Watershed Conservation II
A Collection of Papers for Developing Countries

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The Chinese Soil and Water Conservation Society
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and
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Dedicated to

Dr. Robert E. Dils
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FOREWORD

This second set of papers by Ted Sheng covers the period from 1987 to 1990. As in the first set, the papers cover a wide range of topics — from basic considerations and issues to the more specific technical concerns of structural measures for soil conservation and the application of results from runoff plots. There is more emphasis in this second set on the philosophical and administrative issues, but still with the practical and field-wise viewpoint of the many years of experience of the author.

Much of Ted Sheng’s writings could be categorized under “soil conservation”, yet the series is entitled “watershed conservation”. Four papers in this second series focus on the watershed level needs and issues. In the paper on Taiwan’s experience, emphasis is placed on the integration of soil and water conservation through a joint planning strategy for watersheds by the “Forestry, Water Conservancy, and Soil Conservation Joint Technical Committee”. In the paper on watershed project monitoring and evaluation some of the difficulties related to the multi-sectoral efforts, off-site and indirect benefits, and the long term nature of watershed projects are discussed. These issues are discussed further in the paper on important issues in watershed planning, management and research. Finally, the Wusheh Watershed Paper reviews 40 years of efforts and presents an excellent case study of the dynamics of watershed management in action. Thus the balance of on-farm and the larger watershed aspects are put into perspective. The first line of attack by Ted Sheng is always the farmer and conservation farming. However for success this action must be in the context of larger systems — physical as represented by the watershed — as well as social, economic, and political as represented by the multi-sectoral and multi-agency approach. It is this balance of on-farm/watershed, theory/practice, biophysical/socio-economic, planning/implementing, that makes this second volume such a useful tool for land managers, especially those in the developing world.

James R. Meiman
Associate Vice President
and Director of International Programs
Colorado State University
Fort Collins, Colorado
When the national soil conservation program was initiated in Taiwan in early 1950s, Professor Ted Sheng was one of the planners, working then as a specialist in the Chinese-American Joint Commission on Rural Reconstruction (JCRR). He was one of the original promoters of the Chinese Soil and Water Conservation Society and was elected as a Director of the Executive Board when this Society was first established twenty more years ago. Later, being a permanent member of the Society, he has been always enthusiastic about our activities even though he has worked a long time abroad.

Professor Sheng made significant contributions in watershed management in Taiwan up to 1968. He conducted and participated in many watershed surveys and planning and also initiated watershed research and training for the nation. He and others promoted an inter-agency committee, “The Taiwan Forestry, Water Conservancy and Soil Conservation Joint Technical Committee” which has since carried out many important watershed works. This Committee formed an institutional base for the present national program for watershed management and flood control.

From 1968 to 1984, Professor Sheng worked as a watershed conservation expert under the Food and Agriculture Organization (FAO) of the United Nations in the countries of Jamaica, El Salvador and Thailand. During the period, he had visited many other countries under various missions. Since his retirement from FAO, he has taught at the Colorado State University; his last teaching job in Taiwan was more than twenty years ago at the National Chung Hsing University.

Professor Sheng has written numerous papers and reports about watershed management and soil conservation. His major ones are listed at the end of this volume for reference. In addition to his technical reports and publications for FAO, he has attended and/or presented many papers to international seminars, symposiums and workshops. All of them provide useful information for the developing countries in the field of watershed conservation. In 1986, the Chinese Soil and Water Conservation Society and Colorado State University published the first set of Professor Sheng’s papers in a book entitled “Watershed Conservation”. The second set of papers written by Professor Sheng from 1987 to 1990 is now made available in this volume for watershed managers in the developing countries.

San Wei Lee
President
The Chinese Soil and Water Conservation Society
INTRODUCTION AND ACKNOWLEDGEMENTS

The papers in this second volume of Watershed Conservation cover the period of 1987 to 1990. All of them were originally prepared for various international symposiums or workshops. They are presented here in chronological order.

Since the first volume was published in 1986, there has been an encouraging sign of high demand for such reference material from many parts of the world. This second volume is also published for non-profit purpose and educational use. Those who need a copy of it may write to the addresses shown on the page following the Table of Contents.

The author wishes to sincerely thank to the International Programs of Colorado State University and USAID for their direct and indirect support of this publication. Also, thanks are due to the Chinese Soil and Water Conservation Society for their continuous support and for partially subsidizing the volume.

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T. C. S.
BASIC CONSIDERATIONS IN PLANNING AND IMPLEMENTING
SOIL CONSERVATION PROJECTS*

ABSTRACT

The paper emphasizes that soil conservation projects are people and process-oriented. They involve a learning-by-doing approach and often require a modest start to demonstrate on a practical basis what can be done by working with local people. This bottom-up approach should be combined with work on external factors such as laws, policies, incentives, services, and markets thereby bringing bottom-up and top-down approaches together. Conservation projects should be field oriented and both delegation of authority to field officers and adequate logistical support should be provided. Effective assistance to farmers and sound monitoring of project activities are essential. Finally, projects should be conceived as components of a long-term conservation program that each country should develop and control.

1. FOREWORD

Soil conservation projects are difficult to sell because results from them often require a long time to materialize, benefits are widely dispersed and not easy to identify, and individual farmers must invest heavily. Thus soil conservation is an uphill battle against pressures from individuals and nations looking for quick and direct returns on their investment. However, if planned and implemented properly it is possible to encounter less problems and achieve both short term and long term benefits. This paper will discuss some basic considerations for successful projects based on field experience of the authors. We realize fully that each country has its own unique set of circumstances; considerations mentioned here are generally applicable but should be examined closely in each case.

Before discussing any detail, an overall philosophical issue should first be addressed. As scientists, many of us tend to look at conservation problems in terms of soil-plant-animal-water relationships and neglect the roots of the problems in social, economic and political terms. In reality, technical and socio-economic solutions are equally important.

Soil conservation projects are people or process-oriented. By process-oriented we mean that any biophysical treatments proposed must begin and end with the people living on the land. The approach is becoming well known through experience in on-farm water management in irrigation systems, community forestry and farming systems techniques.

A process-oriented approach means we should not start with all the answers and draw up a plan (blueprint) as we would in designing a bridge. Rather, we start by looking at the environment the way the people living in the area see it. From this starting point a learning-by-doing process is begun and adaptations are made as necessary. You can start small and demonstrate on a practical basis what can be done for a particular problem area before moving to larger ones and you allow enough time for successful solutions to evolve. The small start should show some tangible results quickly. At the same time, external factors which affect people living in the area such as laws, policies, incentives, services, markets, etc. should be addressed. The purpose is to bring bottom-up and top-down approaches together.

An effective interdisciplinary approach is needed for any soil conservation project. Team work should be stressed. Experience has shown that if the project is designed from the start as a team effort, then there is a better chance of success.

2. PLANNING CONSIDERATIONS

2.1 Single or Multi-purpose Project

Should a proposed soil conservation project be solely for erosion control or for multi-purposes is one of the important considerations facing the planner at the beginning of the project formation. Experience has shown that in developed countries or economically advanced developing countries both the government and people are usually concerned with conservation and environment protection. In these countries, projects with the single purpose of erosion control or land conservation will likely get public support.

In less developed countries, 'Production' or 'Development' is often highly emphasized. Conversation becomes secondary because it slows down the rate of resources' use, spreads benefit to a longer period, or simply cannot earn foreign currency. While a nation is struggling for survival, any project aiming only at conservation or protection will hardly get government and farmers' support. In these countries, soil conservation projects should be designed to achieve multi-purposes. The usual strategies are: To include in the conservation projects some production goals such as crop production, water production, or power production; and to integrate soil conservation with other development projects (e.g. rural development, watershed development, land settlement, irrigation development). As long as conservation work will be carried out to benefit the land and people, the name of a project is not important.

The planner should however be concerned about the adequacy and effectiveness of such integration. Inefficiently involving too many other activities or inadequately introducing conservation work will defeat the purpose.

2.2 Targets Against Capabilities

Targets should not be too ambitious. They should be set in accordance with the capabilities of the nation's institutions and of the farmers in the project area. This is quite obvious but many conservation or watershed management projects in the world repeat such a mistake over and over. The underlaying causes are not difficult to understand. For many foreign aid projects, governments take the opportunity to seek as much foreign aid as possible while the international agencies tend to inflate the targets and benefits in order to make justifications.

It is quite common, for instance, that a conservation agency proposes 1,000 ha to be treated in a year, the ministry in charge may alter the target to 2,000 ha. The government planner or, the international agency may later increase it to 5,000 ha. Many people without understanding the reality and working conditions in the field mistakenly think that if only the necessary funds are provided the work will be carried out.

People should however realize that institutional strengthening does have its limit. A conservation agency may not be permitted to out grow or to be unproportionately larger than similar agencies in a government bureaucracy. Many temporarily employed technicians in a conservation project may never become permanent and be dismissed once the project is terminated. This will cause frustrations and a waste of time, training, and human resources.

Even personnel training needs time. A conservation project cannot rely on mainly new recruits, giving them some training and sending them out to do a successful job. Experience shows that a college graduate in soil conservation may need several years of field experience to be able to do independent work. Less qualified persons may need even longer time and require closer supervision. Yet, in many developing countries, the number of professionals in this field who can do independent work as well as supervision are limited.

Institutional coordination is also a problem in developing countries. Qualified professionals are scarce in every agency especially for engineers, hydrologists, soil scientists, and economists who are usually required in soil conservation projects. Often only after an agency's own business is taken care of, may they lend their hands to others.

It is most important to consider the acceptance of farmers and their capabilities. Farmer acceptance is always gradual. We knew some projects that after several years of intensive extension and incentives, farmer acceptance in the watershed or project area was still less than 50%. Even when farmers accept the project, their capability should still be considered. For instance, if terracing a hectare needs 450 maydays, the project should not expect each family to accomplish that much a year.

The above-mentioned considerations should help to determine realistic project targets bearing in mind that a small success is better than a big failure.
2.3 Resources and Schedule Conflicts

After a realistic overall target is estimated, the next important consideration is to set a time schedule based on the flow of resources. Critical stages and bottlenecks should be identified and solutions sought. Realizing it takes time to get human and other resources in place to carry out the planned activities, thorough consideration and preparation are necessary. A comprehensive network analysis is usually needed.

Alternative courses should be adopted in case there are conflicts. Regulating resources flow, modifying technology, and adjusting progress are some of the techniques to overcome the conflicts.

Since farmers acceptance is slow and such a project is process-oriented, a progressive work schedule is most desirable. At the beginning, work can involve pilot farmers or contact farmers and grow gradually as trained staff are available for assisting them. When lessons are learned and both the confidence of farmers and the technicians are established, the project can accelerate. This is why such projects often require a long duration. The same principle can also be applied to individual farm development.

2.4 Appropriate Planning Approaches and Techniques

Planning is a dynamic and iterative process and we should realize that plans are points of departure rather than rigid flats. Any plan should allow for continuous refinement as experience is gained during the project life.

A major problem usually confronting the planner is how to reconcile 'what should be done' and 'what can be done'. The former, 'what should be done', can be found by physical surveys of topography, soils, present land use and erosion hazards, etc. and based on them a rank of critical or priority areas can be set. The latter, 'what can be done', is limited by socio-economic conditions as well as the capabilities and interests of individual farmers. A process approach recognizes that ultimate success will occur only if the soil conservation practices are integrated into the farming systems with the farmer. This takes time and much effort. An effective plan will show how resources will be used to bring together what should and can be done.

Eventually, farm planning for each farm or for groups of farm in a project area will be done and will provide the necessary bottom-up information. But at the stage of planning and before project approval and implementation, it is too time consuming to complete such work on individual farms.

Instead, some simplified bottom-up planning techniques can sometimes be used such as conducting sampling surveys of the farmers' needs, developing farm models, or carrying out reconnaissance type socio-economic surveys of the project area. Whatever it is, the design of questionnaires and survey forms should be done carefully and farmers should be well informed about the objectives.

Technical criteria used for classifying land capability and for estimating conservation needs should be practical and reliable. If not, it will cause difficulties in the later implementing stage. Last, but not the least important, is that the conservation practices to be introduced must be effective in erosion control. Otherwise, the main objective of the project will not be fulfilled.

3. IMPLEMENTATION CONSIDERATIONS

3.1 Effective Mechanisms for Assisting Farmers

An effective mechanism for assisting farmers is the key to the successful implementation of such projects. The problems are always which organization(s) should be involved and how it will be organized? Whatever the answer, emphasis should first be put on establishing field offices that can offer effective assistance to the farmers. Many top heavy traditional institutions in developing countries should therefore alter their structures and shift more resources to the field and delegate more authority to the regional and field offices.

The most effective delivery of soil conservation techniques to farmers involves an understanding of the farmer's system. This often requires an interdisciplinary team to work with farmers. The team may be lead by a key agency such as a soil conservation service or a forest department, or lead by an extension agency. There is no one answer as circumstance vary from country to country. From our observation, the problem of extension service or agency is that their field agents have usually been overloaded with too many other duties while the problem of the key agency is that they normally lack experience, resources and a network to deal with farmers.

Experience shows that a joint approach and
team work between the field officers of the key agency(s) and the extension agents can serve the farmers better. Therefore, at the beginning of implementing conservation projects, time must be spent in organizing and developing such field teams and they should be supported fully by various subject matter specialists.

3.2 Incentive Needs

The need for incentives to encourage farmers to adopt conservation practices has been well documented. The simple reasons are that many farmers have little or no resources to invest in such work. Furthermore, many of the soil conservation benefits accrue in the future and to others.

Incentives are of many kinds; some are direct and others are indirect. Among direct incentives, the popular one is giving cash subsidies in accordance with work performance or as partial wages. Food and other items are also used as incentives. There are pros and cons for using cash as subsidies. Cash is easy to handle but it can be misused by farmers. On the other hand, giving commodities would increase management problems such as transportation and storage and also involve farmer’s preference.

Indirect incentives, except technical assistance, are less used in developing countries. Some, like tax exemption, deduction, and security in land tenure, etc. may require exhaustive discussions and lengthy years of planning with land and tax authorities. Such proposals often need legislative support. Others, like farm credits and marketing service, can be very effective if the project takes an interdisciplinary approach. Sometimes, disincentives can also be effective for promoting conservation work. Governments can set a firm policy that farmers who continuously misuse slopeland or practice destructive type of cultivation cannot receive crop subsidies, farm credits or other related assistance.

Effective use of incentives requires a detailed knowledge of the farming systems as well as a thorough understanding of the farmer. A good incentive will promote the farmers goals, will encourage eventual self-reliance on the part of the farmer and the community, and will fit into both short term and long range plans. A special consideration in conservation work is to provide incentives for proper maintenance.

Incentives should also be given to government staff who work in the field. The working conditions in rural areas especially in uplands are mostly rough and inconvenient. Without proper incentives such as adequate per diem, priorities for promotion, and opportunities for advanced training, the project will have difficulty in attracting and maintaining competent and dedicated personnel.

3.3 Adequate Administrative Support

Good administrative support is essential but it is often neglected. Administrators tend to pay much more attention to the headquarters than to the field offices. The environment and services to the field offices in many countries are very poor and staff assigned there have a sense of downgrading or being punished. Sufficient vehicles need to be provided to them for field use. Necessary equipment should be available in the field. These are essentials since soil conservation work is field-oriented. In many countries, there is no delegation of authority in the field regardless of the difficulty in communication. Much worse is to change project leader and key personnel frequently without much concerns of work continuity.

The above mentioned problems and requirements are quite obvious. However, in the real world, it is not uncommon that the field staff are frequently bogged down because of a lack of transportation, equipment, funds, leadership and/or authority.

3.4 Training and Research Needs

Staff training is a vital element to the success of conservation projects. We believe that any such project can only grow as fast as trained persons are available to implement it. However, as mentioned earlier, professional training in soil conservation or watershed management is rather rare in the third world. Although young people can get trained abroad, the physical and socio-economic conditions are so different that they need to be reoriented when they come back. What really is needed is a well designed and continuous in-service training program tailored for local needs. Such in-service training programs should involve young professionals of various disciplines, technical officers, and field assistants. Experience shows that four to five weeks should be an appropriate duration for the initial basic training for professionals and sub-professionals including substantial time for field practices. For field assistants and extension officers the duration can be shortened.

In addition to staff training, farmer training should also be carried out in the earliest time possi-
ble. Usually, awareness campaigns and project introduction meetings can be employed at the beginning of the project and carried on as long as needed. Special training for farm leaders and contact farmers should follow as soon as technicians and extension officers are properly trained and demonstration plots start to show tangible results.

Problem solving and practical research should be included in the project. Adaptation trials for new species and for transferred technology are also needed. These are short-term, applied experiments that governments and international aid agencies should agree to include as a vital part of the project. Many applied on-farm field studies provide a most effective mechanism for linking together technicians, farmers, and extension workers as well as for developing an interdisciplinary approach.

3.5 Sound Monitoring and Evaluation Systems

Lack of basic data and evaluation results is a common shortcoming of many soil conservation projects in the developing countries. In a highly competitive world, it is necessary to obtain basic data and to keep ongoing evaluation results to attract continuous investment in conservation projects. Final evaluation results should be made known and should include physical accomplishments, economic benefits, and social and environmental impacts.

Using an inexpensive personal computer and some existing software the project’s data base can be gradually established. During the project life, continuous monitoring should compare the planned target with actual achievements. Such internal and continuous self-monitoring becomes a strong building force as well as ensures that a learning process approach is put into practice.

Evaluation mechanisms should be built in the project and its methodology be clearly defined. Establishing an independent unit for evaluation involving partly outside experts is an ideal approach. Since the benefits of soil conservation are relatively difficult to assess, only some major or essential ones should be taken into consideration. For instance, evaluation can be centered on major land use change, farmers’ income, sedimentation rates, water quality, etc. as required. Once the items are determined, the methodology should be spelled out and necessary equipment be installed. Too often evaluation is a last minute endeavor; without proper data it proves ineffective.

Soil conservation work takes time. A project should be given sufficient period to show results. Many times when a project is barely started, groups of outside evaluators are at the doorsteps disrupting the project and its staff. Outside interference should be kept into a minimum especially in the early phases of a project.

4. IN CONCLUSION

There are many more considerations in planning and implementing successful projects, but the most important of those we have identified here are as follows:

1) Projects must be looked at as complicated systems, requiring an inter-disciplinary approach that combines biophysical and socioeconomic elements.

2) A process or learning approach must be used that involves the farmers or land users in each step. In such an approach, the land users and technicians learn from each other.

3) Project activity takes place in the field; therefore, legislative, technical, and administrative support should focus on field operations. This support should be accompanied by delegation of authority to field officers.

4) A project’s duration is usually a brief part of the long-term horizon needed for successful conservation programs, and this should be realized in the planning and implementation of a specific project. It is each country’s responsibility to develop and control this overall conservation program, no matter how much project help it may obtain.

REFERENCES


DEMONSTRATING PROPER USE AND CONSERVATION PRACTICES
ON STEEP LANDS IN JAMAICA*

ABSTRACT

The paper describes the establishment of a small demonstration watershed on steep public lands in northwest part of Jamaica. Specially designed slopeland classification, conservation treatments, and criteria for sound land use are spelled out. Data collection methods and results on soil erosion and cost and benefit are also described. The use of such demonstration for personnel training is emphasized. Finally, the impacts and experience of the demonstration are briefly presented and discussed.

1. BACKGROUND

1.1 Selection of Demonstration Sites

Demonstrations are often needed for soil conservation or watershed projects in new areas. At the initial stage of the first FAO forestry and watershed management project in Jamaica (JAM/67/505) in 1968, the government required the project to select and establish proper demonstrations in a watershed at the northwest part of the island. After a quick survey, two demonstrations were selected for subsequent treatment, one on public land and the other on private.

This paper will discuss the experience of setting up the demonstration watershed on public land and explain its results and impacts.

The demonstration, now called ‘Smithfield Demonstration and Training Centre’, is situated at 25 miles west of Montego Bay which is the second large city of Jamaica. It is a sub-watershed of 45 ha (110 acre) at the upstream of the Maggotty River and on the south end of the Kenilworth Property near the village of Cascade.

The average annual rainfall at the demonstration site is about 3,300 mm (130 in.) and rainfall intensities of 75 mm to 85 mm per hour are not uncommon. The terrain is steep ranging from 10 to 35 degrees with mode slopes around 15 degrees (27%). Two major types of soils are: one being dark red to reddish brown clay loam covering two-thirds of the area and the other, red and light colored clay, covering the remaining area. Both are Oxisols derived from highly weathered tuffs, shales and conglomerates. They are acid and deep soils (around 90 cm and more) with moderate drainage. During rainfall seasons, they can be waterlogged. Fertilities are low. The site had over decades been used for cultivating yams (Dioscorea spp.), a root crop mainly for domestic consumption, followed by banana plantation and grazing. After the government bought the area, again yams were planted in traditional shifting patterns by squatters from the nearby villages. Erosion was very severe. In many areas top soils were eroded away. Gullies as deep as 1.5 m to 2 m were found.

The reasons for selecting the site were: 1) it is a small watershed and easily accessible, 2) its topography, soils, climate, land use and erosion are representative to the region, 3) it is close to a village where laborers are abundant, and 4) it is only three miles away from the second demonstration where farmers could conveniently come to visit. Although rainfall is somewhat higher than the average, the site was considered having advantages for testing the proposed soil conservation practices against heavy rains.

1.2 Background Information

Seventy five percent of Jamaica is hilly land where domestic food and export crops are produced. Soil erosion has long been recognized as a serious land use problem. Even back to the 1930s, the need for soil conservation work was identified. However, due to lack of proper institution, trained personnel, and sound and effective conservation practices the progress of work was greatly hampered. At the time the FAO project was started, only a handful technicians was involved in some watershed protection work and very limited efforts were made on conserving cultivated slopes.

Early in 1950s, conservation projects were emphasized at two pilot ‘Land authorities’. Because lacking of proper land use criteria and effective conservation practices for steep slopes, the work did not reduce much erosion and promote people's interest and therefore discontinued.

The FAO project was given, against such background, the task of establishing demonstrations, preparing scientifically designed land use plans, and training technical personnel, among other stipulated responsibilities.

