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THE CITANDUY RIVER BASIN DEVELOPMENT PROJECT

PANAWANGAN PILOT WATERSHED IMPLEMENTATION AND EVALUATION REPORT

SUBMITTED BY

PRC ENGINEERING CONSULTANTS, INC.
DENVER, COLORADO, U.S.A. BANJAR, WEST JAVA, INDONESIA

JANUARY 1980

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

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PREFACE

The ideas expressed in this report are the effort of many people mainly during the nineteen months existance of the Panawangan Pilot Watershed Project. Their ideas, suggestions and valuable discussions, together with the hard work of the farmers and their sincere opinions on the acceptance of techniques, has made this project a unique one. A great deal of the success of this program was due to the fact that the techniques tested and applied in Panawangan were within the economical and technical capabilities of the farmers. Moreover, the project was done with the support and participation of the local government agencies and the techniques developed are being spread by the Ciamis Bappemka's Office. Since it is difficult to give full credit to all those who gave so many ideas and effort to the Panawangan Watershed Project, this is just an attempt to mention the main contributors:

Mr. Rachlan, Chairman of Bappemka Ciamis and the Bupati of Ciamis technical staff.

Irs. Nurdin, Dodo, Hadi and their staff of P_3RP - DAS Citanduy.

Mr. Suhinta, Suparman, Suryadi, Taryat and Pak Lurah, key farmers of Ciracak, Panawangan.

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Drs. Mursidin, Direktorat Reboisasi dan Rehabilitasi, Jakarta.

Ir. S. Munandar, Direktorat Perlindungan Pertanian Tanaman Pangan.

Dr. Herman Suardi, Kepala Kantor Wilayah Departemen Pertanian Propinsi. Jawa Barat.

Mr. E. Soepardja, Bagian Konservasi Tanah dan Air - Dinas Pertanian Propinsi, Bandung.

PANAWANGAN PILOT WATERSHED

IMPLEMENTATION AND EVALUATION

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CHAPTER I

THE PANAWANGAN PILOT DEMONSTRATION WATERSHED

Introduction

This report is a continuation of the "Panawangan Pilot Watershed Conservation and Development Project" report which was submitted in 1976 by ECI.

The Panawangan Pilot Demonstration Watershed is an implementation project where an integrated plan of multidisciplines is being tested. The main purpose is to establish soil and water conservation practices capable of maintaining a stable high productive agriculture in the dryland farms of the Citanduy Watershed.

The concepts presented in this report from the Panawangan Pilot Watershed for the soil and water conservation and agriculture development of the drylands are the products of:

1. The ideas, conceptions of work plans and formulation of programs through the common effort of many people, representing many agencies and backgrounds.
2. Data from the Pilot Demonstration Farm at Panawangan.
3. The experience on farmers' acceptance and cooperation in the program.
4. The coordination of technical agencies at the subdistrict, district, provincial and national level; their support and participation.

Watershed Description

The Panawangan Pilot Demonstration Project is part of the upper Citanduy River Basin Development Plan. The Citanduy River Basin is located on the southern coast of Java with part of the basin in West Java and the remainder in Central Java. It lies between $108^{o}15'$ and $109^{o}15'$ East longitude and between $7^{o}20'$ and $7^{o}40'$ South latitude. It is bounded on the east by the Serayu River Basin, on the north by the Cimanuk River Basin, on the north and west by the Citarum River Basin and on the south and west by the Indonesian Sea (Indian Ocean).

Panawangan is approximately 7.6 kilometers north of Kawali on the Ciamis-Cirebon highway. It is the seat of the Subdistrict Office and is on the northern boundary of the District of Ciamis, Province of West Java. The pilot watershed is located on the west side of the Ciamis-Cirebon highway (See Figure I-1 at the end of this chapter). The village of Cibogor is on the east boundary and the village of Cibariwal is on the west boundary of the subdistrict.

The pilot watershed consists of a total of 355.9 hectares. The area has been divided into 12 subwatersheds where the conservation and development project will be implemented. Beside these 12 subwatersheds, a control watershed was chosen west of the implemented watershed. The control watershed known as the Ciyangsang River Watershed consists of 77.97 hectares. When the implementation program of the 12 subwatersheds is completed, the quantity of water runoff, sediments and suspended material in the water will be compared to those from the control watershed with traditional practices.

The Pilot Demonstration Farm 6.1 hectares where most of the trials and field studies were evaluated is part of Subwatershed II. Since November 1977 when the implementation program for soil conservation began, the construction of bench terraces and waterways has been completed in Subwatersheds II, III, IV and V with a total area of 177.1 hectares. The agriculture development program however, has not yet been completed except in the Demonstration Farm. See Agriculture Development chapter for precipitation, vegetation, crops, cropping systems, animal husbandry and fish ponds data.

The history of Panawangan reveals that the area where the pilot watershed is located was in native vegetation until a short time before the turn of the century. The native vegetation was removed to establish tea plantations. However because of tea plant diseases and probably economic reasons also, the tea plantations were replaced by coffee plantations. The coffee plantations were neglected during the Japanese occupation in World War II and they never recovered. After the Indonesian Independence, the plantations were divided into the small ownership pattern of today.

The small farms concentrated more in the production of food for the owner's family and cash crops. Citronella grass for distillation of its oil was one of the most important sources of income in the area. In recent years due to the low value of Citronella as a result of production of synthetic oils, most of the land is under food crops. Where Citronella is found on slopes and deteriorated bench terraces, serious soil erosion has taken place. This is evident by the stools of Citronella high above the ground surface indicating that the soil has been washed away from around the plants. In an effort to discourage its planting, The Bupati of Ciamis issued an edict in the early 1950's stating that Citronella was not a good plant for soil conservation.

Prior to the implementation of the pilot watershed project, most of the slopes in the Panawangan area were terraced with only limited success. The terraces were constructed without the proper gradient along the countour, sloping toward the terrace's outer edge and without a disposal system for excess water. The traditional terraces do not adequately protect the land from soil erosion or contribute in a significant way to reduce water runoff and sedimentation.

General Information about the Watershed

The soil erosion problems in the Citanduy Watershed, in general, are aused mainly by one or more of the following conditions:

1. Removal of original vegetation cover which results in sheet erosion.
2. Lack of proper bench terraces especially on steep and long slopes.
3. Lack of waterways to drain excess water from the terraces.

The problems are well known and they have been reported many times. Because of population growth and the increased demand for land, steep slopes are now being farmed. In addition, most of the dryland farmers do not know, or have not yet understood, that if they are to crop the land on a regular basis they must follow certain soil conservation practices and proper soil management. It is hard to predict the life span of the agricultural land in the drylands of the watershed, but if soil conservation measures are not followed, the productivity of the land will continue to decline at the time the population keeps increasing. Sediment from the watershed will continue silting the most productive rice paddies and the efficiency of the irrigation systems will also decline. A.K. Pickering in his report on " Soil Conservation and Rural Unemployment in Java" stated that the number of hectares rehabilitated under the Repelita II program may be exceeded by the number of hectares annually claimed by erosion. Also M.J. Cauchon reports in "Watershed Rehabilitation and Development, the Most Critical Problem Facing Indonesia" that "At the rate of disbursement of rehabilitation funds under Repelita II, it would take 75 to 150 years to rehabilitate Java, by which time most of its soil would be gone to the sea" But again, these are well known generalities that most people have probably heard many times before. The fact is that this is taking place and little is being done about it.

Government action to control the soil erosion in the watershed is a real need in Java. Government investments in the drylands of the watershed should be carefully evaluated to determine which program will provide a stable agriculture with a minimum of soil erosion problems and yet provide farmers a maximum output from the available resources. The watershed projects should be designed to fit into the existing national programs with little structural or legislative changes.

In general, the farmers have difficultly associating themselves and their future goals with large government projects. The farmers usually believe that their problems result from a lack of resources, but their situation is worsened by a lack of proper soil management and the use of inappropriate technology.

Demonstration projects need to be established in the critical areas to show the farmers that if the land is properly managed it can produce much more than under their present system. These demonstrations must be done in the field, in the farmers' fields and with the farmers' help, together with an extension program. The policies to be implemented need to demonstrate to each farmer that he is the one to benefit from them and that his extra effort will be compensated for by greater yields. The farmer has to accept this idea if he is to carry out the conservation work as his own project under technical supervision.

Farmer participation in this project should not be based on wage payment for work because that would inhibit their identification with it. Rather, participation should be based on their sense of responsibility and belonging, the satisfaction of achievement, and village pride. To obtain this participation and community spirit, clear and definite goals and approaches have to be established. The benefits must be carefully evaluated and demonstrated and technical know-how must be readily available for those people willing to try.

An adequate incentive should be provided to the farmers to motivate them to do the job. This incentive will also make it possible for government agencies to control the quality of the work and encourage farmers to follow the proper specifications for soil conservation structures. The dissemination of the ideas and new techniques by an active Extension Service as well as adequate supervision during the implementation of the soil conservation programs are a must.

These small demonstration projects will influence the people to adopt conservation methods more efficiently than would large projects. Meanwhile, the government should encourage the participating farmers by providing such incentives as a credit program, improved seed varieties, fertilizers, pesticides and adequate and appropriate technical support.

Farmers can be expected to do a good job in soil conservation only when they can be assured of an economic return for their effort. The millions of well built and very stable irrigated rice terraces attest to this fact. The problem appears where only marginal earnings are made from dryland cropping and additional land is needed to be put under cultivation, then less effort is put into conservation and management. The integrated use of improved agricultural techniques will increase yields and encourage conservation practices.

The Panawangan Watershed Program Approach

A soil conservation program per se cannot be sold to the farmers. They know how to build good stable bench terraces. This is quite obvious when you travel through the mountain areas and see the irrigated sawah terraces. In contrast though, side-by-side with the irrigated terraces, are the dryland terraces, poorly built and definitely unable to stop soil erosion. With irrigated land the farmer can get yields of about 3 tons per hectare of rice while with dryland they can get only about 1 ton per hectare. Obviously they do not consider their efforts in soil conservation worth while with the low yields from dryland farming. Without soil conservation practices soil erosion, loss of soil fertility and lower yields will occur. In several areas in Central Java, some farmers have given up even planting cassava on the once productive soil and only alang-alang (Imperata cylindrica) is growing in the fields.

Technical inputs available to the dryland farmers of the Citanduy Basin are for all practical purposes is nil. To convince the farmers to follow a soil conservation program an indirect approach is necessary. The farmers must be shown how to improve their income while better soil conservation techniques are put into practice. The farmers must therefore be aware of the potential value of their soil and the benefits that can be derived from maximum utilization of their resources. However it should be made clear to the farmers that to maintain high yields, stable soil conditions must be obtained. This can only be accomplished by good soil conservation practices with the use of proper bench terraces, waterways and with an aggressive grass revegetation program. To make the soil conservation program attractive to the farmers, an agriculture development plan should be simultaneously implemented to fully utilize the stable dryland farms.

Agriculture Development Plan

The integrated comprehensive "Agriculture Development" concept should be emphasized for these reasons:

1. The average land holding of the dryland farmers is about 0.5 hectare.
2. Their farm operations are very diverse, consisting of all or some of the following:
   a. About four major agronomic crops like rice, corn, peanuts and cassava.
   b. Some horticulture crops like sweet potatoes, cucumbers, onions, tomatoes etc.
   c. Fruit trees like orange, avocado, breadfruit, petai, coconut, and many others.
   d. Plantation trees like clove and coffee.
   e. Lumber and fuel trees like albizzia, acacia, puspa, afrika, kaliandra etc.
   f. Pasture and forage management and utilization.
   g. Utilization of farm products by livestock.
   h. Beehives.
   i. Fish ponds.

When the farm size and the variety of enterprises that the farmers are now involved in are evaluated, it is obvious that no single enterprise could significantly improve the income of the farmers. Thus, the dryland farmers need to be supplied with a package deal capable of helping them in their complete enterprise.

The potential for the uplands to double their output with technical assistance is well within reach. The technical assistance for this "Agriculture Development Program" will require well trained Poly - PPL's (extension personnel trained in many fields of expertise). The transfer of knowledge from the Research Institutes to the farmers through the Poly - PPL's

is a must. The use of improved crop varieties responsive to balanced fertilizer applications, proper plant densities, better cropping systems and insects control programs with a full utilization of the farm products setting up of a well planned livestock operation will increase the farm output. The proper use of the land for food crop, cash trees, lumber, fuel and forage is essential to avoid soil erosion and provide maximum utilization of resources.

The Dryland Farms and the Fate of their Soils

At a time when the Indonesian Government is importing rice at the rate of 2.6 million metric tons per year and wheat at 1 million metric tons, the potential production of the drylands and the conservation of the fertile top soil should be very valuable asset to the country. To meet the increased demands for food, fiber, lumber, fuel wood and water resources will require an intense watershed management program. The soil lost in tremendous quantities because of water erosion in the drylands is an irreplaceable natural resource. The number of related problems caused by soil erosion are many, to mention a few:

1. Loss of soil and its fertility that took thousands of year to build.
2. Decrease of waterholding capacity and thus low river flow during the dry season.
3. Increased runoff, which in turn creates flood problems in the low land.
4. Poor quality water which creates many sedimentation problems and poor performance of the irrigation systems.
5. Destruction of valuable shrimp spawning and fishing grounds in the Segara Anakan.

The watershed is not just a place to implement soil conservation practices, but a very valuable agriculture land where high productivity can be attained under proper soil conservation practices.

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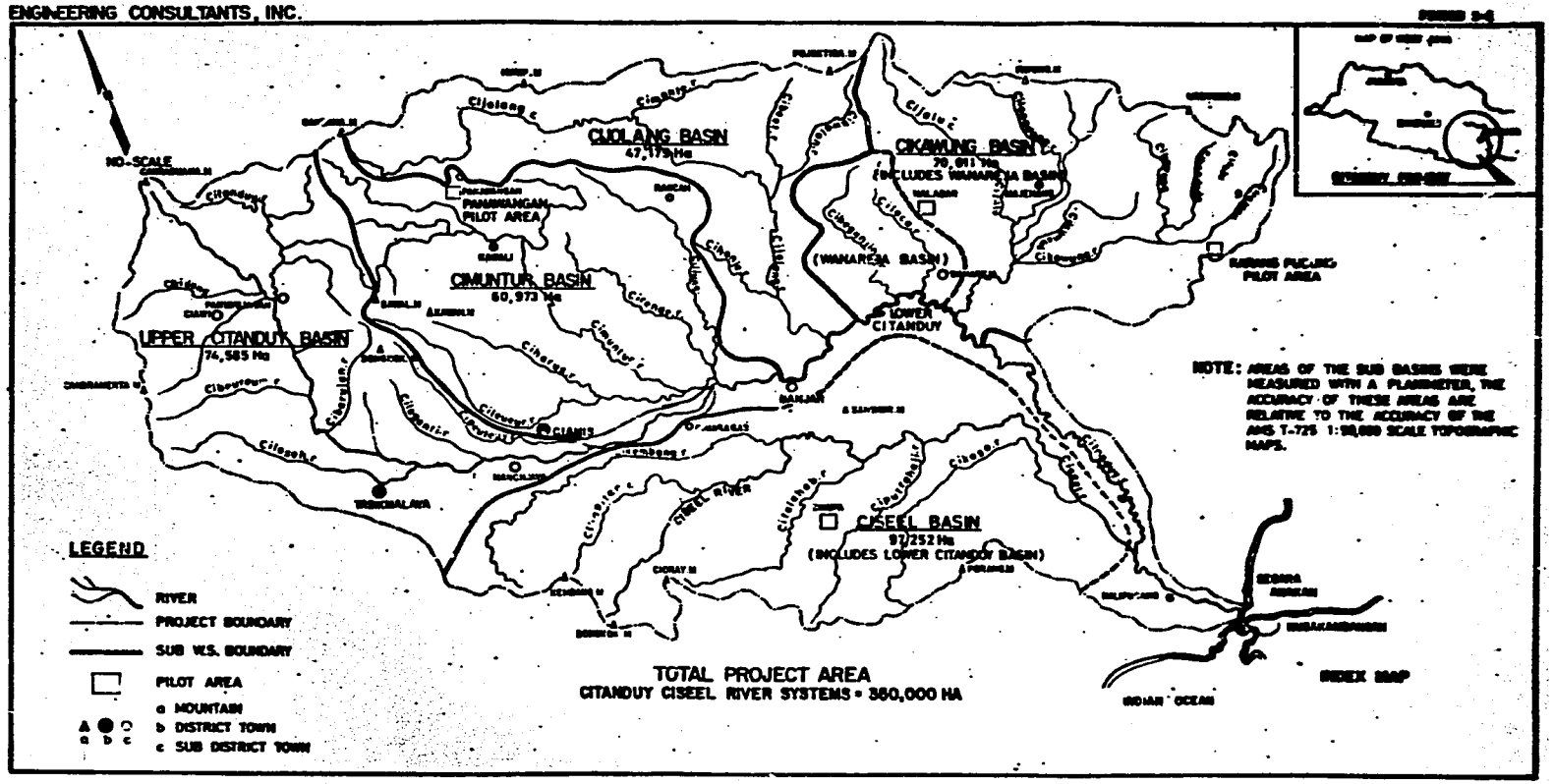


CHAPTER II

SOIL CONSERVATION PRACTICES

The soil erosion taking place in the watershed is caused by the following major activities:

A. The lack of proper soil conservation practices in dryland farming.

B. The ever expanding small fields in the narrow mountain valleys to create more land for sawah. This sawah is usually between steep embankments with slopes over 100 percent (1 horizontal to 1 vertical) on bare soil. Also no water diversions are provided above the steep embankments. The sediments from the side slopes or subsoil when expanding the sawah are taken away by the canal provided at the toe of the embankments.

C. The construction of roads with side slopes cut too steep without adequate vegetation to protect them or waterbars to deviate excess water runoff.

D. Harvesting timber in forest land with clear cutting methods without proper precaution measures against erosion.

The single major source, however, and where the major concern should be is the dryland farms where the rich productive topsoil is being lost. The basic problems seems to be the same regardless of the areas; these are:

A. Soil erosion caused by dryland farming.

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 job opportunities for the growing labor force and thus increasing population pressures on the land.

Soil Erosion Caused by Dryland Farming

The degree of soil erosion taking place in the dryland farms is related to the following factors:

A. Vegetation cover

B. Slope

C. Length of the slope

D. Amount of precipitation

E. Intensity and duration of storms

F. Soil type

The main purpose of the vegetation cover is to stop the raindrop impact on the soil. 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 space which in turn will decrease the soil water infiltration. The erosion resulting from detachment and transportation of soil due to the kinetic energy dissipated 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 thin sheets of topsoil without appreciable turbulent movement or flow. Sheet erosion which is probably not too visible is very damaging to the soil because it is in the topsoil where most of the soil fertility is. The surface flow will cause the channeling action type of erosion like rill, gully and stream dependent 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 vegetation cover, besides stopping the raindrop impact, slows down the water flow and increases the water infiltration rate in the soil. The plant roots act as channels for infiltration of the surface water. The dead vegetation will also provide a mulch for the soil in the case of permanent vegetation cover. However, in any case vegetation will increase the amount of organic matter in the soil which

will act as binding material for better soil aggregration and stability. The use of mulching (dead plant tissue) will increase the organic matter of the soil, regulate the daily fluctuating soil temperatures, increase infiltration rate, reduce the puddle erosion and conserve water during the dry season by reducing the soil water evaporation.

The erodibility factor varies according to the soil type. Values reported for Indonesian soils are:

Location	Soil type	Erodibility factor
Darmage	Latosol	0.034
Sentolo	Lithosol	0.134
Putat	Mediterranean	0.260
Jega	Grumosol	0.204
Punung	Mediterranean	0.140
Citaman	Latosol	0.104

However, the main factors affecting the erosion are the slope, length of slope, precipitation, and the intensity and duration of storms. A grumosol with a high erodibility factor of 0.204 on a 10 percent slope with 1000 millimeters of precipitation annually evenly distributed through the year could produce less sediments than a latosol under the same conditions but with the precipitation coming during 4 months and 50 percent of it in 4 storms of short duration. The manipulation of these factors can affect the calculated amount of soil erosion tremendously. We cannot change the precipitation patterns, however terrain modification by bench terrace building with the proper water outlets, waterways and vegetative stabilization can reduce the soil erosion to a minimum.

A practically flat bench terrace with low gradient towards the waterway will cut down the amount of sheet erosion by minimizing the amount of soil detachment due to rolling, lifting, abrading and transport. This is one of the problems in the already existing terraces, they have excessive gradient and as the water flows toward the lowest points the above mentioned types of erosion will take place. The accumulated excess runoff water without a proper way of

disposal will eventually go down the slope. When the water starts going down the slope it will reach critical velocity at which point rill and gully erosion will take place. Under the present system even the flat bench terraces with lip and back slope against the mountain side will be subject to soil erosion. Splash erosion on the terrace can be avoided only by vegetation cover. This is not absolutely possible unless permanent grass cover is provided, therefore, splash erosion will take place, at least until the crops do provide a full or partial vegetation cover. The splash soil erosion will reduce the water infiltration rate in the soil and it will reach the point at which no more water can be stored or retained by the terrace lip. At that point the water will cascade down to the next bench terrace. This will compound the problem and eventually rill and gully erosion will take place. The bench terrace with lip, drainage ditch and waterways to take care of excess runoff offers many advantages to the farmers as well as the downstream dwellers. Some of the main advantages are:

A. Reduce soil erosion to a minimum.

B. Increase soil fertility by saving and accumulating the soil organic matter.

C. Organic matter will increase the soil aggregration and soil stability.

D. Soil aggregration will provide better water infiltration and aeration in the soil.

E. The farmer will be able to regulate the water flow out of the terrace so that during the dry months he can manage the available precipitation.

F. Because the terraces and waterways have a very low grade, practically flat, the water will travel slowly allowing time for maximum infiltration, recharging of soil water and reduction of water runoff and so reduce flood problems.

G. The recharge of the soil water will provide a longer and more regular water supply to the springs, small creeks and streams.

Low Productivity of the Dryland Farms

Stopping erosion will also stop the loss of soil nutrients from the topsoil. When this is accomplished the soils will begin to accumulate plant residues from the aerial or roots portion of the plants. Good management of the land, the use of organic matter and fertilizers in most cases would bring up the soil fertility and so increase the plant yields.

Poor Land Use and Farm Planning

Land needs to be used according to its capabilities. A steep land, of course, will grow cassava and probably excellent crops for a few years. This will happen only while the topsoil and fertility that took probably thousands of years to build is maintained. Eventually all that soil will end up in the Segara Anakan which in the process will ruin the fishing industry in the area. Siltation of the irrigation canals and some of the rice fields will take place and the decrease of soil water storage capacity in the watershed will increase the chance of floods in the lower areas. The steep lands (over 50 percent slope) would be more profitable if they were used with a permanent vegetation cover to protect the soil. They could produce lumber, fruits, nuts etc. In the under storage, forage grasses of good palatability and high nutritional value could produce excellent and plentiful forage for the so much needed livestock.

The land under 50 percent slope can be intensively cultivated with crops providing that the soil is stabilized with the proper soil conservation measures previously discussed. Full revegetation of the terrace risers with the proper type of grasses will control riser soil erosion, increase the productivity of presently uncultivated terrace riser land which could be providing extra feed for the livestock. Also by doing so, some of the soil nutrients that will be leached from the soil in the bench terraces could be utilized by the grasses growing in the terrace risers.

Lack of Technical Advice and Programs to Help the Dryland Farmers

Lack of technical inputs in the dryland farms, such as best economical use of fertilizers, proper seeding depth, plant population densities, soil

management (land preparation, weeding etc.), introduction of improved plant varieties (resistant to diseases and higher yield potentials), cropping systems, crop rotations and better utilization of the land throughout the year is obvious everywhere in the watershed.

To this date, the main Government concern as far as agriculture, has been the production of rice in the irrigated rice paddies. For this purpose the BIMAS and INMAS programs went into effect. These programs within the period of 1968/1969 to 1973/1974 more than doubled the average rice production of the sawah in West Java. However, practically no help technically or finacially is available to the dryland farmers. Traditionally the Javanese farmers were rice land farmers as attested to by the many sawah fields and irrigated rice terraces throughout Java. Their irrigated terraces and irrigated rice fields are as good as any in the world. However, their dryland terraces can be substantially improved, as previously described. The main problem facing the dryland farmers is that they don't know how and they don't have technical help and available credit to improve their dryland farming. If the farmers would know how to improve the crop yields in their land, there is no reason to believe that they would not do as good of a job in building their terraces and increasing production just as the sawah irrigated rice terrace farmers have done. As a matter of fact, the dryland farmers have more choices and alternatives than the irrigated land farmers. The irrigated land farmers in the Citanduy basin are practically limited to rice production only. However, the dryland farmers have a wide range of crops, trees for fruit, lumber, nuts, fuel etc. Also they can produce livestock by growing forage in areas where crops are not capable of producing well due to soil fertility or land capability limitations. The potential production for the dryland farmers could be substantially upgraded if they would use their lands to its full capability. For example, in the Panawangan Pilot Demonstration Farm, the farmers will grow padi gogo, maize and cassava intercropped from September to March, after that time, 90 percent or more of the farmers will not grow anything else but cassava. Because other crops were growing simultaneously with the cassava, the cassava planting distance needs to be quite sparse, one meter apart within the row and one row per terrace (less than 2 meter wide terraces). Therefore, during seven months out of a year this land is not fully utilized. Also a good percentage

of the land (depending on slope) is wasted on terrace risers. If the risers are not planted to forage their productive potential is wasted.

Very few farmers planted peanuts on their own as a second crop. Plant density trials planted to peanuts on May 4, 1978, yielded over 1,500 kilograms per hectare wet weight with shell, approximately 25 percent of which is the dry shelled peanut weight. (See Agronomic Practices in Chapter III). This crop grows well in the Panawangan area and its present market value makes it a profitable source of income to the farmers, Rp. 400 per kilogram of dry shelled peanut.

Increasing Population Pressures on the Land

As the population increases, more of the marginal land will be placed under crops; this will increase the soil erosion problems. Even if population growth declines rapidly, the absolute size of the population is great and may double in the next 35 years. The present and future problems are, among others, how to provide jobs for a mainly agriculturally oriented population. Another problem will be that the land ownership will be further subdivided and the small present farms will tend to become smaller, therefore, the income potential of the farmers will decrease. To solve this problem there is no simple answer; the only foreseeable solution is to speed up transmigration and industrialization. To release the pressure on some of the presently cultivated land, land exchange between privately owned steep upland (over 50 percent slope) and lower gently sloping land belonging to the Government should take place.

The formation of cooperatives among farmers can be based on the following reasons: to enhance mutual help in managing their lands; to pool their resources toward a common cause for production purposes such as borrowing capital or better utilization of equipment etc. and thus provide better agriculture inputs; to obtain better marketing conditions; to exchange knowledge, experience and build up self-reliance. If the cooperatives prove effective they should be encouraged and initially assisted by the government.

Conservation Structures

The soil conservation practices implemented in the Panawangan Pilot Watershed to control the soil water erosion consisted of the following major items ;

A. Bench terraces

B. Waterways

C. Gully plugs

D. Soil sediment traps

E. Flumes to measure water discharge with the aid of automatic recorders

F. Weather station

The soil conservation structures were stabilized vegetatively to minimize the soil water erosion. The vegetative practices are discussed in Chapter III under Grass Revegetation. Of the 365.8 hectares in the Panawangan Project, 187.3 hectares have already been treated for soil conservation. The subwatersheds completed are II, III, IV and V. The land capabilities of the 12 subwatersheds are presented in Table II-1.

Preparation and Planning for Construction

Prior to the construction of waterways and bench terraces, topography maps of 1:1000 scale were made of the area. For large areas a 1:2000 scale map was used to lay out the terrace system. This was followed by a soil survey to identify the soil features such as texture, horizons, depth etc. With the use of the above data a land capability map was made to allow better utilization of the land. Suporimposed on the land capability map were the field notes of the surface drainage conditions of the area to be terraced in order to determine waterways and field planning preparation prior to construction.

