the Workshop included 1) the integration of veterinary with project specific activities to facilitate agreement with herders that any increase in offtake numbers would come from a decrease in infant calf mortality, and 2) monitoring and evaluation as integral components of every program and project. Basic responsibility for regular monitoring and periodic evaluation should be vested in project management and especially in the beneficiary population, and by so doing increase host-country analytical and managerial capacities.

The research undertaken by the Village Livestock Project indicates the necessity of dealing with range land degradation as an aspect of rural development and not exclusively as a technical program. The principle that environmentally sound livestock interventions be based on collaboration between social and biological scientists, and that action be taken with the involvement and accord of the local population remains valid.

In a situation analogous to that to women and firewood, little is known of the potential for participation of women in livestock projects. In traditional management systems, milk produced by livestock belongs to the women of herding populations. Women would be major beneficiaries of projects to increase milk production. From an environmental point of view, milk production can be a sensitive indicator of range quality. Systems managed for milk production, instead of meat production, have the potential for being less likely to degrade range resources.

Environmental and social variability must be considered in the design of projects for the livestock sector. The exploitation strategies and social structures differ greatly within Upper Volta varying from nomadic pastoralism in the Sahel to semi-sedantary and sedentary production systems in the Sudano-Guinean zones. Assistance strategies must be approprate for the specific sites and will likely have to be evolved on site. In addition projects with limited goals are more compatible with limited time horizons.

A poorly understood area is that of investment in animal ownership by the non-rural population including government functionaries and town merchants. The extent of this investment is unknown but appears to be quite important. When programs to reduce animal numbers (hence overgrazing) are considered, this portion of the national herd should not be overlooked.

What are the livestock investment incentives? What are the potential disincentives and investment alternatives? Although a sensitive subject, a basic investigation of urban investment into livestock ownership is recommended.

There is potential for a pilot project in agro-forestry. A major forest management problem is the control of understory growth in plantation areas. The protection of these plantations has facilized a recolonization of the understory by highly desireable grazing species such as Andropogon gayanus; however, these grasses are left unused and provide dry matter to fires that spread uncontrolled, through the plantations to the detriment of the growth of the arboreal species.

Adjacent to the plantation at Dinderésso, lands are cultivated by sedentary farmers. These farmers keep some on-farm animals. The Forest Service could permit farmers to enter and cut the standing grass in the plantations. This would reduce competition between trees and grass for water and reduce the danger of damage to trees from fire. This would be accomplish at little or no cost to the Forest Service. In order to interest the farmer, an extension program in farm fattening could be implemented. The Bobo market assures a final demand for high quality animals. Animals could be confined in small pens and hand fed, reducing labor demands for animal raising. Sales would increase farmer income, utilize otherwise wasted forage, increase meat export for quality, beef and improve forest productivity.

Such farmer fattening programs in confinement pens have been successful elsewhere in Africa. As a pilot program this type of program could be modified and repeated in other locations where plantations and forest reserves are currently off limits to grazing, i.e. peri-urban plantations around Ouagadougou. Handcut forage is currently being marketed from Water and Forest Service Plantation in the Dori area. Hand cutting programs would be easier to implement, at least initially, given the current Forest Service regulations against allowing grazing in controlled zones.

IV. APPENDICES

A. Institutions Dealing With Environmental Problems

1. Government of Upper Volta

Three ministries of the government of Upper Volta have major roles in managing the environment of the country: the Ministry of Environment and Tourism, the Ministry of Rural Development and the Ministry of Plan and Cooperation.

a. The Ministry of Environment and Tourism is a relatively recently organized Ministry with a relatively small share (1.14%) of the national budget (see section II.F. Financial Constraints). It is subdivided into twelve Directorates, four of which have major roles in environmental management: Direction de l'Amenagement Forestier et du Reboisement; Direction des Parcs Natrionaux et des Reserves, des Faunes et Chasses; Direction de la Peche et de la Pisciculture; and Direction de l'Environnement Urbain. In addition, the Direction des Etudes et Programmes has a potential role in the coordination of environmental research activities in cooperation with the Centre National de la Recherche Scientifique et Technologique as discussed in the strategy section. Figure 1 illustrates the administrative relationships within MET.

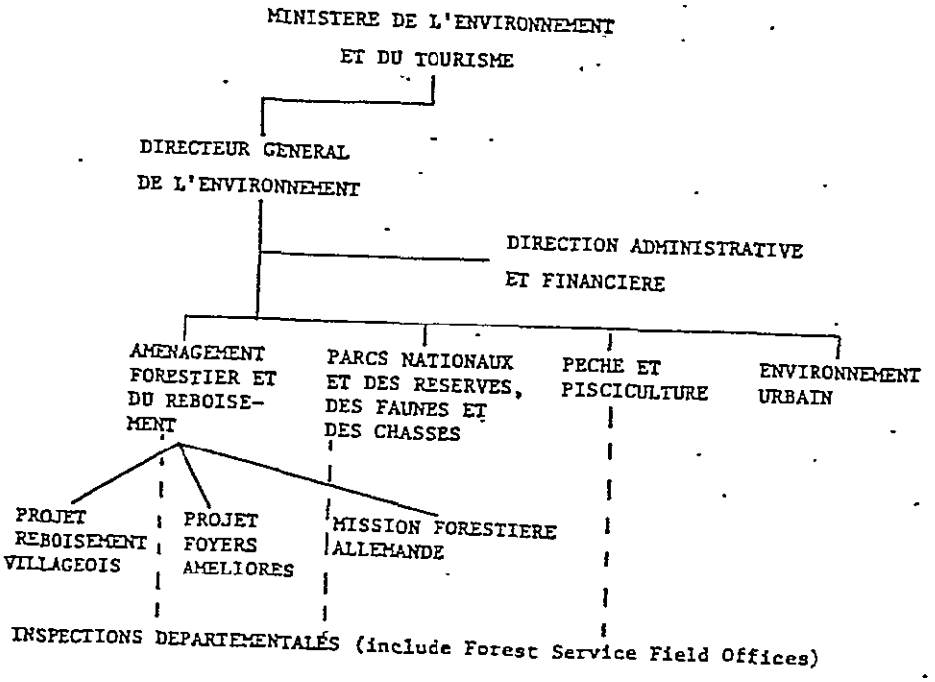

Figure 1. Organizational Diagram of the Ministry of Environment & Tourism

1) Direction de l'Aménagement Forestier et de du Reboisement.

Mr. ZONGO Josef is the current director of this agency which is, in principle, responsible for all forestry activities in Upper Volta. This includes responsibility for the forest reserve system (forêts classées) and reforestation. Reforestation projects may be either industrial-type plantations or village-level reforestation actions. This service has also recently appointed a national coordinator for "Foyer Amélioré" (improved wood stoves), in hopes of coordinating the various donor agencies involved in the development and dissemination of various models of improved wood stoves. The service also hopes to initiate work against fires and against erosion. Forest Service policy is implemented at the local level through "Inspections Departementales". One member of the agency will be trained in the use of trees as animal forage in the Sahel. Additional activities of this agency are described in Sections I.D, Current Interventions, and IV, B.

2) Direction des Parcs Nationaux et des Reserves, des Faunes et des Chasses.

Mr. TONI Doro Thomas is the director. This agency is responsible for managing the national system of parks and reserves to preserve wildlife in Upper Volta and to regulate hunting. Figure 2 locates the major national parks and reserves in Upper Volta. Agents working in these areas are trained to regulate use of the areas, not in wildlife management. Mr. Toni's direction of the park system is in the context of West African parks in general and he is active in regional wildlife protection activities.

To raise the awareness of the public to issues concerning wildlife, Mr. Toni writes a weekly newspaper column.

3) Direction de la Pêche et de la Pisciculture.

Mr. THOMBIANO Julien is director of this service which was established in 1976. The agency goal is to encourage fishing and fish production in the numerous lakes of Upper Volta. Since there is no tradition of fishing in the country, the agency's agents organize groups of men interested in fishing, teach them the techniques of fishing and set the group up as a fishing cooperative. There are now 17 such groups country wide. The agents work closely with the Regional Development Organizations in setting up the groups. Fish production work is only just beginning. The goals are to restock fished out lakes, to encourage family fish raising and to produce fish for the commerical market. The agency staff is trained as enforcers of forest regulations and needs retraining for their roles as fishery extension agents.

4) Direction de l'Environnement Urbain.

Mr. BARRY Jean directs this agency which has recently been formed. The agency has joint responsibilities to the Ministry of Environment and Tourism and the Ministry of Interior. In its formative stage the agency is holding meetings in all major cities and administrative sites in the country to outline the perceived scope of the urban environment. Emphasis seems to be on urban green belts, open recreational areas for adults and children in cities to provide for adult leisure and a wholesome environment for children. This agency is responsible for the green belt around Ouagadougou which is to protect the lakes and dams which are the city's water supply, not to produce fire wood.

