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A REPORT ON

SOIL EROSION AND PROSPECTS FOR LAND RESTORATION IN HAITI

by

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SOIL EROSION

The Issue

Haiti's massive soil erosion problems constitute the worst case of widespread land abuse in the Western Hemisphere. The country-wide population density of more than 160 inhabitants per square kilometer (>400 per sq. mile) may already be greater than the carrying capacity of the land. The amount of land appropriate for intensive food production (<25% slope; adequate soil depth and fertility; adequate rainfall or irrigable) is extremely limited, so most of the >600,000 farm holdings in the nation are on slopes which are really only suited for grazing, forestry, and watershed protection.

Soil erosion is not a new problem in Haiti. Warnings have been issued for decades, yet no effective nation-wide control programs have been implemented. There is a dedicated Soil Conservation unit within the Haitian Department of Agriculture, Natural Resources and Rural Development (DARNDR), but they do not have enough operating funds or trained personnel to mount more than the most humble, ineffective sort of program. The Food and Agriculture Organization (FAO) of the United Nations has had a reforestation and erosion control effort in conjunction with DARNDR for several years, yet their efforts have been restricted to few areas. The Haitian American Community Help Organization (HACHO), working in conjunction with CARE, has an erosion control program in the northern part of the Country, while Church World Services (CWS) has had locally active and effective programs underway for many years. None of the existing erosion control programs, however, is both effective and national in scope, yet severe soil erosion is a country-wide problem.

Soil erosion manifests itself as a problem for Haitian agriculture in several ways. First, and most crucial for assistance programs, are its impacts on the millions of people who practice subsistence agriculture in the hills. One might expect that the subsistence farmers would be the first to note the impact of soil erosion through its affects on loss of fertility and decreased crop yields. In most deeply weathered tropical soils, however, the nutrients essential for plant growth are concentrated in the uppermost soil layers: frequently 90% of the total nutrient supply is found in the top 10 centimeters of soil. Depletion of this topsoil by cropping and erosion is a very rapid process in mountainous areas of the tropics. The underlying subsoil, however, is of relatively uniform, low fertility. As the subsoil continues to erode away yields decline, not so much because of decreased fertility, but because of decreased moisture-holding capacity and increased rockiness. The drop in the ratio of soil-to-rock per unit area increases the difficulty of farming and effectively reduces the food-yielding fraction of each mountainous hectare. Later, the soil is almost

completely eroded away and the land must be abandoned. Land pressures in Haiti thus push from two ends. First, the population is still growing, thus requiring more land. Second, due to soil loss through erosion, the total amount of land available for cultivation is less each year. The status of the subsistence farmer in the mountains, therefore, is not getting any better nor staying the same: it is becoming worse each year and shows no sign of improvement.

In addition to the loss of cultivable soil, erosion also produces pseudo-droughts, i.e., drought conditions which result from a decrease in the water-holding capacity of the soil rather than from decreased rainfall. Soil can be thought of as a sponge capable of holding a certain amount of water: the deeper the soil, the greater its water-holding capacity. Between rains plants use the water stored in the soil. If, however, the water-holding capacity of the soil is greatly reduced (as by soil erosion) then the water stored in the soil cannot satisfy the requirements of the vegetation. The net result is drought-like conditions, both for agricultural crops and for natural vegetation. Much of the natural vegetation in Haiti reflects much drier conditions than would normally be expected considering the amount of rainfall received. This form of desertification is difficult to deal with and can only be rectified by restoring the soil, with its sponge-like moisture holding properties. It is not, however, a problem which is completely impossible to remedy, as is the case with desertification due to long-term decreases in rainfall. Most of upland Haiti, in fact, receives adequate rainfall to support agriculture without irrigation; what is lacking is an adequate soil layer to hold that water for crops.

