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SOIL AND WATER CONSERVATION TECHNIQUES: AN APPROACH TO WATERSHED STABILIZATION ON JAVA, THE CITANDUY PROJECT*

by

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INTRODUCTION

Densely populated watersheds such as those on Java, Bali and Madura present unique problems for soil and water stabilization and agricultural development. Population densities of 600 to 1000 persons/km2 within the major watersheds in Java are common with less than 25% of the land under forest and/or permanent vegetation cover. The intense cultivation of the land under poor soil and water conservation practices, in a tropical environment where precipitation ranges from 1500 to well over 3000 mm/year, is causing a rapid degration of the base resources such as soil and water. Considering that about 3.4 million metric tons of foodstuffs were imported in 1982 to feed the present population and that within the next 30 years the population in these islands is going to double (present population of Java is 91 millions), conservation of soil and water resources is imperative for the well being of the country. Other

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consequences of poor soil and water conservation practices, such as floods, low water for irrigation during the dry season, sedimentation of irrigation systems and hydroelectric dams, etc., are well known to the people of Java, Bali and Madura.

PROBLEM IDENTIFICATION

Source of Soil Erosion and Water Run-off

The major source of sediments and water run-off are the lands with moderate to steep slopes; however, even gentle slopes where the land is denuded of vegetation can be major sources of erosion. In the tropical climate of Java Bali and Madura, when a clear-cut forest harvest takes place, the soil erosion and water run-off is minimal, because after the first showers the ground will be covered with grass, weeds and new shrubs that will stabilize the slopes. The major source of soil erosion and water run-off are the farmers' fields where no grass or weeds are allowed to grow to avoid competition for nutrients, moisture and sun light to the growing crops. With estate crops such as rubber, clove, and coffee the land is usually well protected from erosion by legumes or grass/weed cover among the trees. Only the areas adjacent to each individual tree are free of vegetation and these areas are usually protected from the rain-drop impact by the tree canopy. Road cuts and steep embankments bordering roads and narrow valley paddy fields are also sources of soil erosion Thus we can conclude that the major source of soil erosion and water run-off are the dry land farms in the sloping areas of the watershed.

The Dryland Farms

The major concern should be the upland rainfed areas, which will hereafter be referred to as "dryland farms" because in addition to the soil erosion, sediment and water run-off, the rich productive topsoil, where most of the plant nutrients are located, is being lost. The basic problems seem to be the same regardless of the areas; these are:

a) Soil erosion caused by dryland farming under poor conservation practices,

b) Low productivity of the dryland farms which forces the farmers to expand their operation and neglect soil conservation,

c) Poor land use and farm planning,

d) Lack of technical advice and programs to help the dryland farmers,

e) Lack of off-farm job opportunities for the growing labor force and thus increasing population pressures on the land.

The degree of soil erosion taking place in the dryland farms is related to the following factors: vegetative cover, slope, length of slope, amount of precipitation, intensity and duration of storms, and soil type.

The Soil and Water Erosion Process

The raindrop impact on the soil breaks the soil aggregates thus leaving the soil in a dispersed condition. The fine soil particles then will clog the soil pore spaces which in turn will decrease the soil water infiltration. The erosion resulting from detachment and transportation of soil due to the kinetic energy disscipated when raindrops hit the soil surface is called splash erosion. The detachment and movement of the fine soil particles into the cracks and pores of the soil surface and puddling

of the soil structure by beating action of the rain is called puddle erosion. These are the preliminary steps to sheet erosion which is the detachment and removal of this sheets of topsoil without appreciable turbulent movement or flow. The surface flow will cause the channeling action type of erosion like rill, gully and stream depending on the amount of soil detached and removed from concentrated bands. This process includes detachment due to rolling, lifting, and abrading as well as transport. The erodibility varies according to the soil type. Terrain modification by building bench terraces with the proper water outlets, waterways and vegetative stabilization can reduce soil erosion to a minimum.

FARMER CONSTRAINTS

The main constraint to full development of potential resources at the farm level is the lack of capital. Most of the farmers, especially on dryland farms, are presently living at subsitance levels. Thus they are incapable of saving enough capital to procure the minimum input requirements for improving their farming system production (crops, trees, livestock, fish ponds, etc.). Credit to the farmers can only be effective when the income potential from their farms, besides covering their minimum living standards, provides them with some savings. These savings then can be used to pay their loans and interest. Thus if the farm income cannot provide minimum living standards to the farmer, it will be practically impossible to have a self sufficient system, and the Government will have to keep providing subsidized loans and other measures to improve farm income. It is unrealistic to expect a farmer after he sells his crop to repay his credit when he does not have a comfortable chair to sit on at

home after he finishes his long working day, or a decent shirt and shoes for that special day when he goes to town.