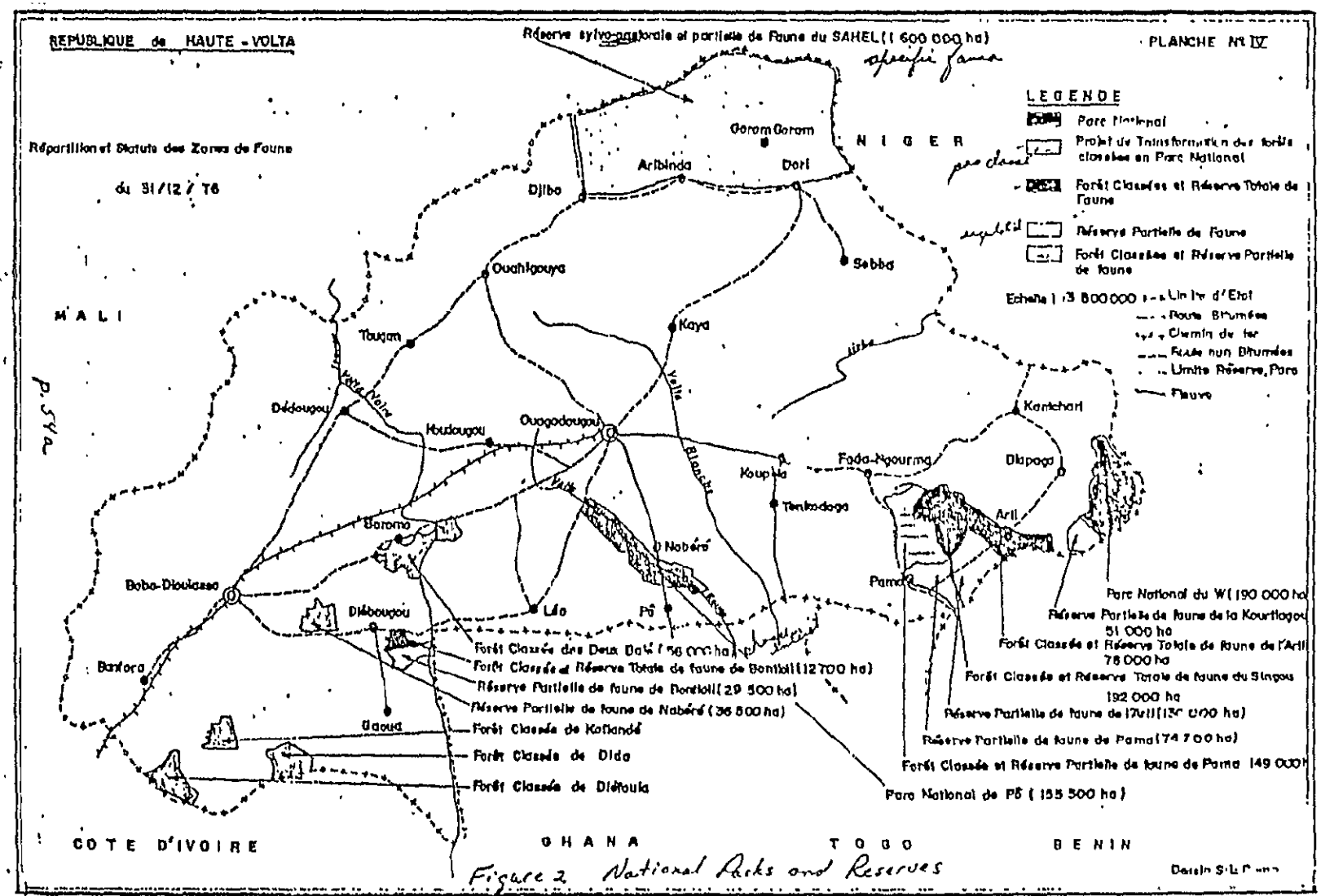

Figure 2 National Parks and Reserves

b. The Ministry of Rural Development is the major agricultural agency for Upper Volta. As such, its policies and programs have a major role in national environmental management. It is a relatively large organization receiving 6.5% of the proposed national budget for 1981. The Ministry is divided into the Direction des Services Agricoles (DSA), Direction de la Formation des Jeunes Agricultures, Direction de l'Hydraulique et de l'Equipement Rural (HER), and Direction des Services de l'Elevage et des Industries Animales. Each agency is important in managing the natural resources of Upper Volta. The Ministry operates throughout the country through Regional Development Organisms (Organisme Regional de Developpement (ORD)).

1) Regional Development Organisms (ORD's).

As early as 1965, the government of Upper Volta proposed the concept of establishing regional units as a means of decentralizing rural development programs in Upper Volta. Subsequently, eleven ORD's have been established whose boundaries correspond exactly with the current division of administrative departments. Although each ORD has within it a planning and coordinating division, it functions more often as an implementation organization for rural development. Effectiveness and funding levels vary considerably among the different ORD's.

ORD functions are as diverse as those of MDR. Within the environment sector, focus has been on working with the Rural Development Fund (FDR) in soil erosion prevention, in providing water sources (with the Hydrology Service (HER)), and in establishing tree nurseries and village woodlots (sometimes, but not always, in conjunction with Forest Service programs). Activities in the livestock field have been more oriented to animal traction programs than to range land improvement. Major animal health campaigns have been relatively independent of ORD participation.

An important related function of ORD's is the establishment of village groups. These groups are organized for numerous reasons (credit, animal traction, bottom land development, reforestation, etc.) and form the cornerstone of rural development programs in the country. Although not always well-trained or highly motivated, the ORD has a network of extension agents based on the outlying rural villages. These agents work at the interface between the government and the farmer.

In 1972 the Yatenga ORD (Ouahigouya) hired a staff forester on permanent loan from the Forest Service. This relationship allows forestry programs to be integrated into the overall regional rural development program.

2) Direction de l'Hydraulique et de l'Equipement Rural (HER) under the Ministry of Rural Development is the Service in charge of the technical aspects of the FDR (Rural Developemnt Fund, Direction du Fonds du Developpement Rural) anti-erosion program. It mainly provides surveying services at the request of the ORD's. However, most of the ORD's have their own surveying teams and equipment. Most of the technical supervision for the FDR project is done by expatriate technicians hired by FDR. Major interventions of HER are discussed in Section I.D., Interventions, and Section IV, B.

3) Direction des Services Agricoles (DSA).

A Soils Service has recently been set up within the Agriculture Service with FAO and UNDP funding. It is still under development. There is a full service soils laboratory and a mapping section, both of which are operational. The laboratory and mapping section both charge for their services and have no budgets for doing in-house work. The Dutch Government funded the building of the soils laboratory of the National Soils Service and is continuing to support its operation. They also support the soils laboratory with two scientists and a laboratory aide, and also provide Dutch volunteer hydraulic engineers for ORD's involved in the FDR anti-erosion projects.

The second phase of expansion of the Soils Service focuses on the creation of a Soil Conservation Service for which J. Dixon, an FAO Soil/Water Conservation expert from Rome, completed a mission to Upper Volta in September, 1981. Mr. Dixon's report (1981), which defines the rationale for and organization and activities of a Soil Conservation Service, is listed in the Bibliography.

4) Direction des Services de l'Elevage et des Industries Animales (National Livestock Service)

Among its many official responsibilities the Livestock Service is charged with carrying out the necessary studies to formulate a livestock development policy and with the preparation and implementation of national livestock programs. Traditionally, this has meant an almost exclusive emphasis on animal health programs. As recently as 1976, upon initiation of the USAID Village Livestock Project, no counterparts were available for the project's important range resource management component. Since that time, the situation and institutional capacity at the Livestock Service has improved dramatically. Not only is the Service now addressing environmental, range, and forage production problems; it is demonstrating a proven capability of getting trained technical personnel out to rurally located research and implementation sites. The country now has twelve livestock engineers of whom several have specialized in range ecology in addition to one range manager who received his training in the United States. The individuals are being placed with livestock and forage projects in the Sahel, in the AVV zone, at the ranches in Western Upper Volta and elsewhere. This dual capacity should facilitate further USAID range and livestock programs undertaken in collaboration with the Service.

At least partially as a result of earlier USAID efforts, livestock service policy now emphasizes the need to establish a rural code of territorial management which permits the harmonious development of livestock production in conjunction with other rural sector activities. This is evidenced by Livestock Service plans to establish grazing reserves in the Eastern and Center-East ORD's. Minimal GOUV funding to the Livestock Service remains an important limiting factor.

5) The National Office of the Exploitation of Animal Resources (ONERA) was established in 1975. It is charged with commercializing and modernizing the livestock industry in Upper Volta. The organization has effectively assumed the activities formerly under the Animal Industries Service of National Livestock Service. The Livestock Service retains technical advisory functions in

overseeing ONERA's activities. In practice, ONERA has operated relatively independently. Recent indications are that the Livestock Service and ONERA are moving towards a closer integration of programs.