2. MULTI-OBJECTIVE DEMONSTRATION

Demonstration of soil conservation work cannot be stopped at showing only conservation techniques. At the very beginning, decisions were made that the future demonstration should serve the following objectives:

1. To demonstrate soil conservation practices together with proper land use and cropping.
2. To collect and analyze data on costs and returns and on erosion rates for future planning use.
3. To serve as a national training centre in watershed conservation.

The first objective is important to any soil conservation demonstration. Farmers and governments are generally interested more in land use and crops than purely conservation techniques. To isolate conservation practices from cropping and land use will not win their support.

Since such demonstration is usually a first step toward a regional or a national program, to collect physical and economic data for the benefits of future planning is a necessity. Under the Jamaica context, due to lack of data at that time, the second objective was deemed very important and essential.

The last objective was to combine demonstration and training sites to one and to use it as a practical training ground for technicians and farmers. Before the FAO project, Jamaica lacked intensive training in this subject even in colleges and schools.

Smithfield Demonstration was established practically in a two year period (1969-1970) after site selection in late 1968. For its 45 ha, every piece of land was properly treated either with conservation practices or with afforestation and put it into suitable use. Essential data collection mechanism and instruments were set. Offices, classroom, dormitory and simple laboratory were constructed. The work progress, results and impacts will be discussed in the following sections.

3. PROPER LAND USE AND CONSERVATION TREATMENTS

3.1 Treatment-oriented Land Capability Classification

To use every piece of land according to or within its capability is probably the first step toward any soil conservation project whether it is in a demonstration area or on a farm. Jamaica, at that time, used a land capability classification derived from the USDA system. It was introduced in 1953 and the system was similar to the one used in Puerto Rico (Steele, 1954). The classification has caused some dilemma to the government as well as farmers. For instance, Jamaica as a whole, has more than half of its land over 20 degree (36%) slope and numerous small farmers were making living on such slopes. Yet, using that classification system, these slopes were excluded from cultivation.

It was apparent then that a practical classification should be introduced. Based on Taiwan experience and modified it for easy application, a new, ‘Treatment-oriented’ land capability classification was first tested in the demonstration area and later improved and adopted by the Government.*

The central theme of the ‘Treatment-oriented’ system is straightforward i.e. if a piece of land can be treated and protected by the prescribed conservation practices and erosion minimized, that piece of land should be allowed for intensive use and safe cultivation. Using slope and soil depth as major factors plus considering other soil limiting factors (stony, wet, severe erosion, etc.), each piece of land is classified to its most intensive use permissible, provided conservation treatment(s) will follow. Lower or less intensive use is allowable if owners so desired whereas over use is discouraged. Because the main factors are easy to measure and detect, the system can be understood by field assistants and

*The system has since been used in El Salvador, Honduras, Thailand, and Nepal, etc.
farmers. The system shows conservation needs and tools for land treatment and cultivation (See App. 1). Details of classification and mapping procedures can be seen from two reports (Sheng, 1972 a, & 1981 a).

Using this system, for instance, lands up to 25 degrees (47%) with deep soil is allowed for cultivation provided the land will be treated with conservation measures accordingly. Slopes up to 30 degree (58 %) can still be used for fruit trees, tree crops or agro-forestry when conservation practices are applied. This system is close to the reality of how farmers are using their lands and therefore creates less land use conflicts between government and farmers. According to our experience in classifying Smithfield and the Kenilworth Property (about 1,000 ha), the system resulted in increasing 100% 'cultivable land' in comparison with the old system.

3.2 Conservation Treatments for Steep Lands

The major conservation practices used in Jamaica at that time was grass barriers, contour furrows and strip cropping. Those are mostly suited on gentle slopes and for mild rainfall countries. In the mid-Fifties, for example, a total of 1,500 miles of grass barriers had been planted on steep slopes of Yallahs Valley (a pioneer project in conservation and land development at Southeast Jamaica). It was found as early as in 1961 by the then Ministry of Agriculture and Land that this practice was not the answer to the soil erosion problem (Jamaica MAL, 1961). The strip cropping work carried out at the same Valley also failed (Champion, 1966). Same result was found at another Land Authority, Christiana, in the central part of Jamaica. Contour furrows on steep slopes have been quite common. However, when rains were heavy and contours were not exact, or waterways were not provided, the furrows were easily broken causing snow-ball effect to the down slope. The labor cost required for making and maintain contour furrows was not cheap.

In the mid-Sixties, some attempt was made to built bench terraces. However, due to using the wrong type, outward sloped type, the terraces were mostly washed out after several rainy seasons.

In considering steep slopes, intense and frequent rainfall, and inevitable runoff, six structural types of conservation treatment and seven types of waterway were introduced at the demonstration area. The six types of land treatments were all reverse sloped bench terraces, continuous or discontinuous, built with machine or hand. Each type was connected to protected waterways for safe drainage. Proper types of terraces were used in conjunction with various agronomic conservation measures for proper land capabilities and crops.

The six major land treatments were: Bench terraces, hillside ditches, individual basins, orchard terraces, convertible terraces, and hexagons*. Fig. 1 and Table 1 show their cross-sectional views and specifications. Detail explanations can be seen from two articles (Sheng, 1977 & 1981 b). Diagrams of waterways and their usage are shown respectively in Fig. 2 and Table 2.

Other type of conservation work carried out in the demonstration center included gully control, slope stabilization, road drainage improvement and protection, and revegetation, etc. By the end of 1970, the entire sub-watershed was fully protected.

3.3 Proper Use and Cropping

Proper use of each piece of land was followed after land treatment. The followings were some major principles observed:

(1) For C2 land (Cultivable Land 2, 7-15 deg.): Grow annual crops and cash crops such as yams and vegetables on bench terraces for 4-wheel mechanization; or grow orchards with hexagons for mechanization.

(2) For C3 land (Cultivable Land 3, 15-20 deg.): Grow annual crops and cash crops on bench terraces using mainly hand tractors; or, grow semi-permanent crops (bananas, coffee, etc.) on discontinuous types of structures such as hillside ditches, individual basins, and hexagons.

(3) For C4 land (Cultivable Land 4, 20-25 deg.): Grow annual crops on hand-made bench ter-

*Later, land treatments were increased to eight types in Jamaica including natural terraces and intermittent terraces.
Figure 1. Cross-sectional view of eight type structures for land treatments

<table>
<thead>
<tr>
<th>Kind</th>
<th>Specification</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bench terraces</td>
<td>Width of flat bench: 2.5-5.0 m, Length: &lt;100 m, Horizontal rise: up to 1%, Vertical rise: 0.75:1</td>
<td>4. Orchard terraces</td>
</tr>
<tr>
<td>(a) Hand made</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Machine built</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Hillside ditches</td>
<td>Length: 1.8-2.0 m, Horizontal rise: &lt;100 m, Vertical rise: 10%</td>
<td>5. Intermittent terraces</td>
</tr>
<tr>
<td>3. Individual basins</td>
<td>Length: 1.5 m (Round),</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Orchard terraces</td>
<td>1.75 m, Length: &lt;100 m, Horizontal rise: 1%, Vertical rise: 0.75:1</td>
<td>6. Convertible terraces</td>
</tr>
<tr>
<td>5. Intermittent terraces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Convertible terraces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Natural terraces</td>
<td>8-20 m</td>
<td></td>
</tr>
<tr>
<td>(a) Natural terraces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Peripheral road</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

*VI is vertical interval between two succeeding terraces, which determines spacing.  
To be applied mostly between the terraces (or on the individual basins) such as contour planting, close planting, cover cropping, mulching, etc.  
CS: Slope as percentage  
Wb: Width of bench
Figure 2. Major types of waterways as described in Table 2 (Sectional views: stilling basins not shown)

Table 2. Major types of protected waterways: their uses and limits

<table>
<thead>
<tr>
<th>Type</th>
<th>Shape</th>
<th>Channel protection</th>
<th>Velocity limit</th>
<th>Slope limit</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Grassed waterway</td>
<td>Parabolic</td>
<td>By grass</td>
<td>1.8 m sec⁻¹</td>
<td>&lt; 11° (20%)</td>
<td>For new waterway or depression</td>
</tr>
<tr>
<td>2. Grassed waterway with drops</td>
<td>Parabolic</td>
<td>By grass and concrete or masonry</td>
<td>1.8 m sec⁻¹</td>
<td>Between two structures: 3%, overall slope &lt; 11° (20%)</td>
<td>For discontinuous type of channel</td>
</tr>
<tr>
<td>3. Ballasted waterway</td>
<td>Parabolic</td>
<td>By stones or stones in wire mesh</td>
<td>3 m sec⁻¹</td>
<td>&lt; 15° (25%)</td>
<td>Where stones are available</td>
</tr>
<tr>
<td>4. Prefabricated (a) Parabolic waterway</td>
<td>Parabolic</td>
<td>By concrete structures and grass</td>
<td>–</td>
<td>&lt; 20° (36°)</td>
<td>A stilling basin is usually needed and where rainfalls are frequent and flows are constant</td>
</tr>
<tr>
<td>(b) V-notch chute</td>
<td>90° V-notch</td>
<td>By concrete structures and grass</td>
<td>–</td>
<td>&gt; 20° (36°)</td>
<td>Same as above and on very steep slopes</td>
</tr>
<tr>
<td>5. Stepped waterway</td>
<td>Parabolic and rectangular</td>
<td>By grass and concrete or masonry drops</td>
<td>On grass part: 1.8 m sec⁻¹</td>
<td>Overall slope &lt; 20° (36%)</td>
<td>For 4 wheel tractors and in the middle of bench terraces</td>
</tr>
<tr>
<td>6. Waterway and road ditch</td>
<td>Parabolic</td>
<td>By grass and stone ballasting</td>
<td>3 m sec⁻¹</td>
<td>&lt; 8° (14%)</td>
<td>For 4 wheel tractors mechanisation</td>
</tr>
<tr>
<td>7. Foot-path and chute complex</td>
<td>Trapezoid or rectangular</td>
<td>By concrete or masonry structures</td>
<td>–</td>
<td>&gt; 20° (36%)</td>
<td>For paths on small farms and on very steep slopes</td>
</tr>
</tbody>
</table>

*These limits are approximations for general reference. In practice, the volume and velocity of runoff and site conditions should all be taken into consideration.*
races and cultivated mostly by hand.

(4) For FT land (Land for food trees, fruit tree etc. 25-30 deg.): Grow citrus, etc. planted on basins between hand-made orchard terraces.

(5) For P land (Pasture Land, <25 deg. shallow soils): Establish grass cover, and if it is wet or severely eroded, practice zero grazing.

(6) For F land (Forest lands, >30 deg., or 25-30 deg. severely eroded): Plant carib pine (Pinus caribaea), Blue Mahoe (Hibiscus elatus), etc.

Although some parcels were deliberately under-used because of inaccessibility or other reasons, the whole demonstration has been put into the most intensive use possible. In later years, further development work was carried out including using small runoff tanks for irrigation, cow raising and compost making, and applying agro-forestry practices such as planting bananas under pines and interplanting foliage crops in pine forest.

4. DATA COLLECTING

4.1 Erosion Data

There was practically no erosion data on slope-land cultivation in Jamaica at the time the project was started. In order to collect such data, a runoff and soil loss study was initiated in 1969 in the demonstration area. The study consisted of four plots of 1/100 ha each and two replications on a 17 degree (30%) slope. Yams were tested first using four treatments: 1) bench terraces & continuous mounds, 2) hillside ditch & continuous mounds, 3) hillside ditch and traditional hills and 4) conventional cultivation as check. The study repeated for four years and found that the check plots lost in average 133 metric tons per ha per year whereas the bench plots were only 17 tons. The soil loss of the two hillside ditch plots were 26 and 38 tons respectively. This experiment was followed by bananas using somewhat different treatments. After a five year study it was found that the soil loss of bench and check plots were quite similar to that of yams (16 tons and 130 tons respectively) but the plots treated with hillside ditches, individual basins and cover crops lost only 7 tons/ha/year while the cover crop plots were 22 tons.

The above data not only provided basic erosion rates but also supplied information for watershed management and soil conservation planning. For instance, hillside ditches plus agronomic conservation measures can reduce 80% or more erosion yet their cost per unit area is only 1/5 of bench terracing under same conditions. For perennial crops and for those small farmers who cannot invest bench terraces for annual crops, hillside ditches or other type of discontinuous terraces (i.e. convertible terraces, intermittent terraces, etc.) should be considered sufficient.*

In addition, studies on erosion and runoff of young pine forest against fallow land, on ground litters and protection function of pine forest, and on road slope stabilization including wattling and staking and hyrdo-seeding, etc. were also carried out in Smithfield.

A complete agro-meteorological station which is one of the sixteen in the Caribbean network was also established in 1969.

4.2 Cost Data

Cost of various conservation treatments were collected by the following procedures:

(1) Using daily working records to keep work progress and accomplishments.

(2) Using the ‘Specification Tables for Soil Conservation Treatments’ which are mathematical calculations of volumes, etc. to check the output per manday or per machine hour.

(3) Giving 'Task Work' to find the maximum output and capability of a laborer or a machine operator.

It was found that, for instance, a manday could averagely cut and fill 3 to 4 cu. m. of soil; a D-6 Bulldozer could move 40 cu. m. an hour; a ha of hillside ditches on 20 degree slope needed 80 mandays to complete where as a ha of 3 m wide

*If the Soil Loss Tolerance Value (T-value) could be set at 20 to 25 t/ha/year for steep lands in the humid tropics.
bench terraces on 24 degree slope required 470 mandays to complete. Using these manday or machine hour figures to multiply with wage or unit cost, the construction cost per ha can thus be obtained. For planning purpose, the ‘Specification Tables’ have been extensively used. For instance, dividing total volume to be cut and filled by output of a manday or machine hour, the treatment cost of an area can also be calculated out.

The cost of cropping was obtained by also keeping daily records on land preparation, planting, weeding, reaping, etc. and by material inputs such as planting material, fertilizers, insecticide.

The above mentioned work seems like routine and simple. Nevertheless, to keep record faithfully and persistently and to analyze them thoroughly is always a tedious and painstaking task. This may be one of the reasons why reliable data are universal lacking for soil conservation projects.

4.3 Benefits and Returns

On-site benefit was obtained from crop returns minus cost of cropping and annual cost of land treatment. Detailed cropping cost and returns were published (Powell, 1974) and annual cost of terracing was examined (Sheng, 1972 b). For instance, it was found in 1971 that the annual cost of bench terracing per ha (including waterway) on moderate slope was around US$175 while the net returns of yams per ha was about US$1,850. The yam produced in Smithfield was always 100% higher than the local yields. Terraces were found reducing cultivation and transportation costs when 4-wheel tractors were used. Also, terraces could keep steep land under permanent cultivation without reversion to fallow, thus greatly increasing production.

The off-site benefits, as usual, was difficult to estimate. Using a sediment delivery ratio of 30% and assuming two-thirds of a watershed is being cultivated at all time, the downstream sedimentation rates could easily be reduced by 20 tons or more per ha per year according to the erosion study mentioned before. To multiply watershed area with this figure a total reduction of annual sediment can thus be obtained. From this, depending on watershed locations or whether there exists a reservoir, benefit figures can then be estimated. Without erosion data, no realistic estimation can be made.

5. TRAINING

Immediately after the establishment of the demonstration, staff training was started in 1971. Two types of residential courses were conducted at the site: one for young professionals and sub-professionals and the other for field assistants and headmen. The first type was a 4-week course consisting of 50% time for field practices whereas the second type was a 2-week course with 75% field training. A full lecture notes in watershed management and soil conservation was provided to the first type of course and later published (Sheng and Stennett, 1975). For the second type, only outlines were given.

The staff of the subsequently established Soil Conservation Division were almost all trained in this two types of courses. Later on, several new types have been added. One type was land use planning course conducted jointly with the British Overseas Development Administration and another type was designed specially for agricultural extension officers, both for three weeks. Special courses for Eastern Caribbean conservation officers, US Peace Corps, and others were also conducted.

From 1971 to 1982, a total of 26 courses and 390 Jamaican official and 15 international technicians were trained. In addition, hundreds of farmers visited the Centre each year to get first hand information in conservation farming.

6. IMPACTS AND CONCLUSIONS

The impacts of the Smithfield Demonstration and the FAO project as a whole can be briefly stated as follows:

(1) The demonstration serves as a practical and educational module for proper use and conservation of steep slopes in Caribbean and Central American.

(2) The demonstration has provided basic data for watershed and conservation project planning and resulted in securing a total investment of US$35 million for Jamaica in six internationally funded projects in the following decade.

(3) About 400 technicians were trained which greatly enhanced the nation’s institutional capability and enabled the government to establish Soil Conservation Division and its field posts.

(4) Experience from the demonstration was used for developing conservation policy including
proper land use and incentive needs etc. and for formulating a national soil conservation program.

Finally, the success of the demonstration was also due to four additional factors: Good planning, proper management, faithful implementation, and excellent support from the government. Lacking any of them the result would be less significant.

REFERENCES


### APPENDIX I

**NEW SCHEME OF LAND CAPABILITY CLASSIFICATION**

- A Treatment-oriented Scheme for Hilly Marginal Lands -

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Depth</td>
<td>&lt; 7° (&lt; 12%)</td>
<td>7° - 15° (12-27%)</td>
<td>15° - 20° (27-36%)</td>
<td>20° - 25° (36-47%)</td>
<td>25° - 30° (47-58%)</td>
<td>&gt; 30° (&gt; 58%)</td>
</tr>
</tbody>
</table>

- Deep (D) > 36 in. (> 90 cm) -
  - C₁
  - C₂
  - C₃
  - C₄
  - FT
  - F

- Moderately Deep (MD) 20 - 36 in. (50-90 cm.) -
  - C₁
  - C₂
  - C₃
  - C₄
  - P
  - FT
  - F₁
  - F

- Shallow (S) 8 - 20 in. (20-50 cm.) -
  - C₁
  - C₂
  - P
  - C₃
  - P
  - P
  - F₁
  - F

- Very Shallow (VS) < 8 in. (< 20 cm.) -
  - C₁
  - P
  - P
  - P
  - P
  - F₁
  - F

1. Symbols for most intensive tillage or uses:

- **C₁**: Cultivable land 1, up to 7° slope, requiring no, or few intensive conservation measures, e.g. contour cultivation, strip cropping, vegetative barriers, rock barriers and in larger farms, broadbase terraces.

- **C₂**: Cultivable land 2, on slopes between 7° and 15°, with moderately deep soils, needing more intensive conservation e.g. bench terracing, hexagons, mini-convertible terracing for the convenience of four wheel tractor farming. The conservation treatments can be done by medium sized machines such as Bulldozer D5 or D6.

- **C₃**: Cultivable land 3, 15° to 20°, needing bench terracing, hexagons and mini-convertible terracing on deep soil and hillside ditching, individual basins on less deep soil. Mechanization is limited to small tractor or walking tractor because of the steepness of the slope. Terracing can be done by a smaller machine.

- **C₄**: Cultivable land 4, 20° to 25°, all the necessary treatments are likely to be done by manual labour. Cultivation is to be practised by walking tractor and hand labour.

- **P**: Pasture, improved and managed. Where the slope is approaching 25° and when the land is too wet, zero grazing should be practised. Rotational grazing is recommended for all kinds of slopes.

- **FT**: Food trees or fruit trees. On slopes of 25° to 30° orchard terracing is the main treatment supplemented with contour planting, diversion ditching and mulching. Because of steepness of the slopes, interspaces should normally be kept in permanent grass cover.

- **F**: Forest land, slopes over 30°, or over 25° where the soil is too shallow for any of the soil conservation treatments.

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1 Author's Note: Since 1980, agroforestry (AF) is added to this category where the soils are shallow but they can still be grown crops together with trees.
2. Any land which is too wet, occasionally flooded or too stony which prevents tillage and treatment should be classified as follows:
   (a) Below 25°: Pasture
   (b) Above 25°: Forest

3. Gully dissected lands which prevent normal tillage activities: Forest or pasture.

4. Mapping Symbols: Could be labelled as follows:

   Most intensive use
   soil – slope – depth

   example: \[
   \text{Means} \quad \frac{C_2}{32 - 2 - D}
   \]

   or, it could be simply labelled as \( C_2 \)
SOME CURRENT ISSUES IN SOIL CONSERVATION*

ABSTRACT

Some current issues in soil conservation, particularly those related to developing countries, are discussed in this paper. These issues are overall objectives in soil conservation, planning approaches, program of work, strategies for inducing farmers' participation, proper technology, selection of appropriate conservation measures, and the needs of future generations. While these issues are often controversial, they are very important and only through more discussion and analysis will better understanding and suitable solutions be obtained.

The author uses theories and practical experience to address and argue each issue in order to stimulate more studies among professionals, field workers, administrators, and policy-makers in developing countries. Realizing there are no universal answers to these issues, the opinions given in this paper are for reference purposes only. The author suggests that each country need to find its own solutions according to its individual environment and needs.

1. INTRODUCTION

Soil conservation has increasingly attracted world's attention since 1980. Many international conferences, seminars, and workshops have been held, and many soil conservation societies have increased their activities. Also, many countries have initiated new programs or enlarged existing ones in response to the urgent need to control soil erosion. Agencies for international development such as FAO, World Bank and USAID, etc. have assisted and invested heavily in soil conservation projects.

Great part of the reason is because soil conservation is a complex and difficult task. In many developing countries, for instance, soil conservation work needs to be carried out by poor, small farmers. Also, conservation work often requires long-term investment and effort to obtain tangible benefits. When economy worsens, government and the farmers usually seek the quickest and maximum return from their land, leaving conservation a low priority. Furthermore, conceptual differences do exist among soil conservation workers regarding conservation objectives, suitability of techniques, and ways to implement the work.

Against this background and based on observations, contacts, and experience, the author has identified seven current issues in soil conservation. These issues are often controversial, yet they are very important. Only through more discussion and study will better understanding and possible solutions be obtained. These issues are the following:

(1) On Overall Objectives: Which main objective should be more emphasized in soil conservation programs or projects: erosion and sediment control or agricultural production?

(2) On Planning Approaches: What are the pros and cons of planning from the bottom up compared to centralized or top-down planning? How do we bring these two approaches together?

(3) On Program of Work: Should soil conservation work be concentrated in a few important watersheds or be carried out nationwide?