Irrigation Terraces Versus Dryland Terraces

When water is available for irrigation, regardless of how steep the slopes, farmers do not hesitate to build magnificent terraces throughout the mountain side. These irrigated terraces are practically perfect, providing a very stable slope with minimum soil erosion. These farmers built their own terraces without any government subsidy or even any technical advice, aerial photomaps, topographic maps or any soil surveying equipment. However, the dryland terraces, many times situated immediately above the practically perfect irrigated terraces, are a complete catastrophy in the over whelming majority of cases. Dryland terraces are poorly built for the following reasons:

a) They are almost never along the contour line of the slopes;
b) When they slope down hill, the water cascades down from terrace to terrace;
c) When they slope against the hillside, because they are not built along the contour, the water accumulates in the lower points cascading down hill, cutting gullies as the water transports the soil down the slopes;
d) They cause excessive run-off because there is nothing to stop or slow the water flow to allow maximum infiltration of water into the soil.

I am sure that in many cases the same farmer that built the good irrigated terrace also built the poor dryland terrace; so obviously the question is "why". Farming rice paddies is an old, well known practice in Indonesia and in recent years the Directorate General (D.G.) of Food Crops and the Agency for Agricultural Research and Development (AARD) have accomplished tremendous achievements increasing the production output per unit of land. Also, it happens, that this is practically the only crop commodity on which the Directorate General of Food Crops has made a real attempt to improve production. This is certainly for very good reasons since rice is the staple food of the country and because until 1981 about 2.5 million metric tons of rice has been imported each year to meet national requirements. Therefore, the farmer knows that if he had water to irrigate his terraces, he could produce at least 2.5 to 3T/ha of rice. However, under dryland conditions he also knows that his upland rice yields will be about 0.5T/ha, thus the economic return for the level of effort to build good terraces is lacking.

Economic Conditions at the Farm level

Under irrigated conditions the farmer is sure of at least one and a half crops of rice per year and if the water source is coming from a technical irrigation system, usually two to two and a half crops per year. At a very low production level of 3T/ha that means a yearly crop production value of Rp.652,500 to 1,087,500 per ha. Since on the paddy fields the land holding is about 0.3 ha per family and since 3T/ha rice yield requires minimum inputs, the income from these farms is approximately Rp.16,^00 to Rp.27,100/month. Under dryland farming, only one crop of upland rice (dryland rice) can be harvested because the growing season of local upland varieties is about 150 days from seed to

maturity. For irrigated rice the growing season is 90 to 135 days depending on the variety planted (IR 36, a common variety planted in Indonesia, has a growing season of 105 days from seed to maturity). Also irrigated rice can be started in the seedbed 20-25 days prior to transplant, this is particularly important for the second crop.

The average production of upland rice is about 0.5T/ha when intercropped with cassava and corn, as traditionally done in most parts of Java. The cassava production in this case is about 2T/ha (wet wt.) and the corn about 0.5T/ha (wet wt with cob).

The upland rice has many disadvantages compared with the irrigated rice, for example:

a) The amount and variability of rainfall are two important constraints on production of upland rice.

b) The availability of nutrients is directly related to the moisture content of the soil; thus, under low moisture conditions plant growth is under stress from lack of nutrients.

c) The weed problems are more severe under dryland conditions if they are not controlled as is the case in the upland (low yield, low level of effort).

d) The upland rice is more susceptible to rice blast disease than irrigated rice.

The second crop in the dryland farms consists of peanuts intercropped with corn and the cassava planted with the first cropping system (cassava is harvested about 10 months after planting). However, only 30% to 40% of the dryland farmers plant a second crop. The second crop yields are about 0.7T/ha (wet wt.) of peanuts and 0.5T/ha (wet wt.) of corn. Thus the yearly farm income from dryland farms ranges from approximately Rp.222,500 to Rp.442,500/ha. Since the average land holding in the dryland farms is

about 0.5 ha per family, the approximate family income from the farm is Rp.9,270 to Rp.18,437 per month.

Assumptions:

Dry rice with hull Rp.145/kg

Dry corn grain 40% of wet corn ears

Dry corn grain Rp.250/kg

Dry peanuts 30% of wet harvest wt.

Dry peanuts Rp.800/kg

Wet cassava Rp.50/kg

Very low levels of inputs were considered and gardens or minor crops were ignored.

Rough average farm monthly incomes are:

Irrigated farms (0.3 ha) Rp.21,700

Dryland farms (0.5 ha) Rp.13,853.

Seed Sources and Credit Availability

Dryland rice seed sources are very limited and the quality of seeds is very poor. Only irrigated rice varieties of fairly good quality can be purchased at the village level and some improved corn varieties at provincial capitals or Jakarta. The overwhelming majority of the dryland farmers are still using impure, traditional seeds of local varieties with poor germination and performance.

The credit availability, if it is at the village level, is used by very few dryland farmers mainly because of the reasons previously discussed under the "FARMER CONSTRAINTS" section. As a rule of thumb, the subsidized low interest level loans are time consuming and more difficult to obtain while high interest loans are very easy to obtain but difficult to repay.