The topography, soil survey and land capability maps were done prior to the implementation stage. The details, criteria and maps for Panawangan were submitted in the "Panawangan Pilot Watershed Conservation and Development Project" report in 1976 by ECI.

The farmers owning the land and some members of the local community participating in the construction of terraces and waterways were organised into groups. It is imperative that the construction of terraces and waterways be done disregarding the property boundaries to attain terrace uniformity throughout the contour and to be able to use efficiently the waterways and obtain proper drainage of the terraces into the waterway system.

First the waterways were built and the bed of the waterways was sodded. Once the land was surveyed and the terraces staked out, terrace construction was started. Terrace construction should always be started at the top of the mountain and the work begun at the point where the terrace will drain into the waterway, and continued progressively away from there (Figure II-1).

No attempt is made here to describe all the engineering details, planning and execution of terrace and waterway construction since that was included in the appendix of the previous report "Panawangan Pilot Watershed Conservation and Development Project" submitted in 1976.

Bench Terraces

The only type of terraces built in the Panawangan Pilot Watershed were the bench terraces. Other types of terraces are currently under study in Waspada (near Garut), Solo etc. and no attempt was made to duplicate the effort. Also the Consultants working in this particular project considered that the most effective type of terraces to control soil erosion is the bench terrace.

The criteria used at Panawangan was that lands with less than 50 percent slope should be terraced for crop production, while lands over 50 percent slope should be put under permanent type of crops such as trees for cash crops, fruit etc. with a forage cover in the understorage. See Chapter III for more details on grass revegetation. The terraces built at Panawangan have different width according to the slope. The terraces were built with a drainage ditch at the toe of the riser above and a lip at the outer edge. The dimensions of the ditch are approximately 20 centimeters wide by 10 centimeters deep. The lip consisted of a small earth dike approximately 20 centimeters wide and 10 centimeters in

height. The terrace risers were built on a 2:1 slope (1 horizontal for each 2 vertical). The terraces were built with a slight back slope towards the mountain side and an allowance of 15 to 20 percent fill compaction was given according to the amount of fill required. The drainage ditches slope toward the waterways with a very low gradient to provide maximum water infiltration. The gradient of the drainage ditches and terrace is about 5 per 1000. The use of temporary dikes in the drainage ditch, never to exceed the heighth of the terrace floor, can be used to accumulate water during the low rainy season. Precautions should always be taken to avoid overflow through the terrace lip. Cascading effect from water overflowing the terrace lip will cause rill/gully erosion.

The terrace risers and lip were revegetated with Brachiaria Brizantha on risers over 0.5 meter vertical height, while on those with lower height Pennisetum Clandestinum was used. See Chapter III for more details on grass revegetation.

In areas where geologically unstable conditions exist, such as landslides, less water infiltration may be desired to avoid soil saturation and thus additional landslides. For this purpose the terrace gradient toward the waterways should be greater to speed up the terrace drainage and thereby decrease the amount of water infiltration.

It was recommended that the topsoil be stock piled and later used as surface soil on the already built terraces. This tedious job is extremely important because it is in the topsoil where most of the soil fertility is. See Figure II-2 at the end of this chapter and Chapter IV for geometry and cost.

Terrace Maintenance. The maintenance of the terraces should not present any problems, providing that the waterways have been functioning properly. The terraces will be reshaped by the farmers two or three times per year when they till the land in preparation for the seed bed to plant the crops. At this time reshaping the lip, drainage ditch and back slope of the terrace toward the mountain side can be done with a minimum effort. It is a must that the farmers understand the purpose of these terrace features to obtain the proper maintenance.

Waterways

The size and capacity of the waterways was designed according to the area to be drained and the available hydrologic data on 25 year frequency storms. The waterways were, when possible, built on the natural drainage sites and consisted of practically flat grade benches connected by drop structures. The walls and floor of the waterway were fully revegetated with local short rhizomatous grasses. The drop structures were built with bamboo cut in half, and interlocked with each other. Refer to Figure II-3 and II-4. The interlocking bamboo wall was keyed into the sides of the sodded drop-wall by no less than 30 centimeters at the top and not less than 15 centimeters at the bottom half. The bed of the waterway at the toe of the drop structure was protected with rocks to dissipate the energy of the falling water.

When stones were available the drop structures were built with them; however, in the Panawangan area there are few stones, thus most of the structures were built with bamboo (Figure II-5 and II-6). The bamboo used on this type of structure should be treated with creosote or other preservative to prolong the life of the structures. The waterways should drain no more than 100 to 150 meters of terrace, thus if the length of the terraces is more than 150 meters, two waterways should be provided. Waterways should never be built on the ridges. The ridges should be used for foot trails if they are needed.

The waterways are an essential component in a soil conservation program, without them the formation of gullies is inevitable. This fact can be easily observed throughout the watershed whenever there is a property boundary. In most cases, the signs of rill or gully erosion are present. This is caused from draining the terraces into the no man's land. Another common problem is the overflow of water on the terraces' outer edge which creates a cascading of water down the terraces with a compound effect which again results in rill and gully erosion. The construction of waterways will need to be fully subsidized by the government or be a prerequisite for the farmers to obtain loans etc.

Gully Plugs

Gully plugs and check dam structures have not been needed in Subwatersheds II, III, IV and V so far implemented. However, several sites suitable for gully

plugs were identified in the remaining subwatersheds still under construction. As previously mentioned the engineering details for construction were presented in the appendices of the "Panawangan Pilot Watershed Conservation and Development Project" submitted in 1976.

In preparation for the construction of gully plugs and small dams, the P_3RP DAS Citanduy Office sent, during the early part of 1979, a forestry engineer and a technical staff member to Solo for special training in that subject.

Landslide Treatment. Several landslide sites in the Panawangan area were treated to control soil erosion. The main practices used were water diversions above the landslide area to prevent runoff water from entering the affected area; retention of the runoff water within the affected area by the use of waterbars to avoid rill and gully erosion; vegetative stabilization of the site with grasses, shrubs and low growing trees.

Flumes, Sediment Traps and Waterflow Recorders

To assess the effect of soil erosion control structures such as terraces and waterways, etc., flow measuring devices and sediment traps were built in the outlet drain of Subwatershed II, where soil conservation measures were implemented, and in the outlet drain of Subwatershed I, the control area where traditional soil conservation practices are followed. The land use in these two subwatersheds is as follows:

Subwatershed No.	Total Area	Bench Terrace	Paddy	Trees and Grass Land
I	13.0	3.5*	1.0	8.5
II	53.2	14.7**	9.0	29.5

* Traditional terraces

** Improved bench terraces with waterways

See Figure II-7 for location of sites.

Based on the cross sections taken at the measuring device sites and at locations upstream (See Figure II-8), and the bed slope, the maximum possible discharge of the drains was estimated. The maximum discharge at bankfull flow and the adopted design capacity for the measuring devices are shown in the table below:

Location	Slope	Cross Section Area m^2 1/	Maximum Discharge m^3/s	Adopted Design Discharge m^3/s 2/
Sub watershed I				
At axis	0.008	0.58	0.53	0.30
18 m u/s	0.008	0.29	0.22	
Sub watershed II				
At axis	0.005	1.70	1.90	1.90
22 m u/s	0.005	1.60	1.75	

1/ At bankfull flow

2/ Design discharge for measuring device

Measuring Devices. The cutthroat flume was selected as the measuring device to be installed. This type of flume is easy to construct (horizontal floor and no throat section) and has a high degree of accuracy under free flow conditions. The selected sizes of cutthroat flumes for both watersheds were based on the three following considerations:

A. Free flow condition under discharge through the drains.

B. Keeping the increase in upstream water depth within reasonable limits.

C. The dimensions of the existing drains.

Subwatershed I. For a maximum free flow discharge of 0.3 cubic meter per second a cutthroat flume with W x L = 0.60 x 1.80 meters was selected. The maximum upstream water depth after installation is 0.45 meter. The height of the right embankment of the upstream section, therefore, is increased by about 0.10 meter. The invert of the flume was at 0.10 meter above the original canal bottom.

Subwatershed II. A maximum free flow discharge of 1.9 cubic meters per second requires a cutthroat flume size 1.20 x 2.70 meters. The maximum upstream water depth after installation is 1.05 meters. As a result the height of the upstream embankment is increased by 0.15 meter. The invert of the flume was constructed 0.25 meter above the original canal bottom. Cutthroat flume of the standard design, constructed in concrete and stone masonry with stilling well was used for the two selected flumes. The flumes are equipped with a water level recorder (Ott Type) to measure the upstream water depth. The free flow discharge rating tables are presented in Table II-2 and II-3.

Installation of Cutthroat Flumes

1. The flume should be placed in a straight section of the channel.
2. The flume should not be located immediately downstream from a constriction.

3. The flume should be aligned straight with the channel.

4. The flume should be level longitudinally and laterally. The staff gauges should zero.

5. Zero of the staff gauges should be at the invert of the flume.

6. The throat width should be checked after construction, and if the width deviates from the design width the discharge rating tables should be adjusted accordingly.

Maintenance of Cutthroat Flumes. After installation of the flume, periodic maintenance is required to insure statisfactory operation. Moss may collect on the walls of the entrance section and debris may collect on the floor and they should be removed. The levelness of the entrance floor should be checked after a few months and again at periodic intervals thereafter. Sediment collected in the stilling well should be removed and the inlet tube should be checked for blockages. The water level recorder should be checked and serviced regularly.

Sediment Traps

Two sediment traps were built in front of the flumes to collect the sediment load in the water drained from Subwatershed I and II. The sediment traps were built in the existing canals with a few modifications to straighten the canal and provide foundations for the masonry work. The dimensions of the sediment traps were:

Subwatershed I

Length	38.00 m
Top width	1.40 m
Bottom width	0.45 m
Height	0.40 m

The height from the bottom of the sediment trap to the flume floor is 0.20 meter.

Subwatershed II

Length	40	m
Top width	2.25	m
Bottom width	1.15	m
Height	1.40	m

The height from the bottom of the sediment trap to the flume floor is 0.40 meter.

The construction cost for the two sediment traps and flumes built by Project Citanduy was Rp. 4,031,700.

Weather Station

A weather station is already operating in the Pilot Watershed under the supervision of Project Citanduy Hydrology Section. The following instruments are presently in operation:

Rainfall Recorders

- Automatic (1)
- Manual (2)

Temperature Recorders

Air temperature, maximum and minimum (manual). Soil temperature at 15 centimeters and 30 centimeters depth (manual) in two locations.

Evaporation Pans

Counter Anemometer

Sling Psychrometer

Soil Erosion Data

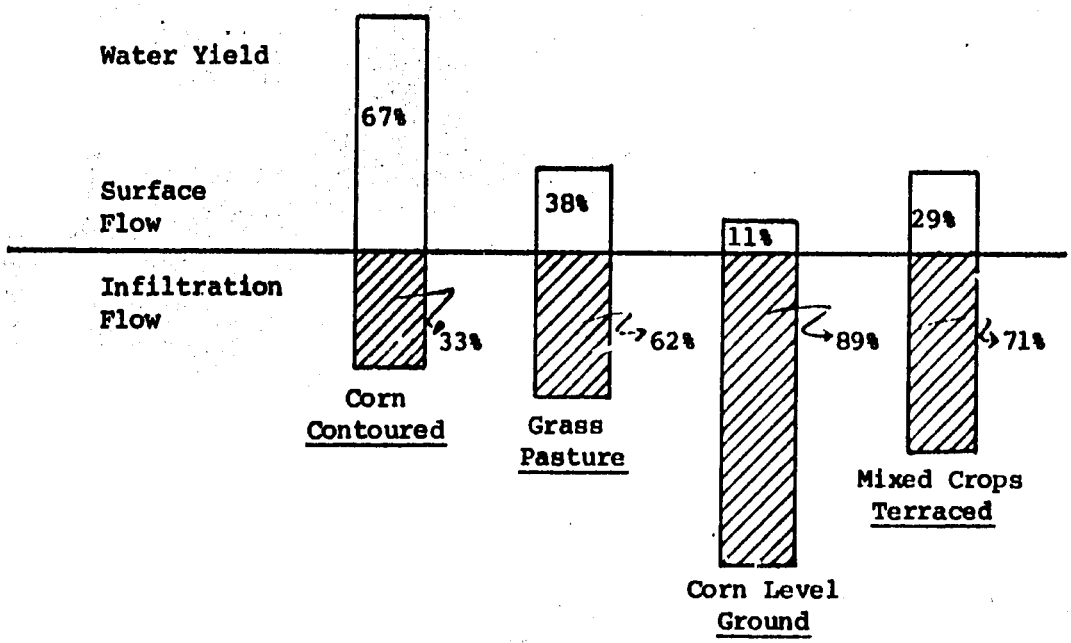
The construction of the sediment traps and flumes and the installation of water measuring recorders were completed in March 1979. However, problems with the flume construction made it impossible to collect relevant data. Presently the flumes are under repair and should be ready for data collection during the 1979-1980 rainy season.

The soil erosion, water and sediment runoff can be substantially decreased with the use of bench terraces and a proper waterway system. This fact is clearly illustrated by the data from the upper Solo Watershed on annual runoff presented in the "Proceedings and Discussion from the Meeting on Watershed Management" at Cibulan on January 30,1978.

Erosion and Runoff in the Subwatersheds Dumpul, Tapan and Wader.

Location	Traditional Terraces		Treated Improved Terraces		Treated Private Forest Land	
	Erosion (cm)	Water and Sediment Runoff (%)	Erosion (cm)	Water and Sediment Runoff (%)	Erosion (cm)	Water and Sediment Runoff (%)
Dumpul	2.9	80	0.2	40	-	-
Tapan	2.0	75	0.1	30	0.06	20
Wader	1.4	75	0.2	30	0.04	30

Studies on the land use effect on average water yield under different soil conservation practices by Sexton and Spomer, USDA-ARS in the USA, resulted in similar conclusions. Their data on the hydrology of five watersheds, with lose soils, studied for six years (1964-1969) revealed:



The soil conservation practices carried on in the Panawangan Pilot Watershed will substantially curtail the soil erosion and allow the build up of soil organic matter and thus increase its fertility. Without the improved bench terraces and waterways, the fertile topsoil will continue to be eroded and at some time in the future, depending on the rate of erosion, the land will have to be abandoned for crop production. The fertile soils that took thousands of years to develop can be easily eroded by improper dryland farming practices in just a few years.

Future Measuring Devices

Stream measuring devices will be installed at the stream outlet of Subwatersheds I and VI and at the stream outlet of the comparison watershed. These measuring devices will be located just above the point where the Cicarenang River and Cinyangsang join together. Details on weir construction and instrumentation were described in the "Panawangan Pilot Watershed Conservation and Development Project" report submitted in 1976.

Total sediment load will be calculated based on suspended materials, sediment concentrations in the trap and the corresponding streamflow discharge at the measuring weirs.

TABLE II-1

LAND CAPABILITY BASED ON SLOPE FOR EACH SUBWATERSHED IN THE PANAWANGAN PILOT WATERSHED

Unit : Hectares

Subwatershed No.	Paddy	Dryland Crop				Land for Trees	Total Area
		I	II	III	IV	V	
	0 - 8%	0 - 3%	8 - 15%	15 - 25%	25 - 50%	+ 50%	
I	1.1	-	1.5	0.6	1.4	8.4	13.0
II	6.7	-	6.6	3.5	4.6	31.8	53.2
III	3.6	0.2	3.7	2.0	2.2	32.3	44.0
IV	6.3	-	1.3	7.5	1.5	30.5	47.1
V	0.6	-	0.2	3.7	9.3	19.0	32.8
VI	1.0	0.2	-	9.6	4.2	21.4	36.4
VII	2.2	0.2	1.7	3.6	1.8	8.7	18.2
VIII	0.7	-	1.4	2.4	1.5	9.3	15.3
IX	2.7	-	1.9	1.8	1.1	12.3	19.8
X	8.8	-	2.0	3.3	7.1	19.1	40.3
XI	1.3	-	1.1	0.9	0.1	11.6	15.0
XII	4.5	-	4.2	2.1	4.7	15.3	30.8
Total Area	39.5	0.6	25.6	41.0	39.5	219.7	365.9

TABLE II-2

FREE FLOW CALIBRATION FOR CUTTHROAT FLUME

W x L = 60 x 180 cm

Q in m^3/s

Ha (m)	00	01	02	03	04	05	06	07	08	09
0.00	0.000	0.001	0.002	0.005	0.007	0.011	0.014	0.018	0.023	0.028
0.10	0.033	0.039	0.045	0.051	0.057	0.064	0.072	0.079	0.087	0.095
0.20	0.104	0.112	0.121	0.130	0.140	0.150	0.160	0.170	0.180	0.191
0.30	0.202	0.213	0.225	0.237	0.249	0.261	0.273	0.286	0.299	0.312
0.40	0.325	0.339	0.352	0.366	0.380	0.395	0.409	0.424	0.439	0.454
0.50	0.470	0.485	0.501	0.517	0.533	0.550	0.566	0.583	0.600	0.617

TBALE II-3

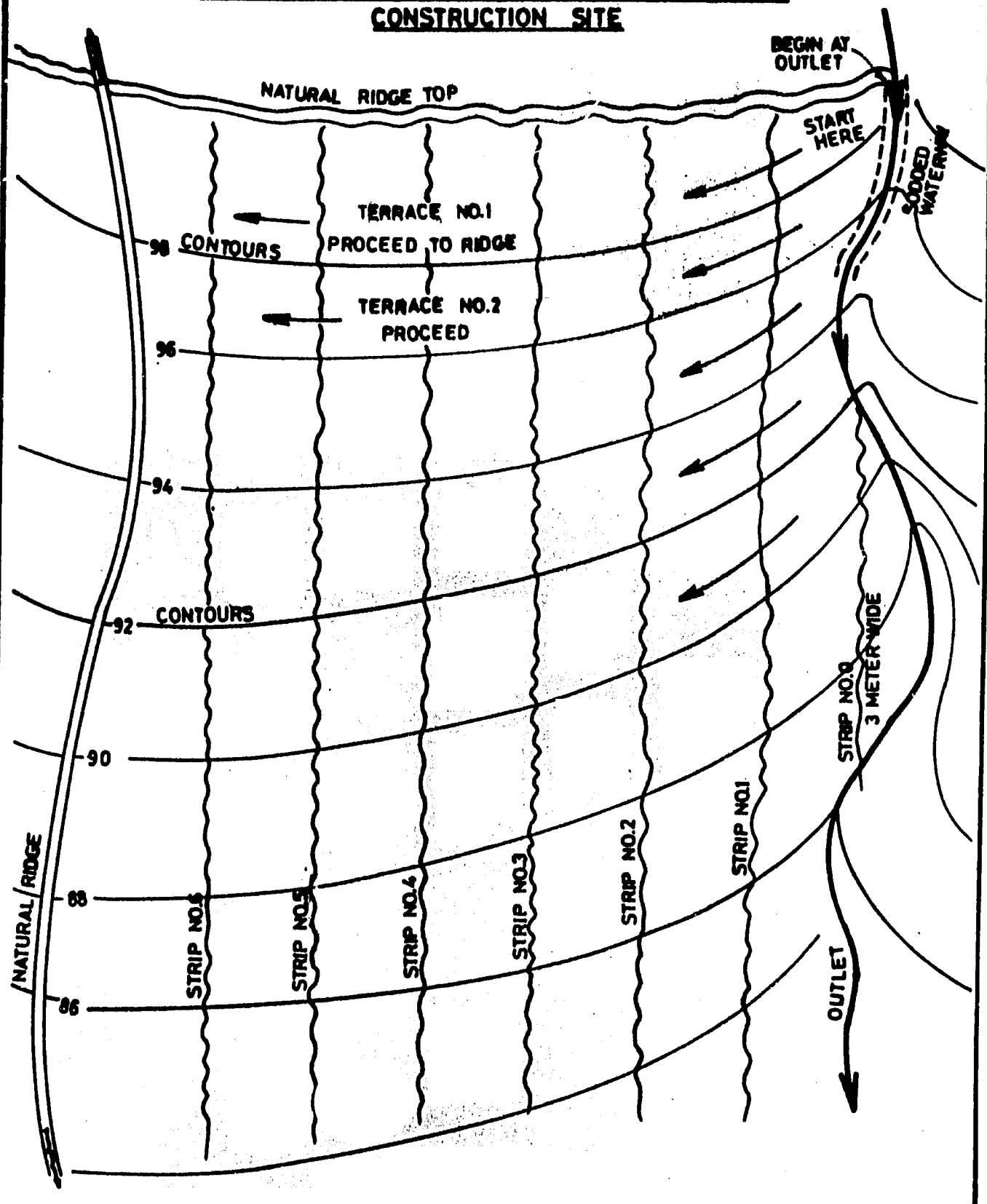
FREE FLOW CALIBRATION FOR CUTTHROAT FLUME

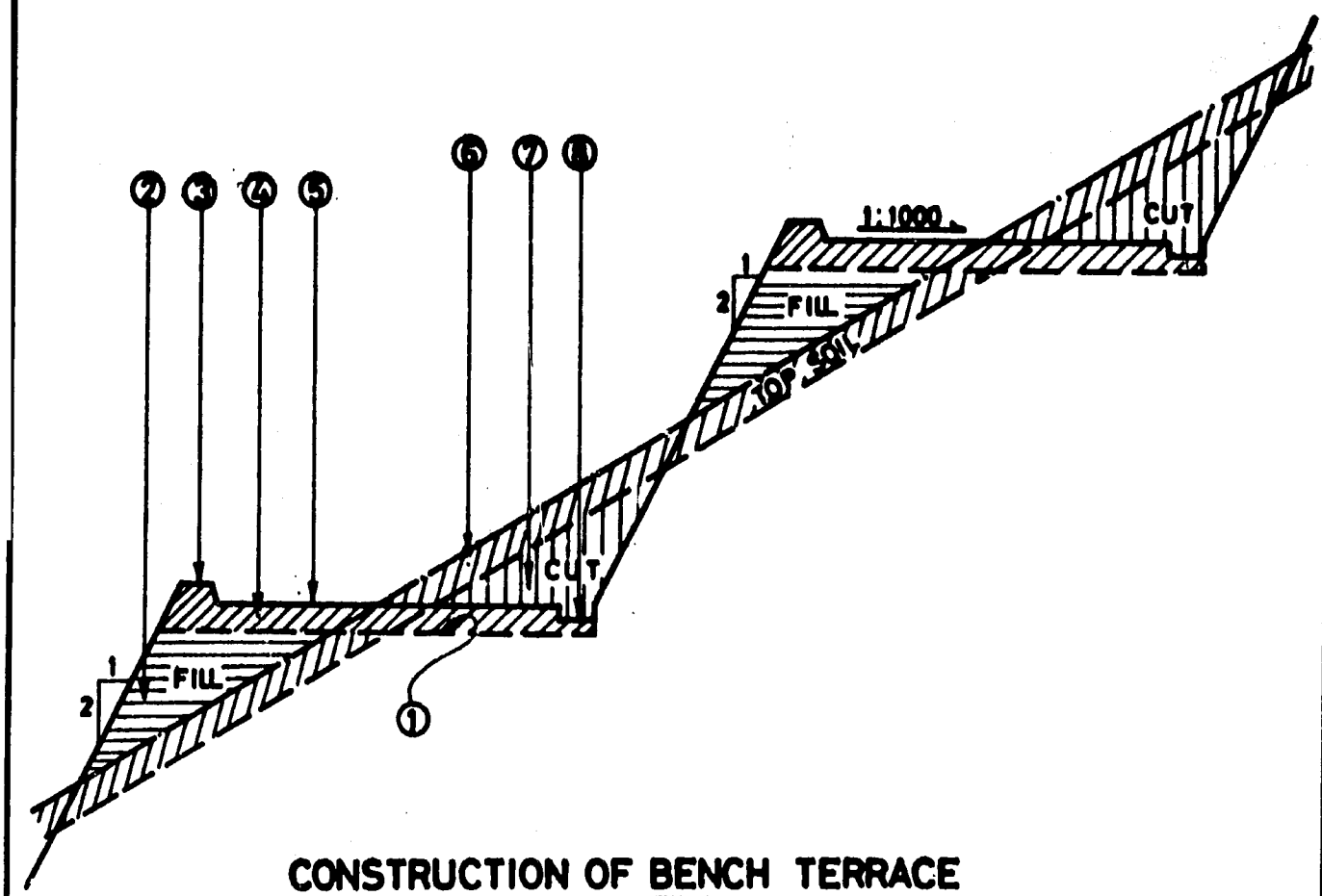
W x L = 120 x 270 cm

Q in m^3/s

Ha (m)	00	01	02	03	04	05	06	07	08	09
0.00	0.000	0.002	0.006	0.011	0.017	0.024	0.032	0.400	0.50	0.060
0.10	0.070	0.082	0.094	0.106	0.119	0.133	0.147	0.161	0.176	0.192
0.20	0.208	0.224	0.241	0.258	0.276	0.294	0.313	0.332	0.351	0.371
0.30	0.391	0.412	0.433	0.454	0.476	0.498	0.512	0.543	0.566	0.589
0.40	0.613	0.637	0.661	0.686	0.711	0.737	0.762	0.788	0.815	0.841
0.50	0.868	0.896	0.923	0.951	0.979	1.008	1.036	1.065	1.095	1.124
0.60	1.154	1.184	1.215	1.246	1.277	1.308	1.339	1.371	1.403	1.436
0.70	1.468	1.501	1.534	1.568	1.601	1.635	1.669	1.704	1.738	1.773
0.80	1.808	1.844	1.880	1.915	1.952	1.988	2.025	2.061	2.099	2.136
0.90	2.173									