(4) On Inducing Farmers's Participation: Which strategy should be relied on more: giving sufficient incentives or depending extensive educational campaigns?

(5) On Proper Technology: Should we adopt cost effective technology or those technologies requiring only minimum knowledge and input? Do we need to establish criteria for land use and conservation practices, or need we only suggest those ones that will be easily accepted by farmers?

(6) On Selection of Conservation Measures: What are the advantages and disadvantages of using structural measures and agronomic measures in relation to their major functions? And how do we select them?

(7) On the Needs of Future Generations: Do we need to concentrate conservation work on subsistence farms or look beyond them into future development of slopeland?

2. ISSUE ONE: OVERALL OBJECTIVES

Is soil conservation a means to achieve agriculture production, or is it an end itself for erosion and sediment control? Or, to put the issue in another way: should soil conservation emphasize production function or protection function?

To answer this question one needs to look into the conditions of the particular country. Where survival is at stake, many developing countries need to produce as much as they can to feed their people and to advance their economy. For these countries, it would be wise, in general, to emphasize the production function of soil conservation programs or projects to help producing more food or more water. There are usually two ways to achieve such objectives. One is to include in the soil conservation program/project some production functions such as crop management and minor irrigation. The other is to integrate soil conservation work into other development projects such as crop expansion, land settlement, and rural development. To insist that soil conservation is only for conservation's sake or to implement it outside of the production or development sectors would be less acceptable to policy-makers.

Similarly, where subsistence farmers are dominant, emphasizing erosion control alone will not attract farmers' participation which is a key to the success of many projects. The best strategy then is to emphasize the production function and to integrate soil conservation practices into the farming system so that the work will be perpetuated by the farmers.

One crucial question, then, is how far soil conservation projects go to achieve production function? Soil conservation has its own scope and is not a substitute for proper crop varieties, insect and pest control, and marketing. Production goal can only be obtained through good coordination with other institutions. To try to do everything by conservationists themselves will be very difficult. Unless, like in some countries, the conservation institution or project is equipped with sufficient professionals of other disciplines and is entrusted to do a production task.

On the other hand, to pursue production function of such project should not be at the expense of protection function. If erosion control objective fails the whole project will fail even though the production function may be fulfilled in the short run. Soil conservationists should not agree with 'land-mining' type of agriculture.

In economically advanced developing countries and developed countries, people are more concerned about environmental protection, disaster prevention, and quality of life. Therefore, their soil conservation programs or projects could emphasize protection more than on production. Torrent control in Europe, ‘Sabo work’ in Japan, and stream channel protection and check dams in many other countries are essential and vital for the protection of nearby communities and downstream areas. Yet, many of us may be inclined to think that such work is unnecessary or too costly.

Fortunately, the nature of soil conservation is such that it can benefit both on-site and off-site depending on proper design, implementation and needs. A thoughtful soil conservationist should embrace an unbiased view and look into the actual conditions of the country and the needs of the people when plans the work.

3. ISSUE TWO: PLANNING APPROACHES

A soil conservation plan should consider the needs of private farmers and the decisions of local communities, especially when they are required to bear part or all of the cost. Therefore, planning from the bottom up is necessary.

'Bottom-up planning' has apparent advantages. The local community's and farmers' problems, constraints, and needs can be well reflected in a realistic plan. Many conservation projects have failed because the local community was not included
in the planning. Unless local people understand clearly the goals and benefits of such projects, their participation will be low.

Therefore, in theory, bottom-up planning is a necessity. In practice, however, what are the usual difficulties in getting local people involved? What methodology should be employed to obtain the needed information? One should seek practical solutions.

In the author's experience, involving numerous small farmers in planning a project without appropriate strategies could cause many problems. First, it is time consuming to plan for hundreds and thousands of small farms less than 2 ha each, yet government usually presses to get a plan in the shortest time. Time is simply not allowed for such undertaking. Also, in many countries farm boundaries are not clearly established because cadastral surveys have never been done. Secondly, communicating with small farmers in developing countries requires special effort when discussing technical matters such as conservation. Yet, properly trained extension officers in this subject are scarce, and educational materials and audiovisual equipment are often lacking. Thirdly, the essential data that need to be collected for soil conservation projects — climate, hydrology, soils, slopes, land capability, land use, erosion, infrastructures, crop management, farming systems, as well as other socio-economic data — can be already overwhelming to a handful of technicians in a developing country.

Then, what can we do? The answer may lie in meeting half way the bottom-up planning and the usual centralized, top-down planning and to make the plan flexible for future adjustment and improvement. Top-down planning is unavoidable because it takes into consideration of government policy, existing legislation, institutional capabilities, available resources, incentives, together with direct findings on physical conditions. All of these are vital to project formulation.

The followings are some strategies that have been used in developing countries to bring local people or grass-root opinions into the overall planning process:

— Include representatives of existing local organizations and interest groups (such as farmers' associations, 4-H clubs, women's organizations) in the planning activities.
— Help local people organize soil conservation or watershed districts to assist in planning as well as in implementing the planned work.
— Conduct sample surveys on socio-economic conditions of farmers including their opinions on soil erosion, preferable conservation measures, and their targets.
— Study local farming systems and develop farm models for estimating conservation needs and goals in a project area.
— Establish village "interface teams", conservation headmen, or contact farmers to reflect from time to time the conservation needs of the villagers.

4. ISSUE THREE: PROGRAM OF WORK

Whether soil conservation work should be concentrated in important watersheds and special areas or be spread nationwide is a crucial issue in many developing countries.

A concentrated program, if successfully carried out, would be most cost effective. Countries with limited manpower and resources should not spread these too thin. They should select priority areas for their program of work. Also, when a country is just starting a program without much experience, they should not be too ambitious even if they have the resources. At the beginning, they should concentrate on pilot areas or watersheds. Any lessons learned could be used for the benefit of later programs in other areas.

However, concentrating the work in an area does have its problems. It usually requires a much longer time to complete the goal. For instance, absent land owners, tenants, aged farmers, and part-time farmers in a watershed may not be easily convinced to join the program. Experience shows that after 2 to 3 years of intensive extension and assistance, farmers' participation was still around 50% in many watershed projects. The time and effort spent to convince these farmers might be better used to assist many enthusiastic farmers outside of the chosen area or watershed.

In fact, soil conservation work is not necessary to be done on large pieces of land, especially in developing countries where farms are small and hand cultivation prevails. Each acre or hectare treated by conservation measures is protected. The motto of the Soil Conservation Service, U.S.A. correctly states: "Use every acre in accordance with its capabilities and treat every acre according to its needs.
for protection and improvement.”

A program that concentrates all manpower and resources for a lengthy time and on a few watersheds and areas may not be fair to farmers in other places. Neither it is politically desirable.

Therefore, a nationwide service should be established as soon as experience is accumulated and personnel and resources are available. This nationwide service can operate on a ‘first come, first served’ basis after proper demonstration and extension. The government’s input, such as subsidy rates for various conservation measures, can be much lowered nationwide than the rates in concentrated watersheds or priority areas where high rates are usually paid to the farmers.

The best approach is to have concentrated programs on public lands, critical watersheds, resettlement areas, and special crop development zones where direct control is desirable and heavy public investment is justifiable. For other areas, providing a nationwide service is most suited. This kind of ‘Two-pronged’ approach could serve most countries’ needs.

5. ISSUE FOUR: FARMER’S PARTICIPATION

Farmer’s participation is the key to the success of any soil conservation program or project. The problem confronting many soil conservationists is how do we induce farmers to participate?

Soil conservation work requires heavy investments of labor and cash. Farmers may need to sacrifice part of the cropping land for conservation purposes or to change the landscape completely. In many instances, the land may initially suffer low production. After establishing conservation structures, maintenance work will still be needed for many years to come. Yet, the benefits cannot be easily seen or will take some time to show. Unlike applying fertilizers or insecticides, soil conservation usually alters the existing farming systems and many traditional and cultural practices. Any farmer would consider twice before he or she accepts such drastic change and risk.

There are generally two schools of thought on inducing farmer’s participation. One school advocates that a well-designed and executed education and extension campaign would suffice to convince most farmers to join such a program. They don’t think incentives, especially subsidies are necessary, because most developing countries have severe financial constraints and farmers may develop a subsidy-dependent mentality for every government-generated program. The other school realizes that it is not fair for small farmers to share the total cost of conservation when their meager income could be reduced in the first few years and the benefit may occur to next generation or to others downstream. Incentives, either direct or indirect, should be given to those farmers who participate in the program. This is deemed as a cost sharing program or a system to exercise equitable income distribution.

These views are not necessarily mutually exclusive. To induce farmers to participate willingly in a program requires good extension. Unless farmers understand well that soil conservation will do them good in the long run, they may not maintain the practices even after they did the work. On the other hand, to convince a majority of farmers to join a program only by means of education may need a good many years. Many farmers simply have no resources and time to start the work unless some tangible incentives are given. Experience shows that in addition to extension and education, giving proper incentives, in cash or in kind (including food), has promoted farmer’s participation and speeded the protection of land.

This paper does not intend to discuss the proper kinds and the details of incentives. Yet, one of the important incentives is free technical service and follow-up, which should be given to all the farmers who join a program. Such technical service would include drawing farm plans, contour surveying, supervision of construction and maintenance, crop management, for example. Small farms of one or two hectares should be given subsidy or material incentives in addition to free technical service.

6. ISSUE FIVE: PROPER TECHNOLOGY

There are two distinguished views among conservationists on applying soil conservation techniques to farmers’ land. One emphasizes technical excellence and intends to control most, if not all, soil erosion, even at high cost. The other view considers what farmers can do or accept and advocates simple and low cost practices.

Farmers’ acceptance is one of the most important factors in implementing soil conservation.
projects. Low acceptance would retard the progress of work in any such project. However, introducing ineffective conservation techniques only because they are easier for the farmers to adopt is also defeating the purpose. Many people advocate simple and low cost conservation practices, yet have no idea of how effective they are. It is a false economy and still a waste if erosion control is not achieved and the land still erodes away.

Therefore, between these two extremes, there must be an optimum, cost effective point. Only through careful studies or research can this point be found. For instance, several countries have found through experiments that hillside ditches supplemented with agronomic conservation measures were cost effective because they could reduce erosion as much as 80%, yet their costs were only 1/5 of bench terraces.

Then, what are the criteria of effectiveness in erosion control? Or, to put it more specifically for conservationists: what is the tolerable soil loss, or T-value? In the United States, the T-value is set between 5-12.5 mt/ha/year. Effective conservation measures bring down erosion within this limit. Should similar criteria be applied to developing countries? Should the T-value be higher or lower? Is the subject worth our careful study? The author's answer is that quantitative criteria are needed to test the effectiveness of conservation measures. Without them, improper measures will prevail and will cause tremendous waste. At the beginning, each country may set their own preliminary criteria to provide some guide for design and application of various soil conservation practices. These criteria should be refined through future experiments and findings. For example, the author has suggested that the T-value in humid tropical countries with hilly terrains like Jamaica and El Salvador could be initially set at 10 to 25 mt/ha/year. The assumptions were that humid tropics have high rates of soil formation due to frequent rains, quick weathering, and more cultivation. Also, if the rates were set low, no other soil conservation measures could be effective but bench terracing, grass cover and reforestation! I admit that the criteria are arbitrary and debatable. The figures quoted here are only for reference purpose and for stimulating further discussion.

Another important technology is proper land use. Using a practical and reasonable system, a project area needs to be classified into various land capabilities or land suitability classes. To use the land according to or within its capability will reduce both erosion and cost of conservation. Soil conservation practices will be more cost effective if they are designed and applied according to the capabilities of the land. Using a 35 degree slope for cultivation, for example, is like using a bicycle to carry 200 kg everyday; it cannot last long. Yet, many projects not only allow for continuous abuse of such kind of slopes, but also give subsidies to encourage cultivation using ineffective conservation practices — all because farmers want to do so! Improper land use should never be encouraged. The best strategy may be relying on using both "the carrot and the stick" to adjust improper land use.

7. ISSUE SIX: SELECTION OF CONSERVATION MEASURES

Conservation measures can be arbitrarily divided into two categories: agronomic (or biological) measures and structural (or mechanical) measures. Each has its own functions in erosion control, and they can be used to supplement one another.

Professional preference does exist, however. For instance, agronomists may tend to apply exclusively agronomic measures regardless of steep slopes and excessive runoff. Conservation engineers may suggest using structural measures everywhere irrespective of cost and necessity. A well-trained soil conservationist should not be biased and should use this two categories according to the actual needs of the land and people.

To control erosion is to control either the 'detachment' or the 'transportation' of soil particles. Rice paddies and other types of bench terraces are examples of controlling transportation, where as dense grasslands and forests are examples of controlling detachment. On cultivated land, applying agronomic conservation measures such as mulching, cover cropping, strip cropping, or relay planting, etc. are mainly for controlling detachment. These measures are comparatively inexpensive and are beneficial to soils. However, where rainfall is intense and slope is steep, runoff will still be unavoidable and will carry loose soils down slope or will concentrate in depressions forming gullies. Another problem is that as soon as the ground cover is reduced e.g. after harvesting, new planting or insufficient mulching, the land is again exposed to erosion.

Structural measures like bench terraces convert slopes to a series of flat lands hence mi-
ianizing erosion and providing grounds for broader crop adoptability. If properly maintained, terraces like rice paddies can be used for hundreds of years as in Southeast Asia. Structures like check dams are necessary for stabilizing channels or to stop sediment already in the channels from moving downstream. However, structural measures do have disadvantages. They generally require high initial investment and technical input, and careful maintenance. If incentives, technical assistance and farmers’ education are not ready or are inadequate, projects emphasizing structural measures may easily fail.

The best outcome may be to rely on the proper combination of agronomic and structural measures. Using simple, low cost, and easily constructed structures such as hillside ditches, intermittent terraces, and convertible terraces to take care of runoff at any time of the year, whether there is a crop or not, and applying agronomic measures to cover the ground during rainy seasons can be very cost effective. Agronomic measures not only help control erosion but also improve the soil which is one of the major objectives of soil conservation.

8. ISSUE SEVEN: THE NEEDS OF FUTURE GENERATIONS

Currently, soil conservation work in developing countries is most likely to be concentrated on small farms or subsistence farms. These farmers are usually the poorest of the poor in these countries. To motivate them and convince them to participate in conservation programs or projects, governments need to exert special effort and assistance, both technically and financially. Since farmers are numerous even in a small project area or a watershed and since most work is done by manual labor, the targeted work is usually planned to be completed in a long period. During implementation, socio-economic constraints may further delay the achievement of targets. Even so, many governments are willing to pay such price in order to improve small farmers’ social and economic conditions and to protect the country’s land and water resources. This is laudable!

However, if we look beyond this stage and into the world’s future, we need to consider one step further: the overall development and conservation of slopeland resources. Because of population increase and food and raw material shortages in many countries, more foothills, uplands, and high-lands will be utilized in the near future. These lands in the humid tropics can also grow many high value cash crops for export due to higher elevation and better climate.

Consequently, we need to look at the role that soil conservation can play in developing slopeland safely and efficiently. It is a challenge to all of us. Any soil conservation practice suggested should not only minimize soil erosion, but should also facilitate, or at least be compatible with, modern farming practices such as mechanization, irrigation and transportation. Therefore, the conservationists should prepare themselves well not only the knowledge of farm roads, mechanization, minor irrigation, and proper drainage, but also of modern conservation practices that are compatible with present day farm management requirements.

Some such practices already exist. ‘Hexgons’, for instance, and some recently designed bench terraces and simple terrace systems are compatible with modern farming. ‘Hexgons’ are particularly good for mechanizing orchards on mid-slopes. Modern bench terraces with uniformed widths, horizontal and reversed gradients, and access roads and waterways are convenient for mechanization, transportation, irrigation and drainage. Improved hillside ditches, with cross-sections of narrow benches instead of trench-shaped, are facilitating transportation and various farming operations.

The reason some conservation practices are abandoned shortly after construction may be because of their incompatibility with modern farming practices. If conservation work is to be installed for lasting benefits, the work should meet the needs of future generations.

9. CONCLUSIONS

This paper uses theories and practical examples to address and argue the above mentioned issues. The main purpose is to stimulate interest among professionals, field workers, administrators and policy-makers in developing countries. Many of the issues are open to further discussion. The author realizes that there are no universal answers to these issues; each country should find its own solutions according to its environment and needs.

REFERENCES

Hauck, F. W. 1985. Soil Erosion and its Control in


STRUCTURAL APPROACHES TO SOIL CONSERVATION*

For the purpose of this Colloquium soil conservation structures are referred here as structures for land treatments and do not include drop structures and check dams for gully control.

1. COMMON MISUNDERSTANDINGS ABOUT STRUCTURES

Misunderstandings about soil conservation structures do prevail among many people and even agricultural workers. The most common ones are as follows:

— Structures are synonymous with bench terraces.
— There is only one type of terrace used on sloping lands.
— Structures are too complicated to build and maintain.
— Structures are extremely expensive.
— Structures are only for erosion control.

In the following section, I will try to clarify and explain soil conservation structures using my own experience and perceptions.

2. A BRIEF EXPLANATION OF STRUCTURES

First of all, structures are not synonymous with bench terraces and bench terraces are not the only type of structure used on sloping lands. There are many types of structures in the world. On gentle slopes, broadbased terraces for large farms and contour dikes or bunds for smaller farms are employed in many countries. Structures of less known are those simple or discontinuous types of terraces developed or refined in the last two decades. They are as follows:

— Hillside Ditches or Hillside Terraces
— Intermittent Terraces
— Convertible Terraces
— Orchard Terraces
— Individual Basins
— Hexagons

Each of these has its own functions and is designed to suit the crop needs, conditions of the lands and the interests of the farmers. Specifications and usage of each type can be seen from the references and hand-out material given in this meeting.

These structures usually cost less than bench terraces but they are quite effective for erosion control. For instance, the cost of hillside ditches is about 1/5 that of bench terraces yet they can reduce erosion 80%. The construction and maintenance of the ditches are much easier than bench terraces. Hillside ditches and most of the structures listed above can be used as farm roads for transporting farm products and for facilitating other farming practices such as crop tending, spraying, and fertilizing. This is probably one of the significant merits of structures compared with any vegetative or agronomic practices.

Even full benching terraces can be less costly if they are properly designed and constructed. The important rules are to make cuts equal to fills, to stake out and control the construction progress, and to avoid wide terraces on steep slopes. Narrow terraces of 2.5 m or 3 m may cost less in the long run than the conventional contour mounds which need to be rebuilt each year after crop reaping. We found in Jamaica, that after three years, the cost of mounds exceeded the cost of bench terraces. Bench terraces are not only the most effective structure in erosion control but also in conserving soil moisture, facilitating cultivation and broadening crop selections.

Structures are not necessarily complicated to built. If farmers are able to practice contour mounds and contour drains, they should have no problem to built flat strips (terraces) along the contours. Bench terraces, for instance, are not new to the Asian farmers. Normally, for any new type of conservation work including agronomic practices, government's technical support is always needed.

Structures need maintenance, so do grass barriers, trees or agro-forestry. Experience shows that the crucial period is the first three years. After that, any earth structure will be settled and its risers will be well protected by grass, hence requiring little maintenance.

3. FUNCTIONS, AND LIMITS OF STRUCTURES

From the erosion control standpoint, structures' main function is to control or slow down the process of "transportation" while vegetative or agronomic practices are for controlling "detachment". In tropical or sub-tropical regions where excess run-off is inevitable due to frequent and intense rains, structures are necessary for diverting run-off safely toward protected waterways or naturally vegetated areas. Otherwise, the run-off will find its own ways to run down and to form gullies.

Crop cover on cultivated slopes is not comparable to natural forest or grass cover in minimizing soil erosion. The reasons are apparent. Natural forest normally has multi-stories of cover, layers of litters and humus, and most importantly, the land beneath is not disturbed. Grass cover, if not over-grazed or severely disturbed, provides good protection to the land. The problems of cultivated slopes are that the soils need to be frequently tilled or loosen, and the crop cover is not permanent. Most serious is that when the rainy season comes the land is usually bare or the crops are too small to provide protection.

Therefore, structural measures become necessary to offer the kind of protection that the cultivated slopes needed. Once a slope is converted to a series of flat lands like bench terraces, erosion is greatly controlled. The bench itself is not different from any flat land and it is even more uniformed due to leveling. Other types of structures such as hillside ditches, intermittent terraces, orchard terraces, etc. can effectively reduce erosion by converting long slopes into many shorter slopes and by intercepting and diverting run-off to safe areas. (Fig. 1).

As mentioned earlier, one unique function of the structures is to facilitate better farm management. Flat strips are convenient for cattle ploughing and hand cultivation. They can be used as cart roads and with proper design they can facilitate 4-wheel mechanization up to 20 degrees or 36% slope. They also provide ideal sites for irrigation and soil moisture conservation. With proper gradients and waterways, they are usually better drained.

Structures do have their limits. The physical limits are slope, soil depths and soil texture. A 30 degree (58%) slope is probably the practical limit, beyond that structures will have serious maintenance problems and will result in limited flat platforms or benches. On the other hand, gentle slopes (below 7 degrees or 12 %) do not often need structures; vegetative and agronomic practices may suffice for erosion control under right sets of conditions. Another limit for using structures is the soil depth (the depth that plant roots can penetrate and not the depth of top soils). For instance, on a 20 degree (36%) slope, the minimum depth for constructing hillside ditches is 53 mm or 21 inches. Depths shallower than that cannot be treated with such type of structure. Also, extremely light or heavy soils such as sandy soils and heavy clays are usually not suitable for structural measures.

Cost is another limit for small farmers to apply structure measures on their farms. However, for any on-farm conservation work, government incentives and/or credits are usually needed. This kind of government intervention is also necessary for vegetative and agronomic practices.

4. CHOICE AND APPLICATION OF SOIL CONSERVATION MEASURES

Choice and application of soil conservation measures in an area usually involves two major processes. The first one is for the government officers, experts in soil conservation, to select and recommend a range of appropriate measures which will be cost effective for the area. Secondly, it is for the individual farmer to select and adopt these recommended measures on his or her farm according to land capability, crops, interest, and resources.