The urea and triple super phosphate fertilizers, however, are available practically everywhere at very reasonable prices because of Government subsidy. There is no good reason why seeds and other fertilizers also needed in the dryland farms cannot be made available by the Government and also at a subsidized price.

Technology and Experience on Dryland Cultivation

While the rice paddy package of technology is well developed and is being rapidly expanded throughout the country, with the exception of AARD research efforts no real practical attempt has yet been made by the Government to promote dryland farming agriculture.

The dryland farmers in the watershed are still using archaic technology because the National Food Crop Extension System does not, in reality, reach these farmers but only those engaged in rice paddy cultivation. Dryland farming systems are also more complex and difficult to implement than irrigated rice cultural practices. In irrigated rice production a single package of technology can be used throughout the country because of the uniform soil conditions of the rice paddies created by the reduced state (lack of soil oxigen) of the soil under flooded conditions. Only on high altitude areas is a change in rice variety, tolerant to cold and high altitude environment, required. However, in dryland farming under each particular environment, the technical cultural practices of each crop need to be retuned to fit the specific soil type, precipitation, and level of nutrients on that specific soil, etc. Thus plant densities, fertilizers levels and variety recommendations will vary from site to site for each specific crop.

THE GOVERNMENT CONSTRAINTS

Traditionally rice has been the staple food of Indonesian and even in areas where other crops such as corn are more abundant, as in certain kabupatens (districts) of Sulawesi, the wealthier population consumed rice. This fact created problems by labeling corn consumption a poor people's diet; thus today special campaigns, organized by the Governor of South Sulawesi, are directed at increasing the corn consumption as a staple food of that province. Due to the over emphasized use of rice as the staple food of the nation, other upland crops, normally grown under dryland conditions, have been ignored. This fact has created a lack of knowledge on crop management and of sources of seed availability for dryland crops (palawija). Today the Government is making an effort to increase the production of upland crops, but putting the facts in perspective, the truth is that our level of knowledge of "palawija" crops is in its infancy. The production of rice is reaching a plateau, while the population is still increasing; thus the staple food needs to the diversified to provide adequate food for all with a more balanced diet. This also may help to decrease rice imports; and therefore, the emphasis is to diversify the agricultural system to meet the new goals.

Research on Farming Systems

Although the Agency and Agricultural Research and Development, und the Ministry of Agriculture (MOA), has been doing a tremendous job in crop breeding, adaptation and cropping systems, their task ahead is a monumental one. This is especially true considering the size of the team of scientists and the magnitude of the goals to be attained. To achieve full production potential of the land resources and to increase the income generated from the farm output, research is needed to determine the most appropriate technology package suited for each specific environmental condition. It is only when enough trials have been conducted under the different environmental conditions and soil types that extrapolation of recommendations to similar sites can be done with a reasonable assurance of success. The research, however, should be oriented to consider all the activities taking place at the farm level and thus recommendations should be offered as a complete package of technology for given farming system. Dryland farms averaging 0.5 ha of land produce many different commodities; therefore, if only the production of one of these commodities is improved, the impact on the farmers' income will be minimal. It is essential that prior to setting up a demonstration for farmers by the extension worker, enough data are available to him about the specific performances of those crops; under different levels of inputs and choices of varieties best adapted to the site type. Applied research is in great demand and at the present level of staff in the AARD, it will be difficult to provide the data required.

Soil and Water Conservation:

The rapid deterioration of Java's, Bali's and Madura's deep, fertile soils in the upper watershed is causing floods during the rainy season, lack of irrigation water during the dry season and tremendous sedimentation problems in the lower watershed areas. The rapid deterioration of these watersheds is not due just to the population pressures and the land use change from permanent vegetation to agricultural production but to the fact that the change in land use took place without proper soil and water conservation practices. Deforestation itself does not cause soil erosion but farming without proper soil and water conservation will destroy the land. It is unrealistic to expect to have the land covered by trees in areas where the population density is about 700 persons/km2 and farming is the only source of income. However, if the land use planning is properly done, each farmer will be able to use his land to its maximum potential under well managed conservation practices. When better sources of alternative income are made available to the farmers, marginal lands of low agricultural productivity can be changed to permanent vegetation land use. Until that time comes, compromises need to be made to assist farmers to obtain adequate income from their lands while deterioration of the environment is reduced to a minimum. As previously stated the majority of the land in the watersheds of these islands is not forest or government owned land but small, private dryland farms with farmers living at subsistance levels. A formula needs to be determined to provide a satisfactory solution to the problems faced by the dryland farmers in the watershed. In the section on "FARMER CONSTRAINTS" under "Irrigated Terraces Versus Dryland Terrace", I discussed the rationale of why the dryland terraces are so poorly built. The conclusion was that low output production from the dryland farms, for

many reasons, makes it unprofitable for the farmers to devote much of their time to conservation practices. Until this point is fully understood and properly addressed by the government agencies in charge of soil and water conservation, the soil and water erosion problems will continue as they are today.