PERSPECTIVE VIEW OF A TYPICAL BENCH TERRACE CONSTRUCTION SITE

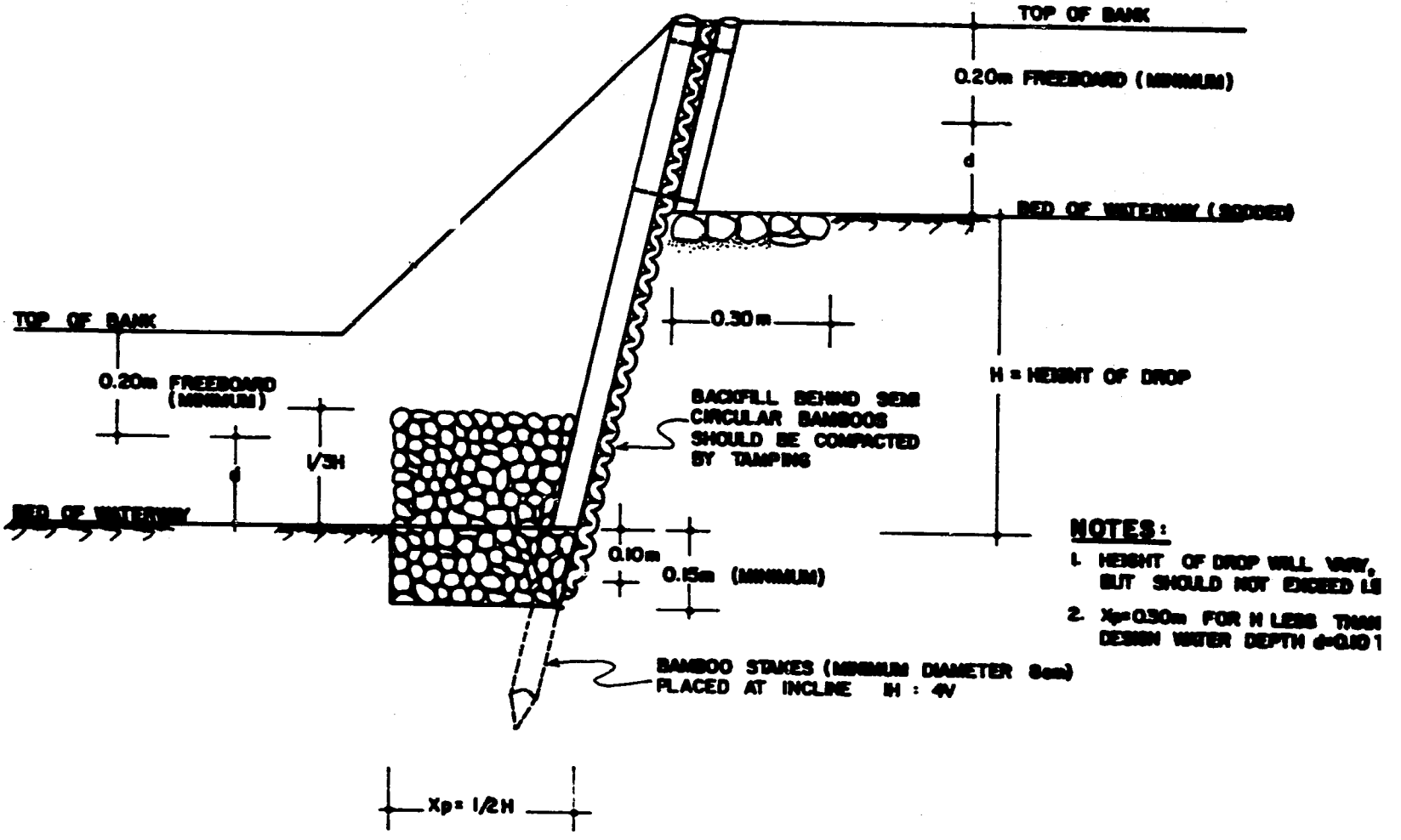




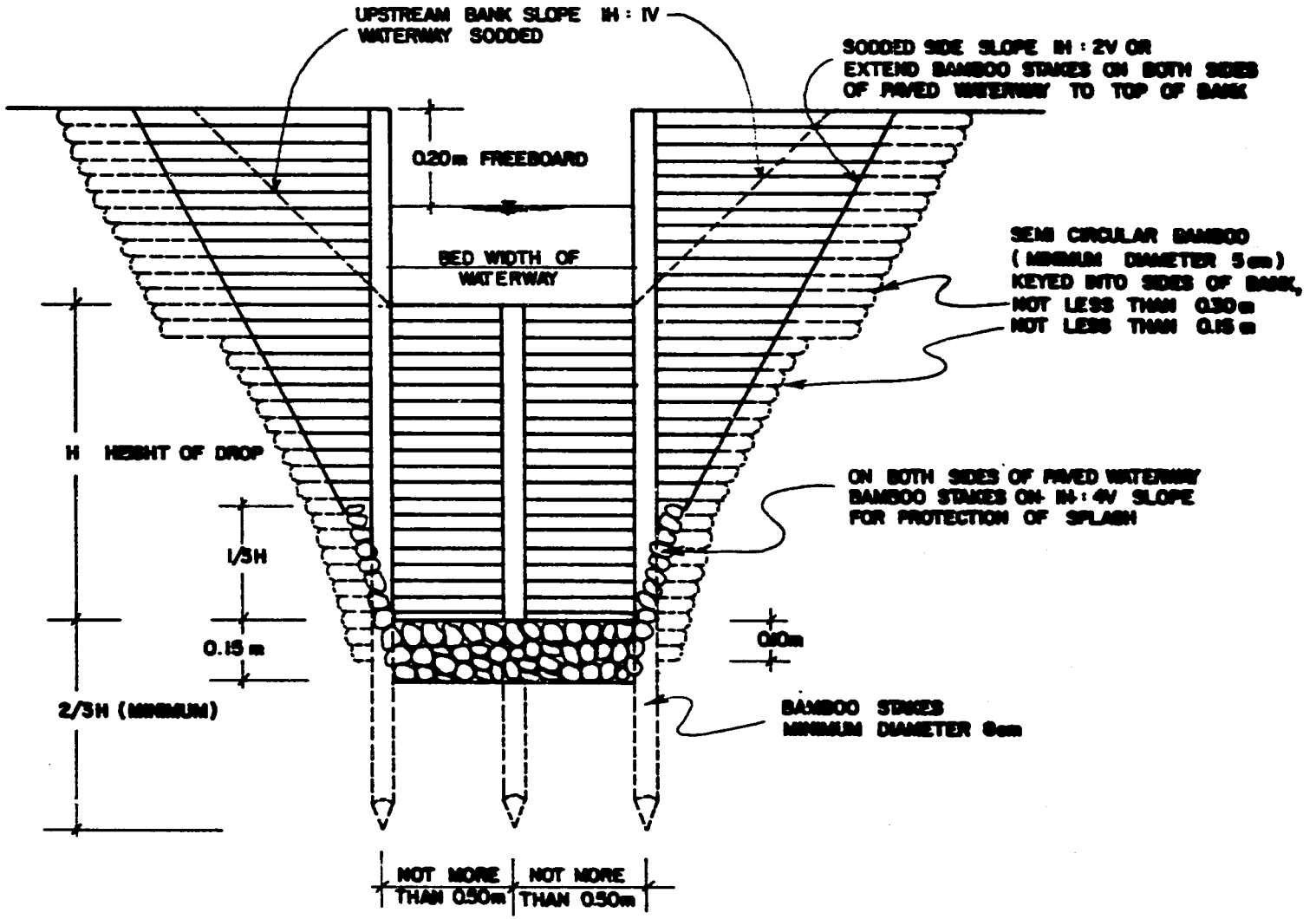
CONSTRUCTION OF BENCH TERRACE
END VIEW

NOTES:

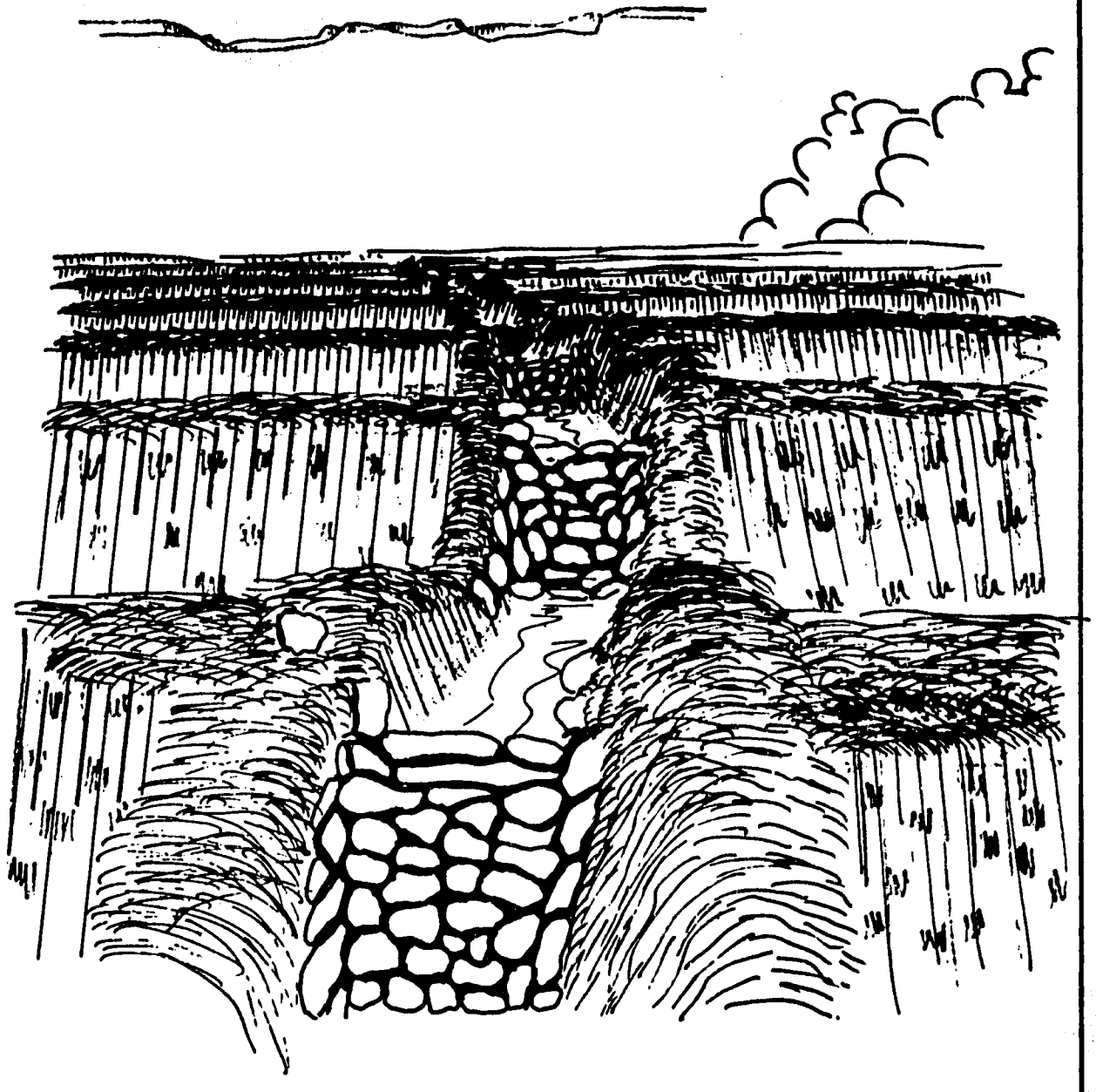
1. Each bench terrace will be cut 30 cm below final elevation. The bench will then be covered with 30 cm of topsoil.
2. For the fill area (2) subsoil removed from the cut area (7) should be used.
3. Small dike 20 cm wide and 10 cm high must be built along the outer side (lip) of the terrace.
4. Topsoil 30 cm deep to be placed on the surface of the subgrade line as the final layer of the completed bench terrace.
5. The terrace must have a slope of approximately 5 to 1000 along the length of the terrace toward the waterway outlet. Also the bench terrace must gently slope toward the inside ditch.
6. Original ground line.
7. Cut area subsoil to be removed and placed in fill area (2).
8. Small drainage ditch 20 cm wide and 10 cm deep must be dug along the interior side of the terrace to remove excess water toward the waterway.



LONGITUDINAL SECTION BAMBOO DROP STRUCTURE

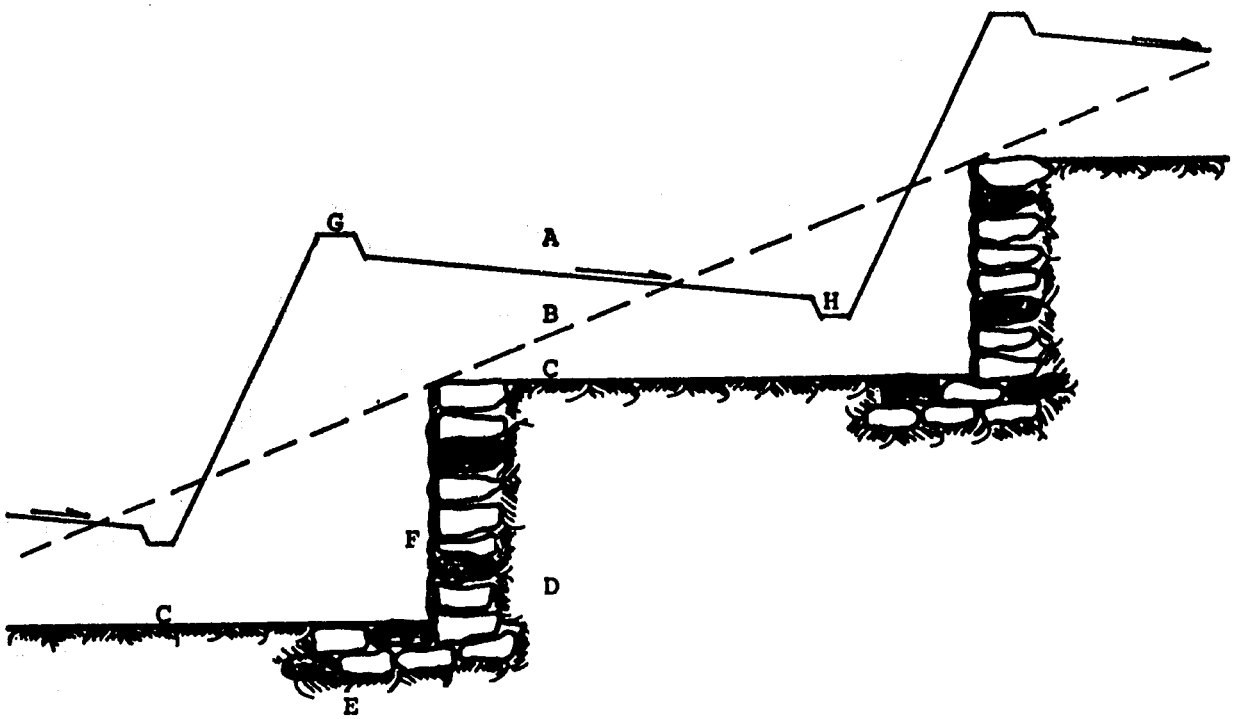


FRONT VIEW BAMBOO DROP STRUCTURE



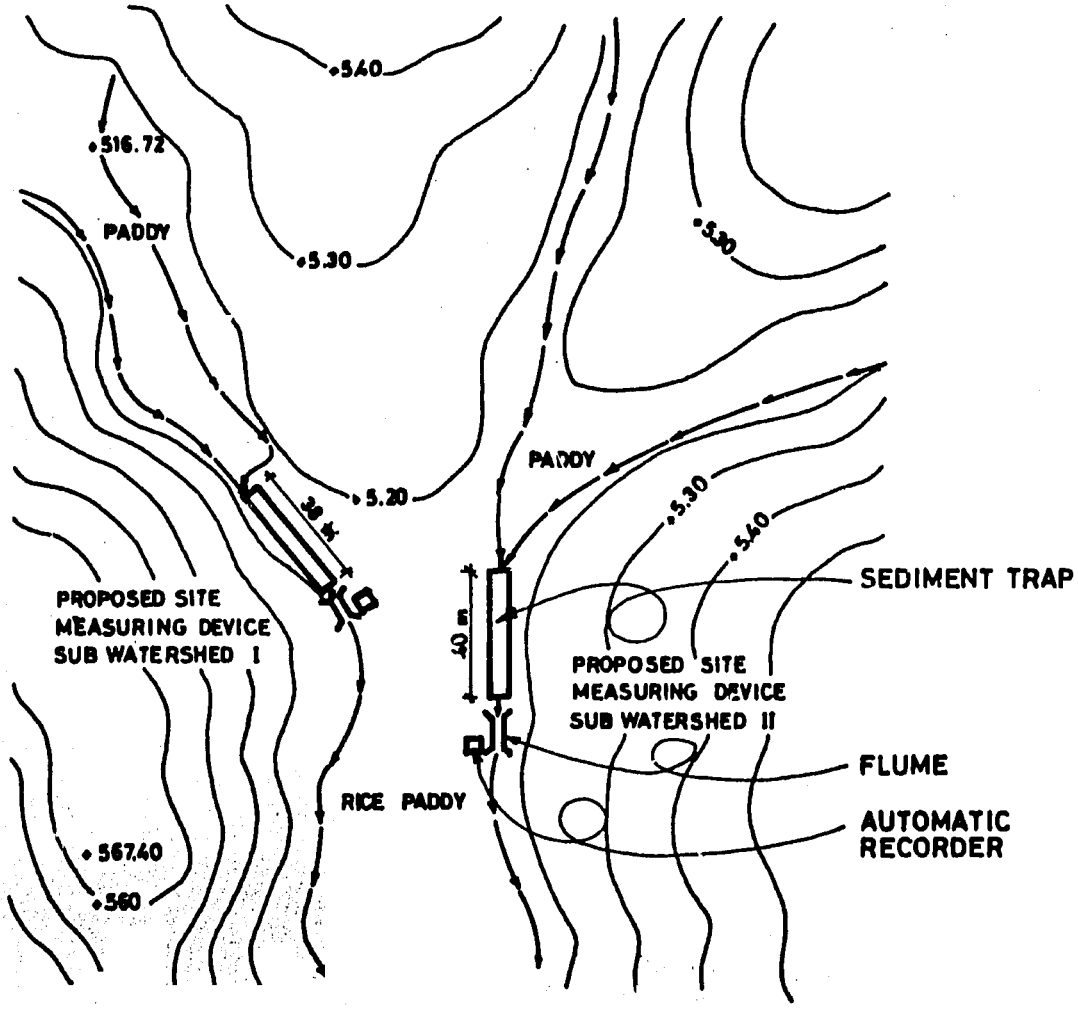
Stone Drop Structures in Waterway

Cross Section of Bench Terrace and Waterway



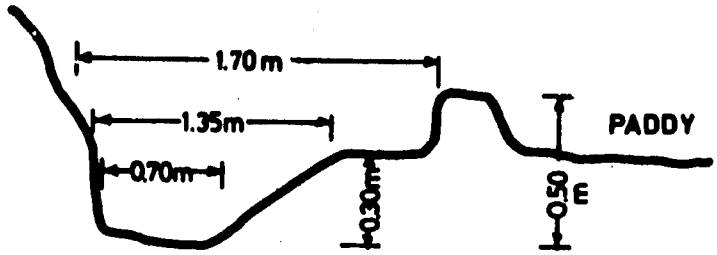
Notes:

A - Profile of Bench Terrace
B - Original ground surface
C - Bed of waterway well sodded (Profile)
D - 0.30 m thick with stones laid horizontally.
E - On foot at drop 0.30 m thick (0.50 m min. length)
F - Position of drop sited such that waterway is kept in cut material
G - Small dike (0.20 m width and 0.10 m high)
H - Small ditch (0.20 m width and 0.10 m deep)

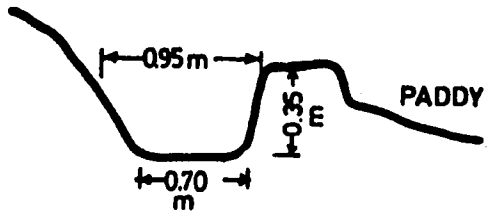


LOCATION OF STREAM FLOW STATIONS
PANAWANGAN PILOT AREA

SUBWATERSHED I (CONTROL AREA)

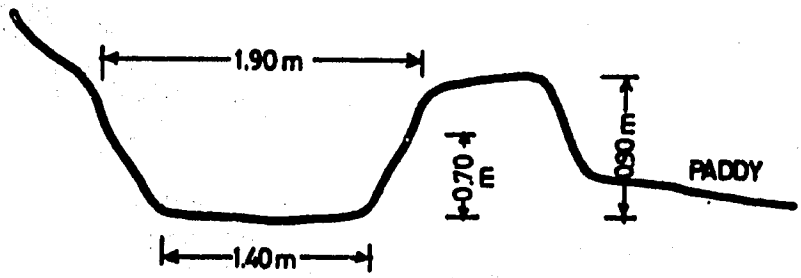


CROSS SECTION AT AXIS BED SLOPE S= 0.008

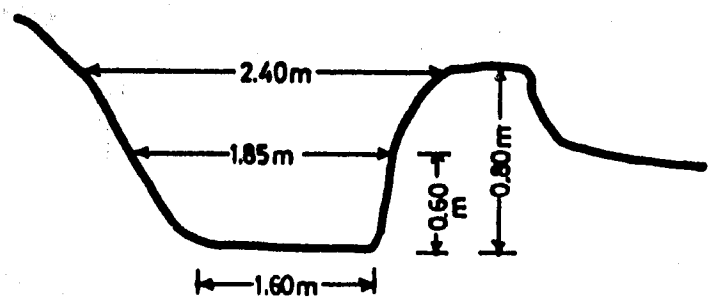


CROOS SECTION 18m UPSTREM

SUBWATERSHED II (CONTROL AREA)



CROSS SECTION AT AXIS BED SLOPE S= 0.005



CROSS SECTION 22m UPSTREAM

DRAIN CROSS SECTION

CHAPTER III

AGRICULTURE DEVELOPMENT PROGRAM

The land holding of the dryland farmer is about 0.5 hectare or less. The farm operations are very diversified, thus if the farmers are not assisted technically and economically (loans etc.) in most of their activities, their farm output will remain the same with little benefits to the farmers.

In the Panawangan Pilot Demonstration Farm, an attempt was made to evaluate the impact of a full agriculture development program on the output of the dryland farms in the watershed.

The agricultural development program consists of the following components :

A. Agronomic practices
B. Grass revegetation
C. Trees for cash crop, lumber and fuel under silvapasture management practices
D. Livestock program
E. Beehives
F. Fish ponds.

Agronomic Practices

The agronomic trials in the 6.1 hectares Pilot Demonstration Farm and in Subwatershed II were designed to provide basic field data for recommendations of improved agronomic practices to the farmers in the Panawangan Pilot Watershed.

These field trials, carried on for 16 months, point out that applied research is very much needed to overcome the constraints to higher yields. Even

with the lack of personnel, budget and required time to do a proper job, it was shown that the yields could easily be doubled.

The main objectives of the agronomic trials were:

1. To determine the most profitable fertilizer application for the farmers to use.
2. To test new upland crop varieties for higher yields under the Panawangan environment.
3. To evaluate the yields and income potential from different cropping systems.
4. To study the effect of plant population density and land management practices on crop yields.

Some of the problems associated with the data are the soil variability in any terraced land. This is especially true in the 6.1 hectare plot where the bulk of the terraces are less than 1.5 meters wide. Also the microclimate modifications from scattered trees throughout the area and terrain configuration affect the reproducibility of treatments.

The agronomic trials were conducted on private land and all the work was done by the owners. No salaries were paid and the only incentive was providing the fertilizers and seeds. This caused some problems such as getting the plots weeded at the right time, organizing the farmers for harvest and getting them to report the yields when the harvest (contrary to the agreement) was done without the Consultant's presence. However, difficults and delays in weekly schedules associated with working with private owners were more than outweighed by the relationship established with the local people. Understanding why things were tested, witnessing the methods used and results obtained, as well as being constant observers of the progress, made the farmers in the area strong supporters and participants in the projects. The farmers' acceptance and support of

new techniques and management have contributed tremendously to the project's success and hopefully the program can be developed and later spread throughout the watershed.

Needless to say, much experimental work is needed to determine all the main parameters affecting the crop yields, however that will take many years of data and the effort of many people. The data generated on this pilot watershed certainly is not the absolute recommendation for the area but it is representative.

The late implementation of the project, due to the late completion of bench terraces, limited time to set as many trials as had been planned. The planting of all the agronomic trials for the first season was done during the 23th, 24th and 25th of November 1977, about three months later than recommended. The plots were set at random and were replicated three times.

Data on a complete cropping cycle has been compiled; unfortunately the project was started over two months too late. This caused several problems:

1. The corn yields were inhibited by the adverse weather. The corn should have been harvested rather than planted during the mid-rainy season.

2. There was not sufficient time to plant a 3rd crop. This could seriously affect the economical feasibility projections of the program.

3. The planting schedule was not representative of that which the farmers should and normally do follow.

This work was done in cooperation with the CRIA* and LPT** at Bogor, the Provincial Agricultural Service in Bandung and the Bupati Offices of the Ciamis District.

Variety Testing

Five varieties of rice were planted to evaluate their yields:

1. Upland rice C-22 from CRIA* in Bogor
2. Upland rice IR-2061-522-69 SL-1213 from CRIA in Bogor
3. IR-36
4. IR-30
5. Local upland rice SAGI

The plots were planted as a monoculture and were fertilized at the rate of 400 kilograms of urea and 200 kilograms of TSP per hectare. The TSP and 200 kilograms per hectare of urea were applied prior to seeding and worked into the soil, 100 kilograms per hectare of urea was applied 48 days after seeding and the remaining 100 kilograms per hectare of urea was applied 80 days after seeding. The size of these plots, because of seed availability, was only 15 square meters rather than the 50 square meters planned. They were replicated three times.

The plots were seeded on November 27, 1977 and harvested on April 17, 1978. The mean yields were:

Rice Variety	kg/ha (wet stalk rice)
C-22	2,828
IR-2061-522-69 SL-1213	1,331
IR-36	1,090
IR-30	1,675
SAGI	1,675

* CRIA - Central Research Institute of Agriculture. (LP_3 - Lembaga Pusat Penelitian Pertanian)

** LPT - Lembaga Penelitian Tanah (Soil Research Institute).

Fertility Trials

To evaluate the yield response to different levels of soil fertility under upland cropping, six fertilizer treatments were used:

kg/ha		
Urea	TSP*	Potash
0	0	0
100	0	0
0	100	0
100	100	0
150	100	0
200	100	0
400	200	0

* TSP-Triple Super Phosphate

All the triple super phosphate and half of the urea fertilizer were incorporated with the soil prior to seeding; the other half of the urea was applied 40 days after seeding. All the fertilizers were hand broadcasted and worked into the soil by the farmers.

The crops planted in this trial were the most common ones used by the farmers in Panawangan. They were also planted in a similar method to that presently used by the farmers but at specific distances to control plant density. The crops and planting arrangement were:

Maize (close to the terrace lip in one row 30 centimeters apart).
Rice (the main crop at 25 x 25 centimeters apart).
Cassava (1 meter away from terrace lip and 1 x 1 meter apart).

The plot sizes are 50 square meters each and they were replicated three times.

Potassium fertilization was also included in the planning of these trials; however, Project Citanduy could not find any potash fertilizers in Bogor, Bandung or Ciamis district; therefore no potassium trials were made during 1977.

The upland rice used in these trials was the variety Sagi, quite common in the area. Out of the three replications planted, the yields of only one are reported here. One replication was completely lost because the land prior to terrace building was under citronella grass, a fact of which the Consultant was not informed. Citronella leaves the soil completely barren and unable to grow crops for one to two years after the grass is pulled. Therefore no yields were obtained from this replication. Another replication was harvested by the farmers who independently changed their chosen harvest day without warning; therefore, no supervisors were present at harvest and proper record of the trial yields was not kept.

The crop yields reported here are from the replication harvested and weighed in the Consultants presence on April 5, 1978. The economic considerations for optimum use of fertilizers is discussed in Chapter IV. The yields were:

Treatments kg/ha Urea - TSP	Rice Yields (Wet stalk rice) kg/ha
0 - 0	300
0 - 100	700
100 - 0	850
100 - 100	1250
150 - 100	1320
200 - 100	1350
400 - 200	1675

The yields of corn and cassava were not recorded by the farmers nor were the Consultants notified of the day the harvest was to take place. The rice yields were well within the range obtained by other farmers. For example two of the key farmers not participating in these trials reported 500 and 750 kilograms per hectare of rice with only urea applications of about 100 kilograms per hectare and the same variety of rice. See rice and peanuts fertility trials under multiple and monoculture cropping sections.

Multiple Cropping

Rice, Cassava and Maize. Improved varieties of upland rice (C-22), Cassava (W-236) and maize (BC-2) from CRIA were planted in the same patterns and plant density as the local varieties used in the fertilizer trials. They were fertilized at the rate of application of 200 kilograms of urea and 100 kilograms of TSP per hectare. Half of the urea and all the TSP were applied prior to seeding and the other half of the urea was applied 40 days after seeding. These plots are 50 square meters and were replicated three times. This trial was to evaluate the yields of CRIA improved varieties vs the local varieties planted at the same plant density and fertilized at the same rate of application.

Crop	Variety	Yield (kg/ha)
Rice	C-22	2,378 (wet stalk rice)
Maize	BC-2	600
Cassava	W-236	2,000

As a comparison under the same plant density, multiple cropping system and fertilizer treatment the yields in kilograms per hectare of wet stalk rice from an old release Sagi (well established variety) versus the new C-22 variety were:

SAGI		C-22
1,350	vs	2,378

The yields from maize and cassava were not recorded by the farmers.

Maize, Peanuts, Cassava and Soybeans. Improved varieties from CRIA included also:

Maize	H-6
Peanuts	Gajah and Kidang
Cassava	W-78
Soybeans	Orba C-1343

The varieties were planted in bed furrows about 60 centimeters wide and 20 centimeters high. Three bed furrows were built along the contour of the bench terraces. The maize was planted in two rows per bed furrow, the rows were 50 centimeters apart and the plants were spaced about 30 centimeters apart within each row. The peanuts of the variety Gajah were planted at about 20 x 20 centimeters apart in three rows per bed furrow. The cassava was planted in two rows per bed furrow at 1 meter intervals within each row in alternating order so that the distance between plants was about 70 centimeters. In between the cassava in the bed furrow,were also planted soybeans in three rows at about 20 x 20 centimeters. However the soybeans died from damage by a fungus infection, so peanuts of the variety Kidang were planted in their place within a month after the other species.