ONERA is involved principally in animal finishing and in the export of animal products. They administer the major urban slaughterhouses, the animal hide tanning and export office, the country's only feedlot (Banfora), and run a fleet of refrigerated trucks to the coastal meat markets. The organization has received major financial support from the Netherlands.

Activities directly related to the environmental sector have until recently remained largely a matter of discussion; ONERA, nonetheless, has administrative responsibility in the following potentially relevant areas:

- to work in rural development to increase livestock production
- to assist in the professional organization of livestock producers
- to research methods for improved use of agricultural bi-products as animal feed
- to develop animal marketing and transportation programs
- to cooperate with the ORD's and the AVV to achieve these aims.

The ranch program at Léo, long in the planning stage, has recently received funding from the Dutch government. Implementation of ONERA's first attempt at environmental management will begin soon. The program proposes to sedentarize herders on 500 ha ranches in the Sudano-Guinean ecological zone. Water, health, forage crop assistance will be provided. ONERA, itself, has no network of rurally based personnel.

6) Autorité pour l'Aménagement des Vallées des Voltas (AVV), is a parastatal organization dealing with all aspects of land management including livestock and reforestation. AVV is the responsible agency in creating new communities in the areas cleared of river-blindness. Specific AVV environmental actions are discussed in Section I.D., Interventions. AVV is partly funded by France (Caisse Centrale de Cooperation Economique : CCCE).

c. Ministry of Plan is charged with cooperation of all development projects undertaken in Upper Volta including those pertaining to the environment. Its budget was 0.57% of the 1981 proposed national budget. This coordination function is largely formalistic insofar as projects relevant to the different technical services are normally negotiated directly with the administering agency subject to approval by Plan. Two recent developments warrant mention here. These are the creation of a Direction de l'Amenagement du Territoire (DAT), and the establishment of Regional Planning Services (Service Departemental de Plantification, SDP), thus far in four of the country's 11 administrative Departments. These new agencies have received financial support from the United Nations and from Euro Action Accord. Should the Government of Upper Volta carry through with its decentralization development objectives, these agencies could assume an increasingly important role.

Direction de l'Amenagement du Territoire (DAT) is charged with the coordination of the spatial aspects of national planning. Current activities are focussing on land use analysis.

DAT is also charged with the coordinating the functioning and the methodological approaches of the individual Regional Planning Services. The relationship between DAT and the SDP's is currently being articulated through a series of meetings. The central role of the SDP is to assist the Préfet in coordinating development activities within his department. This is accomplished through centralizing and analyzing data, carrying out studies, formulating planning priorities and assisting the various technical services at the regional level. A regional Water and Forest Service Office could, for example, request the SDP to determine fuel wood and village reforestation needs for a given period or sub-region within the department. The SDP's have two potential advantages over the ORD as coordinating bodies: 1) their orientation is not confined to that of a particular ministry (i.e. Rural Development) and, 2) they are free of the responsibilities of implementation activities and conflicts of interest that arise therefrom.

2. Non-Volatic Agenies. A number of agencies outside the Voltaic government structure are actively involved in projects to manage the environment. Those agencies with scopes directly related to natural resources are described here. Specific project information is presented in Section I.D., Interventions, and Section IV. B.

a. Comité Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS)- In January 1980 the member states of CILSS adopted a broad program against desertification with four main objectives:

- restoring equilibrium between natural resources and human and animal populations
- increasing potential resources
- anti-desertification work
- meeting forest products needs.

Six programs were delineated by CILSS of which two are related to soil and water conservation. The first program entitled "Program of operation against the degradation of soils and the ecosystem" has components of a) watershed management, b) soil salinity control, c) soil stabilization, d) brush fire control and e) introduction of anti-erosion soil fertility maintenance measures into agricultural, range and water projects. The other program entitled "Specific actions for training, education and research" contains a component called "integration of resource management".

The CILSS programs rely on the use of well known soil and water conservation methods but without any program of adaptive research designed to remake those methods so that they are useful in the various Voltaic milieus.

b. Centre Régional de Télédétection de Ouagadougou (CRTO) - This is a rapidly growing regional remote sensing center which concentrates on the use and interpretation of aerial photos and satellite imagery in the mapping of the land surface of West Africa. Their resources are especially useful for the mapping of vegetation, land use, soils, areas of degradation, erosion, brush fires and changes in any of these. They plan to have a receiving station and ability to computer enhance satellite imagery by 1984. They

will work with any agency but will not do the work themselves as their main goals are to train others to use the imagery and to make the imagery available. They do not have a soil scientist at the center and very much need one.

c. Comité Inter-africain d'Etudes Hydrauliques (CIEH). CIEH with USAID and other funding countinues to work on regional water and land resources studies. Their recent report entitled "Savanna Regional Water Resources and Land Use : Savanna Resources" was funded by USAID. They operate a documentation center useful for soil and water conservation, soil fertility, water resources and allied information.

d. World Bank. In a recent World Bank study (1981) the following priorities for an agricultural production program are given:

- improve effectiveness of agricultural research and extension by:
  a. changing strategy to focus on farming systems (including soil and water conservation) and adaptive trials
  b. strengthening coordination of national research efforts
  c. strengthening research resources particularly manpower, facilities, and financial support;
- improve cultivation practices and soil and water conservation practices on the central plateau;
- build up the technical and coordinating capacities of MDR;
- undertake a long-term commitment to finance operational expenditures for administration, extension and research considerating these as "development costs" associated with a long-term national learning process.

e. Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM). ORSTOM is a French scientific and technical research agency which published the 1:500,000 soils map of Upper Volta, the best soils map yet available for all of Upper Volta. They have been and are now carrying out research on erosion rates under different conditions in Upper Volta. See especially the work by E. J. Roose.

f. Institut de Recherches Agronomiques Tropicales (IRAT). This institute has research stations at Saria and Farako-Ba where among other things, it has been experimenting with fertilizers, and soil and water conservation farming systems especially those using oxen traction mechanization. Its research goes back many years and is a valuable data base even though many results are inconclusive. They also do experimentation with the AVV at five substations. Fertilizer trials and soils conservation experimentation make up a part of the AVV work. IRAT is largely funded by the French.

g. Centre Technique Forestier Tropical (CTFT). CTFT is a Paris headquartered forest research organization with offices throughout the former French colonies, including Upper Volta. The direction of research has traditionally concentrated on the species selection, establishment and maintenance of

industrial plantations with exotics (non-native) species. Little research has gone into the cultural characteristics of the native species. The funding and staffing is mostly French. CTFT has worked jointly with IRAT on fertilizer trials and with ORSTOM on erosion studies.

3. Local and Village Level Groups

Current national policy in Upper Volta emphasizes food self-sufficiency and "auto-development". If the latter is correctly interpreted to mean "self-development" much emphasis will be placed on local groups for a variety of development activities in the future. The necessity of local, village level participation is widely acknowledged to be crucial to projects involving reforestation, range management and soil and water conservation. While it is not feasible to describe all local organizations active in environmental planning, the following are illustrative.

a. Village Livestock Producers Committees. These groups were organized on a pilot project basis and were extremely successful. They are still in place and could be reactivated. One of the important functions they performed was in bringing sedentary agriculturalists together with semi-sedentary herders. These committees were receptive to initiatives oriented to local control of range resources. Such organizations replicated on a broader scale could be important in the auto-enforcement of an agrosylvo-pastoral code. Range management sub-committees were formed in two sites.

b. Groups of ranchers of Projet Elevage Ouest-Volta. Four groups of ers have been formed in the World Bank financed West Volta Livestock Project. In each group, livestock producers have decided to form an economic and social organization that is charged with collective management of a specified area of pasture resources. These groups have adopted a formal set of statutes that entail:

- the rational exploitation of pasture
- maintenance of dry season forage reserves
- control of bush fires and maintenance of fire breaks and
- maintenance of animal watering points.

Although initially tending towards an excessively top-down approaches to organization, ultimately the rules established were the product of an active two-way dialogue between herders and project personnel.

c. AVV experimental block of Sondré-Est. Village groups here are formed along family lines. Lineage groups have occupied sectors within the block. These groups remain informal entities and their internal organization is largely spontaneous. Land access rights are based on the herders agreement to participate in a program that has rational ecological management as one of its components. The zone will be closed to further settlement when animal carrying capacity for each sector has been reached.

d. Fire control committees. In some villages the chief and/or other powerful figures have taken a strong stand in attempting to control brush fires. Village groups are organized for auto-surveillance in fire suppression and for fighting fires when they do break out. They are reflective of both the rural interest in and potential for controlling brush fires in Upper Volta.

c. "Groupements villageois". These are associations of villagers. They are considered the building blocks of rural development by the current administration. There is no single formula or goal in their organization. A few have been formed through autonomous actions taken by the villagers themselves, but most, at least initially, were organized by outside agents. Organizers include the ORD's, non-governmental organizations such as OXFAM and missionaries. Many of the groups have been formed for the purpose of obtaining (or administering) rural credit. These structures, whatever the reason for their organization, could be adapted to environmental sector programs in which local participation plays an important role.

f. Comité de Développement Rural de Yako. The Regional Development Committee of Yako is a local Voltaic organization dealing with rural and urban development in Yako and surrounding villages. It is a dynamic group that works with the ORD sector Chief and local Forestry agent to promote, among other things, installation of village tree nursery, reforestation with predominantly local species well accepted by the people, and use of microcatchments in reforestation and agro-forestry. El Hadj Oumarou KANAZOE, a well known prime contractor in Ouagadougou, is a member of this committee.