Extension

The organization of the extension system is, perhaps, the major constraint of the agriculture development of watersheds. The extension program should not be confused with commodity oriented programs. When farmers in the dryland farms have such diversified operations (crops, forage, livestock, fish, estate crops, timber, fuel wood and fruit trees) it is impossible to supply an extension specialist for each of these activities at the farm or farmers' group level. The polyvalent concept (multi-disciplinary) of extension field workers appears to be the only alternative for the dryland farmers. The polyvalent extension system will require subject matter specialists (PPS) who will meet periodically with the extension workers (PPL) for backstopping and transfering new techniques. This, to some extent, is taking place in the Rural Extension Centers (REC), especially in rice paddy field cultivation. The ratio of PPLs to area of land is 1 PPL per 600 to 1000 ha (in most cases 1 PPL/800 ha). However, that is only in paddy field areas; in my experience, I am unaware of a PPL assigned to 600-1000 ha of dryland. Although 30% to 40% of the PPLs may have attended the 1 1/2 month training course in the polyvalent concept, only PPS's from the Directorate General of Food Crops backstop the RECs. Thus the polyvalent extension system, in reality, is only food crop related. Again, I believe this is all part of the confusion between an extension program and a commodity oriented program.

The question arises as to whether the extension capabilities should be under the DG Food Crops, when in many instances livestock, estate crops or fisheries are much more important activities than those of food crops. This suggests that the system might be more efficient if the Agency for Extension were responsible for bringing to the farmers the latest technology and methods to upgrade the rural community rather than the "Food Crop" commodity oriented program. The PPL is the link between the people of the community, and the technical agencies or program that the Government believes to be appropriate to implement. The RECs then become the centers for dissemination of techniques in rural development subjects such as crops, livestock, fisheries, health and home economics. Obviously the PPLs and also the community leaders will depend on PPSs from the respective Dinases (Government Offices) to develop plans and strategies and provide the techniques for the specific program under consideration. Therefore it appears inefficient to have community centers, as are now the RECs, under a commodity line agency, Food Crops (Dinas Pertanian); they might better come under the Agriculture Agency for Education Training and Extension (BPLPP). However, the PPSs from their respective dinas would be required to backstop the field activities. The fact that some dinases have more employees than others should not be the criteria for assigning responsibilities. A person may work for a specific agency, but above all he works for the Government. Thus the Government should be able to reshuffle its employees in the most effective way to implement its programs rather than the other way around. Concerning the number of PPLs per area of land to be covered in the extension programs, several parameters need to be considered to determine the manpower requirements. Among these a

a) The present level of technology of the population in the targeted area.

b) The size of farms to determine the size of the population to be reached.

c) The rate of dissemination and acceptance of introduced programs.

I believe that rather than assigning fixed numbers of PPLs per area of land, it is more appropriate to use a task/effort concept. By this I mean to concentrate manpower in nuclei of development where project goals can be successfully executed. Once these nuclei are established then the extension workers can move to spread the new techniques to other areas and use the farmers that have already accepted the new techniques as examples and new promoters of ideas at the village level. The best extension is that promoted by the farmers themselves after they have been convinced and have accepted the introduced technology.

SUPPORTING AGENCIES

In Java fertilizers such as urea and TSP (triple super phosphate) and insecticides are usually available at the kabupaten and kecamatan levels (sub-district). As for improved seeds, those for rice paddy are available, while most of the palawija seeds are not. For the farmers as well as the government agencies, only impure local varieties can be obtained. These varieties produce low yields, do not respond well to fertilizers and are very susceptible to diseases and pests. Fertilizers such as potash, sulfate and zinc to which crops will readily respond in many areas are not available. Potash can be found only in major cities and the price is usually not subsidized. Grasses and legumes are

extremely difficult to find and when found the varieties are limited and in very small quantities. In a tropical environment such as in Java, the production of forage has tremendous potential and can serve as well to stabilize terrace risers and other critical lands. It is imperative that the government agencies in charge on watershed development have large grass nurseries for distribution to the farmers. Knowledge of forage for feeding livestock and for soil stabilization purposes is lacking at the present time within the technical government agencies. This simple technique, however, is the major contribution to soil stabilization in the watershed as well as source of income for dryland farmers when livestock is made available to fully utilize the forage production. The only grass presently used by the government agencies is "elephant grass" (Pennisetum purpureum). This grass, when planted in the proper place and if adequately fertilized, will produce excellent forage. But farmers seldom fertilize it and when it is planted on the terrace risers, because of its high growth characteristic, it will shade-out the food crops. If the grass is not allowed to grow to 1.5 m tall, at which state it starts flowering, it will eventually die. It is at the flowering stage that plants stop growing and start accumulating energy reserves in the roots. At that point, if cut, they have stored enough energy to grow again but if cut periodically at an early stage, the plant will deplete its energy stores and die. Also, elephant grass requires high soil fertility whereas in most cases the terrace risers are mainly subsoil of low fertility. Grasses need to form a solid ground cover to be able to stabilize the soil; thus, only rhizomatous or stoloniferous grasses should be used for stabilization proposes. Moreover, many of the grasses with these growth characteristics also have excellent palatability and nutritious value for livestock feeding. Concerning the effect of shading on crop yield, the