The plots were 50 square meters, split so that two rates of fertilizers could be tested, 400 vs 200 kilograms per hectare of urea with 100 kilograms per hectare of TSP as a common application. Half of the urea and all the TSP were applied prior to seeding and the other half of the urea was applied 40 days after seeding. The plots were replicated three times.

The plots were seeded on November 25, 1977 and harvested on March 15, 1978. Again the farmers harvested these plots before their agreed date and did not separate the yields of each of the split plots. The yields reported, therefore, are the means of the split plots treatments. Yields of two out of the three replications were obtained.

The yields are:

Crop	Variety	kg/ha Rep. I	Rep. II
Peanuts*	Gajah	600	400
Maize**	H-6	600	840
Cassava	W-78	3,840	3,200

* Peanuts wet weight with shell

** Maize wet weight of peeled ears

Rice and Maize. Intercropped rice and maize of the varieties C-22 and H-6 were planted on October 5, 1978.

Sixty field plots were set to evaluate the following parameters:

1. Fertilizer treatments.
2. Response to K_2SO_4 vs KCl.
3. Plant population densities.

The plots were located in the north east corner of Subwatershed II under the most uniform conditions found in the area. The plot size was 25 square meters and every treatment was replicated three times. The fertilizers were hand broadcast into each plot. All the TSP, K_2SO_4 and one third of the urea were applied prior to seeding and worked into the top 20 centimeters of soil. The rest of the urea was applied in two other portions 30 and 60 days after planting. The plots were seeded on October 15 and five to six seeds of rice variety C-22 from CRIA were planted per hill. To control the desired plant population densities a rake was used to mark the ground at the proper distance: where the marking lines crossed, the seeds were planted. The holes for the seeds were made by the traditional stick method. Maize of the variety H-6 from CRIA was also planted in a single row along the terrace lip at 30 centimeters apart within the row.

1. Fertilizer Treatments. Field plots seeded with rice at 15 x 15 centimeters apart were evaluated for yield response to the following fertilizer rates of application:

kg/ha		
Urea	TSP	K_2SO_4
0	0	0
100	0	0
0	100	0
0	0	100
0	100	100
100	100	100
200	100	100
300	100	100
100	0	100
150	0	100
150	50	100
150	150	100
150	150	100
100	100	0
150	100	0
150	100	50
150	100	150

2. Response to K_2SO_4 vs KCl. During the previous crop it was well illustrated that peanuts responded to potash application. The soil test also showed low levels of potash; however, since the fertilizer used was K_2SO_4 it was not clear whether the yield response was due to K^+ or SO_4^{2-}. To evaluate the response to potash vs sulfate two sets of plots replicated three times were fertilized at the rate of 150 kilograms per hectare urea, 100 kilograms hectare TSP and 50 kilograms per hectare K_2O. The K_2O was applied, either as KCl or as K_2SO_4. The rice was seeded at 15 x 15 centimeters apart.

3. Plant Population Densities. Two plant density trials were evaluated to determine the effect on upland rice yields. The plots were fertilized at the rate of 150 kilograms per hectare urea, 100 kilograms per hectare TSP and 100 kilograms per hectare K_2SO_4. The planting distances were:

15 x 15 centimeters vs 25 x 25 centimeters

Due to lack of manpower by the owner, who was sick during the growing season, and lack of counterpart or assistance to take care of the field plots,

the effort made in setting the plot, weighing each individual plot fertiliser etc. was wasted. The plots were full of weeds and the data was very erratic; however, even under these adverse conditions some of the plots yielded over 1000 kilograms per hectare of wet stalk rice.

Monoculture Cropping

Sweet Potatoes. Sweet potato cuttings of the varieties LP3 Maura 3-6 and No. 395 from CRIA were each transplanted in two 50 square meter plots. The sweet potatoes were transplanted on bed furrows, about 60 centimeters wide and 20 centimeters high, built along the terrace contour, three per terrace. They were transplanted at a distance of about 20 x 20 centimeters apart. The plots were fertilized at the rate of 200 kilograms of urea and 100 kilograms of TSP per hectare. Half of the urea and all the TSP was applied prior to transplanting and the rest of the urea was applied 40 days after transplanting.

The sweet potatoes were heavily damaged by insects even after periodical spraying with insecticide by the farmers.

Peanuts. Peanuts of the variety Gajah, from CRIA, were planted in a monocrop system to compare the yield to those of the multicropping systems and other seasonal planting. The plot size was 50 square meters and they were replicated two times. The plots were fertilized at the rate of 200 kilograms per hectare of urea and 100 kilograms per hectare TSP. Half of the urea and all the TSP were applied before seeding and the fertilizer was mixed with the top soil. The other half of the urea was broadcast in the soil 40 days after seeding. The plots were seeded on November 24, 1977 and harvested on March 15, 1978. The plot yields for the Gajah peanut variety were:

kg/ha*	
Rep. I	Rep. II
870	1000

* Wet weight with shell

Peanuts are the main cash crop planted by the farmers in Panawangan during the months of April to July. Other crops such as sorghum and soybeans were also tested for the first time in that area as possible crop rotations during the dry season.

In an attempt to improve the upland crop yields and to determine the optimum treatments for best economical return, the following parameters were evaluated under field conditions:

1. Fertilizer applications
2. Plant density
3. Land preparation

This time, precautions were taken to avoid the mistakes committed during the first crop due to private ownership operation. During the second crop the full support and assistance of Ir. Hadi and Ir. Selamat, with their field staff, from Ir. Nurdin's P_3RP-DAS Office at Ciamis made it possible to obtain good data. Their help in setting the field trials, supervision during the growing season and assistance in recording and weighing of plot yields was invaluable.

The plot size was 25 square meters and each treatment was replicated three times. All the fertilizers were broadcast by hand prior to seeding and worked into the top 15 centimeters of soil.

The plots were seeded on May 4 with peanut seeds of variety Gajah from CRIA, and harvested on August 25, 1978. This variety was well accepted by the local farmers for its quality and yield during the first crop in the rainy season.

1. Fertilizer Application. The soil fertility treatments used were:

kg/ha		
Urea	TSP	K_2SO_4
0	0	0
100	0	200
100	100	200
100	200	200
100	300	200
100	200	0
100	200	100
100	200	300

The planting distance was 20 x 20 centimeters on flat ground.

The main interest in these trials was to determine the effect of TSP and K_2SO_4 fertilizer on peanut yields. Soil samples were taken prior to fertilizing and seeding for soil analysis to determine any correlation between soil test, fertilizer application and yield response. The soil test and layout of the plot area is attached to this section of the report (Figure III-1). The economic considerations of fertilizer use and plant densities are discussed in Chapter IV. The yields were as follows:

Treatment kg/ha			Peanut Yields kg/ha*			Mean Yield
Urea	TSP	K_2SO_4	Rep. I	Rep. II	Rep. III	kg/ha
0	0	0	840	728	440	669
100	0	200	1,140	1,500	1,056	1,232
100	100	200	1,440	1,204	1,104	1,249
100	200	200	960	792	1,400	1.051
100	300	200	1,200	840	1,640	1,227
100	200	0	840	1,020	800	887
100	200	100	780	716	1,280	925
100	200	300	740	2,092	984	1,272

* Weight of peanuts with shell just after being harvested.

The duplication of results among replications is bad as would be expected in a terraced area and where manure has been used in the past. Also the plot area was under several ownerships thus there were different management practices in the past which are now reflected in the yields. However,each replication was intended to be placed under the most homogeneous conditions. A map of the plot area is attached at the end of this section to give an idea of the field conditions. Even when the duplication of results from replication to replication is not as wanted, certain yield response patterns are quite evident. For example the interaction of urea - TSP (100 - 200 - 0) yielded 887 kilograms per hectare while urea - K_2SO_4 (100 - 0 - 200) yielded 1,232 kilograms per hectare. The interaction of Urea-TSP-K_2SO_4 (100-200-200) lowered the yield to 1,015 kilograms per hectare. However, when lower TSP levels were used the Urea-TSP-K_2SO_4 (100-100-200) soil treatment produced yields of 1,249 kilograms per hectare. More testing work on the interaction of TSP and K_2SO_4, within the rate ranges of 25 to 200 kilograms per hectare needs to be done.

2. Plant Density. To study the effect of plant density on peanut production, two planting distances were evaluated on flat ground plots, 20 x 20 centimeters and 15 x 15 centimeters. The plots were fertilized at the rate of 100-200-200 kilograms per hectare of Urea-TSP-K_2SO_4 respectively. The plot area was 25 square meters replicated three times. The yields were:

Planting Distance	kg/ha			Mean Yield kg/ha
	Rep. I	Rep. II	Rep. III	
20 x 20 cm	960	792	1,400	1,051
15 x 15 cm	1,700	1,688	1,320	1,569

This is a substantial increase in yield due to one single parameter, plant population.

3. Land Preparation. The land preparation for crop planting on flat ground vs raised bed was also evaluated. The main question to answer was whether soil aeration and drainage was a factor affecting crop yields. Raised bed planting vs flat ground planting trials were evaluated on plots 25 square meters

in size and were replicated three times. The plots were fertilized at the rate of 100-200-200 kilograms per hectare of Urea-TSP-K_2SO_4 respectively. The yields from these plots were:

Land Preparation	kg/ha			Mean Yield
	Rep. I	Rep. II	Rep. III	
Flat ground planting	960	792	1,400	1,051
Raised bed planting	816	1,108	700	875

The lower yields in the raised bed plots might be due to lower plant population density, although the planting distance of 20 x 20 centimeters was used in both land preparations. However, the raised bed plots at the bottom of the furrows of raised beds drain ditches probably had lower plant density. The main point obtained from these trials is that on latosol or oxisol soils no additional drainage and aeration are needed for the plants from rice bed land preparation.

The best pilot treatments obtained in the Panawangan Watershed Pilot Demonstration Farm must be further tested in the new pilot areas in 1979/1980 before the economical analysis recommendations are made for the upper watershed.

Soybeans and Sorghum. Forty plots were planted to evaluate the TSP and K_2SO_4 effect on soybean yields and urea effect on sorghum. Plant population trials were also planned to evaluate the effect on plant yields.

The 1978 dry season, however, was anything but dry. (See weather data on Table III-1). The soybeans, of the variety Orba C-1343 from CRIA, germinated very well and looked very healthy until they reached about 20 centimeters in height. At that time they developed a root rot disese and within about two weeks all the plants in the plots were dead. The pH of 5.3 in these soils (See Table III-2) may also be detrimental to soybeans.

The sorghum did not grow very uniformly; great variation existed within the same plot. In some instances plants were already headed out and 2 meters tall while within 1 meter other plants were only 30 centimeters tall. The yields were not recorded.

Farmers' Cooperation Program

Eighteen farmers from Ciracak village participated in this program. The main purpose was to see how close the farmers could duplicate the results obtained from the previous year's field trials and to show them what yields they can obtain by following the recommended practices. The size of the farmers' fields ranged from 2 to 40 are (1 are is 100 square meter). To assure that the fertilizers given to the farmers were placed in the prescribed fields and that the correct rates were applied, a competition program was designed. The farmers were divided into four groups with one leader per group. The farmers' fields were evaluated four times throughout the growing season and the group with the highest score received Rp. 5,000 per man. The evaluation was done by the Consultant with the assistance of Ir. Hadi and Mr. Dayat from P_3RP-DAS in the presence of the four group leaders. The evaluation was based on:

1. Amount of improved grass variety growing on the terrace risers.
2. Effort made to spread vegetatively these improved grasses (mainly Brachiaria brizantha).
3. Condition of the terrace lip.
4. Maintenance of terrace drain ditch.
5. Crop appearance for corn and rice.
6. Amount of weeds growing on the terrace.
7. Insect control.
8. Over-all appearance of their farm operation.

The main crops planted were corn of the variety H-6 from CRIA and C-22 upland rice also from CRIA. Farmers who did not have enough C-22 rice seed planted rice of the variety Sagi. The corn was planted in a single row by the

side of the terrace lip at 30 centimeters apart within the row. Some farmers, however, did plant two or three rows of corn per terrace. The rice planting recommendation were: seeding at 15 x 15 centimeters apart and five to six seeds per hill. A rake with the teeth 15 centimeters apart was used to mark the ground so that uniform plant populations could be obtained. Cassava planting was left up to the individual farmers, and it was planted in a row located in the middle of the terrace with the plants 1 meter apart.

The fertilizers were applied at the rate of 200 kilograms per hectare of urea, 100 kilograms per hectare TSP and 100 kilograms per hectare K_2SO_4. The TSP, K_2SO_4 and one fourth of the urea were hand broadcast prior to planting and worked into the top six centimeters of soil. The rest of the urea was applied in three additional times at the rate of 50 kilograms per hectare and 30 day intervals.

The planting operation started on September 29, 1978. During the course of the growing season the rice was sprayed five times with Serin. On November 21 the C-22 upland rice variety was also sprayed with Dithane M-45 (fungicide) to protect the plants from a leaf blight disease. The fungicide was provided by the Dinas Pertanian Kabupaten. The symptoms of leaf blight appeared about ten days earlier. The blight was under control by the first part of December. However, the recovery was not necessarily due to the fungicide spray. The damage on the rice fields was evaluated by the farmers as ranging from 5 to 15 percent. The older basal leaves were mainly affected but in some spots the complete plant died.

The corn grew extremely well with a high percentage of plants bearing two ears. The size of the ears was excellent and even when two ears were present both of them were large. The corn was planted on September 29 and the harvest was completed by January 19, 1979. The corn yields were:

FARMER GROUPS							
I SUPARMAN		II TARYAT		III SURYADI		IV SUHINTA	
kg	m^2	kg	m^2	kg	m^2	kg	m^2
80	250	150	600	152	800	205	1800
50	200	202	4000	215	3000	73	700
555	3000	50	1500	70	500	264	1500
180	2000	150	2000	107	1000	73	300
100	800					180	1000
965	6250	552	8100	544	5300	795	5300
1,544 kg/ha		681 kg/ha		1,026 kg/ha		1,500 kg/ha	

Total kg of corn harvested 2,856

Total area (m^2) planted 24,950

Mean yield - 1,145 kg/ha

The rice planted on September 29, 1978, was harvested on February 24, 1979. About 50 percent of the rice was C-22 and the rest was the variety Sagi.

FARMER GROUPS							
I SUPARMAN		II TARYAT		III SURYADI		IV SUHINTA	
kg	m^2	kg	m^2	kg	m^2	kg	m^2
13.0	250	32.6	600	125.4	800	61.6	1,800
40.6	200	183.5	4,000	254.3	3,000	117.0	700
168.5	3,000	30.4	1,500	20.1	500	110.0	1,500
138.8	2,000	166.4	2,000	97.9	1,000	48.5	300
283.0	800					244.2	1,000
643.9	6,250	412.9	8,100	497.7	5,300	581.3	5,300
1030 kg/ha		510 kg/ha		939 kg/ha		1097 kg/ha	

Total wet stalk rice 2,135.8 kg

Total area harvested 24,950 m^2

Mean yield - 856 kg/ha

Within the total area harvested, however, about 25 percent of the land is used in terrace risers, terrace lips and terrace drain ditches. If the above assumption is taken into consideration, the mean yield for the cultivated area was slightly over 1 ton per hectare. Besides the reported yields of rice and corn, most of the fields still had cassava growing on them, and some of the farmers also grew cucumbers and squash. However they never kept yield records. The discrepancies in each farmer's yield is due to soil conditions, trees in the area, slope (the greater the slope the less arable land under crop), the amount of cassava and cucumbers, and individual management.

The farmers' cooperation program was expanded to 25 farmers (out of the 27 farmers operating in the 6.1 hectares) on March 1, 1979. On that date peanuts of the variety Gajah and local varieties were planted, intercropped with maize of the variety H-6. The soils were fertilized at the rate of 50 kilograms per hectare of urea, 100 kilograms per hectare TSP and 50 kilograms per hectare KCl.

Vegetable Planting

Hybrid vegetable seeds purchased from commercial sources in Bogor were given to the farmers participating in the cooperation program to test them under Panawangan environment. The seeds were planted in the farmers' gardens without supervision. The following vegetables were planted: tomatoes, bell peppers, long red cayennes, Chinese cabbage, cauliflower, green onions, eggplant, cucumbers, carrots, leeks, beets, onions, melons, watermelon and beans. None of these vegetables were successfully grown in Panawangan during the rainy season of 1978 - 1979.

Crop Utilization

Most of the crops produced by the farmers are either consumed by them and their families, sold for cash or traded for other commodities. However, the crop residues such as corn stalks and peanut and cassava leaves are usually wasted. These crop residues, if stored in silos, could be an excellent source of high quality silage for later use for livestock as needed (See silo operation Chapter III).

Other crops such as sorghum, millet and cowpeas could be grown during the dry season when none of the traditional crops can grow because of lack of soil moisture. These crops, which the people do not usually consume in Java, can be

used also as feed for sheep, fish and poultry. The June 1979 Draft Report describes the detailed procedures for poultry and livestock feeding programs and drying and proper storage of grains.

Soil Analysis

The soil fertility trials performed in Panawangan were done in cooperation with the Soil Research Institute at Bogor in an attempt to correlate the soil analysis data to the actual field response of crops to fertilizer inputs. The soil analysis data from the monoculture cropping plots of peanuts planted in May of 1978 is presented in Table III-2 (See Figure III-1 for layout of plots).

The soil analyses show that the texture of the soils is a heavy clay, however because these soils are oxisols (latosols) their soil structure is excellent. The water infiltration is very rapid and only when the soils are puddled and their structure broken is the water infiltration slow.

The soil pH is low, about 5.2, which is strongly acid and could effect the growth of certain plants such as soybeans and sorghum.

The organic matter content expressed as percent C (carbon) is about 2.65 which is medium with a percent N (nitrogen) in the organic fraction of about 0.22 which is considered low to medium. The C/N (carbon to nitrogen ratio) is medium, averaging about 12.

The exchangeable bases content shows a medium level of calcium (Ca) of about 2.5 me/100 gm; a medium content of magnesium (Mg) with 1.2 me/100 gm; low sodium (Na) with approximately 0.2 me/100 gm and low potassium with 0.2 me/100 gm.

The peanuts responded very well to potash fertilizers in these trials (See yield data in the section on Monoculture Cropping for peanut fertility trials planted on May 4, 1978).

The cation exchange capacity (CEC) is very low, approximately 4.0 me/100 gm, as would be expected in a latosol. The adsorption capacity is medium with about 21 me/100 gm. The percent exchangeable bases is low to very low ranging from 22 to 15 percent.

The phosphate content (P_2O_5) is low as would be expected in a latosol, since most of the plant available phosphate is being fixed by the iron and aluminum compounds in the soil. The nitrate nitrogen (NO_3^-) and sulfate (SO_4^{2-}) appear adequate, although nitrogen will always be required if high yields are desired.

Fertilizer Recommendation

Based on the soil analysis data and field trial results the fertilizer recommendation for Panawangan are:

Crop	kg/ha		
	Urea	TSP	KCl
Rice	150 to 200	100	50 to 100
Maize	150 to 200	100	50 to 100
Peanuts	50	50 to 100	50 to 100

The urea for the rice and maize should be applied in three equal portions about one month apart.

The TSP should be hand broadcast prior to seeding operation and hoed in with the top 15 centimeters of soil. The phosphate is usually immobilized where it is placed in the soil by the iron and aluminum compounds in the latosol. Thus, it is essential that the phosphate is placed in the root zone so that the plants can have access to it.

The KCl, as well as the urea, is water soluble and thus can be hand broadcast on the soil surface, or incorporated with the soil at the same time as the TSP. The KCl may also be added in two or three applications together with the urea to avoid excess loss of fertilizer by leaching.

For tree fertilization a mixed fertilizer such as 15-15-15 (15 percent N, 15 percent P_2O_5 and 15 percent K_2O) should be used at the rate of 40 to 60 grams per tree. The fertilizer should be applied about 15 to 20 centimeters away from the tree in two or three holes approximately 15 centimeters deep.

Local grasses transplanted on steep eroded road banks for soil stabilization, should also be fertilized with urea at the rate of 100 kilograms per hectare. This will guarantee a quick establishment and fast propagation of the grasses to protect the site from soil erosion.

Grass Revegetation

The main purpose of revegetation is to provide soil cover to protect the structure of the topsoil from breaking down under raindrop impact. Breaking the topsoil structure (usually clay textured) does decrease the infiltration rate of water into the soil, thus increasing water runoff and therefore soil erosion. Once the needs for the vegetation are established, advantage should be taken of the many kinds of grasses and legumes presently available. When possible, they should be used not only for conservation but also as a source of income for the farmers.

It must always be kept in mind that the farmers in the watershed own, on the average, only 0.5 hectare of land per man. Good planning and maximum utilization of the available resources will be required to improve their income. Thus, the main objectives of the grass and legume rehabilitation are:

A. To prevent soil erosion by means of vegetative stabilization of the site.

B. To improve the grasses and legumes of the area for production at sites where weeds are presently growing.

C. To provide a source of good palatable and nutritional forage for livestock in the area.

D. To encourage the farmer to better utilize his land and give him an extra source of income.

The main areas to be vegetated are:

A. Waterways

B. Terrace risers

C. Under tree canopy

Grass Variety Testing

There are several kinds of grasses available with different characteristics and properties, each suited for specific jobs. The criteria for grasses and legumes used is based on growth habit characteristics, forage production, palatability, nutritional value and tolerance to soil problems. Grasses and legumes will be selected to perform different functions in the watershed as:

A. For waterways stabilization strongly rhizomatous, stoloniferous and short sod forming types of grasses for purely soil conservation purpose are needed.

B. For terrace riser stabilization a medium tall grass is needed to avoid shading the crops. However, strong rhizomatous and stoloniferous grass species would be undesirable for this particular use, since they could become a weed problem for the crops in the terrace. Many of these risers will also be a good location for quality forage for livestock and some of the nitrogen leached from the fertilizer applied to the crop in the terrace can then be utilized by the grasses. When terrace risers are over 1 meter high, 30 percent or more of the land is wasted on unproductive land which could be producing high yields of good quality forage.

C. For under tree canopy stabilization, a productive forage of good palatability and high nutritional value is desirable. It is important that these grasses and/or legumes are able to tolerate some shading.

Theoretically the use of legumes in association with grasses should offer the best solution for most of the above conditions. The main function for the legumes is to fix nitrogen in the soil and to increase the protein value of the forage for livestock feed. In practice there are mixed feelings about the validity of the grass-legume systems. More field trials should be evaluated before recommendations are made to the farmers on pasture management under a tree canopy.

In the Panawangan Pilot Demonstration Area, the following types of grasses were evaluated:

1. Local short sod grass
2. Kikuyu grass (Pennisetum clandestinum)
3. Setaria grass (Setaria sphacelata)
4. BB or signal grass (Brachiaria brizantha)
5. Brachiaria decumbens
6. Guinea grass (Panicum maximum)
7. Panicum muticum
8. Elephant grass (Pennisetum purpureum)
9. Pangola grass (Digitaria decumbens)
10. Pakistan grass

Local Short Sod Grass. This grass was excellent for the waterways; it provided the protection needed for the base as well as the side walls of the waterway. On steep roadside banks, when transplated in patches about 50 centimeters in diameter, it did not spread very well after one growing season. The value of this grass as soil conservation species is good but it is of little value as forage.

Kikuyu Grass. This grass grew well and spread quite rapidly on the terrace risers with low soil fertility. This is a good soil conservation species and easy to propagate vegetatively. It grows about 30 to 40 centimeters tall and reproduces by stolons and rhizomes. In steep small risers, it can do an excellent job stabilizing the site. However,its production as a forage species is not as good as Brachiaria under the Panawangan environment.

Setaria Grass. Setaria grass grew very well and was healthy; however as a bunch grass, it has low value as a soil conservation species. In association with legumes, it may be a good species to grow under the tree areas. Its tolerance to low fertility is poor and its forage production is fair.

Brachiaria brizantha and Brachiaria decumbens. These two grasses were definitely the best adapted species to Panawangan. They grew very well under poor soil conditions, their production was excellent, their propagation very good by stolons and they were very easy to spread vegetatively. The plant height is just right for risers 1 meter high and over. When sprigged 70 centimeters apart on a triangular pattern, it would form a sod within six to seven months transplanting. The acceptance by the farmers was very good.

Guinea Grass, Panicum muticum, Elephant, Pangola and Pakistan Grass. These grasses did not grow on the terrace risers. Their fertility requirements are too great to do well in poor soil, except perhaps for Pangola grass. Under well managed pasture and perhaps is association with legumes under a semi-cover tree canopy they may prove to be a more productive system.

Pasture management for best utilization of the land could be a very profitable operation when well planned. The forage production under tropical environment can be great if proper fertilization and the right species are used, and good management is followed. To determine these parameters, however, field trials need to be evaluated under the desired set of conditions. The use of marginal land, waste land, easily eroded land and under tree canopies for forage production will not only improve the soil conservation practices but also provide a greater supply of feed for livestock operations. The initial cost of purchasing good forage varieties will be more than compensated by the meat production since the land where pasture is to be produced was non-productive before. The high meat market prices also guarantee the success of these operations. A side benefit from the livestock program is the production of manure which is a valuable source of fertilizer for the farmers.

Terrace Riser Revegetation

The following amount and kinds of grasses were purchased for the 6.1 hectares Pilot Demonstration Farm in December 1977:

Brachiaria brizantha 16,600 pulls (about 3 plants per pull) at Rp. 3 per pull, with total cost of Rp. 50,000. This grass was purchased from local farmers'

grass nurseries at Rajadesa, Ciamis. From Rumah Perawatan Salib - Putih, Salatiga, Central Java the following grasses were purchased:

Kind of grass	No. of kg. (transplant)	Rp/kg	pulls/kg	Total cost Rp.
Pakistan grass	50	100	10	5,000
Pangola grass (Digitaria decumbens)	500	50	10	25,000
Setaria grass (Setaria sphacelata)	600	200	20	120,000
Elephant grass (Pennisetum purpureum)	500	50	10	25,000
Kikuyu grass (Pennisetum clandestinum)	240	300	50	72,000

The kikuyu and setaria grass were planted in a triangular pattern at 50 centimeters apart in the terrace risers. The Pakistan, pangola and elephant grass were planted is a single row at the bottom of the terrace risers at 20 centimeters apart within the row. The brachiaria was planted on the risers in a triangular pattern at 50 centimeters apart. After a year's evaluation it was concluded that for terrace riser revegetation, Brachiaria brizantha was the best. In December 1978, 80,000 pulls (at Rp. 3 per pull delivered to the site) of brachiaria were purchased from Rajadesa to complete the terrace riser revegetation in the 6.1 hectares. The brachiaria was transplanted in a triangular shape at 50 centimeters apart. Also in December 1978, two truck loads of Brachiaria decumbens were obtained from the Animal Research Station at Lembang, Bandung, for a labor cost of Rp. 20,000. The transportation was supplied by Proyek Citanduy.

Within a year of growth about 100 percent revegetation cover on the terrace risers was attained (complete ground cover with mature grass). The average brachiaria production was 2 kilograms per square meter of green weight per cut and 7 cuts were obtained per year, or 140 tons per hectare (green weight)

To revegetate 1 hectare of dryland farm, assuming that 30 percent of the land is under terrace riser, 12,000 pulls of brachiaria will be needed.

However, the farmers will tend to plant in the order of 16,000 to 18,000 pulls per hectare if they are not supervised.