IV. APPENDICES

B. Current Interventions

A wide variety of projects are currently being carried out in Upper Volta which have components related to natural resource management. To provide coherence, these projects are grouped by subject areas: forestry, soils or range management. Donor involvement is specified in reference to specific projects.

1. Forestry Interventions

Forestry/energy projects can be grouped under found major headings: those aimed at improved forest management, projects to train foresters and forest agents, reforestation projects and conservation/alternative fuels projects.

a. Forest management activities. So far, very little forest management has been done in Upper Volta basically due to lack of funds. In its recent outline on Forest Management Policy, the Ministry of Environment and Tourism, Service d'Aménagement (1981) sketches the problems and indicates its objectives in forest management as follows:

1) Due to its limited budgets, MET will have to rely on foreign funding to do a good job of managing Upper Volta forests.

2) The Forest Service should make every possible effort to create new, i.e. additional Forest Reserves.

3) The Forest Reserves are to produce immediately large quantities of firewood and construction wood.

4) The remainder of the demand should be met with wood from industrial plantations.

5) Protection is a must for the Forest Reserves where encroachment, wood harvesting and fires continue unckecked.

6) Strict policing is to be enforced, including the eviction of squatters.

7) Too little is known about the natural forests to set up a sylviculturally sound management system.

It is striking that the concept of multiple land use is not mentioned at all. Forests are to be managed for the sole use of wood production according to the master plan. What is also striking is that the local people (the villagers) are not taken into consideration at all. On the contrary, these people are only mentioned as needing to be evicted.

b. Training. 1) Dindéresso Forestry School. In 1979 USAID undertook to modernize and reorient the programs of the forestry training center at Dindéresso in order to improve Upper Volta's capacity to provide forestry agents who will work primarily at the village level. This effort, the Forestry Education and Development Project (686-0235), represents a major five-year, six million dollar commitment directed primarily at human resource development and secondarily at developing the surrounding Dindéresso Forest Reserve (6000 ha) as a model of progressive and productive forest management. The two aspects of the program will be integrated. The forest will provide a valuable firsthand practical learning environment for the forestry students at the Dindéresso training center. At present, improvement of the school's physical structures is well under way and three of five technicians are in place. The present enrollment of twenty students in the school will soon be increased to sixty, and in addition, refresher courses will be offered to experienced forestry agents.

The thrust of the program is away from training forestry agents as enforcers of forest laws and towards a restructuring of their roles more as rural change agents. The assumption being that if Upper Volta is to progress towards a rehabilitation and more economically sound utilization of its natural resource base, change must occur at the village level. Forestry programs, thus, need change agents who are responsive to villager's needs and constraints. The Dindéresso School trainees will complement Upper Volta's expanded professional capability thereby improving Forest Service's institutional outreach from the Ministry to the village level. The school and surrounding forest thus provide an ideal set of circumstances in which pilot environmental sector programs, particularly those emphasizing multiple-use concepts, may be undertaken.

2) Institut Superieur Technique. Appropriate program design must come from professional foresters and forestry engineers. This higher level cadre is being trained by other projects including the Agricultural Human Resources Development Project (AID 686-0221). SECID (South East Consortium for International Development) provides professors in forestry at the institution Superieur Polytechnique in Ouagadougou.

c. Reforestation. Major elements in existing tree growing programs include production of seedlings in nurseries, industrial plantations and green belts, and village level tree planting projects.

1) Nurseries - The present capacity of all nurseries in the country that come under the Forest Service is under 2 million seedlings per year. The largest single nursery is the one at Magbangie (near Ouagadougou) set up by the German Forestry Mission. It has a capacity of 1 million seedlings. USAID has provided a project of reforestation and expansion of tree nursery at Kambissiri (U.S. $110,000). Also included is assistance to the Forest Service to expand the Magbangie nursery and plant a 100 ha forest at Zamse. Another project provides assistance to the Forest Service to establish nurseries at Yalgo and Fada N'Gourma and a 200 ha plantation at Markoye. Reforestation in Yalgo, Markoye and Fada N'Gourma are funded at $145,000.

2) Large Scale Projects. The German Forestry Mission's reforestation efforts near Ouagadougou include:

a) The green belt around Ouagadougou. So far, many exotics have been planted. In the first few years, farmers are allowed to grow their crops between the trees. To date (1981), 750 ha have been planted. The total plans call for 3500 ha. The aim is to produce a green recreation space around the capital and protect the lakes which are Ouagadougou's source of drinking water.

b) The industrial firewood plantation in the Forêt Classée de Gonsé approximately 10 miles east of Ougadougou. To date, 3100 ha of exotics (Eucalyptus camaldulensis, Gmelina arobea, Cassia siamea, etc.) have been planted. The goal is 5000 ha. On the relatively poor, shallow soils over laterite, growth has been slower than anticipated: approximately 3 m3/ha/year. The cost/m3 at roadside excluding overhead, runs to about 7500 F.CFA at 1981 estimates. This is high, considering most of the wood is for firewood. The major goal is to produce firewood.

FAO has had one major forest project in Upper Volta (UNDP/FAO Project UV 72/029), which, from 1975-77, established pilot plantations with exotic species in two locations: between Ouagadougou and Pô (1110 ha) and at Dinderesso near Bobo-Dioulasso (540 ha). Presently FAO, under Project UNDP/FAO UPV/78/004 called "Development of Forest Resources in Upper Volta", has the dual objective of generating basic statistics on Upper Volta forestry such as forest area, volume, increment as well as wood consumption; and strengthening MET's Forest Service. The project started in Ougadougou in 1979.

The World Bank Forestry Project (IDA 982 UV) with a budget of $14.5 million and planned for a duration from 1980 to 1984 has the following objectives: strengthening MET's Forest Service, various forestry operations and forest research and training. The forestry operations are to establish 1600 ha of rainfed industrial plantations with exotics in the Maro Forêt Classée; to experimentally manage 1000 ha of natural stands within Maro trying to get natural regeneration, better protection against encroachment and against bush fires; to maintain and manage 16500 ha of industrial plantations established by FAO's project UNDP/FAO UPV/78/004 mentioned above; and to create approximately 325 ha of village woodlots in the Bobo-Dioulasso area. A fulltime expatriate researcher will shortly join the project which is headquartered in Bobo-Diculasso.

The Autorite de l'Aménagement des Vallées des Voltas (AVV) has started industrial plantations in the Forêt Classée de Wazen east of Ouagadougou. From 1975 to 1981 they have planted a total of approximately 3500 ha, the goal being 6000 ha. It is interesting to note that AVV has been clearing forests as part of its resettlement goals.

3) Small Scale Reforestation Projects. Some village level projects are included as elements in large scale plantation projects and have been mentioned above. The major small scale project in progress is "Project Reboisement Villageois" which is administered through MET and draws on foreign funds: a) Swiss money (since 1979) has helped to establish 480 ha of plantations in three departments - Centre, Est and Nord (Yatenga).

b) Dutch money (since 1980): 220 ha in Centre-Nord and Volta-Noire.

c) German money in the Sahel has helped to establish approximately 1000 ha to date (around Dori, Gorom-Gorom, Djibo, Yalogo, Seba, Aribinda, in chronological order, since starting in 1976 in Dori).

d) The Ministry of Rural Development's ORD have been instrumental in some village level reforestation in connection with erosion control. No exact figures are available regarding the area planted. Some ORD's operate their own nurseries.

e) The Fonds de Developpement Rural (FDR) with World Bank money has planted a total of 730 ha from 1978 to 1981.

MET's Service de Reboisement and its previous equivalent from 1960 to 1977, planted a total of approximately 2000 ha.

OXFAM finances agro-forestry projects with a minor tree planting component in connection with with water harvesting (micro-basins). Mainly local tree species are used, Blade, 1981). The major project is located in the Ouahigouya area. No exact figures on areas are available. Much of the planting is in the form of scattered trees in or around agricultural fields.

AFRICARE (USAID funding) has a large integrated rural development project in the Seguenega area. It includes a minor reforestation component which is basically agro-forestry, i.e. planting of trees in and around agricultural fields. An estimated 70 ha of trees was planted in Seguenega between 1979 and 1981.

World Council of Churches starting in 1975 has spent 2 million F.CFA on reforestation at the village level in the northern part of the country. The money was channeled through the ORD du Yatenga (Ouahigouya). Some of the money was used to dig wells.