difference in rice paddy production for example, is 500 kg/ha greater in the dry season than in the wet season (in technical irrigated systems). This is due to greater solar radiation during the dry season because of clear sky versus cloudy sky during the rainy season. Thus the shading effect from tall plants such as elephant grass, Caliandra and other trees can only be detrimental to crop yields. This does not mean that elephant grass, Caliandra or other trees are bad to plant but that there is a place for everything.

The farming system economy, when proved by research on these fields should be the basis for farm planning and land use criteria. Part of this farming system concerns livestock management. With the present level of income from the dryland farms, for reasons explained in the "Dryland Farmers" and "Economic Conditions at the Farm Level" sections of this paper, it is impossible for the farmers to expand their herds. Credit is badly needed to provide farmers with resources to buy sufficient livestock to fully utilize the potential forage and crop by-products from their land. The formation of farmer groups and Cooperative Associations, for the farmers' benefit, could give the farmers a better bargaining position to purchase and obtain inputs, as well as to market their products.

Knowledge of livestock management and animal husbandry techniques is, as with palawija, lacking. The overwhelming majority of farmers have little knowledge of animal health, nutrition, weight gain or breeding; thus their livestock are at the lowest level of performance. Again this, in part, is caused by a lack of extension programs for the reasons explained under the section on "Extension". The low degree of livestock fecundity and the percentage of offspring that die, together with the generally poor health conditions, are mainly due to poor diet. This is

caused by a lack of good forage and leguminous plants to provide and adequate source of protein for proper feeding. Government assistance to the farmers to solve basic livestock management problems, such as proper nutrition and availability of improved studs at the village level, would have a greater impact on farmers' income than the present push for artificial insemination. A particular example of mismanagement of livestock is in Kabupaten Boyalali. In this village at one time the government provided milk cows. The farmers own eight milk cows which produce seven liters of milk per day and are "dry" four months a year. That is an extremely low level of production. They also have problems getting the refrigerated semen for artificial insemination. In practice, of the cows that were inseminated few came to term with abortion quite common. The farmers were feeding mainly local grass which was very coarse and fibrous, and of poor palatability and nutritional value. Water was brought in a bucket twice a day rather than allowing the cows to drink as much as they wanted and when they needed it. The REC, located on the main road to Salatiga, is close to this village where dairy and estate crops are the major sources of income for the farmers.

POSSIBLE SOLUTIONS TO THE WATERSHED PROBLEMS IN JAVA

The most serious problem in the watersheds is the rapid degradation of the base resource which is caused by the lack of soil and water conservation practices on the dryland farms. This is due to ignorance on the part of the farmers, and/or the lack of resources to obtain greater output from their land. Thus, low aconomic return for the level of effort required provides no incentive for improving conservation practices nor resources to develop the potentials of the land. Research is needed to

develop the appropriate technology, for each of the different environments, to obtain maximum productivity of the farming system. The technology needs to have proven economic advantages for the farmers' acceptance. A system of model farms, together with training and extension, must be established to make that technology available to the farmers. Rapid multiplication of seeds, plant materials and livestock must take place to make them available to the farmers. Credit programs need to be established to purchase the inputs not provided by the Government as an incentive for them to participate. Credit and other incentive should be given only to those farmers willing to participate in the soil-water conservation program. The conservation program should not be conducted on an individual farmer basis but as a group of farmers operating in a mini-watershed or hydrologic unit basis. Thus, terraces can be built along the contour of the hill side regardless of property boundaries. Also, for credit purposes, it is better to deal with groups of farmers than with individual farmers since there is a sense of responsibility and moral obligation within the group. The soil-water conservation and agriculture development project should be the people's project and not the central government's project. It is the responsibility of the people and their local government to develop themselves while it is the responsibility of the central government to provide the technology and resources not available at those levels. It is important that the farmers contribute their labor to build their own terraces in order to develop a sense of belonging, responsibility and cooperation within their own community. Our experience in Citanduy and the Solo River Basin is that the farmers are always willing to cooperate if the Government is willing to provide them with technical assistance, seeds, plant materials, fertilizers and credit.