Under Tree Canopy Revegetation

No attempts were made to establish a grass-legume mixed pasture under the trees area, but twenty plots of Panicum muticum, Pennisetum purpureum, Panicum maximum and Pakistan grass were planted under the tree canopy. Presently the ground under the trees is 100 percent covered with local grasses. In areas over 50 percent slope which were under crop cultivation prior to the project implementation, Brachiaria brizantha was planted in existing terrace risers and trees on the narrow bench terraces.

A grass-legume mixture under a tree canopy is probably a good system; however, the available data on this type of system is quite scarce. More trials are needed to evaluate the system before it can be recommended to the farmers. Several serious problems were encountered with the silvapasture culture in Panawangan:

1. The farmers do not take care of the pasture if they do not have a use for it. Thus, either more livestock should be given to the farmers, under the revolving system (See livestock section), or loans at low interest should be made available for the specific purpose of purchasing livestock. (See livestock section for pasture production and feed demand from livestock).
2. During the 16 months' existance of the project, too many activities and too many new concepts were given to the farmers in a short time period.
3. The Consultant did not have a counterpart and a budget for labor and proper trials could not be started and evaluated.
4. The farmers did not take care or show much interest on the plots established under the tree canopy. Without management the grasses did very poorly.

There are a wide variety of legumes well adapted to this environment and with excellent crude protein content and low to good palatability that should be tried in future trials. To mentione a few: Centrosema pubescens, Desmodium heterophyllum, Glycine javanica, Lespedeza striata, Pueraria phaseoloides, Stylosanthes humilis, and many other. Some of these legumes like , Pueraria phaseoloides, Centrosema pubescens, Colopogonium muconoides and Psophocarpus palustris were available for purchase from:

Pangkalredjo
Jalan M.H. Thamrin 77
Semarang

Grass Revegetation in the Other Subwatershed

In Subwatershed II about 10 percent of the terrace risers were revegetated with Brachiaria brizantha during the months of August to September of 1978.

In Subwatershed III, IV and V the following grasses were planted during the early part of 1979:

Pulls of Grass Planted

Watershed	Terrace Risers		Under Tree Canopy			
	Brachiaria brizantha	Brachiaria decumbens	Pennisetum purpureum	Digitaria decumbens	Setaria sphacelata	Panicum maximum
Sub - III	10,300	5,200	3,600	2,800	3,500	2,000
Sub - IV	20,000	3,500	6,900	-	-	500
Sub - V	3,550	-	11,900	-	-	600
Total	33,850	8,700	22,400	2,800	3,500	3,100

Trees for Cash Crop, Lumber and Fuel under Silvapasture Management Practices

The recommended land use for slopes over 50 percent in the Citanduy basin is a permanent silvapasture culture. On these steep slopes, besides the potential soil erosion from annual cropping, the width of the bench terraces for crop production is too narrow and thus, in most cases, not worth the farmers' time and effort. On government owned lands there is little difficulty in establishing most any kind of forest if the depth of the soil is adequate and if there is a budget for it. In Panawangan, however, as in most of the Citanduy drylands, the land is privately owned and is usually the main source of income for the owners. To alleviate the actual or potential soil erosion problems from annual crop farming, on steep slopes stable silvapasture farming is needed but good planning is required to compensate for the loss of crop values. The planning design must be oriented to provide the maximum income to the farmers so that the concept of changing land use is economically attractive. High cash crop trees such as clove (Eugenia aromatica), petai (Parkia spaciosa), citrus, avocado (Persia americana) and other fruit trees are well liked by the farmers. Fast growing lumber trees like Albizzia falcata, puspa (Schima walichii), afrika (Maesopsis sp.) and kaliandra and leucaena species for fuel wood are also well accepted by the farmers. Under the tree canopy, a mixture of high yielding palatable and nutritional grasses and legumes could provide extra feed to expand their livestock operation.

Tree Planting in the Pilot Demonstration Farm

In the 6.1 hectare pilot demonstration farm, 1.7 hectares of land were over 50 percent slope. Some of this 1.7 hectares was already under tree cover. On the remainder of the steep slopes, the following trees were planted:

Kind of Tree	No. of Trees Planted	% Survival
Clove	200	98.5
Petai	100	100
Albizzia	400	10
Mahogany	200	1

The market purchasing prices of these trees were Rp. 300 per clove tree about 30 centimeters tall, Rp. 100 per petai approximately 30 to 40 centimeters tall and Rp. 10 per albizzia rooted stick. The mahogany trees were purchased from the Forest Service at Rp. 10 per tree about 60 to 70 centimeters tall. The clove and petai were potted while the albizzia and mahogany were bare root stocks. The planting and fertilizing was done free by the farmers owning the land where the trees were planted.

The high mortality on the albizzia and mahogany trees was due mainly to poor handling of the bare root stocks of the young trees which must be kept moist and protected from the sun and wind. Also when planted the soil needs to be firmly packed around the roots to guarantee a continous flow of water from the soil to the roots. The flow of water from the soil to the roots is carried on mainly by capillary movement. If large soil pore spaces are present in the vicinity of the roots, capillary movement of water cannot take place and thus the trees will die if under less than field capacity moisture conditions. It is important also to prune the tree tops to cut down the evapotranspiration as much as possible. This is especially critical at the early stages when the roots are starting to grow in a new environment and a regular moisture flow from the soil to the roots has not yet been established.

Although the farmers were informed on several occasions how to handle the bare root stocks, obviously they either forgot to follow the instructions or, more likely, forgot to tell their wives, who usually do the planting but never come to the meetings to know the proper procedure.

The recommended planting distance for the clove trees was 6 meters x 6 meters space per tree, 12 meters x 12 meters for petai and 4 meters x 4 meters for albizzia. Each tree was fertilized at the time of planting with about 40 grams TSP and 20 grams of urea. The fertilizers were placed about 10 centimeters away from the roots on both sides of the tree.

Popular trees with the foresters like mahogany, teak and pine are excellent tree for the National Forest; however they are not recommended for

privately owned lands. The majority of the dryland farmers in the watershed own 0.5 hectare or less; their precious productive land cannot be occupied by a tree that will take at least 30 years before it can be harvested.

The main use of pines by the farmers is as fuel wood, and for that purpose there are other species like leucaena and kaliandra which are better. These species, besides producing much higher calories per unit weight of wood, also grow much faster and can fix nitrogen. Their leaves can be used for feeding livestock (about 5 percent of the diet) and make an excellent green compost because of the high C/N ratio.

Tree Planting in Other Subwatersheds

In Subwatershed II (53.21 hectares) there are 18.3 hectares of land with over 50 percent slope. On this land 1,200 orange trees were planted in October 1978 by Dinas Pertanian Kabupaten (District Agriculture Office).

In the Subwatershed III (45.3 hectares) there are 28.8 hectares with over 50 percent slope; in Sub-IV, out of 47.65 hectares, 31.09 hectares are over 50 percent slope and in Sub-V, out of 40.04 hectares, 26.81 hectares. The P_3RP-DAS, Citanduy (Watershed Mangement Office from Forestry Department at Ciamis) has planted the following kinds and quantities of trees in the Panawangan Pilot Project since December 1978:

Subwatershed	Clove	Petai	Jengkol	Albizzia Kaliandra	Total No. of trees
III	1,366	522	786	2,714	5,388
IV	1,232	729	501	2,012	4,474
Total	2,598	1,251	1,287	4,726	9,862

In Subwatershed V there are presently 9.93 hectares of clove plantation which was planted several years ago by the owners. The land under these plantations is very stable since there is no annual cropping and the tree understorage is covered with local grass. If improved pasture would be grown on this land,

the amount of feed for livestock production could be a extra source of income from meat and organic manure for the cloves. On this type of clove plantation the land is not generally fully utilized and these plantations usually belong to absentee owners.

Tree Production Figures

For clove trees the average dry clove yield by age is:

Age (years)	Yield (kg/tree)
1 to 5	0
6	0.25
7	0.5
8	0.75
9	1.0
10	1.2
11	1.4
12	1.6
13	1.8
14	2.0
15	2.1
16	2.2
17	2.3
18	2.4
19	2.5
20	3.0

From: Bulletin of Indonesian Economic Studies. Vol. XII, No. 2 July 1976

Clove trees grow very well throughout the watershed. The current price of a kilogram of dry clove is about Rp. 5000.

The petai trees grow well at elevations between 200 and 800 meters when sufficient rainfall and good soil drainage exist. These trees are nitrogen fixers and their leaves produce a good compost as do most of the leguminous plants, because of their high C/N ratio. One problem with these trees is that they grow quite big when mature and are very shady, thus few plants can thrive in the under tree storage. These trees bear a pod with 10 to 13 large sized beans per pod. The beans are very tasty and a popular food and sell in the market for about Rp. 50 per pod. A petai tree begins to bear fruit at the age of 10 years with an annual production of about 100 pods per tree. As the tree grows the production increases to several hundred pods per tree. The pods grow in racimes of 5 to 10 pods.

The albizzia grow well in areas with rainfall between 2000 and 6000 millimeters per year. They require a fertile to medium fertile soil and do better at elevations between 10 and 1500 meters. They can reach a height of 45 meters with a trunk diameter of 100 centimeters. They are very fast growers with a thin wide canopy which allows a large portion of sun light to reach the tree understorage. Their trunks are rather straight and up to 20 meters there are no branches. These trees are also nitrogen fixers. They can be harvested after 8 years and at 12 years their wood production is $\pm$ 180 cubic meters per hectare at 5 x 5 meters planting distance. This wood can be used under roof structures, pulp, wood lining etc.

The potential for fruit production is also great in areas over 50 percent slopes. The high existing local market prices should be an incentive for the farmers. For example: the current price of 1 kilogram of local oranges is from Rp. 400 to Rp. 800 depending on size and time of the year; the avocados sell for Rp. 100 to Rp. 200 per kilogram depending on the season. In the case of citrus trees, there are several diseases which if not properly handled will certainly wipe out the orchard. The grass and legume vegetation under the tree canopy is covered in the section on "Grass Revegetation".

Nursery

Large amounts of plant material are needed for revegetation to stabilise the soil and thus avoid soil erosion. Nurseries are an essential part of the program to provide adequate supply of plant material when needed close to the site and to help keep the cost of vegetation down. The nurseries should supply all the required grasses, trees and shrubs suitable for the environment in that area. The nurseries should be located in sites where the topsoil is deep for better soil fertility,adequate water drainage and sufficient irrigation water to provide a year round operation. It is important to provide a good environment for the plants so that optimum growth is achieved and transplanting operations can be carried out as early as possible.

A nursery for trees, shrubs, grasses and some vegetable crops was established in August of 1978 and is maintained by the P_3RP DAS Citanduy. The nursery is located in Cilulumpang settlement, Kertayasa village, subdistrict of Panawangan. The elevation is 400-450 meters above sea level, and its area is about 1 hectare of land with slopes of 10 to 30 percent. The land was bench terraced and waterways were provided to take care of excess water runoff. A spring water source provides some irrigation for the nursery. To maximize the use of this water, four small reservoirs were built and a pump is also being used to irrigate the seedlings.

Building facilities were also provided to store equipment and provide temporary shelter for the attendants.

The seed beds are 1 x 6 meters or 1.2 x 10 meters according to the terrace width. This nursery provided the seedlings mainly for Subwatersheds III, IV and V. The kinds of trees, seed bed size, total area and amount of seed used are summarized in the following table:

Kind of Trees and Grasses	Planting Distance cm x cm	Amount of Seeds per Seed Bed	Size of Seed Bed m^2	Total Area of Seed Beds Planted (m^2)
Albizzia	rows	0.069 kg	6	360
Petai	40 x 40	75 seeds	12	1596
Clove	40 x 40	75 seeds	12	1280
Coffee	30 x 30	132 seeds	12	1908
Kaliandra	rows	0.172 kg	6	900
Grasses (9 varieties)	20 x 20	34,000 (pulls)	12	1392

The grasses growing in the nursery are:

Brachiaria brizantha
Brachiaria decumbens
Setaria sphacelata
Panicum maximum
Pennisetum purpureum
Pannisetum clandestinum
Pakistan grass
Digitaria decumbens

Several seed beds were used to start seedings of cabbage, chilli pepper, tomato, carrot etc. for distribution to the farmers.

Livestock Program

The livestock program is not a single operation by itself but an integral part of the present farm diversification to provide better utilization of resources.

The main activities in the livestock program are the sheep and goat operation and silo evaluation. Already planned and ready for implementation are the poultry operation and grain storage facilities. The poultry operation can go into effect if the production of grain sorghum and/or millet or cowpeas are proven successful in the area.

Sheep and Goat Program

The potential production of meat from sheep and goats could be tremendous under this environment. As much as one third of the terraced land can be out of crop production and wasted in terrace risers depending on the slope of the terrain. The use of forage grasses in the terrace risers would allow the farmers to stabilize their soils and provide them with an extra source of feed for their livestock. On lands over 50 percent slope, where lumber, fuel and cash crop trees will be grown, grasses and legumes of good forage quality should also be produced in the under storage. The expansion of their livestock program, besides bringing an extra source of income to the farmers, will provide them with additional organic fertilizer much needed in their eroded soils.

Traditionally the farmers in the watershed at Panawangan keep their livestock penned. This is an excellent practice as far as soil conservation, maximum utilization of their land for crops and forage, collection of organic fertilizer for their crops, and providing the desired diet for the livestock. The pen consists of a small bamboo frame house with a straw or tile roof and troughs in its side walls. The floor is about 1 meter above the ground surface and a pit is dug under the pen floor to collect the livestock manure. The size of the pen depends on the number of animals that it needs to accomodate.

The preference between sheep or goats among the farmers is about 50 per 50; they both have advantages and disadvantages. For example, the sheep can

put on weight faster than the goats and they may be slightly more resistant to diseases. However the goats can have a more diversified diet because they are browsers and so they are able to utilize foliage from shrubs and trees. Moreover goat meat is the preferred type of meat for the popular "Sate dishes". However when the meat is cooked in ways other than sate, the people usually prefer sheep. The wool from the sheep is of no value for all practical purposes and the goats are seldom milked.

In the Panawangan Pilot Demonstration Farm of 6.1 hectares, 30 sheep (27 ewes and 3 rams) were given to the 27 farmers owning and working their land in this farm. The sheep were given to them on a "revolving system" by which the farmer will keep the animal until the lamb or kid can be weaned, at which time the original sheep or goat will be passed on to another farmer within the watershed. The lamb raising operation by the 27 farmers in the 6.1 hectares needs much improvement. Of the 27 ewes given to the farmers, 15 lambs were born (8 females and 7 males). The mortality rate among the lambs, 53.3 percent, was extremely high. The reproductive capacity of these ewes was 0.3 lamb per ewe. More extension work by the Dinas Peternakan (Animal Husbandry Office) from Panawnagan and Ciamis with the farmers is indeed needed. Some of the farmers in the 6.1 hectares, where plenty of forage is now being produced, have significantly expanded their flocks with the same amount of land to produce the forage. Keeping in mind that only a limited amount of data is presently available, from the 16 months old Panawangan Project and the assumptions made, rough estimates can be made. For example the average dryland farmer owns about 0.5 hectare of which 25 percent, depending on the slope, is wasted on terrace risers. This amounts to 1,250 square meters of wasted land which could be under forage production. The average grass production in the Panawangan terrace risers with 100 percent ground cover (no soil visible when the grass is ready to be cut) is 2 kilograms per square meter of green weight per cut. Presently an average of 7 cuts per year is being obtained. If all the forage was stored in silos and assuming a 50 percent weight reduction, 7 kilograms of silage per square meter of terrace riser could be produced per year. If, on the average, a farmer had 1000 square meters of terrace risers, his production could be 7,000 kilograms of silage. The consumption of a sheep or goat is

about 1.5 to 2 kilograms per day, therefore he could maintain about 10 sheep or goats on the grass produced on the terrace risers on a 0.5 hectare of land. Beside the grass forage, other farm products like corn stalks, cassava and peanut leaves can be used as livestock feed and stored in the silos. Specifically one of the farmers at Panawangan owning 0.5 hectare of land increased his flock from 1 to 9 sheep from November 1977 to November 1978; however, he could easily feed 15 head with his present forage production.

Silos

As a support to the livestock program, different silo facilities are now being tested in Panawangan. The type of silos under evaluation are those which the farmer can afford to build or buy by himself; if it was not within his own budget capability it was not considered. The use of silo facilities is a must to maintain a continous source of livestock feed throughout the year, especially during the three to five months of dry season. Another reason is to better utilize the farm products such as corn stalks after the green ears are harvested, cassava leaves after the roots are pulled out, green tops of the peanut, and even some banana and pineapple leaves for livestock feed. The main types of silos used were:

Asphalt drum silos. Old asphalt drums from road construction can be bought for approximately Rp. 300 to Rp. 400 each. The drum will be open on one end and sufficient holes are made in the other end to allow adequate drainage for the silage. If they have not been opened on their side, they can be installed just about anywhere. The chopped grass can be well packed in the drums, then covered with a piece of plastic and topped with soil. If the drums have been opened on their side, they can be used by placing the drum vertically against the soil embankment. After the drum is filled with forage three to four bamboo poles should be driven into the soil to hold the drum in place and the soil should be packed against the drum. (Figure III-2).

Round, well silos. Well silo should be dug in a location with adequate drainage to prevent water from standing in the bottom of the silo. The bottom should be concave to facilitate forage compaction and drainage in the silo.

The dimensions should be about 75 centimeters diameter by 1.25 meters depth. A silo larger than this may not be practical if the size of the herd is small, as in most cases. Once the top is opened the silage must be used within a relatively short time to avoid spoilage. Also a temporary roof should be placed or top of it once it is open to prevent rainfall from entering the silo. On the side walls of the silo, rice straw and banana leaves can be used to protect the silage from excess water seeping into the silo from lateral soil water movement. Once the silo is full of forage and well packed a piece of plastic sheet can be used to cover the top of the silo with about 30 centimeters of soil over the plastic (Figure III-3).

Trench Silos. The trench silo should be built in the side of a hill, taking advantage of the slope for easy drainage and desired depth of the trench. The dimensions should be approximately 75 centimeters wide, 2 meters long and 1 meter deep (See drawing) with a rounded bottom for easy compaction and improved drainage. The walls and floor of the silo should be protected with rice straw and banana leaves to prevent excess ground water from getting into the silage. After the silo has been filled with well packed forage, the trench can be covered with a plastic sheet and about 30 centimeters of soil placed on top of the plastic sheet. This type of silo has some advantage over the "well type" because only a small portion of silage will be exposed to the atmosphere once the silo is opened. Also since the trench is covered with a plastic sheet and only one end is opened, the silage will always be protected from the rain. The required investment will be Rp. 700 for the plastic sheet and a few hours of digging (Figure III-4).

Plastic Sack Silos. Heavy plastic tubes of about 50 centimeters diameter, cut into lengths of 1.5 meters were given to the farmers to be used as sack silos. The plastic tube can be tied on one end, filled with chopped forage and then a vacuum can be used to remove air from the plastic tube before the other end is tied. The vacuum can be created with the help of a bicycle pump by inverting the seal in the pump plunger. Another way is by using the bamboo water pipes with plasic tubing to create the vacuum (Figure III-5).

It is imperative that a minimum amount of air remain in the sacks to avoid spoilage of silage.

Data from the Institute Pertanian Bogor (Bogor Agriculture University) Department of Animal Science shows that a round, well silo of 60 centimeters in diameter and 1.5 meters deep when well compacted, can store 500 kilograms of silage. The daily silage ration for sheep or goats is about 1.5 to 2 kilograms per head; therefore, a silo of the above dimensions could feed 5 sheep for approximately 1 1/2 months. This data on silo capacity agrees quite well with similar data from the center for the Animal Research and Development at Ciawi (Pusat Penelitian dan Pengembangan Peternakan, P4), RI-CSIRO Australia, developed by Mr. J.E. Anderson.

Beehives

Three beehives were brought to the Panawangan Pilot Demonstration Farm by the Forestry Department. Classes and training for the farmers were also provided on beehive keeping and a budget was submitted to provide more bee units during the 1979-1980 fiscal year.

The beehives require very low labor for maintenance and practically no cost for feeding, thus providing an extra source of income or food for the operator with practically no inputs beyond the original cost. Flowers, which are always abundant under the tropical environment, provide an excellent source of feed for the bees. Honey bees are very important in their role of pollinating the fruit trees and other plants, thus enhancing the potential of these plants to bear fruit.

Poultry Program

The utilization of farm products such as grain sorghum, millet and cowpeas as the main source of food for a poultry operation could represent a substantial increase in income for the farmers. During the dry months of June, July, August and part of September, the land is allowed to stand idle since there is, usually, not enough precipitation to grow drought tolerant crops such as sorghum, millet and cowpeas. The food value of these crops is quite similar to that of corn, for example:

Feeding Stuff	Total dry matter in 100 lbs	Digestable Protein	Total Digestable Nutrients	Nutritive Ratio
	%	%	%	1:
Corn (dent well dry)	88.5	7.5	83.7	10.3
Cowpeas	88.6	19.4	76.5	2.9
Sorghum, grain, sweet	88.8	5.6	74.3	12.3
Millet seed, hog	90.7	8.3	77.1	8.3
Soybeans	90.2	32.8	86.2	1.6

From: Feeds and Feeding by F.B. Morrison, Morrison Publishing Company, Clinton, Iowa, USA.

Although no poultry operations were started at Panawangan mainly because of lack of time, the program was carefully studied and considered, and is thus presented here as a reference for future use.

The egg production of the local layer is approximately 30 to 40 eggs per year, while the improved varieties of layer will produce about 200 eggs per year. The meat production in improved varieties of broilers is just as spectacular, about 1.5 kilograms per birds within 9 to 10 weeks of age. To obtain this level of production certain management techniques must be followed. These include high intakes of well balanced rations, routine vaccination against Newcastle and other diseases, good housing and the use of birds with a high

genetic potential. The demand for eggs and poultry meat is constantly increasing because of population growth and higher incomes which allow people to eat more often the very popular and high protein poultry food products. The majority of the improved varieties of layer operations are located in the vicinity of large towns, while broiler operations exist only near or in large cities like Jakarta, Bandung, Jogjakarta etc. Nearly everyone admits that the "kampung" (village) eggs and chickens taste much better, however because of the production efficiency the difference in prices is large. One kilogram of kampung eggs costs about Rp. 1,000 while improved eggs only about Rp. 650 (one kilogram contains about 16 to 18 eggs), however their nutritional value is the same. To give an idea of the rapid increase in egg production from improved varieties of layers, in Banjar, West Java, a remote town of 35,000 inhabitants close to the Central Java border, the weekly egg production has increased from 100 to 600 kilograms in the past three years. However, no broilers are produced in Banjar.

The major cost, 60 to 65 percent, of a poultry operation is the purchasing of prepared feed rations from commercial supplies. It is also recognized that the difference in price between home mix and commercially prepared poultry feed is very small and that diet imbalances from home mix discourages that practice. However, the use of concentrate poultry feed (25 to 30 percent) with a mixture of sorghum (white grain), millet and cowpeas grain (70 to 75 percent) would produce a good balanced feed at considerable savings if the farmers produced the grain. More data is available in the section on livestock feeding for food values of local feedstuffs, all mash rations and diet requirements.

The price of 10 day old chicks is Rp. 550 per chick and that of started pullets (young hens) Rp. 2750 per pullet (Banjar prices).

The most popular white-shelled layer is the Hyline bird and brown-shelled layer the Harco bird. They are preferred because of their survivability and cost of egg production.

The food consumption of layers is approximately 40 kilograms per year per hen. The price of feed is:

	Home mix	Purchased
Starter	115 Rp/kg	125 Rp/kg
Grower	110 Rp/kg	115 Rp/kg
Layer	90 Rp/kg	110 Rp/kg

Building facilities for layers should be at least 10 meters apart for hygiene reasons. The number of birds per cubic meter should be four to five, good aeration should be provided and enough overhang in the roof to protect the birds from the rain. Dry conditions should be maintained since birds are very susceptible to dampness and can easily get diseases such as colds, pneumonia, etc. See Figure III-6, III-7 and III-8. About one nest per every five birds is required. The nest should be placed in the darkest side of the building since hens prefer to lay the eggs in dark places. About 10 linear centimeters of feeder space should be allowed per bird. The watering space requirements per 100 birds is about 2 meters running length of channel type trough. Clean water should be kept in the trough at all times for sanitary purposes. Space to put feed hoppers and linear feeders for forage, grit and shell need to be provided also (See Figure III-9 and III-10). To cut down expenses and provide maximum use of local materials, at least two of the walls and the floor can be of split bamboo with an open space between bamboo of about 2.5 centimeters. The floor is designed at about 1 meter from the ground surface for easy collection of poultry manure. Metal protection should be placed in the stilts to prevent rodents from getting into the building. Kerosene or other repellents can also be placed on the base of the stilts to keep ants and other crawling insects from getting into the building.

The split bamboo at 2.5 centimeters apart in the floor will allow the excreta to fall to the ground to provide better sanitation and easy maintenance. All the troughs and nests are placed on the outside walls of the building so that the building attendants do not need to enter the building to avoid contamination of diseases by soil carried on their shoes or feet. Dry and

clean rice hull must be kept at all times in the bird nests. The building walls facing the predominant wind direction should be protected by woven bamboo mat walls. The building design of 5 x 5 meters will easily accommodate 100 birds which is a good size unit to handle until more experience is gained. These kinds of units could be run by group of farmers or perhaps by the village as a community project. The government program, Bimas Ayam, provides credit to purchase 100 to 500 chicks, plus some information on hygiene, vaccination, vitamins etc. at the Kecamatan (Subdistrict) level. Poultry extension agents to advise and assist owners of poultry operations are available at the Kecamatan (Subdistrict) level.

Fish Ponds

The use of fish ponds in Java is a common practice. In the Citanduy watershed it appears that in Tasikmalaya and Ciamis districts fish ponds are more abundant than in Kuningan or Cilacap districts.

The use of fish ponds is an excellent practice not only as a high source of protein food (See Table III-4) but also as an extra source of income. Fish has a very high food quotient (kilogram of gain per kilogram of feed consumed). The food quotient for the common carp averages from 1.3 to 6 according to the feed type used. However, in most of the cases, no feed is required since existing natural fish food in the ponds provides sufficient nutrients.

If the fish ponds are used as a source of food for the family, they can produce a year round supply and if used as a commercial operation, at least two harvests per year can be expected.

The fish ponds at Ciracak village, Panawangan, are located mainly along the creek, with some also in side slopes where natural springs existed or water diversions were made. In all the cases the farmers have taken advantage of the topography to use gravitational flow to fill and drain their ponds.

The soil textures are heavy clays of good fertility, thus providing an ideal condition for fish ponds. The water temperatures, because of the elevation and semi-shade protection, are within the optimum range for warm water fish cultures (20-35^{o} C). The oxygen content appears to be adequate, perhaps because of the relatively cool temperature and the fact that the water falling constantly into the ponds through the bamboo pipes is aerated. Other factors like pH (acidity and/or alkalinity), hardness, turbidity, and nutrient availability of the water seem to be adequate. A good indicator of the suitability of the soils for fish pond culture is the soil's ability to grow crops, and these soils are good.

The turbidity of the water from clay and silt load, trash etc. from runoff after heavy rains and flash floods can be easily controlled in the diversion ponds with the aid of water filters (Figure III-11). The use of a water filter will also keep trash fish out of the ponds.

The major considerations for improving fish pond cultures in this area are : the stocking density for optimum fish growth and proper feeding to obtain this density; the use of polyculture to provide a better utilization of the ponds's available fish food, thus giving greater fish yields with the same inputs. For example fish feeding on phytoplankton (small aquatic plants), others feeding on zooplankton (small aquatic animals), worms, snails etc. and some others feeding on vegetation, such as aquatic grasses, can live together without competing for food supplies.

In Panawangan fifteen fish ponds were rehabilitated in January 1979 and used to evaluate two different rates of stocking polyculture with and without additional feeding, versus the traditional stock and feeding system. Each treatment was replicated three times.