Summary of the reforestation efforts in Upper Volta to date (1981):

Agency/Project	Hectares
MET and predecessor	2000
Reboisement Villageois	
Swiss funding	480
Dutch funding	220
German funding	1000
AFRICARE	70
Large Scale reforestation	
MFA (German) Ceinture Verte	850
MFA (German) Gonse	3100
AVV Wazen	3500
FAO	1650
Various others (incl. CTFT)	1200
	13970 ha $\hat{=}$ 14000 ha

d. Conservation/Alternative Fuels. The German Forestry Mission is involved in "Projet Foyers Ameliores", i.e., improved cooking stoves. The goal is to get away from the traditional open fires with three stones and replace them with energy efficient stoves. The project is associated with the Ministry of Environment and Tourism. The concrete stoves with two holes cost around 5000 F.CFA, everything included. The three hole stoves, in great demand, cost 7500 F.CFA. Both stoves are fixed, i.e., not portable.

Improved stoves are also being developed by AIDR (Association Internationale de Developpement Rural) under the Ministry of Social and Women Affairs (Ministere des Affaires Sociales de la Condition Feminine). They receive funds from Belgium and World Bank. There are three demonstration centers for stoves at Kaya (staffed by a Peace Corps Volunteer), Koudougou and Nouna. Additional centers are planned for Fada and Dori. CILSS (Comite Permanemt Inter-Etats de Lutte Contre la Secheresse au Sahel), a regional organization with headquarters in Ougadougou, is working on development of fuel efficient stoves in cooperation with local craftsmen. It takes a more scientific and objective approach in evaluating various stoves already on the market. A local blacksmith in the Ouahigougou area is making fired clay stove tops which sell at a low price and are locally accepted. Even the Voltaic Boy Scouts have been involved in stove construction. Solar cookers have been tested in Upper Volta and found to be expensive and to have a variety of disadvantages when compared to traditional stoves: in the early morning, before sunrise, and at night, after sundown, when people do much of their cooking, the solar stoves cannot be used; stoves have to be re-set every 5 minutes, which is cumbersome; their glare is intense; food apparently does not have the "right taste".

Within the FAO Project "Culture Attelée", some small scale, biogas experiments have been carried out. Some technical problems have yet to be straightened out. As a general rule, biogas only has potential as a reliable energy source if there is a continuous and concentrated source of raw material (such as cow dung, millet stalks, etc.).

USAID funded a solar energy demonstration on "Energy needs in food systems" in 1976-80. Funding level was $155,000. Solar cells were installed to meet village needs in food and water supply.

2. Soils Interventions

Numerous projects in the past and present have concentrated on improving Voltaic soils. The major emphasis has been on soil and water conservation. Less extensive efforts have been made in soil fertility and soil reclamation. The concern for soil management has been institutionalized in a National Soil Service.

a. Soil and Water Conservation. Serious problem of soil erosion have been evident in Upper Volta for many years. Projects aimed at soil and water conservation began in the 1960s and continue to the present.

1) Groupement Européen de Restauration des Sols (GERES) - The first soils project was executed by a European consortium (GERES). They worked in the

Ouahigouya area from 1960 through 1964 and covered 120,000 hectares in the 200,000 hectare project zone with a complete soil and water conservation system using mostly graded bench terraces. The project was designed according to accepted techniques of soil/water conservation which are still widely used in areas of the world and under cultivation systems for which they are appropriate. Except for twelve small erosion control dams, constructed as part of the system, the project was a dismal failure. The dams still provide seasonal, and in one case quasi-permanent, sources of stock water. The main reasons for failure were a) a design that was appropriate for use only with mechanized cultivation, in an area where even the introduction of animal traction was limited, b) a design that emphasized erosion control over short term benefits and ignored the need for farmer motivation, and c) lack of extension and cooperative work with farmers. All work was accomplished as a construction project, farmer participation being reduced to hiring on as laborers.

2) FOR I - The second project grew out of experiments conducted by Centre Techniques Forestier Tropical (CTFT) through 1970 which indicated that a system of closed contour terraces assuring total infiltration of rainfall would provide both erosion control and increased yields especially in droughty years. Contour terraces built on 25 cm vertical intervals in some fields around Ouagadougou in 1970 assured at least a minimal harvest during the ensuing drought. As a result the World Bank funded the first Rural Development Fund (FDR) anti-erosion program called FDR I within the Ministry of Rural Development. The goal was to cover about 1000 hectares from 1972-1976. The total infiltration system was used, with contour terraces at 40 or 60 cm vertical intervals. Surveying, design, implantation and construction supervision were assured by FDR contracted expatriate technicians and some HER (Direction de l'Hydraulique et de l'Equipement Rural) technicians. Results were encouraging though benefits of either erosion control or improved yields due to increased soil moisture were never shown by trials on farmers' fields.

A contour terrace as built by FDR is essentially a low (30 to 50 cm high) dike built along the contour lines. In the FDR system the dikes are put on contours separated by vertical distances of 50 cm which results in a horizontal spacing of about 50 m between dikes on land having a 1% slope. In a closed, total infiltration system the ends of the dikes are closed with dikes running up hill so that none of the runoff collected uphill of a particular dike can escape. This closed system conserves both water and soil to the maximum extent possible, but is extremely susceptible to failure unless built carefully. Failure at one point in one dike leads to failure of all dikes lower in the system. Erosion can easily be enhanced by such a system since water is channeled through that break and other breaks down hill causing gullying, rill and sheet erosion.

3) FDR II - The second phase of the project, FDR II, 1976 through 1981, covered 9200 heactares in the ORDs of Ouagadougou, Koudougou, Kaya, Ouahigouya and Koupéla. Response has been greatest in the Ouahigouya area, Yatenga ORD, where erosion is the most severe. Demand has almost doubled yearly and was about 10,000 ha for the 1981 season.

It is unclear if the strong demand is a result of farmer interest in a system that they are experiencing to be beneficial to crop yields, or if the demand is a response to the food aid now given out in conjunction with some

or all of the projects. Certainly it is difficult to find evidence that the system increases either rain water infiltration or yields. Work done in 1976 and 1977 is already in poor condition (much of it not working at all) indicating a lack of farmer interest after initial construction. The closed contour terrace (total infiltration) system was abandoned after the first year of FDR II when it became clear that the system was failing widely, due to failure to follow the contours, poor construction and no maintenance.

The replacement system, used since 1977, is one of open-ended level terraces which channel water to both ends of the terrace where the water exits into a drainage way. The open system uses dikes on the contour lines or dikes sloping very gently in one direction (slopes of 0.1 or 0.2%). Water collected uphill from the dike flows until it reaches the end and flows out into a drainage way. In the FDR system these dikes are limited to 200 m in length in order to limit the amount of water collected behind the dike, consequently limiting the flow along the dike and the size of channel required to carry that flow. This system limits the length of slope over which runoff flows thus reducing erosion which is directly related to slope length. Under a given rainfall intensity, the depth of water running off the lower end of a slope increases in accord with the length of the slope. Erosion rates increase in accord with the depth of runoff.

Water storage is enhanced only in so far as the water flowing in the channel just above the terrace infiltrates into the soil in that narrow band. Since the terraces are not closed, essentially no ponding occurs unless the field is also contour plowed in which case some surface storage and enhanced infiltration may occur. The supposed benefits of oxen plowing have not been well proven and are quite dependent on associated farming practices, especially leaving of plant residues on the fields. Since animal traction mechanization has lagged far behind the installation of anti-erosion terraces in FDR II, and since plant residues are still almost totally removed from the field, the system has essentially come almost full circle and is now duplicating the work done by GERES in the early 60s. The system, while possibly effective for erosion control, is minimally effective or ineffective for increasing soil moisture levels. Jonathan Hooper, who has worked in Kaya for several years is now doing erosion control work there, has seen so many breaks in FDR terraces that he feels there are very few protected hectares in the Kaya ORD.

The Regional Development Organization of Kaya, Ouahigouya (Yatenga), Ouagadougou, Koudougou and Koupéla are participating in the FDR anti-erosion program with the following areas covered with anti-erosion systems by mid-1980:

Ouahigouya	1339 hectares
Kaya	1077
Ouagadougou	1008
Koudougou	780
Koupela	71

4) FDR III - The World Bank continues to fund FDR so that HER under MDR can carry out anti-erosion work described in the previous section. FDR III aims to do 20,000 hectares of anti-erosion work from 1981 through 1987. They will emphasize stabilization of terraces with plants. There is budget

component for animal traction which goes to CNCA to make available credit for farmers to buy oxen and equipment. Acceptance of animal traction is lagging far behind the anti-erosion work. They are not advising the use of chemical fertilizers because they feel that organic matter must be first built up in the soil.

It should be pointed out that the rate of work proposed under FDR III is very low (20,000 ha/6 years or about 3,300 ha/yr) and the cost is high. The Dutch technician involved with FDR work in Ouahigouyou stated that a single drop structure in a waterway would cost about 200,000 f CFA. These drop structures are essential to control erosion in the system and one might expect to see several of them installed within a 20 hectare perimeter.