THE FARMING SYSTEM "Package of Technology"

The dryland farmers are presently living at only subsistance level, with land holdings of about 0.5 ha. A comprehensive farm development program is required to provide a significant contribution to their farming income. This farm development program should consist of the following:

1. Crops
   a) Improved cropping systems adapted to the specific environmental conditions of the specific site.
   b) Introduction of a third crop when feasible, (such as sorghum, legumes, etc.) which is drought resistant, and can make use of the residual moisture at the end of the rainy season.
   c) Introduction of improved high yielding varieties of seeds which are responsive to fertilizers and resistant to pests and diseases.
   d) Consistent multiplication and distribution of pure seed lines.
   e) The economic use of fertilizer to provide the best return (yields) for the level of inputs (fertilizers).
   f) The best plant density for the level of inputs.
   g) Comprehensive crop protection against pests and diseases.
2. Forage
   a) Proper grasses and/or legumes best suited for the specific site for terrace riser stabilization and livestock feed.
   b) The use of Leucaena to supplement protein in the livestock diet, and as a source of fuel wood. It can be planted as a hedge to mark property boundries or in areas over 50% slope. In shallow soils where bench terraces cannot be built, thick hedges of Leucaena can act as vegetative barriers to stop soil erosion.

3. Livestock

a) Small ruminants such as sheep and goats will be more appropriate in most cases when compared to larger livestock. They are more easily marketed, a portion of the herd can be sold when funds are needed, and the loss of an animal due to death is less disastrous.

b) Cows and buffalos may be preferred in areas where they are used as draft animals.

c) Dairy cows in areas where milk industry facilities are available may also be desired.

4. Trees

a) Cash crop trees such as clove, coffee, etc. to provide a source of income.

b) Fruit trees to provide food and income.

c) Timber trees such as the fast growing and nitrogen fixing *Albizia falcata*.

d) Fuel wood and animal feed trees such as Caliandra and Leucaena. A combination of these trees should be planted in areas with over 50% slope or other marginal lands. Aprropriate forage grasses and legumes that will also tolerate shade and are adapted to the specific site for soil stabilization and to be used as animal feed, could be an alternative source of income to farmers.

5. Fish Ponds

If a suitable water source is available, fish ponds should be built and stocked with different non-competitive varieties of fresh water fingerlings. An eight by ten meter fisnpond can produce an income of about Rp.600,000/year.

6. Beehives

In a tropical environment where there are always some plants flowering, honey can be an easy source of income and food sweetener for a minimum effort and investment.

7. Poultry

Layer or broiler operations should be established when about 70% of their feed can be grown as a third crop during the dry season with crops such as sorghum or some kind of legume.

8. Charcoal

In areas where it is not possible to grow a third crop and there is sufficient land not suitable for crops or over 50% slope, the manufacture of charcoal should be considered. This type of operation will be able to supplement the farm income during the dry season by pruning trees such as Leucaena and Caliandra. Other crop residues such as corn cobs and cassava stems can also be used to make a charcoal brickette, using cassava paste as a binder.

Tripling the present income of the dryland farms in the Panawangan Pilot Watershed (Citanduy Basin) was well within the fasrmers' reach using the previously explained technology and minimum assistance from government resources.

Organization and Administration

The apparatus by which the Government can spread the concepts, technology and assistance to people, community and local and provincial governments must be well designed with an organization which is neither too large nor complex for it to be effective. The goals and target areas should be clearly stated with a step-by-step scheduled program designed to reach the objectives.

A specific agency should be responsible for the implementation and coordination of all technical inputs for the stabilization and developmen of the watersheds. This agency, although operating within each of the provinces where watershed development programs are taking place, should b directed from Jakarta. The reasons for this are:

a) To provide a cohesive and uniform program.

b) To better utilize the available manpower across provincial and kabupaten boundaries.

c) To have the flexibility and to provide the required coordination to implement such a comprehensive program.

This agency should be similar to the present Directorate of Reforestation and Land Rehabilitation (DITSI); however, it should not be under the Directorate General of Forestry since the target areas are not the forests but the privately owned dryland farms in the watershed. Thus the mentality of this agency needs to shift from the present reforestation oriented to soil conservation agricultural development. It also needs to be consolidated under one agency whereas at the present time different groups are trying to accomplish the same objectives. These groups are DITSI, the Subdirectorate of Soil and Water Conservation in Critical Food Crop Areas under the Directorate of Food Crop Area Development, Directorate General of Food Crops and another Soil Conservation group under the Directorate General of Agraria. This new consolidated agency, because it would represent a specialization of its own, soil-water conservation and watershed development, should be promoted to the DG rank to be effective in implementing its program. The function of this new agency should be:

a) The implementation of soil and water conservation technique, that is by PPSs, PPMs (mid-level specialists) and perhaps some PPLs to provide backstopping for extension programs on their specific subject matter of soil and water conservation. This should be done just as the other dinases provide technical backstopping to the "polyvalent" extension workers in the field through the RECs.

b) Coordination of the different activities taking place in the watershed development program. Thus it must be the "umbrella organization" responsible for the coordination and integration of the watershed program.