The fish ponds were rehabilitated free by the owners while the planning, supervision, stocking, feeding and data collection was done by the Ciamis Kabupaten (District) Dinas Perikanan (Fishery Offices) and the study was financed by a special grant from U.S. AID Jakarta office. The treatments were as follows :

Treatment A

Stocking rate of fingerling polyculture per pond

Gold fish	7.5 kg
Tawes	1.5 kg
Mujaer	1.0 kg

Size of pond for each replication and owner's name for identification :

Replication	Pond Size (m^2)	Owner's Name
A - I	80	Sukinta
A - II	102	Winita
A - III	117	Sutardi

Treatment B

Stocking rate of fingerling polyculture per pond :

Gold fish	7.5 kg
Tawes	1.5 kg
Mujaer	1.0 kg

Nutrient fertilizers per fish pond :

Organic Manure	30 kg
Triple super phosphate (TSP)	0.8 kg
Urea	3.6 kg
Extra fish feed (fine rice bran)	10 kg

Size of pond for each replication and owner's name for identification

Replication	Pond Size (m^2)	Owner's Name
B - I	98	Wiharto
B - II	100	Suwirya
B - III	195	Hamidi

Treatment C

Stocking rate of fingerling polyculture per pond

Gold fish	1.5 kg
Tawes	7.5 kg
Mujaer	1.0 kg

Size of pond for each replication and owner's name of identification

Replication	Pond Size (m^2)	Owner's Name
C - I	80	Wiharta
C - II	84	Amanta
C - III	60	Sukinta

Treatment D

Stocking rate of fingerling polyculture per pond

Gold fish	1.5 kg
Tawes	7.5 kg
Mujaer	1.0 kg

Nutrient fertilizers per fish pond :

Organic manure	30 kg
TSP	0.8 kg
Urea	3.6 kg
Extra fish feed (fine rice bran)	10 kg

Size of pond for each replication and owner's name of identification

Replication	Pond Size (m^2)	Owner's Name
D - I	78	Sukinta
D - II	60	Parman
D - III	117	Sukanta

Treatment E

This treatment is the control where traditional fish stocks and feeding practices were used.

Size of pond for each replication and owner's name for identification

Replication	Pond Size (m^2)	Owner's Name
E - I	221	Wianta
E - II	235	Winita
E - III	204	Bakri

For location of fish ponds at Ciracak village, Pahawangan, see map on Figure III-12 at the end of this Chapter.

The cost of materials used in the fish pond studies in rupiah per kilogram is as follows :

Gold fish	1000
Tawes	750
Mujaer	500
Organic manure	50
TSP	70
Urea	70
Fine rice bran	50

The total average production for the four treatments used in these trials is as follows :

Treatment	Total Mean Production kg of Fish per Pond *	LSR 0.5%	LSR 0.1%
C	11.7 a		
D	12.6 a	3.52	5.12
A	15.1 ab	3.66	5.40
B	18.5 bc	3.75	5.55

* Yields followed by the same letter are not significantly different by Duncan's Multiple Range Test. No data was available for treatment E.

The fish production of treatment B was :

Fish Variety	Mean kg of Fish/Pond
Gold fish	9.4
Tawes	4.1
Mujaer	5.0
Total Mean	18.5

The Fishery Department at Ciamis estimated that about 60 percent of the fingerlings were dead at the time they arrived at Ciracak, Panawangan. The high mortality was due to inadequate facilities to transport the fingerlings to the site.

This data was collected and analyzed by the Ciamis Kabupaten Fishery Department. The economic evaluation is presented in Chapter IV.

TABLE III-1

MONTHLY PRECIPITATION IN MILLIMETERS FROM TWO LOCATIONS WITHIN THE PROJECT AREA AT CIRACAK

Month	Location I	Location II
	1977	
December	407	491
	1978	
January	291	235
February	456	425
March	230	236
April	206	225
May	361	420
June	419	476
July	209	210
August	206	232
September	283	355
October	592	557
November	362	369
December	264	391
	1979	
January	332	349
February	367	333
March	218	263

TABLE III-2

SOIL ANALYSIS FOR COMPOUND SAMPLES FROM THE PEANUT PLOTS PLANTED IN MAY 1978

Location	%			pH		Organic Matter			NH_4AOC at pH7 - Soil Dry at 105°C me/100 gm						%	Bray I ppm	Dry Soil ppm	
	Sand	Silt	Clay	H_2O	KCl	%C	%N	C/N	Ca	Mg	K	Na	CEC	Adsorpt. Capacity	Exch. Bases	P_2O_5	NO_3	SO_4
Rep. IA	3	14	83	5.3	4.3	2.70	0.22	12	2.5	1.2	0.3	0.4	4.4	21.9	20	1.3	87	363
Rep. IB	4	16	80	5.2	4.3	2.50	0.21	12	2.4	1.2	0.4	0.3	4.3	22.9	19	0.8	91	337
Rep. IIA	3	14	83	5.1	4.2	2.64	0.21	13	2.0	1.0	0.2	0.1	3.3	20.6	16	0.8	176	329
Rep. IIB	3	17	80	5.1	4.2	2.78	0.23	12	1.8	1.0	0.2	0.2	3.2	21.6	15	0.8	110	347
Rep. IIIA	3	21	76	5.2	4.3	2.67	0.22	12	2.9	1.4	0.2	0.1	4.6	20.5	22	1.3	92	362
Rep. IIIB	4	15	81	5.4	4.3	2.49	0.22	11	2.9	1.5	0.2	0.1	4.7	21.2	22	1.3	102	292

TABLE III-3

SILAGE ANALYSES FROM DATA OF MR. J.E. ANDERSON FROM

PUSAT PENELITIAN DAN PENGEMBANGAN (ANIMAL RESEARCH AND DEVELOPMENT) AT CIAWI, BOGOR

Type of Silage	kg of Material	Moisture %	Ash %	Fiber %	Protein %	Fat %	Calcium %	Phosphorus %
Cassava tubers	30							
Rice bran	15	47.90	7.47	4.28	13.64	8.04	0.03	1.17
Urea	0.9							
Cassava leaves	20							
Rice bran	10	58.79	9.87	14.08	21.99	1.33	0.66	1.57
Urea	0.6							
Sweet potatoes	37							
Rice bran	18	52.56	6.65	3.66	15.14	8.11	0.06	1.20
Urea	1.1							
Pineapple leaves	25							
Rice bran	12	65.28	9.84	11.98	16.98	12.13	0.09	1.72
Urea	0.75							
Banana leaves	15							
Rice bran	7.5	60.87	9.74	14.25	16.57	16.00	0.31	1.24
Urea	0.45							
Pennisetum purpureum	20							
Rice bran	10	62.15	10.40	15.42	14.64	9.88	0.08	1.41
Urea	0.6							

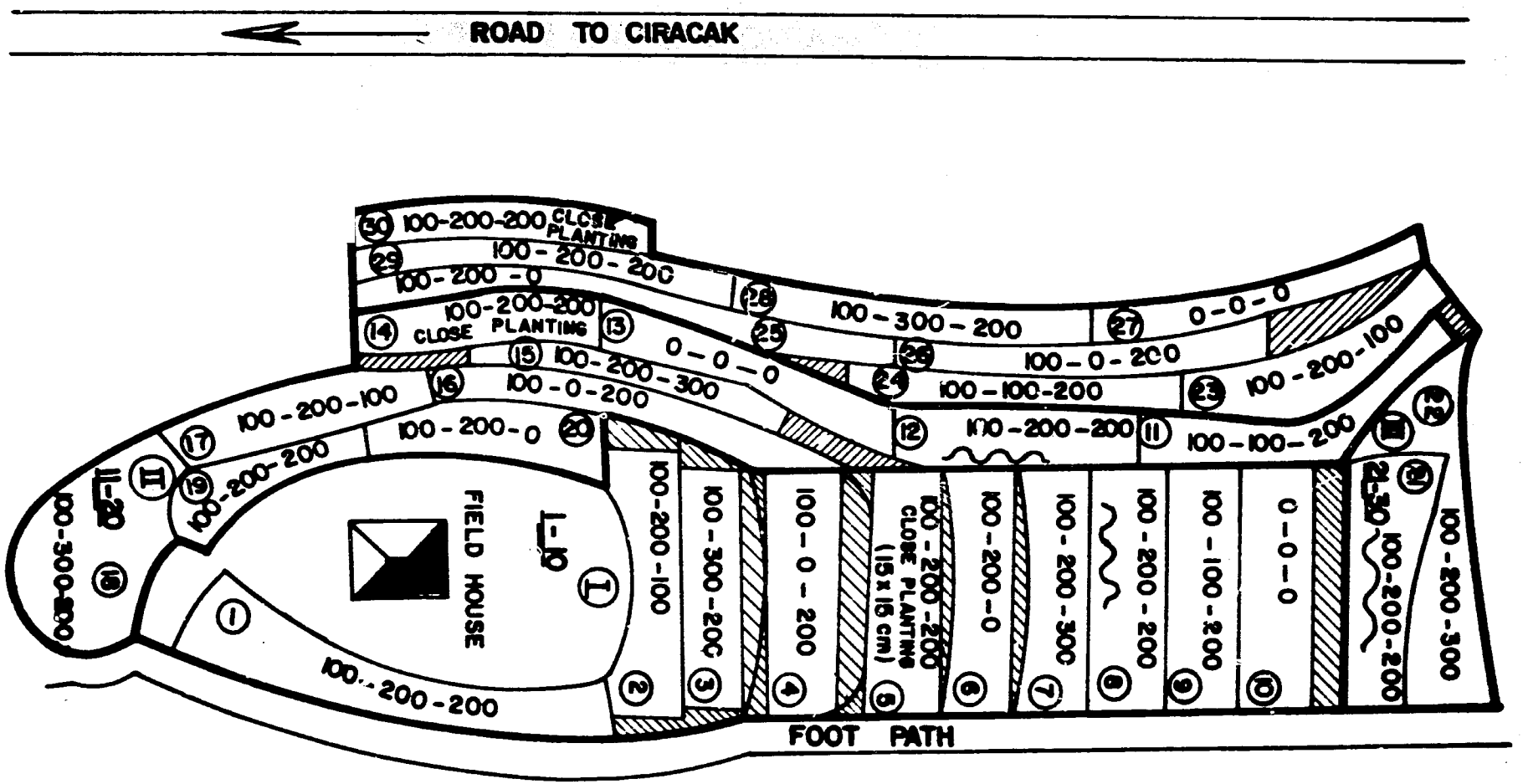
TABLE III-4

PROTEIN CONTENT OF FOODS*

Food	Fresh, gm protein per 100 gm	Dried, gm protein per 100 gm
Fish		
Fatty (herring)	17	46
Non-fatty (haddock)	16	84
Meat		
Beef	20	67
Pork, loin	20	67
Liver	20	67
Dairy Products		
Milk	3.4	26
Eggs	12	46
Cereals		
Wheat	12	14
Maize	10	11
Oats	10	11
Rice	8	9
Oil Seeds		
Soya	33	37
Cottonseed	20	21
Sesame	21	22
Green Leafy Vegetables		
Cabbage	1.4 - 3.3	24
Spinach	2.3 - 5.5	26
Roots		
Cassava (manioc)	0.7	2
Potatoes	2.1	9
Yams	2.1	7
Plantains	1.0	3

* These values are estimates only; the amount of protein varies according to the age, size, and quality of the food, and how it was cooked and stored.

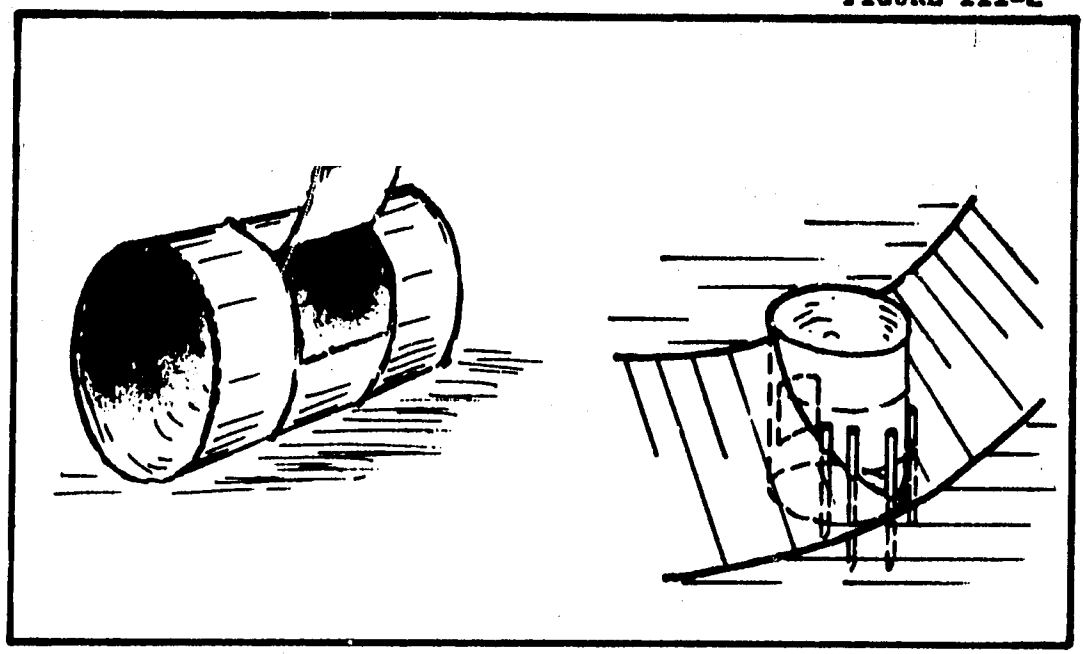
From: Freshwater Fish Pond Culture and Management. 2nd Edition 1978, by Marilyn Chackroff, Action/Peace Corps. Program & Training Journal Manual Series No. 1B.



LAY-OUT OF PEANUT FIELD TRIALS

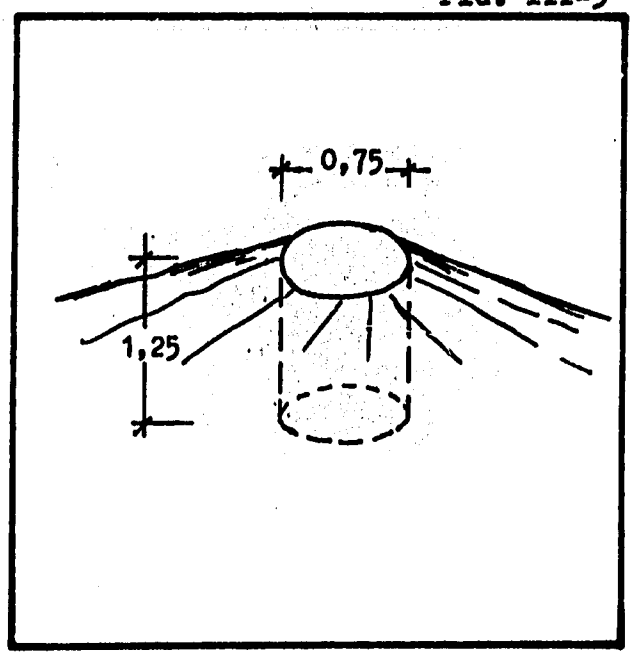
FIGURE III-1

FIGURE III-2



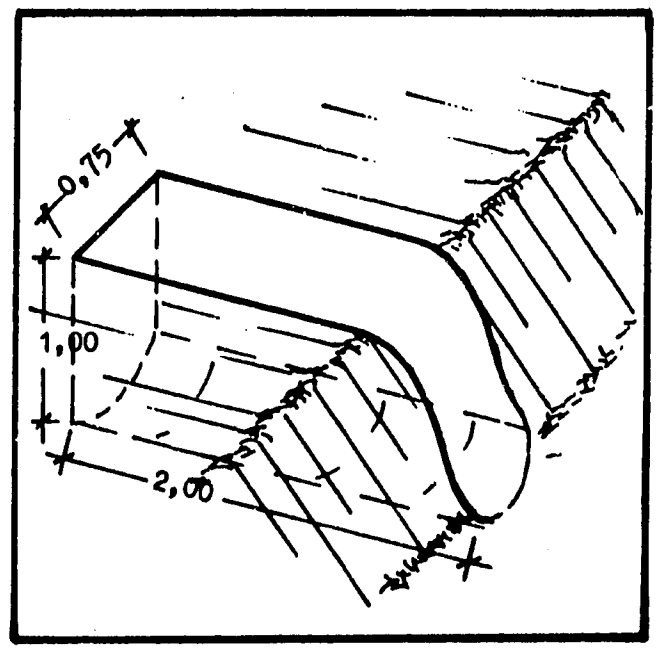
ASPHALT DRUM SILO

FIG. III-3

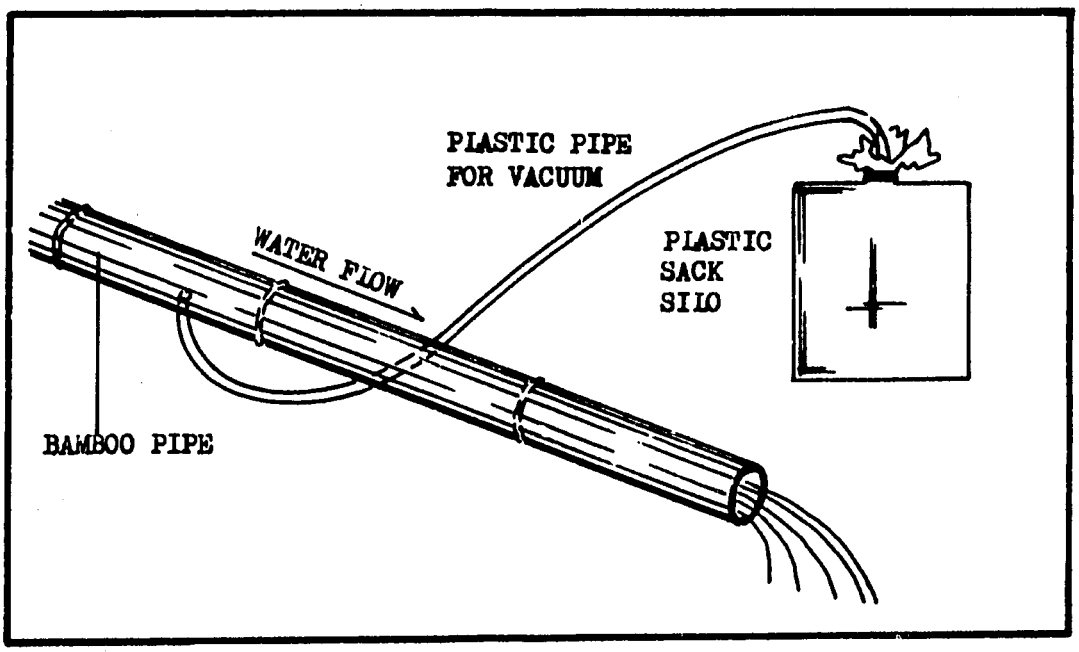


ROUND, WELL SILO

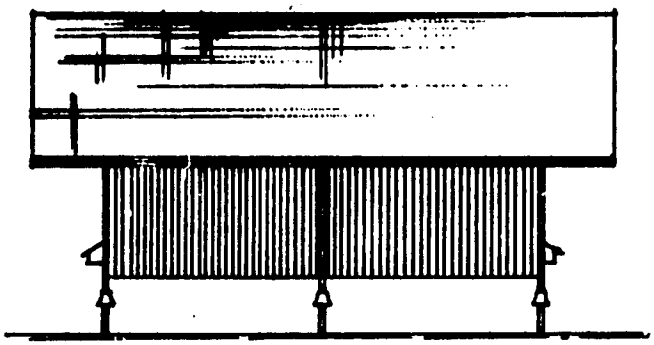
FIG. III-4



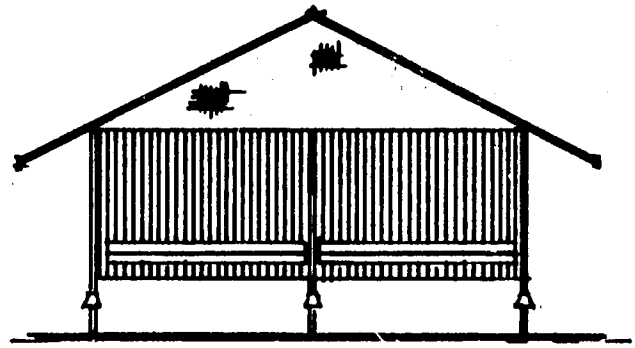
TRENCH SILO



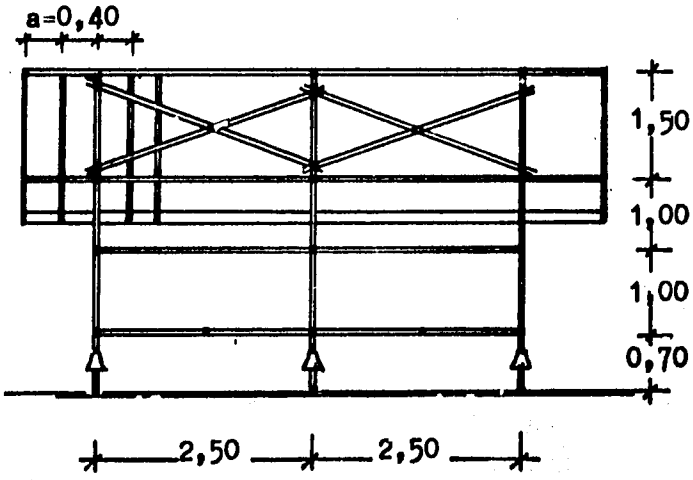
VACUUM FOR PLASTIC SACK SILOS



FRONT VIEW



SIDE VIEW



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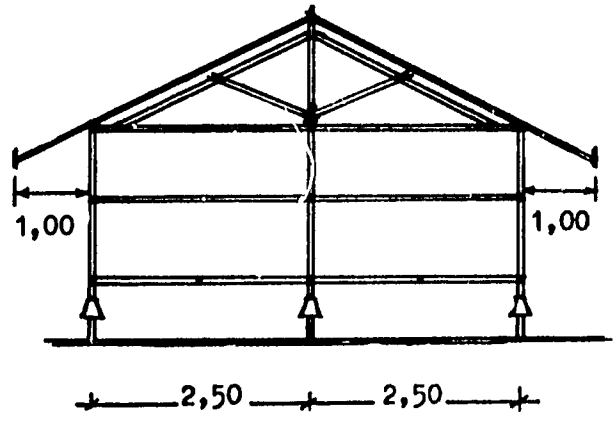

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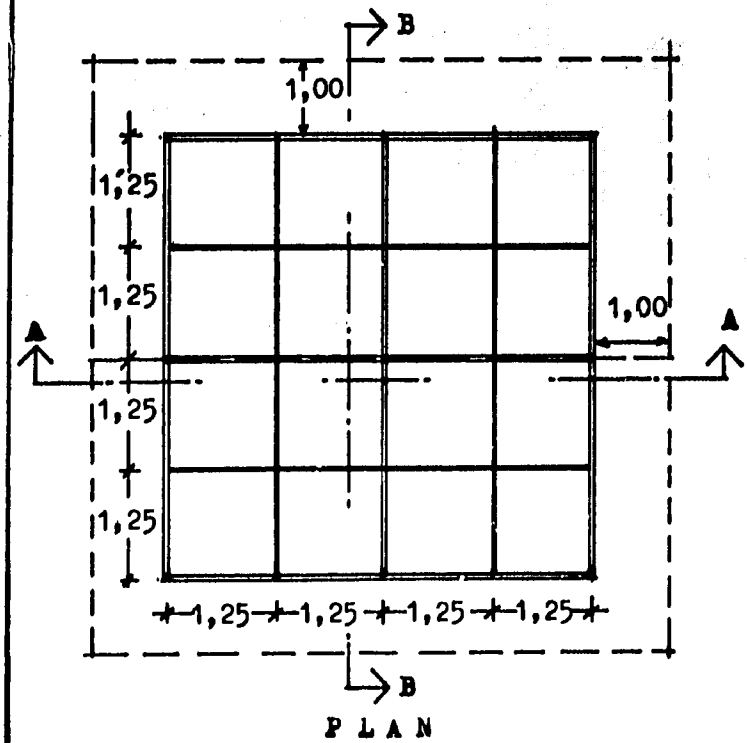
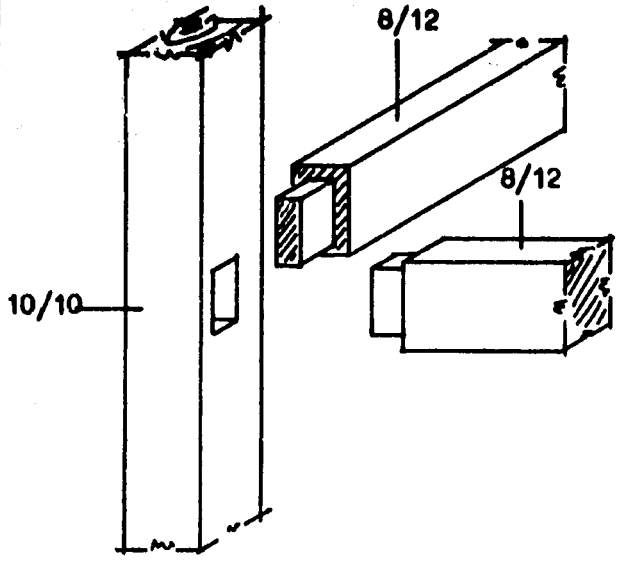


PLAN

BUILDING DESIGN FOR
POULTRY HOUSES

FLOOR PLAN POULTRY HOUSES



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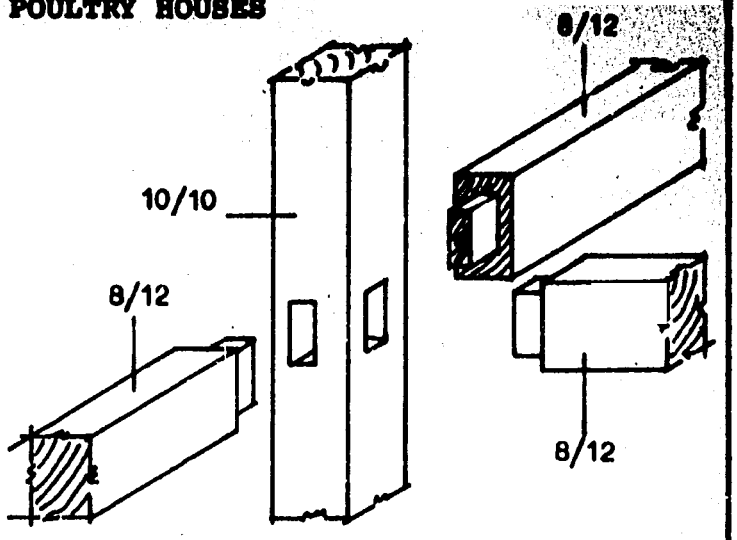