Soil erosion not only has important implications for subsistence farmers in the mountains, but also for the small areas of flat land suitable for intensive agriculture. There are about six such large areas and many small ones. Together they account for less than 10 percent of Haiti's total area. Successful agriculture in the irrigated flat land, however, is dependent upon the surrounding mountains as a source of high quality water. If erosion occurs in the hills, the lowland agriculture suffers in two ways. First, the water delivered from the hills to the valleys occurs in bursts following each storm, rather than in a more desirable even flow. Second, the eroded mountain soil shows up as sediments which clog reservoirs, streams, and irrigation works. Irrigation systems which are blocked with sediments are key items of concerns to Haitian agriculture today. Almost all of the systems are operating at only a fraction of their potential efficiency. Yet, irrigation system renovation without watershed protection can only be the most short-sighted kind of remedy: a cure for the symptoms, but not the disease. Because of its effect on the irrigated farmlands, however, attention has finally been drawn to the severe erosion problem. A 1954 FAO report pointed out that it was widely recognized that watershed protection was essential for the survival of the Artibonite River dam and irrigation system. If protection was not afforded, the report warned, "the efficiency of the reservoir will . . . be reduced 40% over the next 30 years." Now, 23 years later, that warning proves to have been conservative. The efficiency of the reservoir has already been reduced by much more than the amount predicted and Port-au-Prince (which receives its electricity from the Artibonite River dam) has power for only five hours per day. Thus, the

erosion problem in Haiti not only affects the poorest of the poor--the subsistence farmers in the uplands--but has also had an important impact on the intensively cultivated, irrigated lowlands, as well as on the daily commercial and industrial activities in the capital.

The problem is not primarily one of ignorant rural subsistence farmers destroying their lands because they don't know any better. Rather, they have no alternatives. Their caloric intake is deficient, and agriculture, coupled with charcoal production, is their only means of survival. The key to the success of any soil conservation programs implemented in Haiti will center on their ability to provide short-term and long-term subsistence alternatives to the people forced to farm lands which are inappropriate for agriculture. No one, regardless of their socio-cultural background, farms 100 percent slopes because they like to. Rather, they are forced onto these lands for lack of alternative means of subsistence. Soil conservation efforts must, therefore, proceed along one of two lines: either provide subsistence alternatives on lands appropriate for sustained agriculture, or mesh intimately with the agricultural systems currently practiced so that the farmers can at least maintain their present levels of food consumption during and after the implementation of the soil conservation efforts. The first option (subsistence alternatives) is probably not possible under Haiti's current socio-political status and population density. The second option (soil conservation without concomitant reduction in yields from hill farms) may have promise, but will be extremely difficult to achieve. It will require a delicate simultaneous union of farming and soil conservation practices, and/or an outside subsidy (money/food) to permit farmers to survive during the period when erosion control is established.

Possible Action

Several courses of action may be open, but two points must be kept in mind when considering any of them. First, no program will be able to provide a short-term (5 to 10 years) nation-wide solution. Second, the probability of failure of any program which is broad and bold enough to achieve large-scale progress toward erosion control and land restoration is not only going to be finite; it is, in fact, going to be quite large. The distasteful alternative, however, would be to do nothing. No action might well spell the end for the only means of subsistence available to the vast majority of Haiti's rural poor.

In the sections which follow, some of the difficulties which will be encountered in developing and implementing an erosion control program are described; some of the data gaps which must be filled before wide-scale restoration projects can be initiated are identified; and some points which might be considered in developing an integrated, watershed-level land restoration and agricultural improvement program are mentioned.

Risks and Problems

The ecological and logistical problems associated with a land recuperation program are going to be difficult. They include the advanced state of erosion over much of upland Haiti; the absence or degraded state of natural

vegetation which might serve as a source of propagules for revegetation; and difficulties in transportation and communication in rural areas. Nevertheless, these kinds of problems, no matter how complex, are more or less surmountable. Far more crucial than the ecological and logistical problems, however, are the suite of local cultural-political problems which will be encountered.

Assistance programs are designed, insofar as possible, to aid the poorest-of-the-poor, or at least the poorest group for which meaningful assistance can be provided. One important design constraint, however, is that assistance must be provided in close conjunction with, and through the auspices of, existing national agencies. The goal (help the poor) and the constraint (work through local government agencies) may not be compatible.

In the case of erosion control, the obvious candidate for a local collaborative agency would be the Soil Conservation Service of DARNDR. There is no question concerning the genuine sincerity, dedication, knowledge, and honest concern regarding the country's soil conservation problems on the part of the technical staff of this unit. Yet, the personnel, facilities, and operating budget provided them (as is the case with most, if not all, of the units within DARNDR) is pitifully inadequate. An assistance program thrust upon this unit would, under present conditions, receive no response. They would be unable to respond with counterpart personnel because none are available and there is no local budget with which to pay them even if they were. Current salaries within DARNDR are too low to attract top personnel, except for that handful of proud, dedicated (and frustrated) individuals who hope to someday be able to solve some of Haiti's agricultural problems.