In many cases, it was the conservationist's fault to introduce inappropriate techniques or mono-practices to the farmers without taking into consideration the slope, type of rainfall, crop systems, and the farmer's needs. For instances, using grass barriers on steep slopes in a heavy rainfall region may not halt runoff and erosion as was the case in Jamaica's Upper Yallahs Valley. In this small watershed of 60 sq. km. some 2,400 km. of grass barriers were established in the Fifties. Still the erosion was very serious when the government conducted an evaluation and a survey in the Sixties and the Eighties respectively. Grass barriers can be quite effective on gentle slopes of low rainfall areas where soils have high infiltration rates.

There is a tendency everywhere to use low cost practices without looking into their effectiveness. If such practices are ineffective in erosion control, the efforts and resources invested will be wasted in the long run. On the other hand, to apply bench
Figure 1. **Main Functions of Structures for Erosion Control**

1. Eliminate or reduce slope
2. Change long slope to shorter ones
3. Intercept runoff and drain it safely to a waterway or a protected area
terraces to any crops or anywhere is also a waste. The real challenge of the conservationist, like other professions, is to find an optimum point between the cost and the effectiveness.

Structural measures and vegetative/agronomic practices are not mutually exclusive. In fact, they are complimentary to each other. The structure systems introduced earlier in this paper do include vegetative/agronomic practices as their supplementary or supporting systems. Hillside ditches supported with cover crops or other agronomic measures were found cost effective in many countries. Probably, a sound principle in erosion control is to maintain crop cover as dense as possible throughout the rainy season and to use minimum structures to take care of excess runoff. The proper combination of these two types of measures depends on slope, soil, rainfall, and crop needs.

After a series of conservation measures are devised for various environments and uses, they can then be used for demonstration, education, and extension to the farms of the region. Farm planning is a necessary step for applying conservation measures to a farm. During farm planning, government officers should walk through the farm with the farmers, parcel by parcel, to discuss its land capability, proposed use, and conservation needs. After discussion and explanation, the final choice of conservation measures should belong to the farmer. This is an essential, bottom-up planning process through which a final conservation plan can be mutually developed.

For any soil conservation measures to be applied or established on small farms, technical assistance, incentives, and/or credits from government are needed. An integrated approach including soil conservation and improvement of land productivity, cropping, and marketing is much more receptive by farmers than a single-purpose approach for controlling erosion alone.

5. FINAL REMARKS AND RECOMMENDATIONS

Structural measures do have their unique func-
1. THE NECESSITY OF PLANNING AT THE FARM LEVEL

Many soil conservation projects have failed because farmers were not involved in a planning and decisionmaking process. Planning soil conservation at the farm level is a kind of "Bottom-up Planning" which has long been overlooked. Government officers can find out, through physical surveys, certain priority areas, targets, and what should be done in a project area. What can really be accomplished, however, is limited by farmers' decisions. Without fully consulting, discussing, and planning with farmers, government goals in soil conservation can never be achieved.

Therefore, planning at the farm level is a necessity. Using proper land use concepts and modern conservation and agricultural knowledge, government technicians should plan with individual farmer and render advice on how the farm should be properly used and protected. It should be the farmer, however, who makes the final decision according to his or her own interest, resources and ability.

A written farm plan is a basic record of development as well as an agreement between government and a farmer in which the obligations of both parties are spelled out and documented.

2. CHALLENGES OF AND APPROACHES TO FARM PLANNING

Questions are always raised about how to do farm planning for hundreds or thousands of small farms in a project or a watershed area. Many of the farms are further fragmented to small parcels. Planning is therefore a serious challenge not only is preparing these farm plans time consuming, but also such work often encounters problems of illiteracy, old age, insecure of land tenure, among others.

Since farm planning is a necessity, proper approaches should be sought to cope with the difficulties. Several useful approaches are suggested as follows:

- Allow for sufficient time and resources for planning.
- Exercise group, sub-watershed or stratified planning.
- Apply a "first come, first served" principle.
- Use computer programs for assistance.

Many projects have only allowed limited time and resources for farm planning, if any. This shortcoming should be rectified by allowing sufficient time and resources for such activities. Governments need to realize that farm planning is a required process, and without farmers' participation and decisionmaking, conservation work will not be done.

Planning with groups of farmers or by sub-watersheds will save time and manpower. In a group, farmers can help each other in disseminating information and in doing field work. Consequently, some of the constraints associated with old age and illiteracy could be alleviated. Moreover, it is always desirable to plan and implement drainage systems, gully control, or irrigation installations on a community basis.

Governments usually provide incentives to promote soil conservation work. These incentives can be used tactically to encourage farmers to organize themselves into groups either by sub-watershed or by neighborhood.

Stratifying farms by several farming systems and establishing basic model of each can facilitate planning. With these models, both the farmers and the technicians can come to a faster decision.

Farmers can also be very independent and individualistic. Each farmer may prefer to have an individual plan. In such a circumstance, governments can only proceed with individual farm planning by applying a "first come, first served" principle. During a publicity or education campaign, farmers should be clearly told that such planning

service is rendered by this sequence.

Using a microcomputer and software to guide planning, establish a database, and for mapping will not only save time and reduce paperwork but also be convenient for future retrieving, updating, analyzing, and reporting. This subject is further discussed in section 7.

3. MECHANISMS NEEDED FOR FARM PLANNING

Sufficient numbers of field teams need to be organized and stationed in project or watershed areas to assist farmers in farm planning. Such planning should not only include land use and soil conservation, but also cropping and infrastructural needs such as farm roads, drainage systems, minor irrigation, and marketing, if required. In other words, planning should be integrated and should not solely for erosion control. Therefore, field teams should also be multi-disciplinary.

Since manpower is a constraint in many developing countries, the number of members on a field team should be kept to a minimum. However, a backup professional group should be organized and stationed nearby to support these teams. Depending on local conditions, field team members may include one extension officer and one conservation officer. The same team would assist in future implementation, maintenance, and follow-up work. Appendix 1. shows a coordinated effort in Jamaica as an example. From the example, it is apparent that coordination is necessary between government agencies and that the work needs a team approach.

The professional backup group should have an agronomist, an economist, a sociologist, and an engineer as its basic members. Other experts may be added if so required.

Equally as important as manpower is administrative support. Vehicles, equipment, travel expenses and per diem should be well provided. It is important to render quick, responsive, and adequate service to the farmers who need it. Waiting too long or giving inadequate service will discourage farmer’s participation.

4. STRATEGIES FOR FARM PLANNING

Small farmers of the world have serious constraints in capital and land. Consequently, their main objective is to maximize short term returns from the farm irrespective of land capability and conservation needs. To plan soil conservation with them, we should employ appropriate strategies that will be accepted by them. Some suggested strategies are introduced in the following sections.

4.1 Integrate Soil Conservation into Farming Systems

Soil conservation alone will not be easily accepted by small farmers. To win farmer’s acceptance, soil conservation needs to be integrated with cropping and farming systems. For instance, Asian farmers will accept level bench terraces and paddy rice as a package deal. If sources of water can be identified and utilized and vegetable cultivation is introduced, small farmers around towns and cities of the world would accept terracing readily. Farming practices such as multicropping, close planting, and crop rotation have been used by farmers in Central America and elsewhere. Most of these practices not only generate income but also provide quick and dense ground cover or improve soil properties. Conservationists should help to incorporate these practices into the plan. Early crop varieties which form ground cover before heavy rains could also be considered in the package.

Therefore, conservationists need to study the existing farming systems of a project area and to see whether or not soil conservation can fit into the systems, or whether a new farming system could be introduced with soil conservation as a major component. Viewing the whole farm as a system, conservationists should avoid a narrow-minded or over-specialized approach. To emphasize only soil conservation will not be acceptable to small farmers.

4.2 Flexibility in Choice

Soil conservationists need to devise a host of conservation practices for farmers to choose. Depending on slopes, crops, and farmer interest, conservation practices may vary to suit for actual needs. For instance, on gentle slopes, agronomic conservation measures can be used effectively to control erosion, e.g. contour and close planting, contour ridge or furrow, striping cropping, grass barriers. On steeper slopes where permanent and semi-permanent crops are to be grown, simple conservation structures together with agronomic measures such as hillside ditches with mulching, or orchard terraces with cover crops can be suggested. If a farmer does not like to invest much in conservation work initially, he could invest over several
years with intermittent type of terraces. For those farmers who did not make decisions on long-term land use, convertible terraces can be employed.

This kind of flexibility in choice is necessary. Yet, in so many countries, only predetermined, mono-conservation practice such as bench terracing is introduced to farmers irrespective of their conditions and actual needs. This no doubt results in low farmer participation.

4.3 Progressive Land Treatment

Structural measures for land treatment such as terracing, ditch building and waterway installation can be labor intensive or costly. During planning, many farmers without much experience, for the purpose of obtaining more subsidies, or being too enthusiastic, may ask to complete all conservation treatments in a short while. Conservationists should examine farmers' abilities and real intentions. If they cannot complete shortly, farmers should be told to treat their lands in a progressive manner.

The best plan is for farmers to use family labor to treat and protect their own lands progressively. This way, they do not need to hire extra laborers and can receive the full benefit of government incentives, e.g. subsidies. Using their leisure time to do land treatment will reduce competition with normal cropping work.

Experience has shown that farmers who treated more lands than they could use or manage often resulted in poor maintenance in the future. Government officers should be realistic when suggesting annual goals in farm plans and should not be too ambitious themselves.

4.4 Plan for Partial Intensification

Progressive treatment will allow farmers to initiate and concentrate intensified land use at one or two plots on their farms. Usually those plots having the best potential, e.g. deep soils, gentle slopes, adjacent to house or water sources, are chosen for priority development. After farmers treat the land with proper conservation measures, resources and energy need to be concentrated on them in order to obtain maximum returns. In many cases, the increase of production and incomes from these priority areas could well compensate for not cultivating the whole farm in the old way (See Appendix 2).

Partial intensification of priority areas in a farm is desirable because small farmers usually do not have the resources to develop all the land at once. More importantly, they should not suffer a loss from abandoning cultivation on steep lands resulting from land capability classification. Partial intensification will also give farmers confidence to continue the improvement work according to the plan. Therefore, at the planning stage, the priority areas should be identified and government assistance should be channeled to the development and protection of these areas.

4.5 Using Incentives to Encourage Proper Land Use

Without knowledge of proper land use, farmers may overuse and underuse the same farm. Cultivating steep slopes which may only be suitable for trees is a common example of overuse. On the other hand, gently sloping or good lands may be left fallow and underused. After a land capability classification, farmers may still plan to continue cultivation on steep slopes or on land which is not suitable for cultivation. To correct improper use, government can use incentives as a means for gradually adjusting land use. During the planning stage, for instance, farmers should be told clearly that if he or she continues farming in the old way, no incentives will be given and that incentives can only be given when the farmer uses and treats the land according to the farm plan.

5. PROCEDURES FOR FARM PLANNING

After a farmer or a group of farmers shows interest in participating in a soil conservation program, government teams should begin planning work without delay.

Before going to the field, team members should prepare themselves well in the subject of farm environment, farming systems, and socioeconomic conditions of the area. Meantime, existing maps, aerial photographs or orthophoto maps, together with technical data, related reports and information should be collected. Questionnaires should also be prepared for interviewing purpose.

Planning can be divided into two phases. The first phase is interviewing the farmer(s). Questionnaires should be kept as concise and practical as possible. Only essential information should be collected such as present land use, major crops, labor supply, conservation interests, proposed improve-
ment, assistance needs, and so on, in addition to items normally contained in farm surveys.

The second phase is planning, which may follow the interview or it can be carried out at another time in the near future. During the planning phase, team members should walk through with the farmers plot by plot to examine soils, soil depths, and slopes using soil augers and hand levels, and to determine land capabilities. Proposed land use and conservation needs for each plot should be discussed. Finally, a time schedule for conservation and development work, including designating priority areas, should be agreed upon taking into consideration all the information gathered for this purpose.

While a detailed plan can be worked out later in the office, some principal agreements and decisions should be obtained during this phase. Farmers should be told clearly his or her responsibility, as well as government’s obligations.

Farmers usually need several days to consider a proposed plan, so do the government officers. After that, an agreement can be drawn up and signed. However, the farm plan should be kept flexible and allow room for future revision when needed.

6. CONTENTS OF A FARM PLAN

Experience shows that there is a tendency to make a farm plan too detailed and elaborate. People are not aware how much paperwork will be involved when the number of the plans increases by hundreds or thousands. Therefore, content of a farm plan should be kept as concise as possible with only essential information. A few sheets of facts with maps would be adequate.

The exact content of a farm plan may vary; its basic components include the following:

— Farmer’s name, address, and other personal information
— Site and area of the farm with some physical data
— Soils and land capability of each plot. Use a topographic map, a cadastral map, or an orthophoto map of 1:2,500 scale as a base map for recording such information. Sometimes, an aerial photo or even a sketch map can serve the same purpose.
— Present land use map and proposed land use map including major crops, conservation treatments, and priority areas.
— A concise written plan with tables and figures to show, plot by plot, its development phases including conservation treatments and land use schedules. Cost, cost sharing, and credit needs, if any, should be listed.
— An overall progress and accomplishment record to be used in the future
— Other technical notes if needed

7. COMPUTER ASSISTANCE IN FARM PLANNING

A microcomputer and software can be used to assist in farm planning, database establishment, and monitoring and evaluation. A microcomputer is now inexpensive and affordable, and training programs for general application are available in many countries. Field offices could use it to save time and paperwork, while increasing their technical capability for planning. Examples of major software packages that can be used for this purpose are as follows:

— Using a specially designed “Expert System” to assist field officers in determining land capability and soil conservation needs of each plot of a farm. Example: LANDCONS (for hilly, small farms) developed by Computer Assisted Development, Inc. and Colorado State University using the VPExpert System.

— Using database management software (i.e., dBASE and PFS: Professional File) to keep farm records for data retrieval, combination, revision, analysis, progress monitoring and reporting.

— Using MapInfo or ARC/INFO (both commercial available) for managing and analyzing spatial database and geographic information. Results can be directly presented in map form. CAD/CAM (Computer-Aided Design and Computer-Aided Mapping) may also be used for designing purpose.

REFERENCES


AN EXAMPLE OF COORDINATION OR DIVISION OF LABOUR BETWEEN EXTENSION AND SOIL CONSERVATION AGENCIES
— For Conservation Farming Work —

(1) Overall planning & budgeting
(2) Farmer's meeting & Extension
(3) Farmer's interviewing & farm planning
(4) Surveying & staking
(5) Supervision construction
(6) Mapping & recording
(7) Soil conservation subsidy distribution
(8) Follow-up activities (i.e. cropping, credit & marketing)
(9) Maintenance inspection
(10) Farmer's training in soil conservation

Joint efforts
Joint efforts
Extension officers supported by soil conservation staff
Soil conservation staff
Soil conservation staff
Joint efforts
Extension officers
Soil conservation staff
Joint efforts

Source: Soil Conservation Division, Jamaica
APP. 2 PARTIAL INTENSIFICATION OF CULTIVABLE LAND IN A FARM

Area unit: Ha

Land Capability Classification

C: Cultivable Land
P: Land for Pasture
FT: Land for Tree Crops
F: Land for Forest

Gradual Improvement
Terracing & Intensified Cropping
CONSERVATION FARMING: A CHALLENGE TO US ALL*

ABSTRACT

The definition and meaning of conservation farming on hillslopes are briefly discussed. The emphasis is on sustainability and on viewing the whole farm as a system. Scopes of work and examples in conservation farming are given while the paper stresses more studies on the existing systems.

The paper further discusses what we can learn from the field of farming systems research and development (FSR&D). Problems, constraints, and challenges for applying conservation farming systems on hilly, small farms are also discussed. The paper recognizes that unless soil conservation is integrated into farming systems, the work cannot easily win farmer's support.

Finally, the paper makes some recommendations on studying existing systems, undertaking integrated approaches, carrying out bottom-up planning, obtaining policy support, and pursuing system and managerial research to tackle this new challenge.

1. WHAT IS CONSERVATION FARMING?

1.1 A Tentative Definition

"Conservation Farming" is a new term which has been used extensively in recent years but which has not yet been clearly defined. It is by no means synonymous with "Conservation Tillage" which is a kind of practice "that reduces loss of soil and water relative to conventional tillage" (5). Nor does conservation farming simply mean farming on lands treated with some conservation measures.

A brief definition could be given as: "Farming according to conservation principles". However, conservation farming implies more than that. A tentative definition is suggested as follows:

"Conservation farming is a type of farming system that reduces soil erosion and maintains or improves land productivity at the same time for the purpose of benefiting farmers and nation's soil and water resources."

1.2 Some Key Elements

If the above definition is agreeable, we could then look further into several key elements of conservation farming. First, it should be a farming system. From our experience, we know that unless soil conservation is integrated into a farming system as one package, or unless it emerges as a new system, it will not be accepted easily by farmers. Second, conservation farming stresses "sustainability": not only the sustainability of land productivity, but also the sustainability of the whole system of production, including maintenance of conservation practices. Lastly, the system should be beneficial to the nation or society, but more importantly, it should benefit the farmers who practice it. This is probably most crucial, and certainly the most essential, element.

2. SCOPE OF CONSERVATION FARMING

2.1 Existing Examples

There should be no lack of examples of conservation farming in the world. The problem is that until recently we have not studied or investigated this area. We are not talking about farming systems in general; we are talking about farming systems that apply conservation principles and benefit both the land and the people. Except for the wet rice paddy system which has sustained Asia's population for a thousand years, what do we know about other conservation farming systems? Should we study the multicultural systems in the hills of Central America and to examine its protection functions? What about tea and rubber plantations in Asia where conservation principles have been observed, or coffee planta-

tions in Latin America where agro-forestry is practiced? In Taiwan, for instance, vegetables, fruits, cut-flowers and other horticultural crops are grown on terraces. Does this type of intensive cultivation and cash crops induce or promote conservation work? What about hill farms around the cities or towns of the world where water is available and vegetables are grown? Have these farmers easily accepted soil conservation as a necessary measure? No doubt, we could learn much from these and other existing examples.

2.2 Scope of Work

Since our knowledge on conservation farming is still limited, we can only make a temporary list to start with. From my own perspective, the following categories of work are included:

— Cropping practices that provide protective cover to the ground temporally or spatially for the purpose of minimizing soil detachment and/or increasing production.
— Land treatments that control or slow down runoff and soil transportation, and at the same time, facilitate irrigation, drainage, or farming practices on hillslopes.
— Farming activities that improve soil fertility, structure, infiltration capacity, and other soil properties and that increase water supplies or conserve soil moisture.
— Other farm work that conserves energy, increases biomass, or recycles organic matters and farm waste.

3. CONSERVATION FARMING AND FARMING SYSTEM RESEARCH AND DEVELOPMENT

3.1 Trends of Farming System Research and Development

Before we further discuss conservation farming systems, a brief introduction of the trends of farming system research and development (FSR&D) is essential. FSR&D is a new activity stemming from the small farmers of the Third World being unreceptive to research results delivered by government stations or extension agents. Therefore, a close study of the problem is needed on viewing the whole farm as a system (6). In the past, most studies concentrated on cropping systems or farming practices. The new approach stresses reaching an overall understanding of farming systems from both micro and macro standpoints and thereby developing technologies to fit the needs of farmers (1). This kind of "Client Oriented" research and development is based on the farmers' perspective rather than "push out" from government researchers (2). Consequently, to develop or improve any farming system, farmers' active participation is necessary (3).

3.2 What Can We Learn from FSR&D?

First, from a broader perspective, conservation farming is a farming system (or systems) that is very necessary on hillslopes. Such systems are not yet recognized by many, not to mention receiving profound research and study. We should learn the approaches of FSR&D or cooperate with the experts in this field to look into various systems of conservation farming in the world. As FSR&D people point out, any farming system is not a closed system. It actually interacts within a milieu of other systems (1).

Second, soil conservationists in developing countries face much more difficulty in selling their technology than agricultural researchers or extension people, simply because small farmers traditionally exploit their lands to maximize quick returns. From a farmer's view, soil conservation may do just the opposite i.e. benefiting distant future with an additional cost for land treatment. Therefore, soil conservation is less receptive to them than other agricultural improvement activities. For this reason alone, conservationists should work harder than researchers and people in extension to understand the constraints and problems of the small farmers and their overall farming systems in order to get the message across. We need to learn more techniques from FSR&D.

Finally, soil conservation is a science as well as an art. It is also field-specific. We should not use one predetermined technology or practice, such as bench terracing, to apply on every farm. Conservationists need to devise a host of techniques for farmers to choose from according to his or her interest, resources and cropping plans. The real challenge is how to fit farmers' needs and keep the work cost effective, because farmers tend to invest as little as possible in soil conservation. We may also learn something from FSR&D.

4. OUR CHALLENGE

For any farming system to succeed, it must be
productive, profitable, acceptable, and sustainable (4). Although sustainability is the conservationist’s chief skill and goal, to achieve it still requires proper technology to fit each farm. After farmers adopt recommended conservation measures, maintenance may still pose a problem.

Acceptability is always a problem confronting most soil conservation projects in the world. It is related to problems of tradition, culture, and socioeconomic conditions of the farmers. Since soil conservation means extra cost or labor, and its benefits may be distant, it contradicts the farmers’ immediate goal for maximizing returns. Taking away productive lands for conservation installations makes conservation projects even more unpopular. Here, in addition to persuasion, compensation or other incentives may be required. However, these measures could become a heavy burden to many developing countries.

Productivity cannot be easily attained by simply building terraces and putting compost and fertilizers into the soils. Increasing productivity may involve the entire cropping system and a series of farming activities including better seeds, weeding, tillage techniques, and insect and pest controls. Sometimes, small irrigation, water harvesting, and moisture retention techniques are also required. Do we have all this expertise?

Probably, the most crucial criterion is profitability. Increasing crop production does not necessarily mean increase profit to the farmers if the products cannot reach the proper market or prices are low. On the other hand, all conservation and cropping improvements mean more input. Farmers’ risks are very high unless an interdisciplinary approach, including better access to market and price support, is provided.

From the above discussion, it is apparent that we have a serious challenge ahead of us. The task cannot be done single-handed; a team approach is a must. Most soil conservationists are physical scientists such as agronomists, foresters, engineers, or soil scientists. To search for or develop proper conservation farming systems, we need close support from experts in farming systems, and from economists, sociologists, and people from other disciplines.