The Watershed Program should consist of the following components:

a) Research

1. To develop the "Farming System Package of Technology" (see that section for details)
2. To develop the most appropriate soil conservation techniques and land uses as determined by the Soil Research Institute at Bogor.

b) Extension backstopped by the following organizations:

1. Soil and Water Conservation and Watershed Development Agency
2. DG Agricultural Research
3. DG Food Crops
4. DG Animal Husbandry
5. DG Estate Crops
6. DG Forestry
7. DG Fisheries
8. DG Bangda
9. DG Water Resources
10. Others as program activities require.

c) Coordinating Agency. The Soil-Water Conservation and Watershed Development Agency should, on behalf of the Bupatis and Governors, coordinate all technical inputs for the Watershed Program. Since most of the activities to take place are within the DOA, and Agricultural Watershed Development Basin Headquarters should be established to provide the central coordinating facilities at the basin level. Those DG's or Agencies actively involved in the watershed program should have a representative in the headquarters, either from the national or provincial level, depending on whether the basin is within only one province or more than one. This senior person will provide the liaison among the Kabupatens or Provinces and Kabupaten Dinases to assure a uniform program and backstopping for the extension program. For example, in the Citanduy Watershed Project, there are two provinces and five kabupatens within the Citanduy Basin (West and Central Java and Kabupatens of Ciamis, Tasikmalaya, Kuningan, Majalengka and Cilacap). These autonomously administer units, especially at each provincial level, can have quite different goals. Thus to provide a uniform watershed program and to be able to operate within the existing organizational framework, a senior official from the specific DG or agency involved in the watershed program must be present at the Basin Headquarters.

In the "PROBLEM IDENTIFICATION" section, it was pointed out that the source of land degradation was the dryland farms; that means the watershed development target is the dryland farmers and their community. This brings a new element into the watershed program, the "Local Governments", since they are the people's representatives and the ones responsible for

the economic development of the area. It was also pointed out under the "FARMER CONSTRAINTS" section, that if the farmer's income was not substantially increased by the watershed program, there would be little incentive on the part of the farmers for implementing and maintaining soil and water conservation efforts. Thus the participation of the local governments in motivating, organizing, providing the support and serving as a channel to express the people's desires is essential for watershed development. To assure local government participation and encourage cooperation of the technical agencies with the local government, the budgets for implementation (other than research) should go directly to the local governments. The Bupatis, however, should appoint a watershed coordinator to administer, monitor and be the liaison between the local government (Bupati) and the technical agencies (the Director of the Agriculture Watershed Development Basin Headquarter, AWDBHQ). That "Director" should then allocate the budgets to each sector within his headquarters and be responsible to the Bupati for the final end-product. The director of the headquarters will be responsible, with the support of his technical multi-sectoral staff, for requesting and obtaining the required sectoral budget to provide a viable organization capable of implementing the watershed program. A third party, the auditors from BAPPENAS, should periodically audit the overall operation to assure that the budgets are properly spent and the targets reached. Thus the Bupatis and Directors of AWDBHQ should be held responsible for the success or failure of the watershed development projects. Authorities at the basin and national level will provide guidance on policies.

CITANDUY II CASE STUDY

The Citanduy River Basin Development Project covers an area of 446.000 Ha with two watersheds, the Citanduy with 350.000 Ha and the Segera Anakan with 96.000 Ha. The average population density of the Citanduy Basin (1979) is approximately 640/km2.

The Citanduy Watershed land use pattern is as follows: lowland rice (25%), upland crop (34%), plantation (13%), forest (13%), home and gardens (8%), pond, rivers, etc. (1%) others (6%). About 59.000 Ha or 17% of the area in the upper watershed is classified as critical area.

The goal of the project is to sustain the productive capacity of the basin, by using better soil and water conservation techniques while enchancing the capacity to produce food through better use of soil and water resources.

The Citanduy II Project consists of the following components: a) Upper Watershed Development to designed to develop and deliver a package of upland conservation and production technology to upland farmers, b) Development of Irrigation Systems to provide the rehabilitation of upper Citanduy Irrigation Systems including the on-farm-water management, c) Local Development Planning and Management to provide training and assistance to district government personnel to enchance their planning and management capability.

The Citanduy II Watershed component of the project is based on the soil and water conservation technology developed in Solo and farming system technology developed in Panawangan (Citanduy Basin) pilot watershed projects. This project has provided the technological and institutional framework for development and execution of a watershed

development program which moves beyond pilot implementation into a basin wide program. A farming system approach was used with components to increase upland agriculture and livestock production while simultaneously reducing soil erosion with the use of bench terraces, waterways and vegetative stabilization of the terrace risers.

Organization

A basin coordinating committee was established by decree of the ministries of Agriculture, Home Affairs and Public Works to coordinate the project implementation under the national level Steering Committee established by Presidential Decree.