The solution to this difficult problem must come from top Haitian government officials: those responsible for making budgetary decisions to and within DARNDR. They can be influenced from two directions. First, they can be approached from the bottom up. This will involve development of appropriate project(s) in continuous, close collaboration with DARNDR technical staff. If it is, to a great extent, <u>their</u> project, they are likely to be most effective in selling its merits to higher government officials.

Second, the highest officials possible must be approached from the top and convinced of the absolute necessity for maintaining a viable agriculture. It can, and must, be clearly demonstrated that land is the life blood of Haiti: not only for the subsistence farmers of the mountains but also for the cash crops which are the mainstay of Haiti's economy.

In addition to problems associated with government support and infrastructure, the socio-cultural attitudes and pressures of the rural poor will increase the difficulty of the land-restoration task. These problems might be grouped into three overlapping categories: land tenure, subsistence farmer conservatism, and population pressure.

The unusual (or lack of a) land tenure system of rural Haiti has long been decribed as one of the key obstacles to agricultural development. It might be an obstacle to <u>orderly</u> agricultural development, but perhaps orderliness is not a luxury that subsistence agriculture in Haiti can afford. Rather, an assistance program might get further faster by recognizing that the current system--a complex one involving multiple small plots in different

ecological zones; intricate family relationships; land loan and rental; mobile husbands and sedentary, produce-marketing wives; and an inheritance scheme which covers all offspring--has evolved over the past 170 years. It apparently works well enough for its practitioners and land restoration projects are likely to be more successful by working in the context of the present scheme rather than by attempting to change it.

As is the case with almost all subsistence people everywhere, the mountain farmers of Haiti will undoubtedly be reluctant to change their land use practices unless they are certain that any changes instituted will be to their advantage. Furthermore, they must be absolutely convinced that the risk associated with any possible change for the better does not increase substantially. Low risk--not high yield--is the name of the game in subsistence agriculture. Low inputs, diverse crops, multiple plots, door-yard gardens, nearly self-sustaining poultry and livestock, and low but certain-to-get-something yields: these are all reflections of the harsh fact that the subsistence farmer cannot absorb a single failure. All agricultural assistance programs, including soil conservation efforts, must recognize the adaptive reasons why rural poor are often reluctant to immediately employ the latest "improvements" that technology has to offer.

The issues of land tenure and farmer conservatism are tightly coupled to, and accentuated by, Haiti's high population density. This means that lands which should be removed from cultivation will be under great pressure for return to farming; that lands which are reforested will be subjected to grazing, burning, and premature cutting for charcoal; and that farmers will be reluctant to remove any of their limited land holdings from cultivation while terraces and retaining walls are constructed. To meet this intense pressure for land will require the close cooperation of the local community. Some of this cooperation might be achieved by law enforcement and some by short-term incentive programs which subsidize the farmers affected (with food, money, or agricultural products and services) for the production losses incurred as a result of the implementation of soil conservation measures. But the most important, and the only long-term, solution will come from working closely with the local community and demonstrating to the people that land protection is in their own best interests. This will not be an easy idea to sell, but if it is not accomplished the soil restoration effort is certain to fail.

A final problem associated with soil conservation efforts in Haiti concerns the choice between proceeding slowly, carefully, one-step-at-a-time and developing small-scale pilot programs where the bugs can be worked out of the system, or forging ahead full-blast and running the risk of relatively large-scale failure. Any prudent assistance program would select the first alternative: any assistance program, that is, which had any sort of reasonable time-frame in which to operate. But the Haitian situation is too critical for that. The time for proper action is now past and any action taken, to have any recuperative affect at all, must be instituted on a relatively large scale as quickly as possible. The alternative--no action at all--would be irresponsible.