In developing countries where human resources and institutional capacity are limited and erosion and land degradation hazards are serious, our challenge is really tremendous!

5. SOME RECOMMENDED STRATEGIES

Against this kind of challenge, we need to carefully devise our strategies to alleviate the problems confronting us. A farming systems approach will definitely have a better chance to succeed than a narrow minded or over-specialized one.

5.1 Study of Existing Systems

As mentioned earlier, we need first to study local farming systems, whether they are conservation-oriented or not, in order to comprehend their problems, constraints and improvement possibilities. Only after such studies, can a practical system(s) that is integrated with conservation principles be devised or modified for the farmers in an area.

5.2 Interdisciplinary Approach

An interdisciplinary approach is needed for studying or introducing conservation farming systems. In the past, over-specialized approaches resulted in providing fragmentary or even conflicting information to farmers. For any conservation program or project, interdisciplinary teams should be organized at the field level to assist farmers who are interested in conservation farming. Governments in developing countries should try their best to place such teams in project or watershed areas.

5.3 Bottom-Up Planning

For planning an individual farm or a cluster of farms in conservation program, the farmer(s) should be actively involved in the planning process and decisionmaking (8). Many conservation projects have failed because farmers were not involved in such processes at all. Meanwhile, the emphasis of conservation farm planning should best be placed on viewing the whole farm as a system. Farmer’s ability, resources, interest and constraints all need to be considered. In addition, the macro settings of the farming enterprise such as government policy, incentive schemes, credit availability, and marketing should also be taken into consideration. After explaining and advising by government technicians, the final decision should be made by the farmer(s). There is no lack of theories regarding bottom-up planning. The real problems are putting them into practice with hundreds and thousands of small farmers in a project area and whether or not governments have the will, patience, and resources to do it. Soil conservationists need to insist and make it known that bottom-up planning is necessary. In the
meantime, they need to develop practical means and ways to do such planning work, e.g. using a sub-watershed or neighboring area as a unit, applying stratification techniques (7), and employing computer expert system and GIS (Geographic Information Systems) mapping.

5.4 Policy Support

The need for government policy support for conservation farming cannot be over-emphasized. In many developing countries, inconsistent policy sometimes encourages soil depletion rather than conservation. For instance, subsidies are given to farmers to open and cultivate new hillslopes irrespective of conservation necessity. Government land settlement or crop expansion schemes on hillslopes omit soil conservation inputs. Farmers are confused and many of them practice conservation farming and slash and burn agriculture at the same time. Government should therefore hold a steady policy everywhere in the nation. For instance, farmers who practice conservation farming could be given priorities for government technical and financial assistance. On the other hand, government itself should set good examples and include soil conservation in its own land development schemes.

5.5 System and Management Research

Most of the research in soil conservation today centers on erosion rates and conservation techniques. Seldom have research activities been channeled, for instance, to study whole systems of conservation farming, farmers’ attitudes toward conservation, or constraints and risks in applying soil conservation. More studies need to be done in this respect. In addition, management research on policy issues, on incentives, on cost sharing, and on other socio-economics of conservation should be emphasized. This kind of system and managerial research is very much needed in the Third World.

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IS TAIWAN'S EXPERIENCE IN SOIL CONSERVATION APPLICABLE TO OTHER DEVELOPING COUNTRIES?*

ABSTRACT

With both his long experience in Taiwan and the Third World, the author reviews and compares Taiwan's conservation farming program with that of the other developing countries. Taiwan's unique socio-economic background, institutional set-up, and its conservation strategies and approaches are briefly discussed. Examples are also given to illustrate their differences, especially the constraints of the other countries.

Special discussions are centered on the subjects of integrated approach, manpower and training, incentives and services, practical research, and government support. In addition, some underlying philosophy and principles in carrying out the conservation program in Taiwan are also analyzed.

In conclusion, the author feels that much of the Taiwan's experience can be applied to other countries, although to be successful in such a program, a firm commitment from government is always a prerequisite.

1. INTRODUCTION

The keynote speaker of this workshop has explained vividly the progress and evolution of conservation farming on hillslopes in Taiwan since the 1950s (1). As successful as Taiwan's soil conservation program is, one could naturally ask a question: Is Taiwan's experience applicable to other developing countries?

The author of this paper, being a co-worker from the early 1950s to late 1960s in Taiwan and thereafter working in other developing countries under United Nation's FAO projects, is invited to answer this interesting question and, meanwhile, to exchange views with the participants of this workshop.

2. A BRIEF ANALYSIS OF TAIWAN'S EXPERIENCE

A brief analysis of Taiwan's experience is necessary in order to compare it with the conditions and experiences of other countries.

2.1 A Gradually Expanded Program

2.1.1 Starting with Sufficient Demonstrations

Although rice paddies are century old conservation measures in Taiwan, new techniques of conservation practices such as reverse-sloped bench terracing for uplands, improved hillside ditches for semi-permanent crops and many others need to be introduced to farmers. Before Taiwan launched a national soil conservation program in the early 1960s, hundreds of small demonstrations were established in almost every mountainous district in a duration of 6 years (6) to show conservation benefits and to educate farmers in the area. Taiwan's approach was not like those in many other countries where national programs were hastily carried out without farmers' clear understanding and support.

2.1.2 Institutions Built up from the Bottom

When Taiwan started its conservation program in the early 1950s, only a handful people worked at national and provincial (state) levels. Along with establishing demonstration plots, each county or city gradually set up its field offices over several years.

Field offices were also set gradually in major watersheds. Not until 1961 was a state bureau, Mountain Agricultural Resources Development Bureau (MARDB), institutionalized when the actual need of such organization was identified, sufficient numbers of technicians were trained and field experience in conservation gained. MARDB is not purely a soil conservation organization. Rather, it is an agency responsible for the overall development and conservation of sloping land resources. Its function is well reflected in its structure where divisions of mountain agriculture, animal husbandry, and soil conservation are of equal importance. This organization has proved effective in carrying out its duty due to its interdisciplinary teamwork.

2.1.3 Establishing Effective Services and Incentives

Since the very beginning of the program, attention and emphasis have been given to the field offices. The best technicians were sent to the field and were supported with vehicles, instruments, and equipment. Sufficient per diem, allowance, and expenses were provided to them to render effective service to the farmers. Since the inception of the program, Taiwan has provided two-pronged services to farmers: 1) a concentrated service in the important watersheds or in special project areas provided by MARDB or other watershed institutions, and 2) a "first come, first served" service for the remaining area of the nation by the local governments. No farmers are left out. In addition to technical service, cash subsidies or food was given to the farmers at the initiation of the program. This type of incentive was deemed necessary until farmers understood the benefits of the conservation program. In recent years, the emphasis has been gradually shifted to loan programs offered by MARDB.

2.1.4 Continuous Training and Supply of Manpower

The first professional training course in soil conservation took place in 1953. Since then various types of courses have been conducted. A permanent training center was established in 1958 and with the establishment of MARDB training becomes a regular and continuous program. Up to now, over 5,000 participants have gone through various courses. In view of the increasing need for professionals, the National Chung-Hsing University in 1964 established a soil conservation department. Two other junior colleges established, in later years, soil conservation departments for training sub-professionals. In the 1970s, a master's program was created in the said University and a Ph.D. program was also established in the National Taiwan University in forestry hydrology and watershed management. Each year these colleges provide about one hundred professionals and sub-professionals which well satisfy the needs of the nation.

2.2 A Sound Approach

2.2.1 Early Adoption of an Integrated Approach

From the experience of the 1950s, Taiwan learned a clear lesson that for soil conservation to expand, an integrated approach was a must. Since 1966, many so called "Integrated Soil Conservation and Land Use Pilot Areas" have been established all over the island. Up to 1974, for instance, ninety (90) such areas totalling 18,000 ha had been established. Each of them involved the work of crop development, soil conservation, farm roads, and other public installations such as small irrigation and check dams (2). In many instances, farm machinery, crop storage, marketing, and processing arrangements were carefully made. This kind of approach was quite new among developing countries at that time. Only in the later years did the concept of "Integrated Development" begin to emerge in many countries or within international agencies. Taiwan has continued this approach ever since and has found it economically feasible and beneficial to its agricultural development (5).

2.2.2 Joint Planning for Watersheds and Special Projects

The Integral nature of conservation and land use projects as well as the multidisciplinary nature of watershed work, called for close coordination among related organizations. Taiwan, from the early 1950s, exercised a joint planning strategy for watersheds such as in Wusheh and Shihmen (4). In 1963, a "Forestry, Water Conservancy and Soil Conservation Joint Technical Committee" was officially organized to undertake most planning work for the important watersheds. This Committee was reorganized and strengthened in 1983 and became the "Watershed Protection and Planning Commission". The chief function of the Commission is to conduct joint surveys and planning and to help with overall programming and budgeting for each agency. The Commission also oversees the progress of the work carried out by individual agencies. This type of joint and coordinated planning and decentralized implementation has proved very effective in Taiwan. For the development of special crops or special areas, local development committees are organized. Seven to nine farmers are elected as board members. The committees help in planning and implementation especially in local funding and land acquiring (6).
2.2.3 Practical Research

Although there is no specialized research institute in soil conservation, Taiwan started off quite early in practical research. Research on runoff and soil erosion rates under various land uses, waterways, soil conservation plants, hillslope transportation systems and mechanization, and on labor saving conservation measures etc. have been carried out. Most of the work has been conducted by agricultural and forestry research institutes, universities and colleges, or local experiment stations, with the support of the JCRR (Joint Commission on Rural Reconstruction) or later, the COA (Council of Agriculture). Over decades, many of the results have been fruitful and have been applied to the field readily (3).

2.3 Steady Support from the Government

2.3.1 Firm Policy

From the 1950s, Taiwan had a firm policy on conservation and development of its sloping marginal lands. At the national level, the then JCRR set priority on slopeland development and established a multidisciplinary team to pursue such policy and to support various activities in this field. Later, at the state level, the provincial government proclaimed that mountain watershed management and flood control was its first priority. Over the last three decades, this policy was enforced even further despite reorganization and changes of administration. Taiwan did not start its soil and water conservation program with national laws or regulations. A “Slopeland Conservation and Utilization Statute” was promulgated as late as 1976 and the draft Soil Conservation Act is still under scrutiny. A firm policy was sufficient for Taiwan to readily initiate the program. In many other developing countries, legislation was hastily done at the beginning of the program. Because lack of experience, local support and resources, such legislation was often found impractical and did not help the program.

2.3.2 Adequate Supporting Resources

At the beginning of the program, government’s support in terms of staff and budgetary resources were adequate. With the gradual expansion of the program, the support also increased. MARDB and the county/city field offices have maintained a total of 350 technical officials since 1961. More than half are professionals. In many developing countries of similar size, the number of qualified personnel is very limited. At present, Taiwan still maintains a target of developing some 3,000 ha of hillslopes a year plus watershed rehabilitation program. These plans include soil conservation, crop development, and rural infrastructure. The government’s investment increased greatly in recent years for protecting important watersheds and fragile mountain environment particularly in East Taiwan. The total allocation of funds, including conservation farming, watershed rehabilitation, and infrastructure amounts US$ 100 million a year.

3. IS TAIWAN’S EXPERIENCE APPLICABLE TO DEVELOPING COUNTRIES?

3.1 Some Unique Conditions of Taiwan

The above gives only a brief account of Taiwan’s successful experience in soil conservation. An overall picture would not be complete without discussing the unique conditions that helped its conservation program. They are the following:

— Farmers have a long tradition of building, maintaining and using of conservation structures — predominantly paddies.
— Most of Taiwan’s farmers are well educated and hard working.
— The mountainous terrain and heavy population pressure make hillslope development essential.
— The disaster-prone environment constantly reminds the people in Taiwan of the importance of conservation needs.
— Organizations like JCRR and COA which embrace policy formulation, research, extension and funding at one body greatly enhance the promotion and guidance of the program.
— The recent industrialization and the rise of the living standard have profound impacts on land use changes and conservation demands which benefit the soil conservation program.

It is realized that socio-economic conditions and institutional set-up vary from country to country. Other countries do not have to follow the footsteps of Taiwan. However, Taiwan’s experience and background may provide a case for the Third World to examine and study.

3.2 General Constraints in Developing Countries

Many developing countries have serious constraints in their soil conservation programs. The common ones are as follows:

— Lack of manpower by number, by experience,
or both.
— Shortage of funds, vehicles, and equipment to support the field work.
— Inadequate service to farmers and poor coordination among agencies to undertake an integrated approach.
— Lack of incentive schemes to help farmers who are willing to join a soil conservation program.
— Inconstancy in policy or a lack of policy.

It is not fair to say that Taiwan has had no such constraints. It has, but to a lesser degree due to steady government support. Its conservationists have struggled since the 1950s to alleviate such bottlenecks.

3.3 What Can be Really Applicable?

With the above in mind, developing countries that are about to launch or have already started a national soil conservation program could learn something from Taiwan. While there is no universal answer to the diversity of conditions, some basic approaches used in Taiwan can be applicable to others.

— A gradual expansion of a program is the safest way to take. Not only because farmers' acceptance is gradual, but also because institutions need time to build up. Taiwan's experience shows that such a program should only grow as fast as trained personnel are available and to a time farmers are receptive.
— An integrated approach is the right approach which Taiwan has adopted since the initiation of its program. Soil conservation for conservation's sake only will not win people's support in developing countries. Therefore, the production functions of any conservation program together with infrastructural needs should be emphasized.
— A well-supported field operation is essential because soil conservation is a field-oriented program. Technical service and incentives must be available to all farmers who are willing to join the program. Delegating authority to the field offices and involving local farmers in planning and implementation processes are equally important.
— Applied research is necessary to solve urgent problems arising from the field. With proper coordination, the work can be carried out without setting up special research organizations. Taiwan has done its research quite cost effectively in soil conservation and the results have been used extensively and promptly in the field.
— Last, but not least important, is that for a soil conservation program to be successful, government must first commit itself to maintain a firm policy and to give such program steady support due to its long term nature. Taiwan’s experience shows just that.

4. FINAL REMARKS

Taiwan has become highly industrialized in this decade and its people are more and more concerned with their environment. The emphasis of the soil conservation program in hillslopes has gradually shifted to disaster prevention and watershed rehabilitation. Nevertheless, its path and experience can be a good example for many other countries.

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1. FOREWORD

Lacking monitoring and especially evaluation results is said to be one of the reasons that further investment in watershed projects in developing countries has been hampered. There are difficulties involved in monitoring and evaluating watershed projects due mainly to their multi-sectoral activities, their off-site and indirect benefits and their long term nature. However, the watershed managers should do everything they can to identify benefits and to show good results in order to attract further investment.

2. DESCRIPTIONS OF MONITORING AND EVALUATION

Monitoring and evaluation is usually mentioned together as “M & E”. Each has nevertheless a distinct function. By definition, monitoring is an arrangement or an action to observe or record the operation of a system or a project. Evaluation means to determine or set value to the work accomplished.

Although the items for monitoring and evaluation can be quite similar, the former is a systematic and continuous data collection process while the later is a periodical examination and analysis. Without monitoring, evaluation will become difficult if not impossible. On the other hand, without evaluation, the monitoring work will be fruitless. Therefore, “M & E” are interrelated although each has its own function.

3. SELECTION OF KEY INDICATORS FOR ‘M & E’

It is impossible to include every activity in a project to be monitored and evaluated. Especially, nowadays, watershed projects often cover a wide range of activities from protecting and improving natural resources to developing rural areas and human resources.

Therefore, at the initial stage of any watershed project, a careful selection of key indicators should be made. Once they are selected, detailed monitoring techniques and procedures can be decided, and data collection be initiated.

Some general criteria for selecting key indicators are suggested as follows:

— They should reflect the main objectives of the project.
— They can be clearly defined or measured no matter who does the work.
— The indicators are sensitive to change or responsive to the project work.
— The data needed for the indicators should be relatively easy to collect or obtain.

Choice of the indicators should be project specific. However, they can be generally selected from three categories as follows:

1) Output Indicators: Whatever the goals and objectives of the plan, these indicators are the physical output of the project.

2) Impact Indicators: Project impacts including direct and indirect ones are often used as indicators. Environment impacts, economic impacts, social impacts, impacts on health and nutrition, and on living standard, life quality, etc. belong to this category.

3) Adoption Indicators: These kind of indicators are also called “Beneficiary Contact Indicators”. For instance, what portion of the target population adopt the new and improved methods for farming? What portion has used the extension service? What portion has continued the work even without much government input, etc. These indicators show the sustainability of the project.

4. KEY INDICATORS FOR WATERSHED PROJECTS

For watershed projects, either rehabilitation or development type, the main concerns are: people, land, and water together with certain special interests such as protection of reservoirs, forest, or downstream communities. Therefore, watershed projects usually cover a wider range of activities to be monitored and evaluated than, say, agricultural production projects. Furthermore, the time needed for generating main benefits is long and techniques are usually sophisticated. All of these will make the watershed manager to think twice before selecting key indicators for "M & E".

Are there any common indicators for watershed projects that can be used for monitoring and evaluation? Very little literature has discussed this topic. However, from our experience and knowledge, we may suggest a simple list as a starting point. The recommended key indicators are as follows:

— Major physical output against the original plan. This includes, for instance, hectares of trees planted, terraces completed, meters of stream bank protected and kilometers of road built, etc. and their progress against the original plan and time schedule.

— Land use changes over time. Periodically record and compare the data of various types of land use and their trends.

— Erosion, sedimentation, and runoff. These are usually the main concern of any watershed project. One or two of them may be more important than the others depending on the main objectives.

— Farm income, production and/or productivity. Increase of farm income and production may be the major concern of farmers in a watershed. From government point of view, increase of land productivity may be more important in the long run. One or more can be considered as indicator(s) depending on the actual needs and time frame.

— Sustainability and viability. Whether the work can sustain itself after the project is terminated is an important indicator of the success or failure of the project. The viability of the project should be analyzed and evaluated against the original benefits planned.

5. INTRODUCTION OF METHODOLOGY

Using the five key indicators mentioned above, a brief introduction of their monitoring and evaluation methodology is presented here for reference.

5.1 Monitoring

5.1.1 Monitoring Unit:

A monitoring unit should be established within a project. If microcomputers are used, at least two persons trained in computer program application should be in service. In addition, key technicians of related branches should be trained to understand data input and analysis techniques using computers.

5.1.2 Design and Methodology:

Proper design for each item to be monitored (and to be evaluated eventually) is the first important step to be carefully taken. This includes getting appropriate records and materials, setting up measuring devices and instruments, and making special surveys. Whatever is needed, there should be uniformity in criteria, methodology, scale, unit, etc. so that over a period of time the collected results can be readily used for comparison and analysis.

For monitoring the above mentioned five key indicators, the design and methodology suggested are as follows:

1) For Major Physical Output: A data base should be established consisting of, for instance, items of work, overall targets, sub-targets, planned progress, periodical accomplishments, work completed Vs. planned, etc. Rooms should be left for possible revisions of the original plan.

2) For Land Use Changes: Establish an initial survey using a chosen methodology of remote sensing. Conduct repeated surveys at regular intervals and after important events (i.e. forest fires, disastrous rains, etc.).

3) For Erosion, Sedimentation and Runoff: Setting up gauging stations to collect runoff and sediment data; collecting reservoir, cheek dam, or pond sedimentation rates; establishing watershed experiment, and runoff and soil loss plot studies are the usually
techniques. It is our challenge to select and use the right techniques for this purpose.

4) For Income, Production and Productivity: A baseline survey is usually needed at the beginning of the project. It can be done independently or in conjunction with socio-economic surveys. Repeated surveys will provide information on general trends. For more accurate data, individual farm records should be kept at selected farms and the records should well be monitored to know the real causes. For monitoring production and productivity, either comparing soil fertility or directly measuring crop yields could be employed.

5) For Sustainability and Viability: The former can be monitored, for instance, by the number of farmers who have participated in conservation farming and by conservation work accomplished and properly maintained on these farms. The portion of farmers who voluntarily join the project with little or no incentives from the government can also be a good indicator of sustainability. For monitoring viability, the cost and benefit figures of main items of work should be continuously collected and periodically analyzed against the original figures planned at the initial stage.

5.1.3 Data Collection and Analysis:

Type of data, time to collect, and data collecting and editing methodology should be carefully determined at the very beginning of a project. There is a tendency to collect more data than actual needs and this can be very costly. For presenting monitoring data, some simple, explanatory analysis is needed. To present only raw data to the management is in many cases unwarranted.

5.2 Evaluation

5.2.1 Independent Evaluation Mechanism:

An independent mechanism is usually needed for project evaluation simply because evaluation may continue after a project is terminated or for avoiding bias. Such mechanism may include people from high levels or those unrelated to the project i.e. university professors.

5.2.2 Use of Monitoring Data:

If the monitoring work is properly done, evaluation can be carried out smoothly and swiftly. Sometimes, additional information still needs to be collected at the time evaluation is in process. To avoid collecting too much extra information in a short period, the evaluation team or unit should be involved at the very beginning when monitoring is planned.

5.2.3 Evaluation Criteria, Techniques, and Results:

Evaluation should be done by comparing the actual accomplishments or results to the original (or revised) plan which usually includes goals, progress, expected benefits and impacts. Any additional achievements or major discrepancies due to whatever the reasons i.e. design flaws, implementation problems, or political interference should be pointed out and discussed. Detailed discussion should be concentrated on those “Indicators”.

Data analysis techniques may include exploratory, statistical, and economical i.e. B/C ratio, NPV, IRR which are standard procedures and have been discussed previously.

Evaluation results should be published or made known so that experience and lessons can be learned by similar projects.

6. CONCLUSIONS

In the past, very few watershed projects went through the process of proper monitoring and evaluation. Or, evaluations were done in a hasty manner or rather superficially without the support of monitoring data, and the results were kept confidential or locked in a cabinet.

As resources become more and more limited and competition is high for investment, proper monitoring and evaluation of watershed projects will become a necessary task.