5) OXFAM has been supporting an agroforestry project in the Ouahigouya area since 1979. Peter Wright, who has several years experience here as a Peace Corps forester and who recently received his M.S. from the University of Arizona, is the project head based in Ouahigouya. Arlene Blade, previous project head, has written a very interesting report detailing project methodology, approach and activities for 1979 and 1980. (Blade, 1981).

The project started with an emphasis on reforestation using simple water harvesting techniques and founded on a data base of local plant resources es, their uses, germination trials and farmers' reasons for having tried small water harvesting systems. Despite the fact that OXFAM projects work only with those who ask for assistance, farmer demand has outgrown the time resources of the project head and has changed the direction of the project until it is mainly a water harvesting and soil and water conservation project for agricultural purposes.

The project is very successful due to the following characteristics:

a) Continuing adaptation of and on-going experimentation with the systems by the farmers is encouraged. Guidance is given but farmers are allowed to make mistakes and thereby learn why the systems work. Thus the project also learns and changes its guidelines to match local environments.

b) All participants are there due to their interest in soil and water conservation farming. No food aid nor other irrelevant incentives are used to "buy" farmer cooperation.

c) Local tools and resources are emphasized. The farmers quickly recognize that this is an idea that they themselves can put to work without outside aid.

d) The systems have both immediate short term and more long term benefits. Soil buildup is evident on many of the plots and much improved soil moisture content was clear on all the plots examined.

e) The system is small scale and has been adapted to fit local resources and conditions. Instead of the 60 meters common between dikes in the FDR system, dikes are often only 10 meters or less apart. Contour dikes are interconnected by dikes going up and down slope dividing the area into many individual parcels. Water control is very much improved and the system is closer to a total infiltration type system and so conserves much more water. The small scale and large number of interconnecting dikes reduce the need for exact

placement of dikes on the contour lines and make the use of rustic, very cheap leveling methods possible.

f) Emphasis is placed on natural grass regeneration on dikes. In addition Andropogon and local bush or tree species may be planted.

The project works in coordination with the ORD chief of secteur, German volunteers in Djibo, and the CDRY (Comité de Développement Régional de Yako) in Yako. The project's most important goal now is to integrate its activities with the ORD so that OXFAM support can be dispensed with.

6) Belgian Volunteers - Two Belgian Volunteers, Blaise Hommgien, hortriculturist, and Patricia De Goure are working with CDRY in Yako on agroforestry projects using water harvesting techniques similar to those developed in the OXFAM project.

7) German Volunteer Service - Helmut Friesch is experimenting with agroforestry in cooperation with local farmers around Djibo. Systems include microparcelles with trees planted on dikes. He's in communication with Peter Wright, OXFAM, and the work is somewhat the same. They are setting up a program in Ouahigouya.

8) SAFGRAD - By means of a contract from its African Regional Affairs Office, AID is supporting the operations of SAFGRAD, the Farming System Unit of which is doing specific work on the problems of soil and water conservation and soil fertility. Dr. Gene Perrier and Dr. Peter Matlon, ICRISAT, will be doing a four-year study in Djibo, Yako and Borohom (three climatic zones) on small watersheds with animal traction using zero runoff techniques. They are already doing controlled plot studies of various soil/water conservation systems at the Kamboinse research station. They will also be building a soil physics and chemistry laboratory at Kamboinsé.

Dr. Paul Christenson is experimenting with low rates of rock phosphate application on millet and sorghum. Other SAFGRAD research focuses on 1) economics of donkey traction for mechanization, 2) commercial cowpea production, 3) intercropping and crop associations with emphasis on looking at what farmers are already doing, and 4) a computerized analysis of rainfall data which should prove useful for erosion studies as well as for soil and water conservation work.

b. Soil Fertility. A number of agencies have been involved in rock phosphate trials including IRAT trials at the Saria Research Station between 1976 and 1979, the trials by the Dedougou ORD in 1977. There was a Phosphate Project in 1978 which carried out trials. ICRISAT/SAFGRAD started trials in 1979 which are continuing.

The German Government has provided technical and funding support for the creation of a mine and mill for Upper Volta's rock phosphate reserves. Although this mill is operational, rock phosphate is not yet becoming an important phosphate source due to problems with distribution, agricultural extension policy and pricing policy for rock phosphate and other agricultural inputs as well as outputs.

Irrigation is one way of improving soil fertility as far as moisture availability is concerned. It is estimated that 125,000 ha could be irrigated with full water control and another 25,000 ha with partial water control in Upper Volta. Less than 10,000 ha of irrigated land has so far been developed. Development of irrigated lands is extremely expensive (1 to 2 million CFA/ha) and not known to be cost effective. Furthermore, existing irrigation schemes are fraught with problems including salinization, poor design and lack of farmer interest. The FDR program has developed over 3600 hectares of bottomlands (bas-fonds) since 1976, using water spreading techniques, but less than half of these schemes are still operational. Even if all irrigable land were developed it would remain a small percentage of cultivated land. On the Central Plateau especially, irrigation possibilities are very limited due to the absence of permanent streamflow and the low relief which limits the number and size of damsites suitable for irrigation. In the future most agriculture will continue to be rainfed dry farming.

c. Reclamation. Reclamation of severely degraded areas may prove either difficult or relatively easy (if still costly) depending on slopes, soil types and degree of degradation. Two examples illustrate the point.

1) Around Ouahigouya barren areas were treated with contour and graded terraces in the early 60's using rippers mounted on bulldozers followed by graders. Today many of these terraces remain but their effect has been minimal. Most terraces support at most a thin one or two meter wide band of grass on their uphill sides. There has been no further revegetation of the very degraded sites and erosion is continuing, in some areas, removing the subsoil down to the laterite pan not far below. Continued uncontrolled grazing pressure undoubtedly has had some part to play in the lack of success of this system but the main factors were inappropriate design, an already severely degraded environment and failure to work cooperatively with local farmers.

2) At the Markoye Ranch revegation of sandy soils was accomplished by simple plowing or harrowing of the soil surface. The physical treatment broke the crust and encouraged infiltration of rain water and germination of annual seeds still present in soil.

d. Research. Institute Panafricain du Développement (IPD) in coordination with IRAT and the ORD at Ouahigouya is conducting adaptive research in farmers fields and training of ORD Service Heads and Sector Chiefs. The research and training centers on farming systems to be used in conjunction with the FDR/HER anti-erosion project. Results of the experimentation viewed by the team were inconclusive.

HER completed a runoff/erosion study on FDR type anti-erosion works compared to traditional farming practices but was unable to prove the advantage of the FDR system. The study report was published in April 1981.

3. Range Interventions

There are numerous on going or recently completed projects dealing with range land management in Upper Volta. The salient lessons of these investigations are summarized below under the following topics: a) range management, b) animal husbandry and c) forage development.

a. Range management. 1) Projet Elevage Ouest Volta (PEOV) was instigated in 1975 as an experiment to establish a private ranch operated by sedantarized Fulani. The project was financed by the World Bank after the Government of Upper Volta agreed to a 99-year lease on 300,000 hectares. At this time, three of nine projected ranches are in operation by settled Fulani. There is still technical involvement by the Service de l'Elevage. Physical improvements include a road network, headquarter buildings, vaccination parks and tick dips, fire breaks and improved water point distribution. There are no fences. Grazing distribution and animal control is accomplished by herding.

The ranch site is northwest of Bobo-Dioulasso with a average rainfall of 1100 mm/year. Vegetation is a forest-savanna mozaic within the Sudano-Guinean type. Summer pasture is provided by a large bottom land area. The absolute carrying capacity has not been determined. But the current stocking rate on one of the ranches is nine ha/animal-year. The ranch falls well within the former Onchocerciasis region. One of the reasons for selecting this site was the low human population density. Trypanosomiasis and tick borne maladies are also quite prevalent. The successful ranching of the Zebu cattle here results from an intense animal health program, which is paid for by the herders.

Certainly one of the major achievements of the program was the development of legal code of statutes governing the ranch operation. This was only achieved because of a very flexible approach and numerous iterations of the code until it was fully acceptable. Another major reason for the project's success has been the tenure security afforded to the Fulani who participate.

One of the problems which developed was the lack of nearby village markets for the women to sell their milk. This problem is still unresolved.

The World Bank investment for this project was revised to 6.8 million dollars U.S. Most of these funds were for physical improvements and equipment. A sizable portion went for roadwork which is of questionable value.

2) Projet Aménagement Zone Pastorale de Sondré-Est - This project is one segment of the vast l'Autorité des Aménagements des Vallées des Voltas (AVV) program to utilize the lands opened by the Onchocerciasis eradication program. While funding is multi-donor for the AVV, the Sondré-Est range project is funded by Holland.

The project area is 16,000 hectares with plans to add other adjacent lands. Vegetation type is Sudanian. Physical improvements include animal health facilities, supplementary water development and an experimental station/ headquarters.