Data Gaps

One kind of information which need not be gathered prior to design and implementation of a soil conservation and restoration program for Haiti is a nation-wide survey of the extent and severity of the problem. Soil erosion is a nation-wide problem and its severity is obvious to even the most casual, untrained observer. However, because of the constraints on any program that might be undertaken, it will be impossible to cover the whole country. Therefore, it will be necessary to identify target areas for first-priority action. It is this accurate assessment and identification of appropriate target areas which constitutes the major research effort needed before a major soil conservation program can get underway.

Soil erosion is not the sort of problem which is amenable to small scale (e.g., single farm) solutions. To be effective it must be practiced over larger natural units. The logical choice for a natural, functional unit for erosion control is the watershed, or catchment basin, of a stream. It may be a very large unit, as, for example, the entire drainage basin of a large river, or it may be a small unit of only a few hectares encompassing the entire watershed of a small feeder stream. In either case a watershed is a natural unit and the downhill flow of a common supply of water through it is the thread that holds it together. Actions upstream inevitably affect processes downstream, so treatment is more effective if applied throughout an entire watershed. Conservation efforts on 100 contiguous farms on a single watershed will inevitably produce better results than if the same effort is spread haphazardly across a landscape and includes several watersheds.

How should the watersheds to be treated be selected? In Haiti, that question is difficult to answer because of the severity of the erosion problem. First of all, two classes of watersheds can be eliminated from consideration. One of these includes those watersheds which have already been selected for conservation measures by other agencies such as FAO, HACHO, and CWS. The other includes those watersheds which have already been subjected to such severe erosion that little soil remains to be saved. In these extreme cases--and there are many such watersheds in Haiti--little is to be gained by spending efforts on land which is incapable of supporting subsistence agriculture and which constitutes no real sedimentation danger for downstream irrigation systems.

Selection then boils down to a subset of all the remaining watersheds. To choose among them some criteria must be applied. Three suggested criteria, in order of greatest priority, are listed below. Haiti undoubtedly contains many drainage basins which satisfy all three criteria, in which case further selection should be based on social, rather than ecological, characteristics.

1. Select watersheds which, if improved, will provide the greatest amount of assistance for the greatest number of subsistence farmers per unit area. The subsistence farmers helped would include both those on the uplands and those on the alluvial valleys within the watersheds.

2. If two watersheds between which a choice must be made are nearly identical with respect to criterion No. 1, above, then select the one which contains the highest quality agricultural soils. This will, in the long run, achieve the highest possible carrying capacity, i.e., it will assure that the greatest number of people possible will be supported.

3. After satisfying criteria 1 and 2, above, select watersheds in terms of the amount of benefit likely to accruo to larger downstream irrigation, flood control, and hydro-electric power systems. There is likely to be a tendency to make this the first-priority criterion, rather than the third-priority criterion as listed here. But that would not be consistent with the assistance philosophy of providing help for the poorest-of-the-poor: the subsistence farmers of the uplands.

In addition to the research necessary to choose appropriate watersheds, it will also be imperative to provide a monitoring program to evaluate successes and failures as erosion control measures are implemented. This monitoring should include ecological variables such as quantity and quality of runoff, post-treatment erosion, and rates of vegetation regrowth. Simultaneously the impact on the socio-economic status of the subsistence farmers who participate in the program should be carefully observed. Their long-term well-being is the single overwhelming criterion for determining the success or failure of any land restoration efforts.

Integrated Program

Any watersheds selected for restoration, together with their subsistence-level inhabitants, should be treated as an integrated, functional unit. The people of the land should do the restoration work and reap the benefits. Each selected watershed will consist of a continous gradient of environments, encompassing a range of topography, soils, and vegetation. For purposes of preliminary (not site-specific) planning this continuum of environments can be broken down into three broad categories: steep, eroded slopes of little or no agricultural productivity; cultivated, unirrigated hillsides; and irrigable alluvial valleys. Each watershed is certain to include at least two of these three environments, and in most watersheds it will probably be useful to consider a finer ecological breakdown than these three broad categories.

In any case, watershed restoration should proceed from top to bottom. If it does not, the restoration works at lower elevation are likely to be undone by continued erosion of the steep slopes above. The kinds of programs which might be applied to each of the three broad categories of ecological units likely to be found within most watersheds--steep, eroded slopes; cultivated hillsides; and alluvial valleys--are described below. This is followed by a statement of realistic, achievable program objectives.