Between doing nothing and undertaking very sophisticated monitoring and evaluation procedures, there must be some essential and practical methods which can be employed. To find out the appropriate indicators and the proper methodology is a challenge to all watershed managers and planners.
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CONSERVATION EXTENSION WITH SMALL FARMERS IN DEVELOPING COUNTRIES*

ABSTRACT

Soil conservation extension is an extremely important but difficult task in developing countries, where the work usually involves hundreds and thousands of small farmers and the government manpower and resources are limited. Many soil conservation projects or programs have been hampered or have failed because of low participation of farmers due to poor or inadequate extension.

Three major questions in soil conservation extension usually face governments in developing countries: 1) Which government agency or agencies should be responsible for the work? 2) How can the work be carried out effectively? 3) What necessary assistance should be given to small farmers?

In this paper, the author tries to give some answers to the above, based on his experience obtained in developing countries. Also, the author suggests strongly that the governments should first have the political will to help and support small farmers. Instead of information diffusion type of extension, governments should pursue active roles and undertake integrated approach to make conservation profitable and sustainable.

1. INTRODUCTION

Many soil conservation projects in developing countries have been hampered or have even failed because of poor or inadequate extension work. Regardless of how sound the planning and design work are, if farmers are not convinced or cannot afford to participate, the project can hardly make any progress.

Conservation extension is extremely important where the majority of the conservation work is to be done by farmers. It is also an extremely difficult task where hundreds and thousands of small farmers are involved in a project and where government staff and resources are limited.

Three major questions usually facing the policy makers, planners, or project administrators in regard to conservation extension are:

1) Which government agency or agencies should be responsible for such extension work?
2) How can farmers be effectively motivated to participate in the project?
3) What necessary assistance should be given to farmers once they agree to join the work?

2. WHO SHOULD BE RESPONSIBLE?

There are two schools of thought in regard to extension responsibility. One school prefers the agricultural extension agency in the country to be responsible. The main reason given is that soil conservation is not different from other agricultural work and should be included in the normal extension program. Another reason is that an extension agency usually has its network already established and their people have ample experience in extension work. As obvious as these reasons are, such agencies in developing countries may have many problems and shortcomings including the following:

— The number of extension agents is usually far from sufficient to deal with the number of farmers in an area. In many developing countries, the ratio is 1:4,000 or more. The agent cannot even pay a visit to the majority of the farms in his or her district in a year, not to mention planning and working with individual farmers; both of which are required by soil conservation projects.
— Each extension agent may have already been overloaded with a dozen or more responsibilities such as crop development, animal husbandry, fertilizing, insect and pest control, credit, and others. They can

hardly absorb additional duties and find time to do an adequate job.
— The general lack of basic training in soil and water conservation at all school levels in developing countries makes the work difficult for the agent to perform. The subject of soil conservation relates not only in agronomy and soils but also in hydrology and engineering which are absent from the curricula of agricultural graduates.
— Soil conservation or conservation farming is a complex work which includes managing land, water, and plants for both protection and production purposes. Experience shows that even college graduates from soil conservation or watershed management major need about three years of practical field experience to be able to assist farmers independently.
— Finally, the type of conservation extension needed is much more intensive than the usual information diffusion type of work. Conservation extension normally includes conservation farm planning with farmers; land treatment design, survey and construction supervision; maintenance inspection; and follow-up activities. Farmers normally have experience in agricultural production, but lack knowledge in proper land use and soil conservation.

The other school of thought prefers to give extension responsibility to the agency which is responsible for the soil conservation work in the area. These agencies can be a soil conservation service, watershed management agency, slopeland development organization, local land authority, or a project office. Whichever it is, the agency needs to hire and train additional staff to carry out its own extension work. The advantage is that because of their primary interest in the area or watershed, they would much more concerned and active in conservation extension than the extension agency. This, however, also has some problems including the following:

— The responsible agency needs to establish a new network of extension which may overlap the existing one, and it may over burden itself to hire new staff and establish additional offices and administration.
— The agency may over emphasize its own interest and lose sight of overall agricultural development.
— Sometimes, the agency and extension service may have policy differences and dual standards which may cause confusions to the farmers.
— Most gravely, if it is a project and when it is terminated, the area will fall back to the routine extension work and, in many cases, totally neglected. The farmers are left with the impression that the government is inconsistent and untrustworthy.

Considering both short-term and long-term requirements, the best arrangement may lie with a close coordination between the responsible agency and the extension agency. A clear division of labor for overall extension activities should be set. Each agency should exercise its duty within its authority and help the other to achieve the mutual goal. Being this way, not only will each agency complement the other to overcome manpower and knowledge deficiencies, but also their staff will learn from their counterparts the necessary skills of conservation extension. If a project should be terminated, the work will be likely to continue.

3. HOW CAN THE EXTENSION WORK BE CARRIED OUT EFFECTIVELY?

As mentioned earlier, for soil conservation projects to succeed in developing countries, the extension work should be much more intensive than just information diffusion. The reasons are many. The most significant ones are as follows:

— Soil conservation work is not like using better seeds or fertilizers which farmers can do with little effort and see benefits in a short while. Small farmers will not undertake soil conservation work after only attending an extension meeting. They normally need much more time to realize benefits from demonstrations or pilot plots and to consider what inputs are really required for such work.
— The risk involved in soil conservation is much higher than other agricultural work such as using extra land for terracing, making heavy investments, and disturbing top soils which may cause lower production in the initial period. Even if farmers are aware of soil erosion, they may still be reluctant to take any action unless the government provides an attractive incentive program.
— The techniques involved in soil conservation may not be grasped easily by farmers in developing countries, especially for conservation structures and waterways. Without technical assistance, many work will be improperly executed and may cause more erosion than before.

— Soil erosion is also a socio-economic problem that cannot be solved easily just by diffusing information to the farmers without helping them lessen their constraints.

Unfortunately, the type of conservation extension, or agricultural extension as a whole, in most developing countries is not much more than information diffusion. This might be useful for well educated and well-to-do farmers in developed countries. It is certainly not sufficient and effective for poor, small farmers in developing countries.

Whichever agency or agencies are responsible for conservation extension, the work needs to be carried out actively, jointly, and thoroughly. "Actively" means that in addition to information diffusion, active technical services should be provided to all the farmers who are interested in soil conservation. To provide this kind of service, the agency or agencies should have a sufficient number of trained agents in the field to assist the farmers whenever they need help. "Jointly" means involving farmers in a joint effort to plan conservation farming and to execute and maintain the work. Most importantly, soil conservation should not be viewed for conservation's sake only; it should be considered "thoroughly" with the whole farming system and the benefits and profits of the farms. The conservation measures suggested should at least be compatible with, if not facilitate to, farming practices (Sheng, 1988). In other words, conservation extension should take into consideration all aspects of farming, completely and thoroughly.

While actual plans for carrying out conservation extension are site-specific, the following work may be required in most cases:

— Establish a sufficient number of small demonstration or pilot plots on both public and private farms, and conduct education tours.
— Recruit government field agents, village headmen, and contact farmers for proper training. The trained villagers and farmers can be assigned to assist in extension work.
— Organize a comprehensive extension network for the area with needed manpower, equipment, and vehicles. Government and village joint or interacting teams need to be established to maintain dialogue and to take care daily extension chores.
— Launch public campaigns in soil conservation to inform the general public and farmers about project policy, goals, government assistance, as well as farmers' obligations.
— Provide technical service after such campaigns. Once farmers show interest in participating in the project, the agency or agencies should immediately arrange interviews, joint farm planning, and other related activities. Otherwise, farmers' enthusiasm may die quickly.
— Design enough conservation packages to give farmers to choose according to their interests, resources, and crop needs.
— Organize farmers into groups for group actions, including planning, implementation, and maintenance work. Encourage them to help each other and to share labor and experience. This may be needed very much for saving government manpower and extension time, especially where numerous small farmers are involved.
— Assist farmers in every respect to pursue conservation farming, including obtaining planting material, fertilizers, pesticides, farming tools, credit or subsidies, and marketing and so on. (Details will be discussed in the next Section).

4. WHAT ASSISTANCE SHOULD BE GIVEN TO FARMERS?

Persons who expect to solve erosion problems through educational programs alone are too optimistic (Napier & Forster, 1982). Even farmers in the United States are offered incentives for practicing soil conservation work. Incentives may include tax benefits, technical assistance and cost-sharing, and low interest loans. Experience in the U.S. revealed that, among all the incentives, the most common one is the technical assistance and cost-sharing package.

Cost-sharing for conservation work has also been practiced in many developing countries. At government side, cash subsidies or in kind, such as food, is provided to farmers according to the job performed. In some countries such as Thailand and Taiwan, government machinery is used to do conservation work and the government charges farmers
a reduced rate. At farmer's side, their own labor is the major matching cost.

There is some criticism regarding cost sharing especially cash subsidies in developing countries. First of all, cash subsidies can be a heavy burden for developing countries; some countries just cannot afford them. Second, cash subsidies are sometimes misused, or, as found in Jamaica, farmers deliberately treated more lands in conservation practices than they can use and maintain in order to collect more subsidies (Sheng, 1984). Most critical is that farmers may develop a subsidy dependent mentality in whatever improvement scheme initiated by the government.

What, then, the alternatives? Giving tax benefits, food, or low interest loans? Tax incentives are meaningless to most small farmers in developing countries who pay no or little tax. To give food requires transportation, storage, and distribution which cost additional efforts and money than giving subsidies. Food preferences by farmers may also cause problems. In providing loans and credits, there are also problems of credit worthy, low repayment rates, or simply resistant to incurring debts. Even in the United States, loans are not popular in soil conservation work because the monetary returns are low or nonexistent and farmers are reluctant to use their limited borrowing capacity for soil erosion control (Napier and Forster, 1982).

Small farmers simply have no capital to spend on soil conservation work. Since soil conservation benefits the society, the society or nation should share a part of the cost. Cost sharing also helps to distribute income equitably. Regardless the actual ways of cost sharing and in spite of some problems, governments in developing countries need to try their best to generate funds or other resources for this purpose, and to use them in the best interest of the farmers. Some strategies for funding, resources generating and incentive utilizing are suggested as follows:

- A small fee can be collected from export crops to be used for protecting the land from being eroded away.
- Dues can be included in the water or electricity bills of the city dwellers benefit from upstream watershed or soil conservation projects.
- Government reservoir projects should include budget funds for watershed conservation needs.
- Watershed or soil conservation districts can be organized to collect fees and grants for erosion control purpose.
- Government employment programs can be directed to do gully control, waterway, streambank protection, and public erosion control work in order to reduce the burden on the local people.
- Government can provide community roads, irrigation, or other public work as incentives. This strategy has been found to be very effective in Taiwan, India, and many other countries to induce farmers to participate in conservation projects.

Technical assistance should go hand in hand with cost-sharing or other incentive programs. As mentioned previously, such assistance should be complete and thorough. The major work needed in technical assistance includes the following:

- Conservation farm planning. Government agents and farmers should jointly plan the conservation needs of a farm or a group of farms. After examining land capability of each parcel, a series of conservation alternatives should be presented to the farmers for discussion. The final decision, however, should be made by farmers themselves according to their interest, resources, and crop needs.
- Conservation implementation. Government agents need to assist farmers to design, layout, survey, and supervise the conservation work so that it will be carried out properly according to the plan.
- Follow-up and maintenance. Follow-up activities are very necessary, such as providing planting materials, fertilizers, pesticides, and marketing. Production and profitability are the farmer's ultimate goals and the government should give them full support. Proper maintenance of conservation structures and waterways is also essential. Without this, any conservation effort will soon be self-defeating.

In technical assistance, the most difficulty task is to give advice on cropping. Farmers who accept conservation farming are usually advanced type of farmers. They will demand better crops or cash-earning crops once the land is terraced or improved. Unless the government already has had crop development plans or crop zoning in the area, any suggestion of new crops without price support may have risk in future marketing. On the other hand, re-
stricting the growing of certain crops and encouraging others may sometimes reduce farmers' income. In an Indonesian project, for instance, the government’s restricting cassava in favor of rice has resulted in less income for those model conservation farms where government package was adopted (Huszar and Cochrane, 1989). In fact, once the slope is terraced or protected, any crop can be grown if proper fertility management is practiced.

This leads to another important topic: The integrated approach of soil conservation projects. For soil conservation projects to be successful, socio-economic and institutional factors or constraints should be taken into serious consideration. Such factors may include inherited land use problems, inconsistency of government policy, problems of trade, unfavorable domestic or international prices, and so on. The government needs to put additional time and effort in solving such problems or removing such constraints. The work may involve regional or concentrated crop development, better means of transportation and access, marketing arrangements, storage and processing of farm products, price support, farm insurance, and sometimes changing or modifying existing policies. The ultimate goal is to help farmers to make sustained profits while protecting their land. Taiwan, for instance, has set an excellent example in developing and protecting its slopeland resources by actively pursuing an integrated approach (Koh et al. 1989).

5. CONCLUSIONS

Conservation extension plays a key role in the success of any soil conservation project involving small farmers. In developing countries where government manpower and resources are limited and small farmers are numerous, extension work usually faces great difficulties. Many soil conservation projects fail because farmers participation is low. To improve the situation, governments in developing countries must have first the political will to pursue an active role in conservation extension. Instead of merely diffusing information, government extension workers should act as “coaches in the ball games” and actively engage or organize farmers in undertaking integrated type of conservation farming. To do this, coordination among government agencies should be strengthened, and proper incentives and technical assistance should be given. Most importantly, extension work should not stop short at soil conservation only; it should give farmers all the necessary support to make conservation farming profitable and sustainable.

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1. INTRODUCTION

The subject of watershed management has become increasingly important in Asia and the Pacific region. Since the mid Eighties, many international workshops and meetings in watershed management have been conducted. In addition, regional studies and training are being actively pursued. Most countries are now aware of the importance of proper management of their watershed resources.

However, watershed management is a complex and difficult task. Further studies and meetings like this are needed for discussing problems and exchanging experience. After reviewing the results of past meetings and studies (FAO, 1983; FAO 1986; East-West Center, 1985; ASEAN-US Watershed Project, 1984 & 1985; East-West Center & TFRI, 1987), the author finds that some important issues still need to be addressed or strengthened. This paper will concentrate on the aspects of watershed planning, management, and research.

2. WATERSHED PLANNING

Under watershed planning, three important issues will be discussed: land use and land capability; conservation farm planning; and planning for sustainability.

2.1 Land Use and Land Capability

To use land properly in a watershed, certain criteria or use limits need to be established. Such criteria are normally referred to as land capabilities or land suitabilities. During the planning stage, planners and watershed managers need to apply such criteria to classify all the lands into capability or suitability classes. Without such classification, it would be difficult to know the site and degrees of misuse when compared with present land use. Only after detailed data are obtained on overuse, under-use, and conservation needs, can planners then propose work plans for proper management.

Do we have such criteria available for the hilly upland watersheds of this region? Many countries have used the USDA classification system or its modifications and have found it rather problematic in hilly areas. For instance, slopes classified as class VII, which, by definition, should not be used for cultivation, are under permanent cultivation with terraces. In Taiwan, after a 6-year classification of 1.5 million hectares of slopeland, using a modified USDA system, the government was not satisfied and again reclassified the lands using different criteria.

Since the mid Seventies FAO has devised a framework for land suitability classification (FAO, 1976) which has been used for developing several systems (FAO, 1984a; 1984b; & 1985) and tried in developing countries. While the systems have merits, they are dependent much upon economic considerations and detailed soil information, such as the availability of moisture, nutrients, and oxygen in root zone, which need a special collection even if information from a standard soil survey was available. In developing countries where soil information is sketchy in hilly areas and economic information on land use is lacking, the application of these systems may cause many problems. As indicated in a recent land capability classification report in Nepal (Sthapit, 1987), the FAO approach demands considerably high resource inputs which are far beyond the scope of the developing countries.

What is really needed is a system which can be simply applied under conditions of limited data and which can promote proper land use in the watersheds of developing countries. Only a few such systems are available for steep, tropical watersheds. A treatment-oriented system for classifying hilly tropical watersheds was developed by the author in the early Seventies (Sheng, 1971). The system depends mainly on slopes, soil depths and limiting factors which can be easily learned and applied for both watershed and farm levels. Although the system or its modification has been used in a half dozen countries in Asia and Central America, its application is...
still limited. Since the issue is important and urgent, this system together with those newly developed in Nepal (Sthapit, 1987), Philippines (Driscoll et al., 1987), India (Jaiswal, 1988), Malaysia (Crop Suitability Classification) and many others in the region should be brought forth for a comprehensive study and discussion in regional workshops.

2.2 Conservation Farm Planning

Conservation farm planning is a process involving farmers in the planning of the use and conservation of their farms. It is a kind of “Bottom-up” planning approach. In the past, many watershed conservation projects have failed because farmers were not involved in planning and decision-making. However, farm planning is a time-consuming and difficult task in Asia countries where hundreds and thousands of small farms are situated in a watershed area. Therefore, this subject merits careful thought and discussion.

Since such planning work is necessary, appropriate strategies should be sought to overcome the difficulties. For instance, at the initial planning stage, only stratified farm samples are used for estimating work needs, leaving the bulk of individual farm planning to the implementation stage when time and resources are less restricted. During implementation, planning can also be carried out with groups of farmers or by sub-watersheds in order to save time and energy. In the case of farmers are too individualistic to be organized, planning work can only be carried out gradually with a “first come, first served” order.

For all the cases, proper planning mechanisms should be well organized and placed in the field to assist the farmers in the area. Microcomputers and existing software can be employed to assist such planning. For instance, inexpensive mapping software such as MapInfo can be used for managing and analyzing spatial database and geographic information. Database management software such as PFS: Professional File and dBASE can be used for storing large numbers of farm records for data retrieval, query, analysis, and reporting. An “Expert System” called “LANDCONS”, developed recently by the Computer Assisted Development, Inc. and Colorado State University can be used for classifying land capability and recommending soil conservation needs for hilly, small farms. These software and many others need to be tested and used in order to facilitate farm planning work.

2.3 Planning for Sustainability

Probably the greatest challenge confronting watershed planners is to plan for sustainability. First, serious consideration should be given to institutional arrangement. Watershed work, especially the integrated type, is multi-sectoral and multi-disciplinary. No one single agency has the resources and manpower to cope with the complex activities. Temporary offices or a staff-borrowing type of arrangement prevails in many countries. But their continuity is often questionable when a project or any short term work is completed. On the other hand, setting a single and complete authority in each watershed is a heavy burden that most governments cannot afford. The solution may rely on good coordination among related agencies. Coordination is difficult in developing countries when each agency has only limited manpower and resources to contribute to the others. However, joint planning conducted at the ministerial level and decentralized implementation after a plan is approved has been proved a successful strategy in Taiwan and some watersheds in India. Decentralized implementation means that each agency does its duty within its jurisdiction or boundary in a watershed according to the plan, and not merely doing others a favor. The work is usually carried out more fruitfully in this fashion.

Besides institutional arrangement, the need for long-term work to obtain the planned results should also be considered in planning. The benefits of watershed work rarely show over a short period and usually need persistent effort for a longer period of time to realize. Short-term projects may inject temporary services and goods in a watershed area, they may cause more damages than good once projects are terminated. For instance, infrastructure, tree plantations, and conservation structures require many years of proper maintenance and care. Otherwise, they will not be beneficial or may even cause erosion or damage. People will also lose faith in the government if support and incentives are abruptly cancelled. Therefore, in the planning of any watershed project, planners need to consider the necessity of continuity and sustainability, and to stress the needs for a long term, permanent program.

Continuation with a permanent program is most ideal, but it is not an easy task to ask any government to make a long-term commitment. There is uncertainty even in government itself. Therefore, the most important thing to be considered is whether the project will achieve self-sustenance in the long run. This may include stepping up efforts in education and extension, motivation, grass-root
communication, intensive technical assistance, sound farmers organization, establishing upstream and downstream relationship, and alternative resource seeking, among other strategies. Until the people really benefit from the work and understand its importance, the sustainability cannot be achieved easily. This is, of course, the planners’ and watershed managers’ greatest challenge.

3. MANAGEMENT

Much has been discussed in the past workshops and meetings in this region about approaches and strategies for proper management. This paper will deal only with two important issues as follows:

3.1 Management Strategies for Small Farmers

Many watersheds in this region are populated with hundreds and thousands of small farmers. The average farm sizes may around one hectare or so that are often fragmented. In addition to the difficulties of planning as mentioned in Section 2.2., implementation of such plans may cause even greater hardship to any watershed administration. Therefore, proper strategies must be developed to manage the progress.

Group actions should again be stressed. Farmers should be encouraged to organize themselves into groups, whether by neighborhood, sub-watershed, or other convenient means. Priority of government incentives can be given to groups rather than the individuals. By group actions, farmers can learn from each other and also the supervision work can be kept to a minimum. Group pressure can make many reluctant farmers progressive.

For individual farms, partial intensification should be emphasized. This means to concentrate available resources initially at the best piece or pieces of land for protection and production. If production can be raised, and it usually would, the farmer does not have to go back to practice shifting cultivation on other pieces of land which may be unsuitable or too steep for cultivation.

Meanwhile, progressive development of a farm should be encouraged. Regardless of how small the farm is, soil conservation and revegetation work means extra labor for farmers in addition to their already busy farming activities. Furthermore, experience shows that using each family’s labor to protect or improve their own farm will result in better maintenance in the future.

The toughest job is to regulate or adjust improper land use on a farm. Education, negative incentives, giving no help to destructive type of land use, compensation, or even resettlement are some of the strategies to be employed. This subject needs a careful study under local environment.

3.2 Monitoring and Evaluation

Lack of monitoring and especially evaluation are said to be one of the main reasons that further investment in watershed projects in developing countries has been hampered. Monitoring is an action or an arrangement to observe or record the operation of a system while evaluation means to determine the value of the work accomplished. Monitoring and evaluation are continuous processes; one without the other is inconvenient and/or incomplete.

Although there are difficulties involved in monitoring and evaluating watershed work due to their externalities, multi-sectoral and long-term nature, watershed managers should do everything they can to record and review the progress of work and, if necessary, revise the original plan according to the actual needs.

It is rather impossible to include every activity for monitoring and evaluation. Only key indicators should therefore be included. These indicators should reflect the main objectives, respond to changes, and be clearly defined and measured. Although they are project specific, indicators for watershed work may generally include 1) physical outputs, 2) land use changes, 3) conditions of erosion, sedimentation, and runoff, 4) farm production and income, 5) social impacts, and 6) sustainability.