A primary goal of the project is to develop the lands liberated by the Oncho Control Program. In particular, the lands not suited for commercial agricultural development are targeted for integrated sedentary agriculture and livestock production. Fulani herders with their Zebu cattle were attracted by guaranteed land, adequate water and livestock health program.

Other specified objectives include range land improvement via controlled stocking rates (currently at four ha/UBT based on utilization of 25% of

the standing herbaceous biomass). A fire control program using 10 m wide fire breaks and early burning (November), and a forage cultivation program.

There is also an animal breeding/selection component directed at improving the disease resistance qualities of the Zebu white Fulani breed. Other activities include the formation of a livestockmen's association, commercialization (current market price is 200 F.CFA/kilo live weight), and supplementary animal nutrition (cotton seed, minerals and legume forage).

The animal health program includes vaccinations for rinderpest, contagious pleuropneumonia, pasturelosis, blackleg and brucellosis. Theraputic and prophlatic treatments are against trypanosomiasis as well as internal and external parasites. Prior to treatments, baseline data were collected on disease incidence of the natural population and detailed records (animals indentified with eartags) are kept for percent fertility, calfing interval, growth rate and incidence of endoparasites.

The forage cultivation component comprises a major effort to determine optimal species and techniques. Experimental plantings were made with the following species:

Grasses	Legumes
Andropogon gayanus	Alysicarpus glumacaeus
Brachiaria ruziziensis	A. ovalifolius
Cenchrus ciliaris	A. vaginalis
Chloris gayana	Cajanus cajan
Hyparrhenia rufa	Canavalia ensiformis
Rottboelia exaltata	Clitoria ternatea
Sorghum almum	Crotalaria juncea
	Dolichos uniflorus
	Glycine Wrighitii
	Lablab purpureus
	Leucaena leucocephala
	Marcroptilium atropurpureum var. siratro
	Stylosanthes guianensis
	S. hamata
	Phaseolus aureus
	Vigna unguiculata

Experiments were also conducted with different phosphate additions. Both commercial soluble and natural rock phosphate were used.

Best results with grass species were with Andropogon gayanus. Both siratro and Stilosanthes also produced good results although full data is not yet available. S. hamata appears to be fire resistant to early burns (November). Dry matter production from cultivated plots was 5 tons/hectare in November and 3.5 tons/ha at the end of January.

The forage cultivation program has another objective of reseeding 1000 hectares (6% of the project area) in strips. Soil preparation will be accomplished with a disc harrow.

The long term objective of the Sondré-Est program is to develop appropriate techniques to develop an additional 80,000 hectares in the southeast corner of Upper Volta. The results of both the forage cultivation and livestock selection programs should be followed with interest.

Two potential problems were also identified regarding trypanosomiasis. The first concerns the possible expansion of the trypanosome area as a result of the dam construction at Bagre. The other is that the sometimes erratic and inadequate treatments might be contributing to a development of immunity of the organism to the treatments.

3) Project Aménagement Zone Pastorale de Léo. This project is financed by Holland and under the direction of ONERA. The project area is located near Leo (54 year precipitation average = 1006 mm), and comprises 40,000 ha, with 20,000 has being developed during the first phase. Forage production in this region has been measured at 1500 to 4000 kg/ha depending on the vegetation type. This provides a theoretical stocking rate of 2 to 5 ha/UBT. The program also entails pasture rotation, forage culture (legumes), animal selection and a vigorous animal health program.

The basic concept of this project is to develop the maximum usage of a pasture area, then charge the herders to use it. Use areas for each herder will be designated base 4 ha/UBT. According to a January, 1980 technical analysis, the fee rate will be 33300 F.CFA/year/UBT.

Total initial investment costs are listed at 76,500,000 F.CFA.

4) Village Livestock Project (VLP). The VLP was a major livestock/range management development effort funded by USAID. It was terminated after the first phase. The goals and accomplishments of this project include:

a) Selection and definition of six sites.

b) Collection of baseline data. For two sites a detailed range survey and utilization study was conducted and a sociological study of land tenure, livestock ownership and grazing patterns. There was not much reliable data on the livestock production system for the site areas.

c) Organization of six livestock producers associations was accomplished.

d) Identification of problems and demonstration of solutions: A vaccination and anti-parasite program was instigated; a supplementary feeding program was designed but not accepted by the herders. They did not seem to be interested in growing and storing feed for the dry season; a water well improvement program was conducted; inclosure-exclosure plots were established. Programs developed for these included determination of carrying capacity and demonstration of vegetation recuperation after elimination of grazing pressure; prescribed burning techniques; and rest-rotation grazing system. Most of these programs were designed but never implemented. The exclosure was constructed and detailed baseline data was collected; and training. Over 24 people received training; two were sent to the U.S. for B.S. degrees.

Another objective of phase one was to further detail problems and recommend solutions, the final result being a detailed work plan for an operational phase two. A detailed document was prepared that should serve as excellent background material for future livestock/range management activities (CID, 1980).

b. Animal husbandry. Two projects described above under rangeland management incorporated livestock selection programs for Zebu cattle (AVV Sondré-Est and ONERA Leo).

1) Centre de'Elevage et de Formation d'Oudalan de Markoye. The Markoye Ranch is a demonstration center having as its principal goal the initiation of practical demonstration for livestock producers to show the value of using improved animal and improved pastures. Included in the additonal goals is the establishment of a high quality pure bred race of cattle. At the Markoye Ranch the 1200 ha fenced area and its physical improvements (sorting corrals, etc.) are used for a Zebu Azaouak breeding program. These animals were introduced in the late 1960's from western Niger. At the same time a herd of of Marad: red goats were brought in, followed by a herd of sheep in the mid-1970's.

The herd is now maintained at about 300 head. Approximately 60 bulls (2 1/2 to 3 years old) are sold each year. The price in October 1981 was quoted as 35,000 F.CFA, which is substantially less than the 125,000 F.CFA quoted at the Gorom market or for the 200 F.CFA/kg live weight paid by AVV. The majority of these animals are sold to civil servants not to local herders.

Another comment of interest concerns the fencing used at the ranch. Excluded herders are constantly cutting it, even though there is a 600 F.CFA fine/head for trespass. In spite of this, the vegetative contrast is still visible on satellite imagery of the area.

c. Forage Development. Several of the range management projects included forage cultivation components. These were the AVV Sondré-Est and ONERA Léo. Other projects involved in forage cultivation include:

1) CIDR/ORD supplementary feed program at Gorom-Gorom. This is a quasi-commercial venture which provides cotton seed and forage (cut grass).

2) Eaux et Forets/German Aid at Dori. Laborers are paid to cut grass within reforestation exclosures. This grass is sold at 1000 F.CFA per cart load to donkey cart entrepreneurs who in turn sell it to the herders reportedly at 2000 F.CFA.

3) FAO/CILSS at Dori. This is a regional experimental program designed to identify suitable species and techniques to produce forage crops. Results to date include two to three cuttings/year of Andropogon gayanus and successful storage of this crop without termite damage. Studies also include developing living hedges to protect forage plots (species used include Euphorbia balsamifera and several thorny species).

4) University of Ouagadougou experimental work.

5) Other projects/activities with potential for forage crop production include: Common farmer practice to intercrop Andropogan gayanus (intended for mat making) and Niebe, Dolichos ungiculatus in sorghum and millet fields; Eaux et Foret at Gorum-Gorum are cutting grass in woodlots to deter termite activity. Apparently no use is made of these cuttings; Eaux et Foret at Bobo-Dioulasso cut grass to prevent wildfire damage in tree plantations. Again no use is made of this grass.

IV. APPENDICES

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IV. APPENDICES

D. Contacts Made In Upper Volta By Environmental Assessemnt Team

Person Contacted	Team Member (s)	Topic Discussed
ALLAIRE, Denis World Bank	Reuter	Field Trip to Koulima Forest Reserve, declassification due to use overcutting causes start erosion.
BALIMA, Dr. NEON, Mr. WINTERBOTTOM, Bob TAYLOR, George West Volta Livestock Project Bobo-Dioulasso	Treadwell Sowers	Goals of ranch Fulani herders World Bank herders Animal Health Program No fences No market for milk
BALIMA, Olivier AVV, Sondre-Est project Ouagadougou		Social organization animal health
BAMA, Zameri SOUMI, Emmanuel Eaux et Forets Gorum - Gorum	Treadwell Coulibaly(1) Ferguson Sowers	Reforestation - industrial and village exotic species die new plant natives
BAR, Andre Direction de Service Elevage Ministry of Rural De	Sionne Ferguson Bertolin Treadwell	Introduction to Service country overview
BARRY, Jean Direction of Urban Environment Ministry of Environment and Tourism	Bertolin Ferguson Negash Treadwell Reuter Evett	Urban recreational space Goals of direction Team logistics
BASSTYR, Ben Dinderesso School Dinderesso	Reuter	Field trip to Banfora Forest vegetation and soils

(1) specialist in range management from Service de l'Elevage who accompanied team on trip to NE