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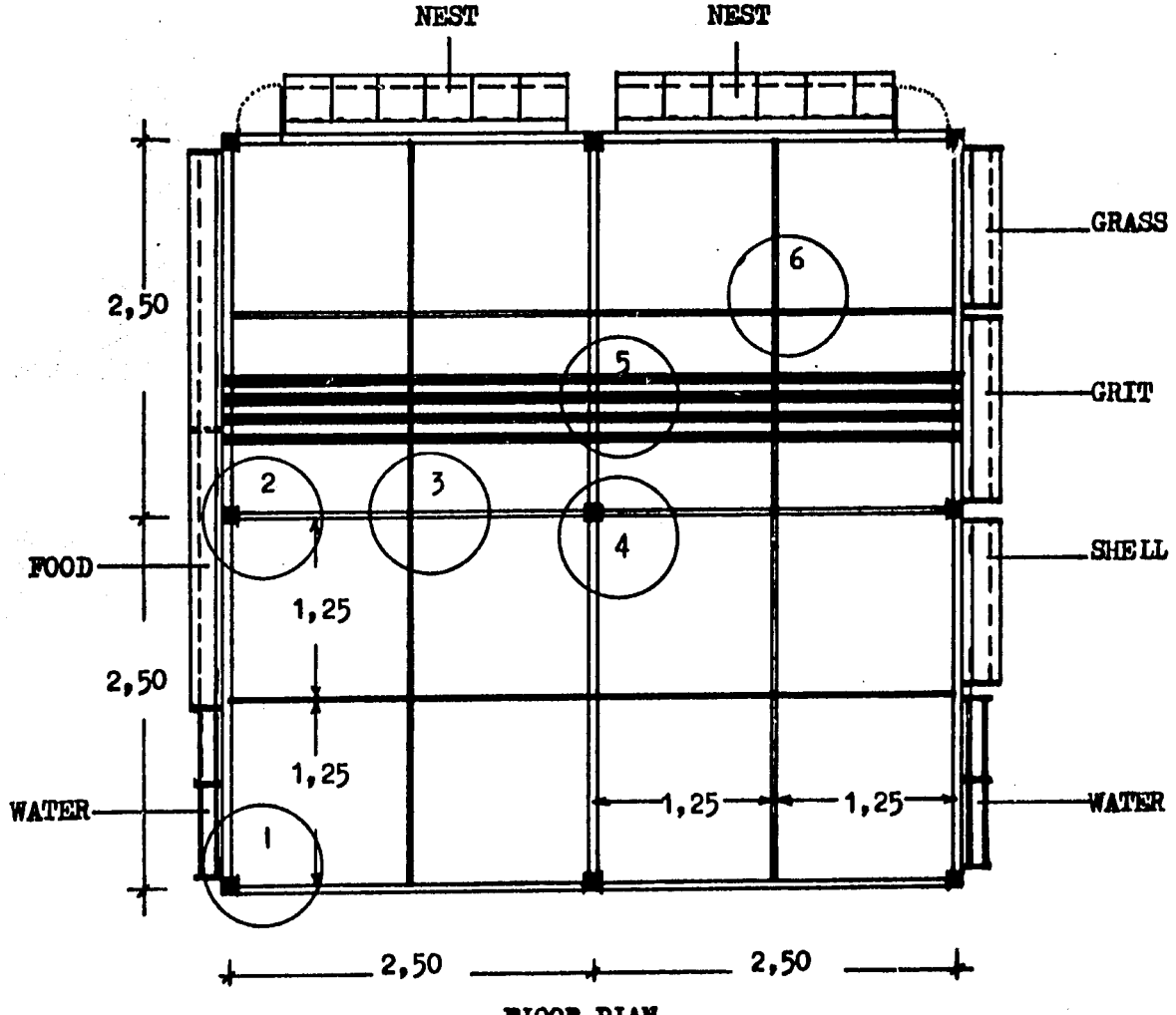

FLOOR PLAN
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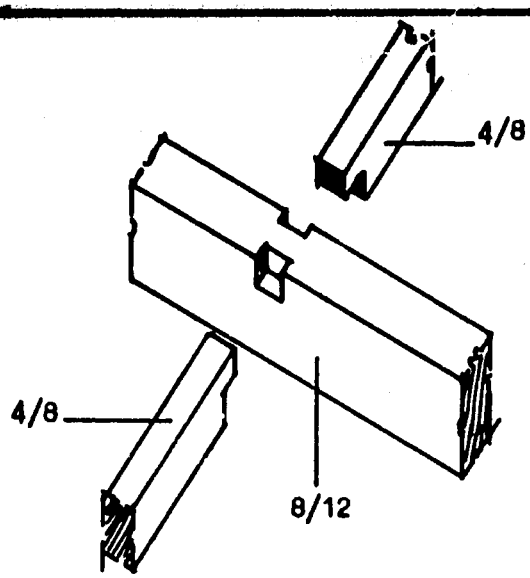

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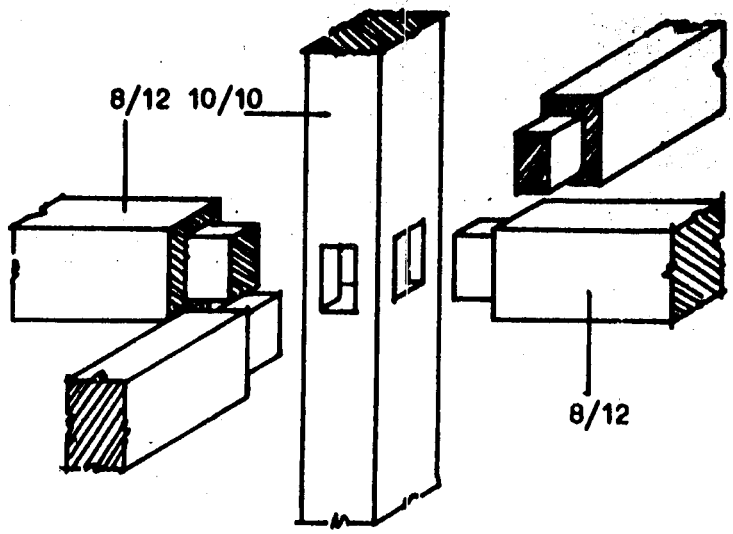

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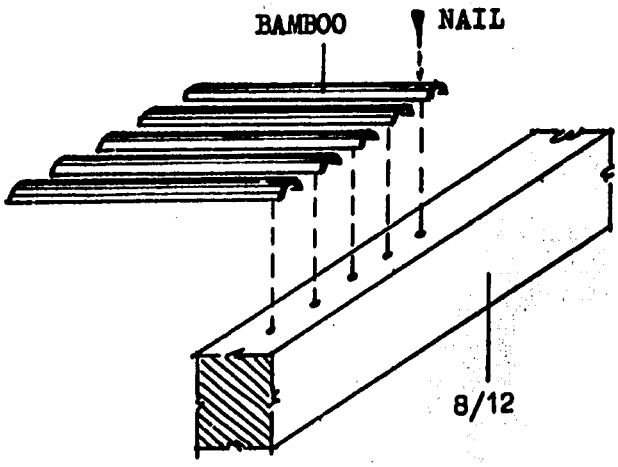

PERSPECTIVE

DETAIL 5
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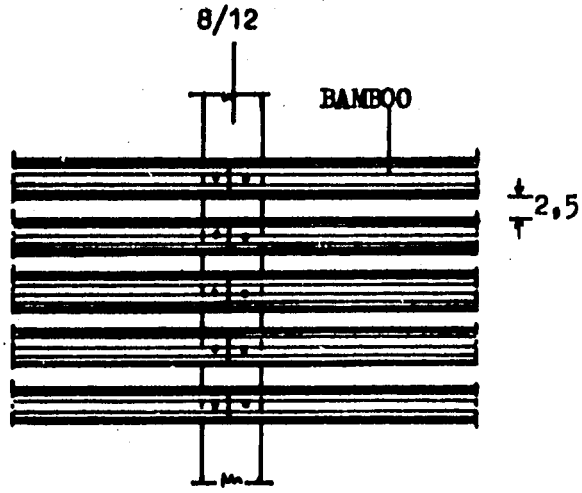
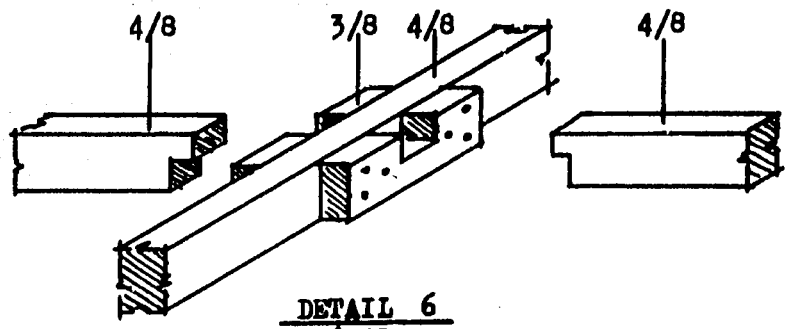


PLAN



DETAIL 6
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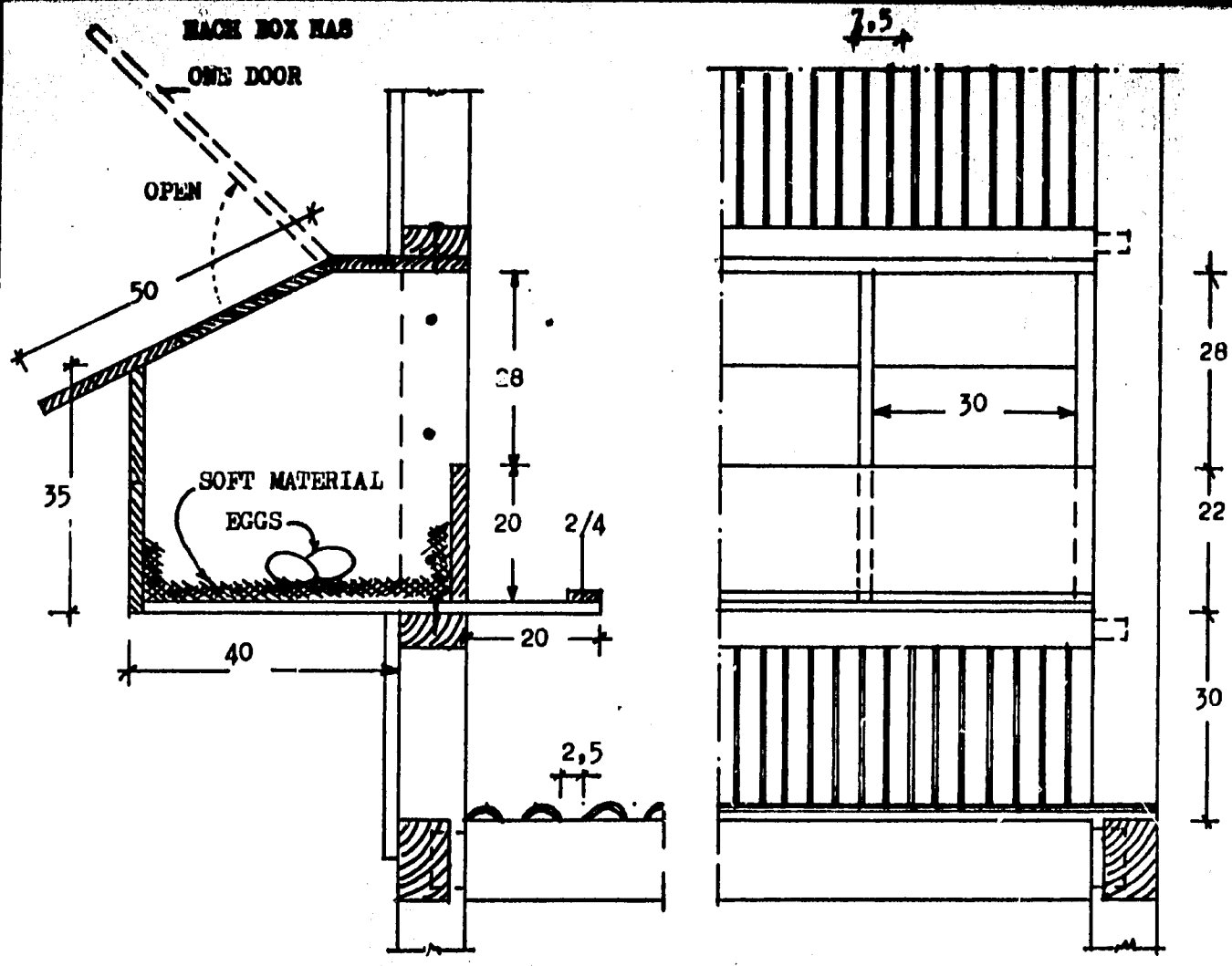
CONSTRUCTION DETAILS FOR POULTRY HOUSES

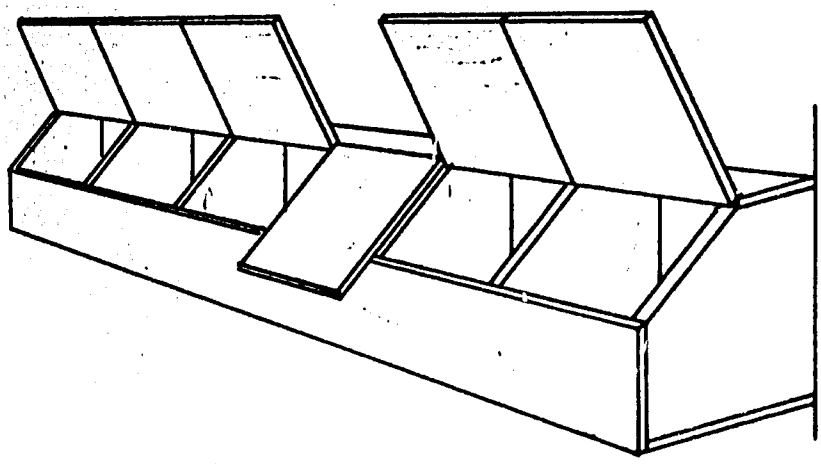


SECTION VIEW

INNER SIDE VIEW

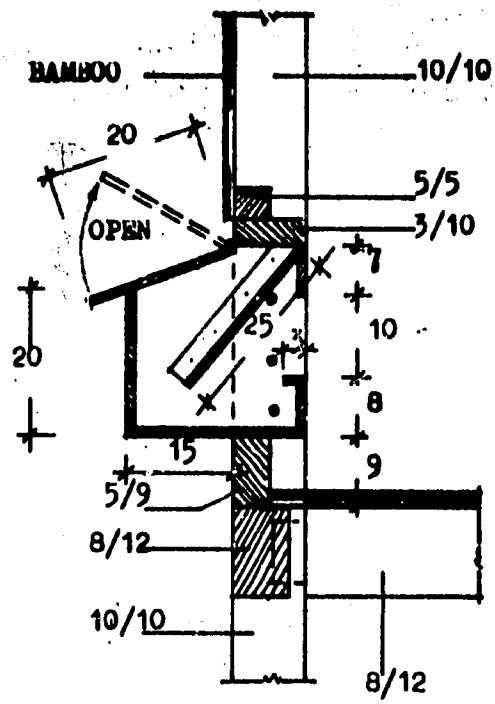
DETAIL OF NEST

1:10

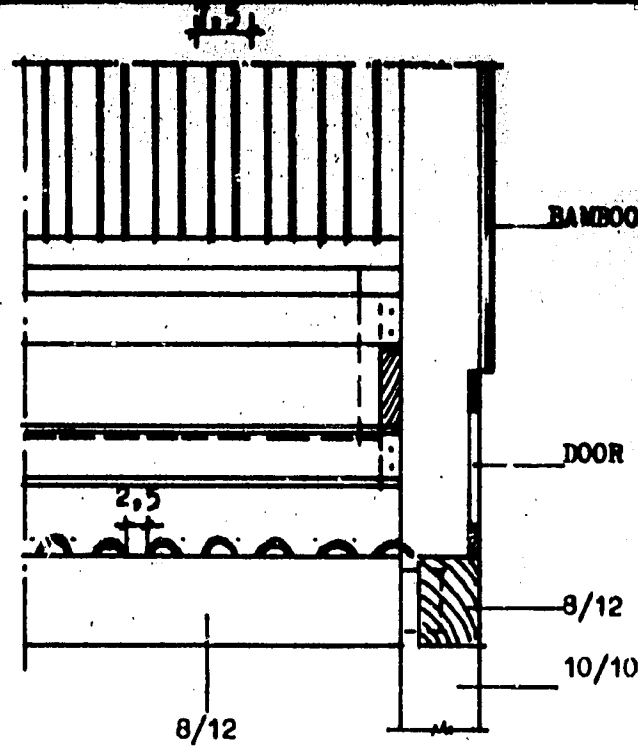


THIS PERSPECTIVE IS NOT SCALE

LAYERS NEST CONSTRUCTION DETAILS



SIDE VIEW



INNER SIDE VIEW

DETAIL OF FEEDER

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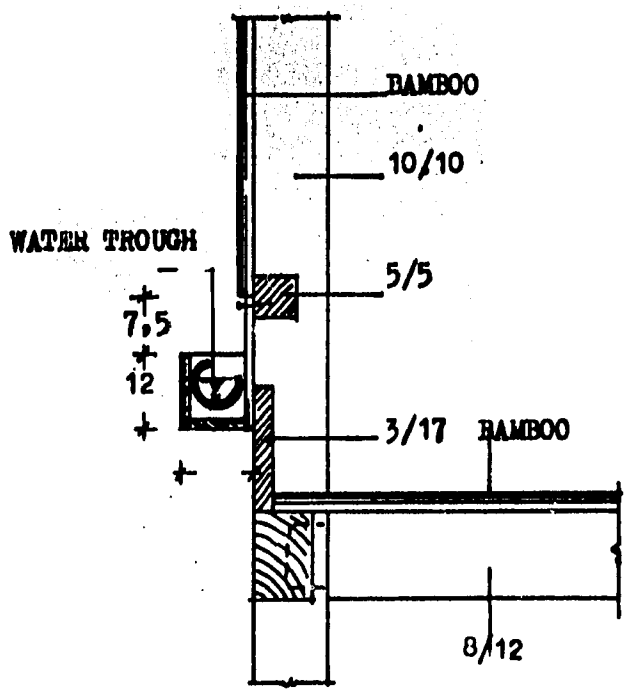
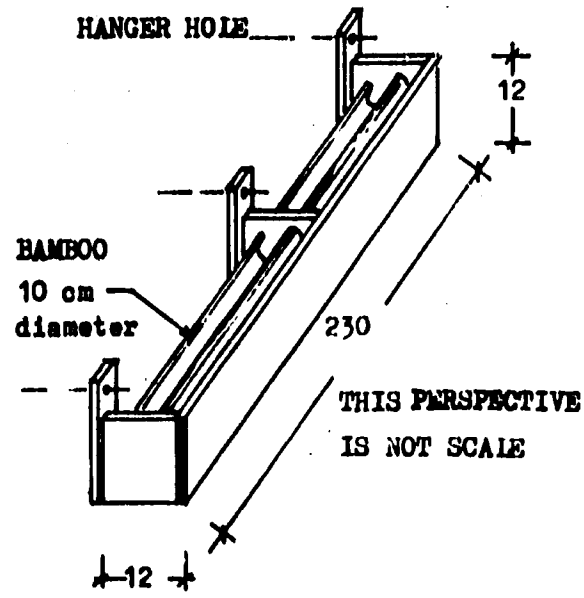


SIDE VIEW

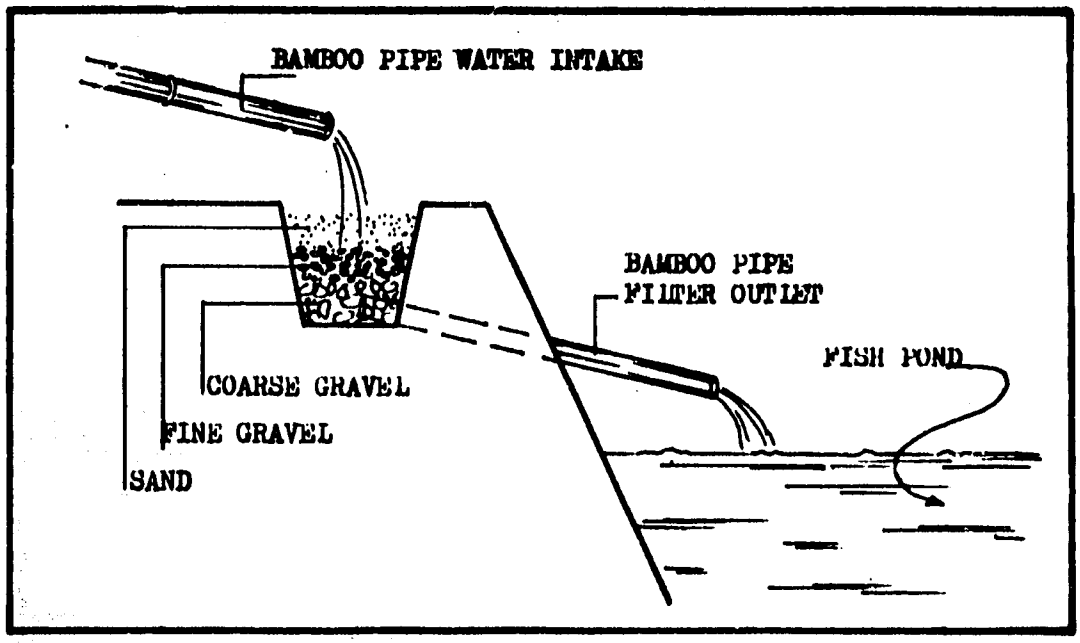


REMOVABLE UNIT

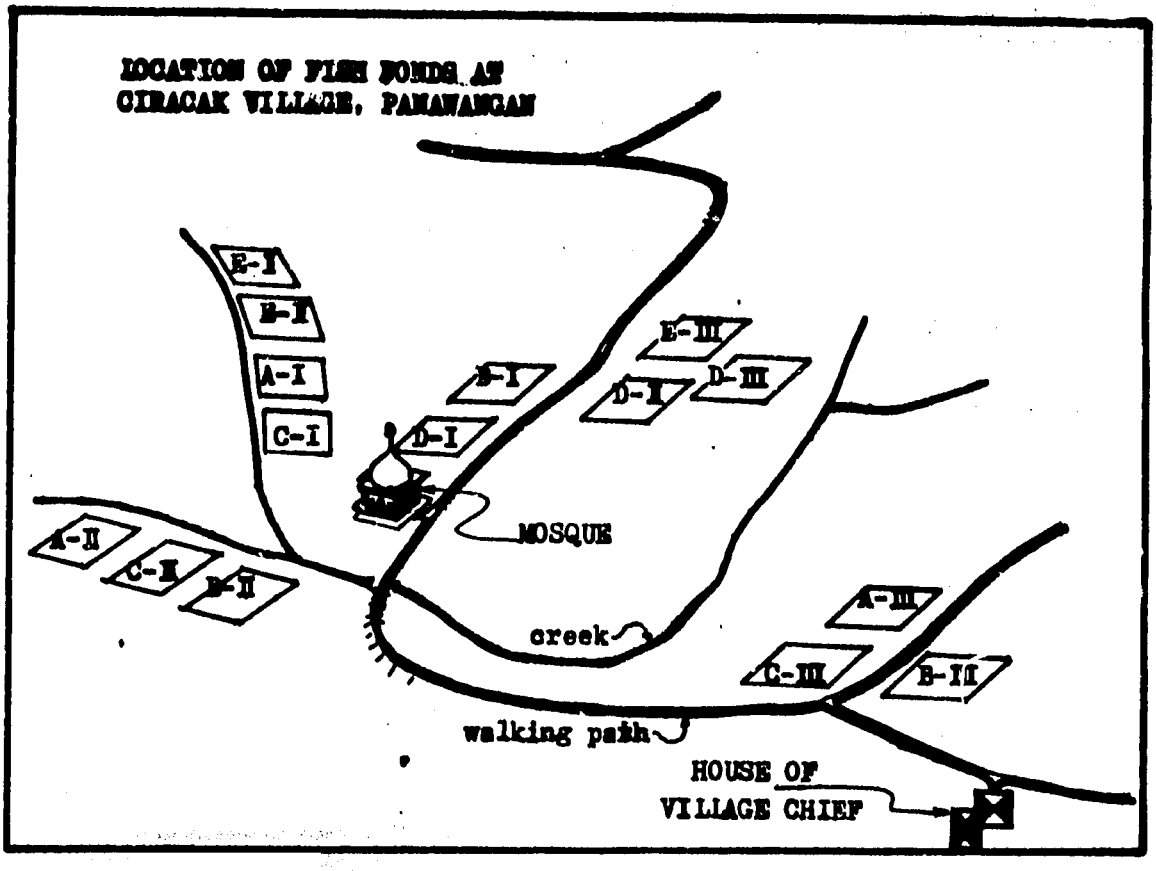
DETAIL WATER TROUGH

1;10

FEEDER AND WATER TROUGH CONSTRUCTION DETAILS



WATER FILTER OF FISH PONDS



SKETCH MAP OF FISH PONDS AT CIRACAK PANAWANGAN

CHAPTER IV

ECONOMIC CONSIDERATIONS

To improve the production and thus the income of the dryland farm, a synchronized integrated agriculture development program is required. An essential component of the program is the financial assistance by means of low interest loans etc. With the present level of resources in the dryland farms, it is imposible for the farmers to finance the required inputs to attain higher output. For example if Brachiaria brizantha grass is grown in the now idle land used as terrace risers, the forage production for a hectare of terrace land would be over 20,000 kilograms (green weight) per year. This amount of forage is capable of supporting twenty penned sheep. The price per sheep is Rp. 15,000 to Rp. 17,000, however with his present level of income it will take the farmer two full months of net income to purchase one sheep. Thus for the farmers to take full advantage of the technology brought to them at the demonstration sites, a financial assistance program is a must.

Assumptions

In the following economic considerations, no labor cost is included since the work is done by the farmers and their families, and the objective was to increase the farmers' income through higher production. Also the following assumptions were made in the tabulation of the data:

Conversion of Field Weights to Market Weights

Rice - milled rice 40 percent of wet stalk rice.
Maize - dry grain weight 30 percent of wet weight of ears.
Peanuts - dry shelled peanuts 25 percent of wet shell peanuts

Sorghum, millet, cowpeas - 1000 kilograms per hectare production of mix grains (no field data available)

Cost of Sheep Operation

Sheep		
Lamb (year old)	Rp. 17,000	per head
Resale value of a 8 to 9 year old sheep	Rp. 12,000	per head
	Rp. 10,000	per head
Total cost of 20 sheep	Rp.340,000	
Resale at 8.5 years, assuming 10 percent mortality	Rp.180,000	
Net Cost	Rp.160,000	
Assuming 7 years of reproductive life for amortization purpose, the per year cost would be: Rp. 160,000 : 7 =	Rp. 22,900	
Pen maintenance etc.	Rp..10,000	
Total Net Cost per Year	Rp. 32,900	

Reproduction capacity 0.9 lamb per year per ewe

Current Market Prices of Crops and Fertilizers

Rice (grain)	Rp. 150 per kilogram
Maize (grain)	Rp. 200 per kilogram
Peanuts (dry shelled)	Rp. 400 per kilogram
Sorghum, millet, cowpeas (grain)	Rp. 100 per kilogram
Cassava	Rp. 10 per kilogram
Urea	Rp. 70 per kilogram
TSP	Rp. 70 per kilogram
KCl	Rp. 80 per kilogram

Grass Cost

Brachiaria brizantha	Rp. 3 per pull
Planted at 12,000 pulls per hectare, (Assuming 25 percent of a hectare of bench terrace land is on terrace riser)	Rp.36,000 per hectare
Total cost of grass to be amortized in 10 years	Rp. 3,600 per hectare per year.

Seeding, Fertilizers and Insecticide Inputs with Project

1st cropping system (Intercropping)

Materials	kg/ha	Rp/ha
Upland Rice	30	4,500
Maize	10	2,000
Urea	150	10,500
TSP	100	7,000
KCl	100	8,000
Insecticide		1,500
Total Cost		33,500
2nd crop		
Peanuts	60	24,000
Urea	50	3,500
TSP	50	3,500
KCl	100	8,000
Insecticide		1,500
Total Cost		40,500

3rd crop

Materials	kg/ha	Rp/ha
Sorghum Millet Cowpeas	15	1,500
Urea	100	7,000
TSP	50	3,500
KCl	50	4,000
Insecticide		1,500
Total Cost		17,500

Seeding and Fertilizer Inputs Without Project

Assumptions for without project conditions are the same as previously mentioned for prices and seed materials, however the level of inputs was different The fertilizer used was 100 kilograms per hectare of urea or 50 kilograms per hectare urea and 50 kilograms per hectare TSP, in both cases costing Rp. 7,000 per hectare.

No fertilization was done for peanuts and no drought tolerant crops were planted during the dry season.