A monitoring unit needs to be established for data collection and primary analysis. Much work can be done by using microcomputers. Technical staff need to help obtain relevant data and give close support. Evaluation can be done periodically by an independent group. Most importantly, the results should not be treated as confidential. They should be made known so that experience is gained and shared, and lessons can be learned and applied by the others.

4. RESEARCH

Research in watershed or resource conservation
is always a controversial subject in developing countries. On the one hand, local data are lacking for planning, design and implementation. On the other hand, research means more time and resources input which many countries cannot afford. For instance, the conventional type of paired watershed research may need 10 years to obtain meaningful results. Also, in developing countries, qualified researchers are scarce or they are not allowed to stay long enough to get results. According to a FAO report (FAO, 1983), research activities in watershed conservation in this region was largely neglected. Out of a total of 17, 70 percent or eleven countries’ research facilities and personnel were rated poor to very poor. In fact, worldwide, research in resource conservation has received little support in comparison with research in crop and livestock production. Against this background, the author will make suggestions on only a few subjects of high priority.

4.1 Managerial Research

This is a new category of research that many countries have neglected. It concentrates on studying management techniques in order to improve performance of work. This may include policy issues, institution and legislation needs, proper planning approaches, management strategies, monitoring and evaluation techniques, etc. Each country can establish a priority list according to its needs. Some subjects of prime importance to many countries are suggested below:

1) Approaches in Land Use Adjustment. How do we rationalize land use in a watershed without raising much objection from the local people?

2) Strategies for Farmer’s Participation. With what type of incentives, assistance, and/or extension and education schemes can farmers participation in watershed work be encouraged?

3) Basics for Self-sustenance. What are the basic requirements for fulfilling self-sustenance of watershed work by farmers and local communities when government inputs are reduced or withdrawn?

4.2 Research in Applied Techniques

This group may simply be called applied research. It also consists of a vast area to be studied. Leaving out conservation farming and agroforestry which have been dealt with frequently in other meetings, some important research subjects of watershed proper are suggested as follows:

1) Mountain Road Protection and Drainage. Erosion from mountain roads and/or forest roads is a serious watershed problem in many countries in this region. In addition to sound design and construction, the proper protection of cut slopes, fill slopes, and road surface is a subject for profound study. The safe drainage of runoff from a road to the steep and long slopes below without causing serious erosion or damage is a priority subject for research.

2) Cost Effectiveness of Check Dams. Many countries in this region have embarked on a large scale and expensive check dam program. The functions and necessities of such investment are still debatable and not clear to many people. The cost effectiveness of check dams needs to be properly researched.

3) Water Harvesting Techniques. Even in humid tropics there are several months of dry spans when no crop can be grown on any land including terraced land. Harvesting runoff from the rainy season and storing it for supplementary irrigation for one additional crop will benefit the farmers a great deal. Appropriate application techniques of this along with moisture conservation practices should be developed through research.

4.3 Basic Research

Some advanced developing countries and international institutions where manpower and resources are available should help this region to conduct or strengthen basic or fundamental research. Some priority subjects are suggested as follows:

1) Determine Tolerable Soil Loss. The rates of tolerable soil loss of the major soils in this region need to be estimated through research. The North American criteria are not applicable, and the lack of any appropriate standard makes planning for erosion control work difficult.

2) Predicting Erosion and Runoff. Using some of the watershed hydrology experiments and runoff plot studies in this region as bases to test, modify, or develop proper
models for estimating erosion and runoff from hill watersheds. A success in modelling will save investment in watershed hydrology and erosion studies and will facilitate planning work as well.

3) Research on Relationships Between Erosion and Productivity. This is a new trend of erosion research in contrast with the conventional ones aimed at only quantities of erosion. North America and Africa (Stocking, 1988) have already made progress, but this region seems left behind.

5. FINAL REMARKS

Most of the watersheds in this region are characterized by steep slopes, heavy and frequently rains, and dense populations of subsistence-type of farmers. Improper land use and soil erosion have been increasingly serious. Fortunately, watershed management has received ample attention from the governments and people of the region.

However, proper management of watersheds not only requires long-term investment and care, but also necessitates sound approach in planning and implementation, as well as the support of research. The ultimate objectives of watershed work should be twofold: Provide effective protection and management of soil, water and other resources in the watershed, and improve the livelihood of the people in the area. This paper highlights some of the important issues for general reference and stresses practical approach as well as work sustainability.

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RUNOFF PLOTS AND EROSION PHENOMENA ON TROPICAL STEEPLANDS*

ABSTRACT

Runoff plots are used in many developing countries for erosion studies. In the past, reports of plot studies concentrated mostly on presenting figures and statistics and less on explaining the background and the applicability of the results. This paper takes a different angle and emphasizes on discussion of plot design and logics, management needs, and particularly erosion phenomena and their implications for erosion control work. Its contents are based mainly on the experience obtained from the runoff plots in the steeplands of Jamaica, El Salvador, and Thailand from the early Seventies to the mid Eighties. The paper finally recommends the need for international societies' efforts to support, coordinate and synthesize such experiments.

1. FOREWORD

Runoff plots are extensively used in developing countries for erosion studies. Plot design, instrumentation, and data collection procedures vary greatly from place to place, so as their results even under similar climatic and physical conditions. People may sometimes wonder whether these results reflected the real situations or were due to design and management differences.

In the past, reports of erosion studies concentrated greatly on presenting figures and statistics (i.e. tons per hectare per year), but not very much on design criteria, logics, management experience, data usefulness and their applications.

This paper will briefly review the experience of establishing and maintaining the runoff plots in the steeplands of Jamaica, El Salvador, and Thailand from 1970 to 1984. Particularly, design criteria, management needs, erosion phenomena, and data usefulness and applications will be discussed. No attempt is made to present detailed figures of these plots since their results have already been published or reported (Sheng & Michaelsen, 1973; Michaelsen & Heymans, 1976; Sheng et al, 1981; Kraayenhagen et al., 1981).

2. DESIGN, INSTALLATION AND MANAGEMENT

2.1 Design and Installation

Selection of crops and soils for plot study is usually not difficult. Government policy, research objectives and major soils and crops in the area usually dictate such needs. Design problems have always been the selection of slopes, sites, sizes, replications, and appropriate installations.

1) Slope and site: Slope of plots depends on the terrain of the area, the major slope under which the test crops are grown, and the availability of the sites for such studies. In steep countries, it is not necessary to limit to 9% slope or follow the Universal Soil Loss Equation (USLE) standard. For instance, the plots in Jamaica, El Salvador and Thailand were all established on 30 percent slopes (17°) which is quite representative of the hill cultivation conditions of these countries. The site selected should be convenient for daily work and supervision. This is primarily important, otherwise, plot maintenance could be hampered.

2) Size and replications: Plot length, width, and total area are usually constrained by the available sites. A proper size, however, should not only be chosen for economic maintenance but also for producing good results. On dissected hilly areas, it may be difficult to find a constant slope of 22.1m (72.6 feet) as required by USLE type of study. A minimum length of 9-10 m (Mutchler et al., 1988) should be sufficient. The appropriate width of a plot depends upon crop needs. Too narrow a plot

will have serious border effects. Many tree plots of 2m wide in some countries may result in data inaccuracy. The total size of a plot should be manageable in terms of instrument capabilities and manpower to measure and clean the runoff and sediments. An integral fraction of a hectare or an acre would be convenient for future analysis i.e. 1/100 ha.

The sizes of a single plot in these three countries are:

a) Jamaica: 6 m by 16.6 m (1/100 ha) for yellow yams (*Discorea cayennensis*) and subsequently for bananas.

b) El Salvador: 5 m by 20 m (1/100 ha) for maize.

c) Thailand: 5 m by 20 m (1/100 ha) for upland rice.

Replications may be needed for this kind of study. In Jamaica, two replications (two sets) were used, but many times the same treatment gave quite different results. Therefore, in both El Salvador and Thailand, three replications (three sets) were used for better statistical analysis.

3) Instruments and installations: In developing countries, automatic devices such as various types of H-flumes with water level recorders and sediment samplers should only be used where repair and maintenance service is readily available. Otherwise, these instruments, once broken down, need to be sent elsewhere for repairs, causing a loss of data. Yet, heavy sediments due to cultivation from these kind of plots and high moisture in the tropics can cause these instruments to easily malfunction. Considering these problems, manual collection of data with simple devices and tanks were used in these three sets of plots. For instance, Jamaica and El Salvador had installed Parshall flume type of simple device which can be easily maintained. In Thailand, a slot type of device was used. At each plot, two tanks were installed, one for collecting mainly sediments and the other for additional runoff. The flumes and slots are actually runoff divisors which connect two tanks and allow only a portion of the runoff to go to the second tank. Design criterion for the tanks depends on local climate. For example, the Jamaican tanks were designed for holding the runoff from 178 mm (7 inches) of maximum daily rainfall, an equivalent of a 10 year return period. Over the last 20 years, the tanks overflowed only a few time. This is an important design because if tanks overflow often, the measurements and records will suffer.

Partitions of the plots in the three countries were built by bricks and placed deep enough to prevent any foreign flows from outside or between the plots. The tanks were built by bricks with mortar or by precasted concrete. This was deemed necessary for two reasons: First, that the plots can be used for many years to come and secondly, that the installation cost was only a fraction in comparison with long term maintenance cost.

4) Treatments: Treatment needs vary from research objectives. In all the cases, a control (or check) plot is needed for a unit set of treatments. However, whether the control plot should be representative of the farmers' cultural methods is a subject of debate. During Jamaica's first yam experimentation (1969-1973), the control plots were given the same amount of organic and chemical fertilizers as the treated plots resulting in a better first year production of yams of the control than the treated plots. The farmers in the region used no fertilizers at all. Although from the second year onwards, the yam production of the control plots was declined due to more erosion than the treated plots, the yields were still higher than the surrounding farmers'. The result may give a false impression to the farmers that for increasing production, soil conservation is not at all necessary. The argument then was that if everything being held equal (i.e. slope, soil, size, fertilizers, etc.) the differences in soil erosion and yam production among the plots would be attributable to the single factor of conservation treatment.

One important consideration for all plots on steeplands under tropical conditions is drainage. It is unrealistic under the humid tropics that a plot be designed to hold all the rainfall. Without drainage systems, a plot will yield unusually low runoff and sediments, but the crops will be damaged. On the other hand, the land used for installing a waterway in a plot should be appropriate (i.e. not over 5 percent). Otherwise, runoff will be unusually high because waterways are normally protected with structures or sod which will seldom take in rainfall, especially on steeplands.

2.2 Management

1) Personnel needs: In the tropics and subtropics, heavy rains may fall every day during the three to four peak months of rainy season. Collection of runoff and sediment data becomes a tedious task. Therefore, ample manpower and good ma-
management should be provided. The personnel needs, according to the past experience, was as follows: One overall supervisor, two field assistants stationed nearby, and two to four laborers for about one dozen plots. The necessity of two field assistants is because rains may fall on holidays and weekends. With two of them, they can alternatively cover the necessary work year round.

2) Measurement and data collection: It is essential to measure and collect data from plots after every runoff-producing rain. This means that such chores will be needed almost every day during the rain seasons. For instance, the number of runoff-producing rains in Jamaica amounted to 75-95 a year. Usually the torrential rain falls in the afternoon, and all the necessary work needs to be completed by the following morning to make way for the next storm. The work includes measuring and recording rainfall and runoff, weighing and sampling sediment for each plot and clearing all the tanks, etc. The overall task usually requires two to three hours to complete. If the measurements are carried out after several storms, as many other countries did, not only will the results of individual storms be unidentifiable, but also the tanks will easily overflow, affecting data accuracy.

3) Data analysis: Runoff, sediment, and crop productions may constitute the major items for analysis. Under runoff, the total amount and percentage of runoff in relation to rainfall are probably two of the most important items. Runoff timing and peak flows cannot be measured without automatic recorders. For sediment measurements, the sludges of the tanks, mainly heavy sediments, can be weighed, sampled, and oven dried for determining their dry weight contents. Whether suspended loads need to be measured is a subject for further study. The work could be time consuming, and the quantity obtained may be quite negligible according to our experience. Therefore, for all three sets of runoff plots, no suspended load measurements were made. Also, nutrient loss was not measured for these sets of plots. Crop productions of the plots was analyzed in Jamaica for yams and bananas but there were no complete reports on production for the other two sets of plots. Too busy on erosion measurements and neglecting crop management were the major reasons.

3. EROSION PHENOMENA

This paper does not intend to give a detailed analysis of erosion results of the three sets of runoff plots. Instead, some important findings and interesting phenomena are brought up for discussion:

3.1 Important Findings

From the results of these plots and other reports (JCRR, 1977; Liao, 1981; Sheng, 1982; Veloz & Logan; 1988), it can be summarized that under the humid tropics, cultivated slopes of 30% and the like could lose soils at 100-200 t/ha/year without practicing proper conservation measures. The actual rates vary according to crops, tillage, soils, and local rainfall patterns and intensities. To reduce soil erosion to an acceptable level, therefore, is a much greater challenge to the conservationists under this kind of environment than others. According to our experience, both conservation structures and agronomic conservation measures are needed to control soil detachment and transportation, as well as to safeguard runoff which is inevitable in humid tropics. The right combination of structures and agronomic measures are dependent on local research. For instance, based on the runoff plots in Jamaica and Thailand, hillside ditches (the improved type) combined with agronomic measures could reduce erosion by 80%, yet their cost was about 1/5 the cost of bench terraces which may reduce additional 10% of erosion.

3.2 Interesting Phenomena

Some interesting phenomena found from these plots are explained as follows:

1) Bench terraces were most effective in reducing erosion, but not for runoff especially for new terraces. The main reasons except the intense and frequent rains are: a) In a plot, the risers of bench terraces and a waterway occupy considerable area. The risers are protected by grasses, and the waterway by grasses or structure. These areas can take in very little rain, if any. b) Subsoils exposed at the cut portion of the terraces need several years of continuous tillage to improve its infiltration. c) The type of terraces designed in the tropics are for safe drainage of runoff so that the water has less chance to infiltrate. According to an experiment conducted in Taiwan, the runoff reducing function of bench terraces was greatly improved after several years of cultivation (Liao, 1981). An earlier study in Taiwan found that the benches generally conserved more moisture than the check plots on slopelands (Chiang, 1965). This subject may need more studies.

2) The majority of soil losses were due to a dozen or so heavy storms in a year. For instance,
on 1 June 1972, a storm of 103 mm at the Jamaican site produced 30 t/ha of sediment (in terms of dry soils) from the check plots (Sheng & Michaelson, 1973). The amount was almost 1/4 of the average annual soil loss per hectare from the checks. The 1979 results of the Thailand plots showed that 88% of the soil loss from the control was caused by six storms (Sheng et al. 1981). In 1981, 33 t/ha were lost from the control during two storms fell on 2-4 September (Kraayenhagen et al, 1981). Therefore, data collection during heavy storms should be carefully exercised and no overflow of tanks should be allowed.

3) Runoff percentage can be as high as 95% according to Jamaica experience (Sheng & Michaelsen, 1973). This may be because of heavy soils, but more probably because of frequent, torrential rains and steep slopes. During the rainy season, soils are saturated or nearly saturated so that any additional rains will run off quickly. Runoff percentage is an important factor used for designing flood and erosion control structures.

4) Soil loss figures obtained from this kind of runoff plots are usually less than actual erosion occurring in the field, mainly because the length of a plot is confined by walls and no foreign runoff is allowed to flow in. This may not be the case in the field. Longer slopes and added runoff usually cause more erosion. Another reason is that the plot length of 10-15 m may fit in the designed space between two structures (hillside ditches or other types of discontinuous terrace) under the field conditions. In other words, the walls at the two ends protect the plot, just as conservation structures protect the field. With this kind of protection, agronomic conservation measures such as grass barriers and residue management seem quite effective in erosion control, as some results indicated in El Salvador. However, this may not be true when they are applied alone on long slopes in the field without structures to take care of the runoff. The effectiveness of agronomic conservation measures on tropical steeplands merits further studies.

5) Minimum tillage seems quite helpful for erosion reduction. In the upland rice plots of Thailand, “Dibbling method” (Using a wooden stick to open a hole) was used for seeding rice and leaving the remaining area untilled. The average soil loss of the control plots for three years was 48 t/ha year. This amount might be doubled without practicing minimum tillage. Soil erosion rates could reach 100 t/ha year or more under traditional cultivation in the region of Northern Thailand (Wichaidit & Bourreau, 1977; Marston et al, 1985; Harper, 1987). Proper minimum tillage systems for tropical steeplands occupied by subsistence type of farmers is a subject for further study. Small farm sizes, root crops, and extra inputs of pesticides and fertilizers, etc. are some of the obstacles for developing and adopting such systems. However, any practical system found through additional studies should be helpful and useful to the farmers.

6) From past records, it can be said that erosion is a more erratic phenomenon than most of us thought it was. In theory, under similar storms, intensities, soil moisture and cover conditions, the erosion rate of a plot should be similar. In reality, however, the results can be quite different. Depressions created by cultivation need to be filled up before sediment enters the tank; sediments may pile up in plots during heavy storms and to be washed out by lighter rains; structures may suddenly slipped off during storms; and weeds may provide better cover before rooted out. All these and others contribute to different erosion rates. Unless the real parameters influencing erosion are completely understood on the site, actual prediction is almost impossible. Predictions can generally be made for average conditions and for long terms.

4. THE USE OF PLOT DATA

4.1 For Verifying Soil Loss Equations

A part of the banana plot data from Jamaica has been used for verifying the USLE, MUSLE (Modified USLE) and the Simplified Process (SP) model developed recently by D. M. Hartley, USDA-ARS. The findings were that the USLE and MUSLE generally overestimated several times more soil loss while the SP model, though somewhat overestimating the soil loss, was much closer to actual measured results. The high LS (Length & slope steepness) and C (Cropping) factors of the USLE and MUSLE are probably the main cause of their overestimation on steep slopes. The SP model performed extremely well in predicting runoff (Hartley et al, 1986: Hartley, 1987).

Another independent study using yam plot data of Jamaica to verify MUSLE and the Morgan and Finney model, was done very recently by Miller (Miller, 1989). His main findings were that the MUSLE grossly overpredicted soil loss in comparison with measured values because the LS values were too high. The Morgan and Finney model produced
results generally closer to the measured ones, though it underestimated soil loss of the control plots and the runoff of all the plots.

4.2 For Conservation Planning

The plot data, together with the results from a demonstration area in Jamaica, have provided a basis for planning several soil conservation and watershed projects in terms of estimating erosion rates, effectiveness of conservation measures, and crop production potentials on treated lands. This has been very helpful in developing countries like Jamaica where basic data are usually lacking.

5. CONCLUSIONS AND RECOMMENDATIONS

Runoff plots are popular for erosion studies in many developing countries because of their relatively simple in installation and briefness in obtaining results. However, to secure useful results, the plots need first to be carefully designed and maintained, and followed with meaningful analysis and interpretation. Merely collecting or presenting erosion figures and statistics without sufficient discussion of their limitations and usefulness is a job incomplete. People can consequently learn more from interpretations and discussions than from cold statistics. This paper is written based on this belief and is meant only for stimulating purpose.

Runoff plot studies have been carried out on the tropical steeplands in many countries and probably over many decades. Yet, their results are still sketchy. It is recommended that international soil conservation societies, research institutions, or other agricultural or environmental bodies should make efforts to investigate their installations, collect, collate, and coordinate their findings, and help synthesize and publish the results. Standardization of plot design and management practices should also be considered in order to avoid mistakes of the past as well as to make comparisons more meaningful.

REFERENCES


Sheng, T. C., Jackson, J. K., Kraayenhagen, J., Nakasthien, N., & Watnaprateep, P. 1981. The Effects of Different Structures on Erosion and


A REVIEW OF FORTY YEARS OF MANAGEMENT IN WUSHEH WATERSHED, TAIWAN*

ABSTRACT

Wusheh Reservoir was one of the earliest reservoirs built in Taiwan in the 1950s. Prior to its construction, watershed management work was initiated, the first of its kind on the island. During the last forty years much has been accomplished, yet new watershed problems arise continuously which require new efforts, investment, and policy to tackle them.

The author was associated with the program from its inception into the late 1960s and has witnessed its progress to date. Recently, the author made a brief tour to the watershed to review its past accomplishments, impacts, problems, and new developments. It is felt that Wusheh can provide useful lessons for similar programs or projects in developing countries, and its experience can be shared with professionals and administrators who are undertaking such work.

1. BACKGROUND

1.1 Physical Background

Wusheh watershed, situated in the Central Mountain Range of Taiwan, has a total area of 20,480 ha above the Wusheh Reservoir (See Fig. 1). The terrain is steep with an average slope of 57% or 30 degrees. Stream gradients are also steep: the main stream has a gradient of 1/17 (6%). Most soils are lithosols (stony soils) with pockets of brown podzolic soils and brown forest soils. The major rocks are Tertiary slates with some sandstones, older schists, and gneissess.

The average annual rainfall is 2,235 mm which falls mostly from May to September. October to January is the dry period. Rainfall intensity is very high: as much as 83 mm/hr was recorded. Annual evaporation is about 1,270 mm. The monthly average temperature ranges from 11.4°C in January to 24.6°C in July. Average relative humidity is 80%.

With the heavy and intense rainfall, steep slopes, coarse soil textures, and weak parent material, geological erosion is severe. This is compounded with accelerated erosion caused by improper land use. Steep valley slopes and channels made the streamflows respond quickly to the rains and also affect the delivery of sediments. In many V-shaped valleys, few storage places for sediments exist. Consequently, the daily streamflow varies greatly – the recorded extremes were 1.4 cms to 615 cms. The annual sediment rate, at the time the dam was being built, was 2.2 million m³, an average of 10 mm over the entire watershed.

1.2 The Dam and Reservoir

Planning for the dam was initiated in the late 1940s. The dam, a concrete arch with a height of 114 m, was eventually completed in August 1958. It is located on Wusheh Creek, the headwater of the Muddy River and also the upstream of the Sun-Moon Lake Reservoir. The reservoir's total storage capacity is 145 million m³ with a dead storage of 18 million m³. The expected life of the reservoir is 108 years.