At the project level the Ministry of Agriculture established a multi-disciplinary team of technical personnel from various agencies led by a project manager. Field staff, is composed of personnel drawn from the various Director Generals and Agencies of the DOA.

The upper watershed development project consists of the following components:

1. Agricultural Research

   An applied agricultural research is carried out by the Agency for Agricultural Research and Development (ADRD) which covers cropping systems, livestock, agroforestry, fresh water fisheries, soil erosion, etc.

2. Model Farms

   The size of a model farm is approximately 10 Ha where terraces are built according to the specification from P3RPDAS and constructed on land below 50% slope with soil depth over 30 cm. For land with greater than 50% slope, a permanent vegetation is established. The agricultural technical package

includes seeds, grass, fertilizers and insecticides for three cropping cycles. The livestock component will depend on the amount of grass produced from the terrace raisers and other available forage. Farmers in the model farms are expected to become a source of technology and seed for other farmers in the surrounding areas.

3. Nurseries

The nurseries approximately 5 Ha each are planted half with grass and the other half with tree crops. The grass and tree crops are given free to the farmers in the model farms and expansion areas.

4. Expansion Areas

This is the area where farmers are voluntary duplicating the model farms. The labor to build the terraces is provided by the farmers at no cost to the project. Grass, tree seedlings, seeds (food crops), and fertilizers are given free. If the terrace risers have more than 70% grass ground cover, the second year, the farmer qualify to obtain credit to purchase the livestock.

5 Access roads

Access road to the model farm are constructed as needed. Construction of this road is administered by the local government.

6. Extension and Training

The extension workers operating from the REC transfer improved upland technology to the farmers in the model farms as well as in the expansion areas.

At first the extension workers are highly concentrated in the model farms moving away from them as the nearby and voluntary expansion program takes place.

Basic training in agricultural and extension methodology is given to all new extension workers. Other courses are offered for key farmers and local government officials.

7. Consultants

Foreign and national consultants are assigned to guide the counterpart staff. The present consultants team have experts in the following fields: watershed management, planning and programming, local government, training upland agricultural extension, irrigation extension, cropping system research, soil conservation and socio-economy.

PRESENT CONSTRAINTS

After the first year of implementation the major constraint is the understanding of the project goals and mechanisms within the project to carry out the implementation. Coordination among agencies within a ministry and among ministries as well as districts, provinces and national governments is also a difficult task. Not withstanding this constraint the project is working and people are recognizing the weak spots and taking action to improve the operation during the second year of implementation. The major problems have been: 1) making the budget available on time to provide farm inputs for the planting season and 2) providing an adequate supply of grass for vegetative stabilization of the terrace risers and forage for the livestock program.

An inadequate supply of grass will in turn delay the implementation of the livestock program and cause some deterioration of the terrace risers. The lack of available grass affects the soil conservation and income generation from livestock which is the major single source of income among the farming system components.

Quality food crop seeds availability in large quantities is another major constraint that will also be faced during the second year of implementation.

PRELIMINARY RESULTS

Officials have shown tremendous understanding, willingness to cooperate and a desire to solve the problems as the project moves ahead. The farmers have shown excellent response in the voluntary expansion program, by building all the soil conservation structures at no cost to the government in exchange for the package of technology (seeds, fertilizers, grass, etc.). During the first year of implementation of five model farms, 300 Ha of land were terraced to project specifications by the farmers under the voluntary expansion program. During the second year with eleven model farms in operation the voluntary expansion area is expected to be approximately 1000 Ha.

CONCLUSION

The objective of the watershed stabilization and development program is not just to build bench terraces on the hillsides, but to prove to the dryland farmers that with the proper techniques and additional resources (high yielding varieties of seeds, fertilizers, forage and livestock)

their dryland terraces can be as productive as their irrigated bench terraces. Then and only then will the farmers be motivated to build and maintain their own bench terraces as they build and maintain their irrigated bench terraces. For this to take place, however, the government must make available to the faramers the technology and resources which are impossible for the farmers to obtain alone. Thus the ability of the government to prove such a technology and to make readily available the supplies and necessary resources are key elements for a watershed program. Of equal importance is the capacity for government organization and institutions to deliver, disseminate and coordinate such inputs. Until these institutional arrangements are in place, there is little hope for rapid expansion of watershed stabilization and development programs. In the meantime, the impact of sedimentation on irrigation and hydro-electric dams, floods in the rainy season and low irrigation water during the dry season for the lower lands are warnings of the rapid deterioration of the watershed. The major problem, however, because it is gradual and difficult to assess, will continue almost unnoticed; that is that the fertile top soil, where in lies the hopes for feeding the ever increasing population of Java, will continue washing away. The population of Java will double in the next 30 years, while the rice paddy production is reaching a plateau, thus leaving the uplands as the last frontier for food production. The watershed program is not just a matter of protecting the environment or investments in irrigation dams, etc., but it is also a vital need for the future of this country. It is particularly critical now in Java.