Steep, Eroded Slopes

The steepest, most erosion-susceptible slopes should never have been subjected to any use other than possibly forestry and limited, carefully controlled grazing. They were, however, deforested for charcoal production and agriculture, which was followed in many cases by erosion so severe that only bedrock, interspersed with small pockets of soil, remains. Land protection and erosion control through revegetation is called for on these areas.

In most tropical and subtropical areas of moderate rainfall (such as most of upland Haiti) the natural vegetation regrows quickly once the stresses of cutting, grazing, and burning are removed. Haiti has an additional problem, however. Because deforestation has been going on for so long and has been so widespread, the seed sources which would normally be the agents of vegetation recovery have been severely depleted. Loss of seed sources, coupled with the severe erosion which has occurred, has three important implications for the expected regrowth of natural vegetation. First, it will undoubtedly be slower than might be expected in other tropical and subtropical areas of equivalent rainfall. Second, the species which initially recolonize these sites will be more typical of drier sites (and, therefore, may be less valuable and slower growing) than would normally be expected. Third, some of the best-quality tree species which might be expected to occur naturally among the natural regrowth may be very scarce or absent because they have been preferentially exploited for so long.

Natural regeneration is, of course, not the only way (though it is usually by far the cheapest and fastest) to reforest steep slopes. Artificial regeneration, both through direct seeding and tree-seedling planting, is another alternative. Direct seeding (scattering large amounts of seeds of desirable species over the landscape, by hand or from an airplane) is fast and can be relatively inexpensive, but has two drawbacks. First, a large supply of seeds must be readily available. The seed of most desirable tropical and subtropical trees is currently under such great worldwide demand that the cost is high and supplies are limited. Second, direct seeding, especially of desirable timber species, is very risky. In most attempts the probability of failure exceeds that of success, so most foresters prefer seedling planting to direct seeding as a means of reforestation.

Although it is more expensive (perhaps $100-200 per hectare) than natural regeneration or direct seeding, tree planting is a less risky way to insure establishment of a forest of desirable species. Tropical foresters frequently jump on the wonder-species bandwagons (e.g., Gmelina, Anthocephalus, various pines, numerous Eucalyptus), but these fast-growing glamour trees may not be best suited for the degraded sites in need of reforestation in Haiti. The issue here is not so much one of a crucial need for wood (although the demand is extremely high and, if it can be met through reforestation, so much the better) as it is a need for immediate soil protection. Thus, native species which are culturally acceptable to rural people and which are known to grow naturally in the forests being reconstructed would be wise first-choices for reforestation.

Because of the advanced state of site deteriotation which has occurred it may be necessary to use more stress-tolerant species than would

normally be the case. These are likely to be relatively slow-growing and will probably not be of the best form. The rapid growth rates reported for plantations in other tropical and subtropical areas are unlikely to be achieved on Haiti's eroded uplands, so predictions concerning rates of wood production should be made carefully and conservatively.

Haiti's native pine (Pinus occidentalis) may be an appropriate candidate for reforestation on extensive areas which it once occupied in upland Haiti. It tolerates relatively poor sites; the know-how to mass-produce it in nurseries is available; it is a valuable species; and, unlike some exotics, such as Eucalyptus, which are often thought to consume excessive amounts of water, it is respected by the rural people.

Cultivated Hillsides

Many, if not most, of the cultivated mountainsides of Haiti are technically too steep to sustain permanent clean cultivation of annual crops. They cannot be removed from cultivation, however, because they are the main source of food for Haiti's poor.

One system of land reclamation which has been successful in some tropical and subtropical areas, and one which has been suggested as appropriate for Haiti, is the so-called taungya system (from the Burmese word for hill cultivation). Forest regeneration through taungya involves the simultaneous planting of tree seedlings together with food crops. Farmers care for the trees along with their crops and, after 2 to 4 years of cultivation, the trees shade the land. The cultivator then moves to a new site, presumably to return at a much later date (say, 10 to 20 years), harvest the trees, and repeat the cycle. The incentive to the farmer is sometimes the availability of land for cultivation and sometimes direct cash payment for planting and tending the young trees. The taungya system has traditionally been successful where government agencies have tight control over land tenure and where adequate land is available to permit both long-term forest production and the cultivation of annual crops. Neither of these conditions obtains in Haiti, however, so it is doubtful that taungya, at least as it is usually practiced, can be effective here. Some modification, perhaps employing fruit trees and permitting nearly continuous cultivation, might be developed to fit the conditions found in Haiti.