The reservoir was built primarily to generate electric power for three stations: one at Wusheh and two at the Sun-Moon Lake. It added about 55,700 kw to the power supply system. This sum was quite significant at that time in Taiwan. In addition, the reservoir helps irrigate 50,000 ha of rice and sugarcane in the lower plains of central Taiwan. The total construction cost then for the Wusheh dam was about 65 million U.S. dollars.

1.3 Land Use and Socio-economic Conditions

Two-thirds of the watershed is covered with natural forest, most of which is nationally owned under the jurisdiction of the Taiwan Forest Bureau. Mixed hardwoods grow at lower elevations (1,000 m

Figure 1. Wusheh Watershed
to 1,500 m) and conifers grow above 2,500 m. Between 1,500 m and 2,500 m a mixture of hardwoods and conifers grows. The remaining one-third (6,000 ha) is composed of cultivation lands, denuded areas, and areas under grass cover. Of this 6,000 ha, 4,100 ha is designated as ‘Aborigine Reservation’ and the rest is university and public farms.

Hill tribes or aborigines make up the majority of the population in the watershed. In the early 50s, the population was 1,900 and now is about 5,500. Originally, the aborigines depended mostly on shifting cultivation to live. They cleared and burned pieces of steep forested slopes to grow mainly millet or sweet potatoes (staple foods). After several years, as the yields became low, the land was gradually abandoned by interplanting fast growing trees such as Alnus spp. for recovering soil fertility and for land marking. Then, they shifted to other places for cultivation. Although the real impact of this kind of shifting cultivation on erosion and land degradation is not known quantitatively, the burning often caused extensive forest fires and the cultivation created severe surface erosion, gullies, and landslides.

The aborigines were the least educated people in the early 50s in Taiwan and they practiced this kind of ‘Slash and Burn’ cultivation through generations as tradition. Most seriously, they preferred using steep slopes for cultivation due to a number of reasons they believed, e.g. avoiding frost, having better drainage, and using conveniently existing short-handled tools.

The ‘Aborigine Reservation’ was designated many decades ago to protect the hill tribes. The preservation of the land up to now has political and social reasons mainly because the aborigines could hardly compete with lowland people. However, this has also caused the aborigines to use the land as they wish irrespective of conservation and protection needs.

1.4 Management Objectives and Major Types of Work

The main objectives of the watershed program can be summarized as follows:

1) Reduce soil erosion and sedimentation to prolong the useful life of the reservoir.
2) Pursue proper land use, land conservation, and watershed protection and, at the same time, improve the livelihood of the local people.

In the beginning, seven major types of work were identified, as follows:

1) Watershed protection and fire prevention and control.
2) Soil conservation on cultivated lands and proper land use.
3) Mountain agricultural development.
4) Reforestation, revegetation and nursery work.
5) Landslide rehabilitation, channel stabilization, and gully control.
6) Road slope stabilization.
7) Villager training and extension.

The above objectives and types of work show that the management program embraced an integrated approach from the beginning, even though, at that time, the idea of ‘Integrated Watershed management’ was not known or as well received as it is today.

1.5 Institutional Arrangement

In the early 50s, Taiwan had only a few experts in the field of watershed management. Taiwan Power Company (TPC), being the beneficial and promoting agency, had mostly engineers, but no land use and watershed specialists. Consequently, the Company requested the then Chinese-American Joint Commission on Rural Reconstruction (JCRR) for technical and financial assistance.

JCRR was a prestigious agricultural agency, known nationally and internationally, acted as the de facto Ministry of Agriculture at that time. Under its auspices, an national advisory committee consisting of experts or representatives from universities, research institutes, and land management administrations was organized to assist in watershed survey and planning and later in implementation work.

At the watershed level, the Taiwan Power Company set up a field station at Wusheh in 1954. The station's chief duties since then have been coordinating various work carried out by respective agencies, supplementing and implementing whatever work deemed necessary. Though small, the station's work has been effective and flexible.

The coordinated agencies at the field level have been as follows:

1) Taiwan Forest Bureau (TFB) for managing and protecting national forest and for providing assistance to reforestation and forest management on all the land.
2) Taiwan Forest Research Institute (TFRI) for conducting research and survey.
3) Taiwan provincial Department of Civil...
Affairs for administering the 'Aborigine Reservation'.

4) Hsiang Office (local government) for coordinating training, extension and infrastructural work.

5) Mountain Agricultural Resources Development Bureau (MARDB, now called Soil Conservation Bureau) for land use and soil conservation work since 1961.

From time to time, coordinated agencies also included the Taiwan Highway Bureau for road slope stabilization, the National Taiwan University for their farm in the watershed, the Retired Serviceman Administration for its settlement areas in the watershed, and the local farmers' association for agricultural development.

2. WORK PROGRESS AND ACCOMPLISHMENTS

2.1 Initial Survey and Planning

The initial survey and planning was done in 1953. The survey concentrated on watershed physical inventory using aerial photos of 1:50,000 scale and topographical maps of 1:20,000 scale. Five field teams consisting of foresters, soil scientists, geologists, and photogrammetrists from various institutions and agencies were organized. In addition to land use and cover-type information, the survey identified four land stability classes for the watershed (relatively stable, intermediate, unstable, and very unstable) using slope, vegetative cover, erosion, parent material, soil depth and soil texture as criteria. The conservation needs of each area were identified based on these classes.

Only limited data on socio-economic conditions in the watershed were collected. Aborigines' customs of using steep slopes and traditions of shifting cultivation were briefly studied. Finally, the survey identified and planned seven major types of work (see section 1.4.) for the watershed.

2.2 Settlement Considerations

During the planning stage, settling the aborigines (1,900 people in four villages) outside the watershed was seriously considered. A preliminary plan was made to move them to the lowlands in Taitung County of eastern Taiwan. However, the plan was later considered impractical because of the budgetary burden and the resistance of the local people. It was decided finally to protect the land 'In-Situ' with the people in the watershed.

2.3 Progress of Work

The progress of work can be arbitrarily divided into three phases as discussed in the follow sections:

2.3.1 First Phase (1952 to 1963):

The initial phase included survey and planning (1952-1953), establishing the field station (1954) and implementing the planned work. Two reports were issued giving work achievements, some statistics and pictures for this initial phase (TPC, 1963; Lin, 1964). During this period, Taiwan Power Company continuously received technical and financial assistance from JCRR, TFB and TFRI. Every year, a joint work plan established the goals of that year. By 1963, total direct expenditures was six million New Taiwan Dollars (1.5 million U.S. Dollars) of which TPC shared 60%; JCRR, 30%; and TFB 10%. The period set a good foundation for the seven types of work and achieved a great deal especially in forest and fire protection, establishing demonstrations, and aborigine training. The livelihood of the villagers had been improved and, most importantly, the aborigines gave up their old concepts of using lands and showed a willingness to accept new techniques for protecting the watershed.

At the end of the phase, a new land use survey was done using aerial photos plus field checks. It was found that land use conditions were improved with increased forest cover and decreased cultivated area (See Table 1) even though the population increased 27%. Also, sedimentation of the reservoir started to show reduction (see Section 3.2.1 and and Table 2).

2.3.2 Second Phase (1964-1983):

The program during this period, while a continuation of the first phase, gradually encountered new challenges and problems due to some unexpected changes. The major ones were as follows:

1) During the end of last phase, several hundred of retired servicemen and refugees from Burma were settled in the watershed. Most of them depended on farming to make a living. Their presence caused a considerable number of land use and social problems.

2) Also, close to the end of the first phase, a major highway (East-West Cross Island Highway) of 38 km long was constructed through the steep terrain of this watershed.
### Table 1. Land Use Changes, 1953-1963
(Unit: Hectare)

<table>
<thead>
<tr>
<th></th>
<th>1953</th>
<th>1963</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forested Land</td>
<td>14,099.1</td>
<td>15,008.5</td>
<td>+ 909.4</td>
</tr>
<tr>
<td>Grass Land</td>
<td>4,205.3</td>
<td>3,019.0</td>
<td>−1,186.3</td>
</tr>
<tr>
<td>Cultivated Land</td>
<td>856.4</td>
<td>740.5*</td>
<td>−115.9</td>
</tr>
<tr>
<td>Denuded Land</td>
<td>1,046.2</td>
<td>1,193.0</td>
<td>+ 146.8</td>
</tr>
<tr>
<td>Others</td>
<td>276.5</td>
<td>522.5**</td>
<td>+ 246.0</td>
</tr>
<tr>
<td>Total</td>
<td>20,483.5</td>
<td>20,483.5</td>
<td></td>
</tr>
</tbody>
</table>

* Including 200.5 ha treated with various conservation structures.
** Including reservoir and urban area.

Source: Lin, 1964

### Table 2. Sediment Data, wusheh Reservoir (1957-1985)

<table>
<thead>
<tr>
<th>Period</th>
<th>Annual Average (Million m³/year)</th>
<th>Avg. Soil Loss in Watershed (mm/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957-1959</td>
<td>2.22</td>
<td>10.8</td>
</tr>
<tr>
<td>1959-1961</td>
<td>2.04</td>
<td>10.0</td>
</tr>
<tr>
<td>1961-1964*</td>
<td>0.15</td>
<td>0.7</td>
</tr>
<tr>
<td>1964-1966</td>
<td>1.25</td>
<td>6.1</td>
</tr>
<tr>
<td>1966-1969</td>
<td>1.49</td>
<td>7.3</td>
</tr>
<tr>
<td>1969-1975</td>
<td>0.75</td>
<td>3.4</td>
</tr>
<tr>
<td>1975-1985</td>
<td>1.38</td>
<td>6.3</td>
</tr>
<tr>
<td>Avg. 1964-1985</td>
<td>1.22</td>
<td>5.9</td>
</tr>
</tbody>
</table>

* Dry years and sediments were partially drained.

Source: Lin, 1989
During rainy and typhoon seasons landslides were abundant. It caused several years of exerted effort to stabilize side slopes and foundations.

3) Beginning the 1970s, the government gradually lessened controls over lowland people entering and living in the 'Aborigine Reservation'. The situation was compounded by the high profits of growing tea, temperate fruits and summer vegetables in the highlands of this watershed. Lowland people were illegally renting or occupying reservation land to grow these crops.

4) The reservoir, plantations, and hot springs in the watershed began attracting hotels and other new constructions as the nation developed economically and the people began demanding more recreation areas and facilities.

5) Several typhoons hit the watershed during the period. The most serious one in the August 1982, caused severe erosion and hundreds of landslides.

6) Assistance from JCRR and other agencies was phased out gradually in the mid 60s due to the termination of U.S. aid. Taiwan Power Company was left almost alone to tackle the new challenges and problems.

The work at the beginning of this phase was quite routine. Later, because of these new problems, the work was redirected and concentrated on the following aspects:

1) Use more check dams, retaining walls, and other structures to stop erosion from road banks, landslides, and stream channels.

2) Close liaise with government farms and agencies within the watershed to minimize abusive land use.

3) Assist in better cropping and marketing.

Consequently, the annual sedimentation rate of the reservoir was reduced and maintained at 1.2 million m³ throughout the whole period in spite of population and cultivation being both doubled (see Section 3.2.2). Although no statistics about income increase was available for this period, the brick buildings and television antennas which appeared during this period indicate that the living standard of the local people had been greatly raised.

2.3.3 Third Phase (1984 to present)

Because of the new challenges and problems in the second phase and particularly the 1982 typhoon, the government and the Taiwan Power Company made a new plan calling for more landslide rehabilitation, stream channel stabilization, and check dams in addition to soil conservation and agricultural development. The total cost was estimated at 1.5 billion New Taiwan Dollars or 56 million U.S. Dollars, of which 8.5 million U.S. Dollars equivalent were approved to fund a pilot program. The main objective is to control extra sediment caused by the 1982 typhoon. Actual work was started in 1989.

It is apparent that for erosion control the emphasis is now put on controlling geological erosion. For instance, the 1982 typhoon created more than 200 landslides and numerous stream cuttings. The new plan calls for treating half of the slides and 12 km of streams in addition to 16 units of large check dams to arrest the heavy sediments already in the stream systems. These, together with the cost of gully control and proper drainage, exceeded 50% of the total budget.

For land use, the emphasis is put on land use adjustment (for agricultural land) by introducing a new system to classify land into various suitable uses. This system uses slopes, soil depths, and erosion as the main factors for classifying land suitable for cultivation, pasture and forest. Use within land suitability or capability is encouraged, while use beyond suitability is prohibited or discouraged.

The current work, however, does not include controlling water pollution caused by garbage and waste water disposed in the streams from hotels and recreation areas. It neither includes any controls over urban expansion or hotel construction. These may require regulatory policy, legislation, and new technology which will take some time to realize.

3. MAJOR ACHIEVEMENTS AND IMPACTS

3.1 Investment and Achievement

From the inception of implementation to 1988, a total of 193 million New Taiwan Dollars (7.2 million U.S. Dollars using the present conversion rate) was invested in the watershed. Average annual expenditure was about U.S.$ 200,000. The major achievements are summarized as follows:

- 2,660 ha of reforestation
- 490 ha of soil conservation on cultivated lands
- 3 fire lookout towers, 29 km fire lanes and a fire fighting network

-67-
— 33 km of new forest road (construction and maintenance) and protection of 38 km of major highway
— 8 large check dams, and much gully control work
— Many agricultural improvement projects such as introducing fruit trees, improving crop varieties and marketing, and promoting sustainable, conservation farming techniques to replace shifting cultivation.
— Numerous training courses in agriculture and conservation techniques, fire protection, tree planting, home economics and hand crafts for women, and so on.

The impact of the above achievements will be discussed in the following sections.

3.2 Impact Evaluation

For a watershed program, impact evaluation and analysis might be more meaningful than, for instance, numbers of hectares reforested or terraced. Impact is usually evaluated against original objective, planned goals or benefits. For this watershed, three areas are to be evaluated.

3.2.1 Sediment Reduction to the Reservoir

Beginning 1957, reservoir sedimentation data were collected using flow duration and sediment rating curve method and actual surveys of the reservoir profile. Table 2 lists the survey results. The average sedimentation rate of the 1957-1959 period could be treated as a base rate because the dam was completed in 1958 and the affect of the new watershed program still lagged. The similar rate of 1959 to 1961 was due to the construction of the East-West Cross Island Highway, which contributed a tremendous amount of sediments to the reservoir. Then, from 1961 to 1964 the area was dry and part of the sediments were drained out by opening the dam gates. However, during the following 20 years up to 1985, the average sedimentation rate was 1.22 million m³, 55% of the base rate. In other words, the sedimentation rate was reduced 45% which can be attributed to the watershed program. The unit cost of reducing one cubic meter of sediment was U.S.$ 0.20.

3.2.2 Land use, Conservation and Forest Cover

Table 1 shows the favorable changes in land use during the first 10 years of the program (as discussed in Section 2.3.1). During the 1983 survey and planning, no detailed data were collected for comparison purposes. However, from the survey of 6,000 ha of 'Aborigine Reservation' and public farms, it was found that from 1963 to 1983 the amount of cultivated land increased 2.3 times, from 740 to 1,720 ha, while the number of watershed inhabitants also increased 2.1 times, from 2,410 to 5,171. Half of the cultivated land was found unsuitable for cultivation. Land use adjustment was therefore necessary. On the lands suitable for cultivation, soil conservation practices were mostly practiced and need only some strengthening and proper maintenance.

The 15,000 ha of forest have been well protected. As early as 1964, the number of forest fire was significantly reduced (Lin, 1964). This condition has been maintained to the present time. Less slash and burn and better fire prevention have been the major reason.

It can be concluded that the original objectives of watershed land protection would have been largely fulfilled if there had been no drastic increase in cultivated area caused by people coming from outside of the watershed.

3.2.3 Improving Villagers’ Livelihood

Improving the villagers’ livelihood was not a prime objective when the original plan was prepared in the early 50s. The Taiwan Power Company was then only interested in protecting its heavy investment in the reservoir and was contemplating moving all the aborigines out of the watershed. However, when settlement was found expensive and impractical, and watershed problems were realized to be inseparable from human problems, the necessity of improving inhabitants’ living standard and of pursuing an integrated approach became apparent.

During the last four decades, the aborigines’ welfare and livelihood have been greatly improved. Temporary huts have been replaced with permanent brick houses; schools have been increased and upgraded; water supplies and transportation have been modernized; and televisions and radios, and sewing machines are owned by the average household. While all of these cannot be attributed only to the program owing to the rapid growth of the country’s economy as a whole, there is no doubt that the program has contributed to a significant part of it.

Unfortunately, no detailed data exist which can show per capita income before and after the program. In 1964, it was reported that the farming income of a villager was about 29% of a lowland farmer
outside of the watershed. Now, the gap is believed to be much narrowed, if not completely eliminated.

4. AN OVERALL REVIEW

4.1 What Can We Learn from Wusheh?

1) *Watershed management is a continuous task.* New watershed problems will always arise from new development or natural disasters for which new plans and investment will be needed. For instance, Wusheh watershed had serious problems with forest fires, shifting cultivation, and working with aborigines during the first 10 years. When these problems lessened and under control, the problems of new settlement, construction of a major highway arose. These were again followed with problems of invasion of lowland people, expansion of cash crops, polluting of streams, and the 1982 typhoon. All these need a continuous program for management and control.

2) *An integrated and coordinated approach is a necessity.* The complex of watershed problems illustrated above can not be solved by one agency alone. An integrated and coordinated approach is always necessary. Also, in a watershed, different kinds of land ownership often exist and each of them has a different governing agency. Many types of work can be carried out only through joint efforts. In Wusheh, Taiwan Power Company has no jurisdiction over land, and only through good coordination can the program be properly implemented. This also signifies that a small station can normally coordinate such program — does not often require a large and overall authority.

3) *Resettlement may not be practical.* As discovered at the beginning of the Wusheh program, resettlement or settlement of watershed inhabitants outside the watershed was too costly and not in the best interest of the local people. The better approach has been protecting the land ‘In Situ’. Judging from the fact that many settlers and low-landers recently moved into the watershed and the development in recreation, any policy to close the watershed to people and society in order to protect it is rather impractical. This point may be applicable to many developing countries where a lack of land and resources to settle the people or where the settlement could cause serious social problems.

4) *Geological erosion needs to be controlled.* Although erosion control is normally concentrated on controlling man-made or accelerated erosion, there are places and times that geological erosion should also be brought to a minimum. Wusheh, for instance, had a 2.2 million m³ of annual sedimentation rate in the 50s when its watershed had only 856 ha of cultivated lands and 1,046 ha of denuded land (totaling 9% of the watershed). These areas could not contribute such huge quantities of sediments; most of which must be from geological erosion. Many upstream watersheds in the tropics may have similar conditions as Wusheh, e.g. steep slopes, torrential rains, erodible soils, and weak geology. Natural or geological erosion in these areas can also be high. Once a multi-million dollar public investment is made, such as a reservoir, every effort should be made to protect it within reasonable cost. Landslide control, check dams, and streambank protection are often necessary for this purpose.

5) *Protecting a reservoir watershed should start much earlier than reservoir construction.* It was apparent at Wusheh that there was a lag between the watershed work performed and realization of impacts. Wusheh watershed work began four years before the completion of the dam in 1958. Yet, reduction of sediments was noticeable only after 1961 (though the construction of the East-West Highway may have offset the results). Nevertheless, Wusheh program showed that a) it is better to start watershed work well before dam construction to have an early effects on sediment reduction, and b) that in Wusheh it was disastrous to have a major construction such as a highway after the reservoir was completed.

6) *Sedimentation and erosion data collection is necessary.* The steady collection of reservoir sedimentation data since 1957 has been very useful for recognizing the impact of the watershed work on sediment reduction. Without such data, it would be difficult to ascertain the effectiveness of the program. The program at early stage did start some small watershed experiment and erosion studies. These were later abandoned because areas were interrupted by highway construction and also due to a lack of research personnel. If these studies had been maintained, it would have provided even more useful data for better management. Data collection, though important, is often neglected in many similar programs in the developing countries.

4.2 What Should Wusheh Do Now?

1) *Devise sound land use policy including zoning.* Wusheh needs urgently to devise a sound land use policy for controlling or regulating housing, hotel, urban, and recreational site expansion in the
watershed. The limited amount of agricultural land should not be used for construction sites, yet the buildings on steep slopes should not risk landslide hazards. If necessary, zoning should be established.

2) Coordinate environmental protection and water pollution control activities. Since Wusheh is a popular tourist area, the villages' environment should be well protected through better garbage disposal, sewage treatment, and recreational area maintenance. Direct discharge of waste water to the stream system should not be allowed. The Wusheh program should coordinate the Environment Protection Administration to monitor environmental quality and water pollution and to take necessary preventive or protective actions.

3) Establish a socio-economic and physical database. Although Wusheh program maintains some physical data and useful sedimentation statistics, it lacks seriously the socio-economic data. The main causes have been: a) economically, the program has been necessary because no alternative site for a reservoir exist in the area, and hence no cost and benefit studies of the program were ever attempted, and b) the proposed resettlement of inhabitants outside the watershed at the beginning made it seemingly unnecessary to collect the usual socio-economic data for watershed management purposes. It is not too late for the program to collect socio-economic baseline data for future monitoring and evaluation use. Microcomputers can be used for establishing such a database together with data from sediment, land use and other watershed characteristics.

4) Conduct cooperative studies on important subjects. It is not advisable for Wusheh to conduct basic research of an academic nature. However, applied research and studies for reducing costs and increasing work effectiveness should be carried out by coordinating with universities or research institutes, or by contracting other eligible bodies to do so. For instance, in the next decade millions of dollars will be invested in landslide control and check dams, yet the cost effectiveness of these types of work has not been evaluated. Studies should be done using models or existing structures in the watershed. Any result and improvement recommendation should readily be adopted. Also, surveys should be made on sediment budgets and source area identification, and on periodic land use changes.

5) The program should establish a self-monitoring and evaluation system. Results and findings of monitoring and evaluation should be published or made known to the others. As the oldest watershed management program in Taiwan covering nearly four decades, such evaluation reports would be of great interest nationally, as well as internationally.

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Note: Most of the above have been published in respective proceedings or in book form.