Person Contacted	Team Member (s)	Topic Discussed
BIAZ, Rene Pan African Institute of Development	Bertolin	
BONOU, Rene Secretary General Ministry of Environment and Tourism	Bertolin Ferguson Reuter Treadwell Evett Negash	Scope of MET: Urban emphasis Interministerial Council agents as teachers
BROCKMAN, Franck SAFGRAD Ouagadougou	Treadwell	Forage crops especially cow peas
CATINOT, Rene former director CTFT CILSS Forestry Sector Analysis	Reuter	Reforestation, history and tactics
CHRISTENSON, Paul Agronomist SAFGRAD	Evett	Soil nutrients erosion economics
COMPAORE, Albert Forests MET	Reuter	
COMPAORE, Andre Roch Markoye Ranch Service de l'Elevage Markoye	Treadwell Coulibaly Ferguson Sowers	training of herders Zebu - Azaoude breeding herd purchases by civil servants animal health program range condition fence maintaining
COMPAORE, Saidou Sector Chief of ORD Yako	Evett Reuter Nagash	Comite de Developpement de Yako Rational tree policy High demand for seedlings Microcatchments
DALSIMER, Anthony Charge d'Affairs U.S. Embasy	Bertolin Negash Ferguson Evett Reuter Treadwell	Country overview logistics

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DIALLO, Moulaye Ecology and Forestry Team CILSS	Ferguson Reuter	Linked energy, environment and human survival monitoring natural resources soil conservation desertification wood production energy and research training and extension funding sources
DIALLO, Sidiki ORD Surveyor Ziga (20 km SW of Ouahigouya)	Negash Evett Reuter	Met ORD agent and president of village "groupement" village wood lot - poor condition Trial forage production 2 FDR anti-erosion sites
DIAMO, Moussa ORD Village Head FRIESCH, Helmut German Volunteer	Evett Reuter Negash	Visited villages of So and Peteka ORD antgi-erosion sites problem a Sondy sites
DILEMA, Salomon Chef d'Inspection Comoe Banfora	Reuter	Field trip to Toumousseni Foret Classee - roads not passable
GHOSSOUB, Youssef Sawmill Owner	Reuter	Local employment Business aspects Partnership with Voltaic Government
GOMTIBOÙ, Bonkougou Institute of Ecology CNRST	Taylor Winterbottom Ferguson	Research coordination Research quality
GNOUMOU, Donfouti Eaux et Forets Djibo	Evett Reuter Negash	Visited large plantation to West Local species and eucalyptus tractor established German financed
GROSENICK, GErald Institut Superieur Polytechnique Univ. of Ouagadougou	Evett Ferguson Reuter Treadwell	Forage species Fire adaptation
HALL, Bob USAID HOMMELEN, Blaise Belgian Volunteer Yako	Evett Ferguson Evett Reuter Negash	Environment of Est ORD Agriculture of Est ORD Forest service - ORD relations Works with OXFAM 3 nurseries visited

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HOOPER, Jonathan Euroaction/Acord	Sowers Ferguson	Erosion Anti-erosion measures
KAFANDO, Ouefo Village Livestock Proj. Tafogo	Sowers Treadwell Coulibaly	Livestock raisers committee Chief's hopes for future Continuation of VLP
LANKOANDE, Moise Moussa Sous-Prefet Tougouri	Sowers Treadwell Coulibaly	Livestock raisers committee New brush fire law Counterfit 1,000 francs notes
MC DONALD, Wayne Peace Corps Assoc. Director	Evett Ferguson Treadwell	Volunteer work with forestry Improved stoves, wildlife and fisheries Forestry PCVs now assigned to MET
MALACAMP, C. Centre de Recherche de Teledetection de Ouagadougou	Evett Reuter Treadwell	Landsat system Ouaga station - 1984 Staffing current and needs
MEYER, Richard C. Director, USAID	Ferguson Negash Bertolin Evett Reuter Treadwell	Team goals Overview
MUGGE, Eric Hydraulic Engineer Dutch Volunteer assigned to ORD	Evett Reuter Negash	Small dams Erosion control structures
PIOT, Jacques Forester CTFT	Winterbottom Taylor Ferguson Reuter	History of soil erosion and anti-erosion work
NEON, Mr. West Volta Livestock Project site Samoroguan	Treadwell Sowers	Design of ranch Animal health facilities Water point distribution Met with herders
NICOU, Mr. IRAT	Reuter Negash Evett Diallo	Field trip to Sabouna (27 km NNE of Ouahigouya) Training for ORD heads of Services and Sector Chiefs Conflict of techniques

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NIKIEMA, Dieudonne Director Hydraulique et Amenag. de l'Espace Rural Ministry of Rural Dev.	Evett Bertolin Ferguson Negash	Discussed soil and water Conservation program Work through ORDs High farmer demand Fertilizers Integration of forestry
OUEDRAOGO, Aime Eaux et Forets Bobo-Dioulasso	Reuter	Field trip coordination Official contact
OUEDRAOGO, Boureima AFRICARE Seguenega Project	Reuter Negash Evett	Integrated rural development No s/w conservation component No coordination with ORD anti-erosion work
OUEDRAOGO, Salam ORD Forester	Negash Evett Reuter	History of reforestation 6 nurseries - high demand ORD Forest Service relations
OUIRAGO, Sidu Defense et Restauration des Sols Euroaction/Accord	Ferguson Sowers Treadwell Coulibaly	2 field sites of tenaces 1) in millet field 2) in abandoned field Use of local tools Volunteer labor
OXFAM sites	Negash Evett Reuter	Done by local farmer Dikes of soil, laterite rock Bundles of sorghum stalks Good soil building
RACHMELER, Dale USAID Seed Multiplication Project	Evett	Description of Soil Service CERCI IITA
SIDIBE, Yaya Secretary General Prefecture of Ouahigouya	Reuter Negash Evett	Problems between Forest Service and ORD Forestry should be under ORD
SIONNE, Lebende Production Animale Service de l'Elevage	Treadwell Sowers Ferguson Bertolin	Field trip plans Need pastoral Code Problems of range management Village Livestock Project
SLENDERS, Gerald	Treadwell	Project description Fire control

Persons Contacted	Team Member (s)	Topic Discussed
SMITH, Jay USAID	Reuter Negash Ferguson Treadwell Evett Bertolin	Recent environmental events in Upper Volta - Tree Day and clean up
SOUBEIGA, Gilbert Director ORD Ouahigouya	Reuter Negash Evett	Protocol and organizational meeting
SOUBI, Amadou Reforestation Project FED, Markoye	Coulibaly Ferguson Sowers Treadwell	ORD of limited help Nursery of native species for local seeds Plantation next to mare
SYLVAN, Mr. Head of ORD anti-erosion work WRIGHT, Peter OXFAM Agro forestry	Evett Reuter Negash	Integration of OXFAM work into ORD structure
TAYLOR, George Sahel Regional Study Team Bamako, Mali	Negash Sowers Ferguson Winterbottom Evett Treadwell Reuter	Regional overview
THOMBIANO, Julien Peche & Pisiculture MET	Ferguson Negash Treadwell	Fishermen Association Equipment Training
THOMSON, James Political Scientist USAID	Ferguson	Village level reforestation in Niger and Upper Volta
TOMPOADI, Amadou Eaux et Forets Kaya	Ferguson Sowers Treadwell Coulibaly	Fish culture Forest reserve Reforestation projects Housing for agents, stoves project/PCV
TONI, Doro Thomson Director of National Porks Ministry of Environment and Tourism	Ferguson Negash Treadwell	Problems protect animals Public relations Training of agents West African region

Person Contacted	Team Member (s)	Topic Discussed
TRAORE, Salif Eau et Forets Dori	Coulibaly Ferguson Sowers Treadwell	Industrial plantation Nurseries established Mixed natives and exotic forage harvesting
VAN VOURTHUIZEN, E. USAID	Threadwell	Village Livestock Project Markoye Ranch
VELDHUYZEN VAN ZANTEN, Tisna PNUD	Ferguson Reuter Evett Treadwell Sowers	Role of SDP's in environment
Village Chief Tengrela	Reuter	Village nurseries Commercial firewood cutting
WINTERBOTTOM, Bob Dinderesso School and Forest Dinderesso	Reuter	Grassfires in plantations Competition between agriculture and forestry teaching program
WOOD, Timothy S. CILSS Improved Stoves	Evett Reuter	MET's role in improved stoves Stoves Lesting Program Bushes for fuel Water table drop in Ouahigouya
YOMI, Abdoul Asst. to Sector Chief Seguenega	Negash Evett Reuter	African Project (USAID) Reforestation Components not closely integrated
ZOGBY, Samir USAID	Ferguson	AID/CILSS interactions CILSS structure
ZONGO, Alfred Director of Forestry and Reforestation Ministry of Environment	Reuter Negash Reuter Treadwell Evett	Goals as Forest Service: Forest Reserves/Management Plantations Exotics as natives Village reforestation Extension Wood stoves Anti-erosion works Trees as forage Social aspects of bush fires Project coordination at National not local level