Because continuous cultivation is a must, structures such as dams, terraces, and barriers have to be used rather than permanent revegetation of the cultivated hillsides. Crude barriers constructed from twigs, stones, and debris are, in fact, commonly used in cultivated fields in many parts of Haiti. Thus, convincing the people of the usefulness of such structures will not be an impossible task. The difficulty will come in devising a way to enable them to fit the construction of erosion control structures into their present life styles. For one thing, doing something new involves taking a risk, and it must be clearly demonstrated to subsistence farmers that this is a change worth making. Second, construction of erosion control structures will sometimes mean that land currently cultivated will be

occupied by a structure. The net yield off the terraced land must increase enough to compensate for this. Finally, time spent in erosion control will often mean time taken away from tending fields. There must be some short-term incentive to do so: wages, food, or agricultural assistance.

Erosion control structures are time consuming and expensive to build, but they can be made with locally available materials (primarily rock: abundant in most, but not all, eroded watersheds). Furthermore, the technical skill required to build adequate structures is minimal. Subsistence farmers could probably do everything except the initial design and structure layout once they were shown the basic process of construction. Typical labor requirements to restore steep, eroded land might run from less than 100 to more than 200 person-days per hectare.

Alluvial Valleys

The alluvial valleys, even the very short, narrow ones associated with the smallest watersheds, are the best agricultural sites in the mountainous areas of Haiti. They are the sites where some soil (often that which was eroded from the surrounding slopes) accumulates and where the availability of water permits dry-season agriculture. The productive alluvial areas, however, also suffer from the erosion problem. They are subject to uneven water availability, flash floods, and washouts. Thus, revegetation and erosion control structures on the surrounding slopes directly benefit the best agricultural land as well.

On the steep hillsides the subsistence farmer is the resident expert agronomist, and it is doubtful that modern agricultural research can add greatly to the existing level of productivity, given the soil and water constraints of those poor sites. But because of the availability of both soil and water in the valleys, it is possible to obtain greater increase in agricultural yields through introduction of improved practices onto these sites than is the case on the soil-and-water-impoverished slopes. Therefore, any efforts toward land restoration and erosion control should be concerned with simultaneous delivery of <u>two</u> technological packages: land renovation <u>and</u> improved, intensive agriculture on the best soils. The two are symbionts: <u>each</u> permits the survival of the other.

Erosion control in the hills means that agriculture in the valleys can be improved, while improved agriculture in the valleys will take some of the pressure off the need to again deforest the slopes. Neither of these technological packages can stand alone; each requires the other for its success. To be most effective an assistance program should deliver both programs--erosion control and agricultural improvement--to the same group of people. Interest in, and benefits received from, either one of the programs will lead to the success of the other.

Reasonable Expectations

A truly integrated program will encompass an entire watershed and involve the same group of people throughout. It will involve three closely

linked aspects: revegetation on the most severely eroded slopes, erosion control structures on the cultivated hillsides, and improved, intensive agriculture on the alluvium. This integration of people, lands, and programs will be necessary for its success; elimination of any component would mean failure of the whole. What might such an integrated assistance program hope, and reasonably expect, to accomplish?

Successes and failures of assistance programs are usually evaluated in economic terms: changes in per capita income, cash flows, and even national balances of payments. Most of these are irrelevant to the life of the average Haitian subsistence farmer. They operate an intensely active economy--one with lots of buying, selling, bartering, and lending--but one which has relatively weak links, in terms of inputs and outputs, to the national economy. Thus, it is not fair to evaluate their condition or performance in terms of the performance of a money economy with which they are only superficially associated.

A more realistic measure of success or failure of a program might be its impact on a person's net energy budget: food energy in, minus work energy out. To achieve a minimum level of subsistence, without any excess for economic consumption, does not at first sound like a very noble goal for an assistance program. Yet, to the rural poor who presently barely survive at sub-minimum levels of food intake, adequate subsistence does not sound like a bad deal. Any Haitian assistance program which provides a stable, sustained food yield for these rural poor involved in their own food production can consider itself successful.