Economics of Fertilizer Use and Plant Densities

The economic evaluations of fertilizer used on upland rice fertility trials seeded with the variety Sagi on November 25, 1977 and harvested on April 5, 1978 (See details in Agronomic Practices on Chapter III) is as follows

Fertilizer Treatment kg/ha Urea - TSP	Rice Yield (Milled Rice) kg/ha	Gross Return Rp/ha	Cost of Materials Rp/ha	Net Return (No labor included) Rp/ha
0 - 0	120	18,000	4,500	13,500
0 - 100	280	42,000	11,500	30,500
100 - 0	340	51,000	11,500	39,500
100 - 100	500	75,000	18,500	56,500
150 - 100	528	79,200	22,000	57,200
200 - 100	540	81,000	25,500	55,500
400 - 200	670	100,500	46,500	54,000

From these fertility trials it appears that the 150 kilograms of urea and 100 kilograms of TSP per hectare give the best return. In another rice variety trial planted and harvested at the same dates as the above trials, using Sagi versus C-22 at the same level of inputs (200 kilograms of urea and 100 kilograms of TSP per hectare) the return was:

Upland Rice Variety	Rice Yield (Milled Rice) kg/ha	Gross Return Rp/ha	Cost of Materials Rp/ha	Net Return (No labor included) Rp/ha
Sagi	540	81,000	25,500	55,500
C-22	951	142,680	25,500	117,180

Peanut fertility trials with the variety Gajah planted on May 4 and harvested on August 25, 1978 as a second crop produced the following returns:

Fertilizer Treatment kg/ha Urea-TSP-K_2SO_4	Peanut Yield (Dry Shelled Weight) (3 Rep's mean) kg/ha	Gross Return Rp/ha	Cost of Materials Rp/ha	Net Return (No labor included) Rp/ha
0 - 0 - 0	167	66,800	40,000	26,800
100- 0 -200	308	123,200	63,000	60,200
100-100-200	312	124,800	70,000	54,800
100-200-200	263	105,200	77,000	28,200
100-300-200	307	122,800	84,000	38,800
100-200- 0	222	88,800	61,000	27,800
100-200-100	231	92,400	69,000	23,400
100-200-300	318	127,200	85,000	42,200

Plant density trials with peanuts, planted and harvested at the same time as the previous fertility trials, increased the yields by 49.3 percent by seeding at 15 x 15 centimeters versus 20 x 20 centimeters. The farmers typically plant at random, however their planting distance is approximately 20 x 20 to 25 x 25 centimeters apart. These trials were fertilized at the rate of 100-200-200 kilograms per hectare of urea-TSP-K_2SO_4 respectively and the yields are the mean of three replications.

Planting Distance (cm)	Peanut Yield (Dry Shelled Weight) (kg/ha	Gross Return Rp/ha	Cost of Materials Rp/ha	Net Return (No labor included) Rp/ha
20 x 20	263	105,200	77,000	28,200
15 x 15	329	156,900	91,400	65,500

The highest net return among all the treatments was obtained with close planting at 15 x 15 centimeters and 100-200-200 kilograms per hectare of urea-TSP-K_2SO_4 respectively. However to obtain Rp. 65,500 net return a Rp. 91,400 investment was required while with 20 x 20 centimeters planting distance and lower fertilizer applications (100-0-200 kilograms per hectare of urea-TSP-K_2SO_4 respectively) a net return of Rp. 60,200 was obtained with a cost of only Rp. 63,000 for materials.

Field research to determine the optimum fertilizer applications, plant densities and management practices for best economic return is essential before specific recommendations can be made to the farmers.

Farmers' Cooperation Program

Complete data on the Farmers' Cooperation Program is not yet available for a years cropping cycle. The data here presented, represents the mean yields of 18 farmers at Panawangan using mainly improved varieties of maize (H-6) and 50 percent improved upland rice variety C-22 and 50 percent local upland rice variety Sagi. Their lands were fertilized at the rate of 200-100-100 kilograms per hectare of urea-TSP-KCl respectively. The mean production of 18 farmers operating in 2.5 hectare of terraced land with 27 percent of the land under risers etc. was:

Crops Planted	Yields kg/ha	Gross Return Rp/ha	Cost of Material Rp/ha	Net Return (No labor include) Rp/ha
Rice (millet rice)	435	65,250		
Maize (dry grain)	436	87.200		
Cassava	3,000	30,000		
Total		182,450	37,000	145,450

The yields of upland rice in the Farmers' Cooperation Program fluctuated from 203 to 3,500 kilograms per hectare (wet stalk rice) and the maize from 330 to 3,200 kilograms per hectare of harvested ears. The main reasons for these yield differences were: the rice and corn varieties, management practices such as weeding, plant densities, soil fertility, amount of trees in the area, slope of the land, degree of crop damage by leaf blight in the rice, and amount of other crops planted simultaneously (cassava, cucumbers etc.).

A good farmer who intercropped only rice and maize with a limited amount of cassava (one row per terrace at 1 meter apart within the row produced 1,900 kilograms per hectare of maize (H-6 variety, harvested ears) and 1,567 kilograms per hectare of rice (wet stalk). The rice seeded was 1/3 C-22 and 2/3 Sagi. These yields did not take into consideration that about 25 percent of this farmer's land was on terrace risers, drain ditches and terrace lip.

The production of Brachiaria brizantha grass on fully revegetated bench terrace risers ranged from 100 to 140 tons per hectare per year. Assuming 20 percent of the land is in sodded terrace risers, the production of grass on a hectare of land bench terraced and under crop production would be 20,000 kilograms of green weight. This amount of grass could easily support at least 20 sheep and 20 lambs per year especially if the crop residues such as maize stalks and cassava and peanut leaves are used for feeding. The feed required per sheep is 1.5 to 2 kilograms of forage daily.

Net Return with Project

Under good management practice following the project recommendations each hectare of terrace land of average soil fertility should produce the following net return:

Crops Planted	Yield per Crop kg/ha	Gross Return Rp/ha	Cost of Materials* Rp/ha	Net Return (No labor included) Rp/ha
Rice (milled rice)	750	112,500		
Maize (dry grain)	450	90,000		
Cassava	3,000	30,000		
Total		232,500	33,500	199,000
Peanuts (dry shelled)	312	124,800	40,500	84,300
Sorghum Millet (grain) Cowpeas	1,000	100,000	17,500	82,500
20 Sheep 18 lambs/year		216,000	36,500	179,500
Total		673,300	128,000	545,300

* See cost assumptions on Page IV-1

Net Return Without Project

Before project implementation the production per hectare on a year basis cropping cycle for the average farmer in the area was:

Crop Planted	Yield per Crop kg/ha	Gross Return Rp/ha	Cost of Materials Rp/ha	Net Return (No labor included) Rp/ha
Rice (milled rice)	200	30,000		
Maize (dry grain)	195	39,000		
Cassava	2,500	25,000		
Total		94,000	13,500	80,500
Peanuts (dry shelled)	150	60,000	24,000	36,000
Sheep '2 lambs/year		21,600	2,300	19,300
Total		175,600	39,800	135,800

To attain the levels of production with project previously mentioned the following items need to be available to the farmers:

A. Loans at low interest for seed, grass, fertilizers and livestock.

B. Improved crop varieties and forage grasses.

C. Technical assistance.

D. Demonstration areas where the farmers can assess for himself the benefits obtained by using specific management recommendations.

E. Applied research centers, with the same environmental conditions, to seek solutions and alternatives which will overcome the present constraints to higher yields.

F. Farmers' coordination through farmers organization.

Economic considerations of other farm products such as vegetables, fuel wood, lumber fruits, poultry products etc. were not made. It is difficult to present any set of figures representative to the area because of the lack of homogeneity. In Chapter III page 35 an attempt was made to identify some of the production figures of the most popular trees. Also in the Poultry Program section (page II-45), some of the economic benefits of improved poultry operations were discussed.

The economic evaluation of the best fish pond treatment tested in Ciracak, Panawangan is:

The fish pond production on a per hectare basis with two harvests per year is

Varieties	kg/ha/year	Rp/kg	Gross Return (Rp)
Gold fish	1,880	1000	1,880,000
Tawes	821	750	615,750
Mujaer	999	500	499,500
The costs were:			2,995,250
Fingerling Varieties	Stocking Rate kg/ha/year	Rp/kg	Gross Cost
Gold fish	1,500	1000	1,500,000
Tawes	300	750	225,000
Mujaer	200	500	100,000
			1,825,000
Materials	kg/ha/year	Rp/kg	
Organic manure	6,000	50	300,000
Urea	720	70	50,400
TSP	160	70	11,200
Rice Bran	2,000	50	100,000
			461,600
Total Cost			2,286,600
Gross Return			2,995,250
Total Cost			2,286,600
Net Return			708,650

No labor on fish pond rehabilitation is included in the cost figures since it was done free by the farmer owners.

The fingerling mortality rate was very high, the Ciamis Fishery Department estimated about 60 percent dead prior to stocking operation.

CHAPTER V

COMMUNITY DEVELOPMENT PROGRAM

The conception of the Panawangan Pilot Watershed from its beginning was a conservation and development project. This project started in early 1976 with the survey of socio-economic conditions in the project area, as well as soils, land capabilities, climate, vegetation, agricultural practices etc. This initial phase and report was completed by the end of 1976, and the implementation phase began in November 1977. The program was carried out by the Kabupaten (district) of Ciamis technical staff coordinated by the chairman of Bappemka (Planning Board) Mr. Rachlan, in close cooperation with Project Citanduy (Directorate of Rivers, Public Works) and the Consultants (Engineering Consultants, Inc.). Most of the action proposed was discussed with the communities for their understanding, approval and support. An effort was made to involve the local communities as much as possible during the implementation phase to give them a sense of belonging and participation. The road construction, agronomic trials, grass transplants, and tree planting on the 6.1 hectares Demonstration Farm were done free by the land owners and/or community. The terrace construction in the 6.1 hectares, was built with an incentive payment of Rp. 50,000 per hectare.

Community Training

The activities taking place in the project area were discussed in detail during the meetings held in the village of Ciracak (Subwatershed II) prior to their implementation. The reasons for terrace designs, waterways construction etc. were throughly explained. The purpose of the field trials for variety testing, the proper use of fertilizers, and simple economic analyses of cost and yield output for best economic return were frequently discussed. After each field trial was harvested the pros and cons of the trials were discussed on the spot with the farmers and members of the community.

The higher plant density of peanut trials by itself increased the yields by nearly 30 percent; this and the many other examples made a deep impression on the farmers on how they themselves could improve their yields. The best proof

of the farmers' understanding the agronomic trials was given in January 1979 after the maize harvest was completed. The farmers admitted that they themselves had been doing their own testing; they planted 10 seeds of local maize under their own traditional system and 10 seeds of improved variety of maize (H-6 from CRIA) under the recommended practices. The yields were 2 kilograms of maize ears for the local variety versus 10 kilograms for the new variety and management practices. Some farmers also tried grafting cassava (Mukibar) that proved to produce 120 kilograms per tree. This practice has been more popular in the neighboring villages.

Farmer Leaders Training

A "Skill Development Training Course" was offered for farmer leaders, PPL's and PLP's. The classroom training was held in the Kecamatan (Subdistrict) Office at Panawangan during the week of March 26 to 31, 1979. The following participants attended the training course:

District	No of Key Farmers	PPL/PLP
Ciamis	8	1
Cilacap	6	2
Tasikmalaya	4	-
Kuningan	2	-

The following topics were covered during the training:

1. Land Use Capabilities
2. Soil and Water Conservation
3. Agronomic Practices for Dryland Farming
4. Grass Management Practices
5. Animal Husbandry
6. Fishpond Management
7. Beehive Management
8. Natural Resources and the Environment
9. The Principles of Nutrition and a Balanced Diet
10. Leadership, Cooperatives and Management of Finances

Two field trips were taken, one to the Fishery Developemnt Center at Singaparna, Tasikmalaya and the other to the Panawangan Pilot Demonstration Watershed.

The training course was organized by Citanduy Project, P.U. and ECI in cooperation with the Bappemka Office of Ciamis and its Technical Staff with Ir. Nurdin (P_3RP DAS Citanduy) as chairman of the Committee.

Special Meetings to Disseminate the Panawangan Watershed Concepts

Many villages and subdistricts throughout the Citanduy Watershed were visited during the years of 1977, 1978 and 1979 to discuss and promote the concepts developed in the Panawangan Pilot Watershed. The meetings took place throughout the four Kabupatens of Ciamis, Cilacap, Tasikmalaya and Kuningan. The team to disseminate the watershed concepts consisted of the following members: Mr. Rachlan (chairman of Bappemka Office in Ciamis), Ir. Nurdin (chief of P_3RP DAS Citanduy), the counterpart staff from Project Citanduy, and the Consultants. Members of the technical staff and the chairman of the Bappemka Office were present on the visits to their respective Kabupatens. The impact of these meetings on the farmers, village chiefs (Lurah) and subdistrict chiefs (Camat) was very good judging by the participation, interest in the discussion and number of attendants. In the last meeting held in the village of Madura (Kecamatan of Kawali, Kabupaten of Ciamis) besides the previously mentioned watershed promoters, the best key farmers of the Panawangan Project, Mr. Suhinta and Suparman, were added to the team. Their discussion with other farmers and their own convictions on why the watershed program was good for the farmers, was a very effective way to disseminate the Panawangan concepts.

Visitors Program

The Kabupaten of Ciamis in 1978 started a program by which the village leaders, PPL's and key farmers of the district of Ciamis were brought to the Panawangan Pilot Demonstration Watershed. The visitors were lectured in the field by Mr. Rachlan, Ir. Nurdin, the Citanduy Project Counterparts and the

Consultants. This program was broadened later on with visits from the technical staff of the other Kabupaten within the Citanduy Basin. In addition, many others, including the Agronomy Engineers' Class and Forester Engineers' Class from IPB (Institute Pertanian Bogor), the Watershed Managers of Indonesia as well as the press, television, government officials from the lower ranks up to the minister level have visited the Demonstration Farm at Panawangan Pilot Watershed Project.

The impact of 6.1 hectares Demonstration Farm is hard to evaluate; however, hundreds of kilometers away, the Panawangan terraces, grasses, agronomic practices and so on are now being used by other farmers. Also the requests for help and advice from village leaders throughout the watershed is constantly increasing. In the March 1979 Steering Committee Meetings for the Citanduy Basin Project, the Director of Rivers, Ir. Sudaryoko agreed that "rather than ask the farmers to come to Panawangan, lets take Panawangan to the farmers" by implementing small (5 to 10 hectares) demonstration areas throughout the Citanduy Watershed.

Community Communication Development Training

Five official representatives of the four Kabupatens in the Citanduy Watershed (Ciamis, Cilacap, Kuningan and Tasikmalaya) attended a course in Community Development held at Solo from January 22 to March 10, 1979. The purpose of this course was to train government officials as future coordinators and instructors for community development programs. The course was taught by the Yayasan Indonesia Sejahtera from Solo. The goal of the course was to upgrade the practical knowledge and methods on how to influence people through efficient and effective communication with the community. This type of program was considered essential to train people to disseminate and influence others to actively participate in an integrated and comprehensive watershed development programs such as the Panawangan Pilot Watershed.

As a continuation of the Solo Community Development courses, on March 26 to 31, 1977 another Community Communication and Development Training took place in Ciamis.

These courses were organized by the consultants with the approval of the Directorat of Rivers and USAID and the full cooperation of the Kabupaten of Ciamis and the P_3RP DAS Citanduy. The chairman of the committee was Mr. Rachlan with Ir. Nurdin as vice chairman.

This training course was attended by:

Agency	No. of Attendants
Kecamatan officials	8
Village officials	9
PPL's and PLP's	10
Key farmers	9
Kabupaten officials (Previously attended the Solo Course)	4
Project Citanduy officials (Previously attended the Solo Course)	1
Total active participants	41

Also, on request, 53 representatives of government agencies at the Kabupaten level participated on a non-regular basis in this course at Ciamis. The participants in this training were representatives from the four Kabupaten within the Citanduy Watershed. The lectures were taught by four members of the Yayasan Indonesia Sejahtera from Solo on matters of community development and by the Project Citanduy Counterparts and P_3RP DAS Citanduy in soil and water conservation. Other topics were covered by representatives of Bappemka and members of the Technical Staff of Ciamis.

During the course there was ample participation and discussion of topics between the participants and lecturers. The course provided an excellent bridge for communication among the officials representing many agencies and the key farmers. The acquaintance, understanding, cooperation and coordination among the officials representing the four Kabupaten are essential for the development of the Citanduy Watershed.

Audio-Visual Aids for Dissemination

Watershed development program illustrations with the aid of slides, pictures, and taped voice are presently underway for the dissemination of concepts. Also the different activities taking place at Panawangan are being filmed to be presented with an eight millimeter movie projector to the people in the watershed.

The use of audio-visual aids, pamphlets and simple manuals with adequate pictorial illustrations and designs for easy understanding would help tremendously to disseminate improved soil conservation and agriculture development practices.

CHAPTER VI

COORDINATION AND PARTICIPATION OF AGENCIES, THEIR BUDGETING AND FUTURE PROJECTIONS

The Panawangan Pilot Watershed was coordinated through the Kabupaten of Ciamis by a very simple and informal but effective implementation committee consisting of the following members

Mr. Rachlan, Chairman of the committee and head of the Ciamis BAPPEMKA's office.
Mr. Nurdin, technical coordinator and P_3RP DAS Citanduy Manager.
The Bupati's of Ciamis technical staff.
Project Citanduy's Counterparts, Directorate of Rivers.
The Consultants.

Inputs in support and guidance to this committee were also given by :

The Project Citanduy Officers from USAID.
The Direktorat Reboisasi dan Rehabilitasi at Jakarta.
The Central Research Institute for Agriculture at Bogor (LP_3).
The Soil Research Institute at Bogor (LPT).
The Center for Animal Research and Development at Ciawi (P_4).
The Sub Direktorat Konservasi Tanah dan Air.
The Kantor Wilayah Departmen Pertanian from West Java.
The Technical Staff under the Chief Division for Planning and Program Implementation, Bureau of Planning Ministry of Agriculture.

The implementation committee was governed by the Citanduy Project Steering Committee consisting of the following members :

Ir. Sudaryoko, Chairman of the committee and head of the Directorate of Rivers, Department of Public Works.
Representatives of the various Sub Directorates within the Ministry of Agriculture.

Representatives of BAPPENAS.
Representatives of the Provincial Government of West Java and Central Java.
Representatives of the Kabupaten of Ciamis.
Representatives of USAID.
Project Citanduy, Directorate of Rivers, Department of Public Works.

The last Steering Committee on March 30, 1979 was coordinated by the Minister of Environment, Dr. Emil Salim.

Coordination

The liaison among the Research Institutes and the Kabupaten Technical Staff and to a large extent among the previously mentioned supporting agencies was the Consultant. It was found that to properly coordinate all the inputs required to carry on an integrated program such as the Panawangan Pilot Watershed, a third party, in this case the Consultant, was a must. The party doing the coordination needs to have access to all the supporting and participating agencies and feel free to speak up to the higher ranking officials. It was the experience of this project that people cannot support and contribute to a program unless they have a clear view and understanding of the goals to be attained. This principle applies to the farmers in the field as well as to the higher ranking officers in Jakarta. An objective position should be taken by the liaison party to incorporate the many ideas that are generated during the meetings with the other members supporting and participating in the project.

It was determined in Panawangan that the coordination of technical inputs in the field needs to be done by a high ranking officer of the implementation committee whose staff members are involved in daily field activities. All planning and execution of activities in the field must be cleared through the technical coordination prior to implementation in order to synchronize the integrated plan.

The Kabupaten and Kecamatan Technical Staff, Their Role in the Pilot Watershed.

The agencies that actively participated in Panawangan and performed a well done job were the P_3RP DAS Citanduy and the Fishery Department. The field performance of the Kabupaten Technical Agencies is related to :

A. Budget allocations

B. Technical qualifications of their staff

C. Available man power

D. Motivation

These agencies can implement their activities only when they know how or they are shown; however, they cannot be expected to do something that they have never done before. This fact was specifically true with two agencies, Dinas Pertanian and Dinas Peternakan. Dinas Pertanian has concentrated their effort in their Bimas and Inmas program but to a large extent, they have ignored the less productive dryland farmers. Thus without the proper technology, qualified and adequate man power and a budget to perform the job, it is practically impossible to do any better. The Dinas Peternakan problems are very similar and in addition there was a lack of motivation.

The technology of the Kabupaten Technical Staff could be and should be upgraded by assigning teams from the Research Institutes to work in the Pilot Watershed to overcome the present constraints to higher production output. These teams from agriculture and animal husbandry, working in close cooperation with the Kabupaten Technical Staff, will be able to transfer a better technology.

The Budget

During the fiscal year of 1977 to 1978 the budget for the implementation of the Panawangan Pilot Watershed came through the Directorate of Rivers. This budget was not available until November of 1977. The availability of the budget at this late date caused many problems; for example, the farmers usually begin planting their fields in late September or early October, thus they were very unhappy building terraces in their own land during the month of November.

There were no allocations in the budget to cover crop compensation in case of failure because of late planting. Also the budget could not be fully utilized because of many restrictions on what could be purchased and delays in making the money available.

During the fiscal year of 1978 - 1979 the budget was allocated as a Sectoral Project. However, no budget was allocated for the Pilot Demonstration Farm and Forestry and Food Crop never did provide counterparts to assist the Consultants. To be able to carry on the work in the Pilot Demonstration Farm at Panawangan the Consultant had to scrounge funds from Project Citanduy and USAID. The supervision, data collection and field assistance were voluntarily done by some of the Kabupaten Technical Staff, P_3RP DAS and the farmers at Ciracak, Panawangan; without proper budget allocations for personnel, materials and labor, the future of the demonstration farm will be jeopardized.

Future Projections

It is essential to understand the farmers attitude and way of thinking in order to propose an effective watershed program. It would be incorrect to believe that the farmers in the watershed will maintain their terraces just because they were told to do so. The success of the Watershed Program will depend on how well the farmers are convinced and are shown that their effort in soil conservation will be rewarded by the increase in output of their farm operations. Thus, if the farmers are not convinced of the value of the topsoil on their farms, it will be very difficult to motivate them to save that soil from water erosion. Therefore, the increase in production from the dryland farms is the key to farmers incentive to soil conservation and awareness of the value of their farm topsoil.

The farmers usually have a difficult time identifying themselves with big government programs. They tend to blame the lack of success in their farm enterprises on their lack of resources to develop their land; however, the main problem is the lack of proper technology. This technology needs to be developed in the watershed. The Panawangan Pilot Watershed in its 16 months existance, from November 1977 to March 1979, has shown many new ways to improve the dryland

production; however, much applied research is needed to overcome many of the present constraints. Two Pilot Watershed Areas should be maintained in the Citanduy Basin, one at Panawangan and another at Karangpucung. These two areas should be used as the applied research centers where the basic dryland farming technology for the Citanduy can be generated. The reason for two centers is that Panawangan is located in the north northwest corner of the watershed at about 700 m in elevation on deep latosol soils derived from volcanic parent materials; Karangpucung is in the north southwest corner at about 100 m or less in elevation on alluvial soils from sedimentary claystone and mudstone parent materials. Besides the soil, topography and environment, some of the crops, cropping systems and culture of the people are also different.

The technology developed in these two dryland research centers will be tested in small mini-watersheds on small demonstration plots located in strategic areas for easy dissemination of agricultural development and soil conservation techniques. These satellite stations as well as the two main centers will be used for demonstration to the farmers and training for the district and subdistrict technical staff. As the local technical staff, village chiefs, key farmers and farmers absorb the new ideas and technology, they in turn will become new sources of dissemination.

It was proposed at the March 1979 steering committee meetings that nine small mini-watershed demonstration sites, about 5 hectares each, be located in strategic areas throughout the watershed. Three different alternatives are to be tested in the nine mini-watershed demonstration sites:

1. The farmers owning the land will build terraces and other soil conservation structures and will be paid in full for their work. Complete agricultue development package (described later in the text) given to the farmers.
2. The farmers build the terraces for free with no cost to the government in exchange for the full agriculture package and pay for waterway construction.

3. The farmers build the terraces free of cost to the government but the government provides farmers with grass for terrace riser revegetation, pays for waterway construction, and provides a loan with little or no interest to the farmers to purchase all the other items included in the agriculture package.

Whenever possible for livestock distribution the revolving system approach will be used: if sheep or goats are given to the farmers, they will keep them until the lamb or kid can be weaned at which time the mother sheep or goat will be passed to another farmer.

The terrace construction within the mini-watershed should be organized in such a way that the entire area is built as a single unit. This will assure terrace continuation along the hillside contour, and continuation between ownership boundaries. Without this prerequisite the waterways to take excess water out of the terrace cannot be functional.

The agricultural development package will consist of :

1. 15,000 to 20,000 pulls (3 stems/pull) of Brachiaria brizantha/ha of land terraced to revegetate the terrace risers. This grass, besides doing a good job in soil conservation, is an excellent source of forage for livestock.
2. Improved seed varieties for the farmers for their three crops for one year.
3. The recommended amount of fertilizer for the farmers for each of the crops for one year.
4. Three sheep or goats for the farmer with at least 0.5 hectare, under the revolving system approach.
5. Tree seedlings, such as clove, albizzia, petai and citrus, for areas over 50 percent slope.
6. Improved fingerling stocks for fishponds and feed for one fish crop.

7. Technical assistance and materials, if necessary, will be provided to build silos to store forage and crop wastes such as corn stalks, cassava and peanut leaves. This will allow a better utilization of farm products and maintain a constant feed supply for livestock during the dry season.

8. If sorghum can be grown in the dryland farms as a third crop, a poultry operation of layers and broilers should be established on a cooperative basis with the farmers of that mini-watershed.

9. If sorghum can be grown in the area, technical assistance and materials should be provided to build simple grain dryers and storage facilities for grain preservation. This would be small farm units of low cost and within the individual farmer financial capabilities.

These demonstration areas should be done with full support and technical help. The government should use their demonstration areas and carry out special lectures and meetings to teach the local agency personnel and key farmers the techniques that have been proven successful in the Panawangan Pilot Watershed Center.

Conclusions

The support of the Bupaties and Camats is of most importance, because they are political leaders and representatives of the people. The watershed program should be directed by the local governments since they should know better than anyone else the desires, needs and ambitions of their people. The idea of a government army of technicians marching through the watershed and leaving behind in their path hills and mountains full of terraces does not work.

The farmers in the watershed are not concerned about the sediments being deposited in the lower irrigation system and the loss of its efficiency. They don't realize either that their improper management of the drylands is causing flash floods during the rainy season and lack of irrigation water during the dry periods. But even if they realized that their dryland management could provid a more uniform river flow throughout the year, they would probably not care. It is not easy for the farmers to understand that the loss of the very valuable rich, fertile topsoil, that took thousand of years to form, can affect their farm production, because it is a gradual process which doesn't happen overnight. The people's acceptance and realization of the benefits that they themselves can obtain from an agriculture development program, are essential to the solution of the watershed problems.

To ensure the adoption of the integrated and comprehensive agriculture techniques throughout the Citanduy River Basin with economic, ecological and soil conservation approaches, there must be coordination among the concerned government officials, coordination among dryland farmers and coordination among government officials and farmers.

LOCAL TERMS

Kabupaten	- District/Regency
Bupati	- Chief of District/Kabupaten
Kecamatan	- Sub-district (Administrative Unit)
Camat	- Chief of Kecamatan
Desa	- Village (West Java)
Kepala Desa	- Chief of Village/Desa
Kelurahan	- Sub-village (West Java)
Lurah	- Chief of Sub-village
BAPPENAS	- National Planning Board
BAPPEMKA	- District Planning Board
BIMAS	- Mass Guidance for Agricultural Intensification with Government Credit at Low Interest Rate
INMAS	- Mass Guidance for Agricultural Intensification without Government Credit
Penyuluh Pertanian Lapangan (PPL)	- Agricultural Extension Agent
Petugas Lapangan Penghijauan (PLP)	- Greening Field Officer
Lembaga Pusat Penelitian Pertanian (LP3)	- Agricultural Research Institute
Lembaga Penelitian Tanah (LPT)	- Soil Research Institute
Pusat Penelitian dan Pengembangan Peternakan (P4)	- Central Research and Animal Husbandry Development

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