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SOIL CONSERVATION TECHNIQUES

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(Lecture Notes)

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Crisis

In the light of recent findings in both physical and social aspects of soil conservation in developing as well as developed countries, a rapidly-growing body of acknowledged authorities are collaborating to revise strategies and techniques to combat soil erosion.

Soils are not only washing and blowing away, but are becoming less and less productive. This loss is having far-reaching effects:

- At the local level, this can mean, at worst, starvation followed by death. At the national level, lowered production leads cumulatively to greater economic instability for the country.
- At the international level, repercussions follow, because a country without foreign exchange ceases to become a consumer of goods produced by other countries. Economics, politics and a series of other complications, often begin to work together to the detriment of the developing country concerned; ultimately, however, all parties suffer.

Locally, famine is intertwined with the energy crisis as well as the environmental crisis and inevitably, the development crisis. They all become one crisis.[1]

Awareness of these crises has been slow to arrive and did not happen until the early 1970s.

Soil Conservation Group

FAO is responding to growing demands for specialist attention to soil erosion and conservation, through the operation of a Soil Conservation Group; this Group is actively servicing soil conservation projects in developing countries.

An earlier approach to soil conservation, inside as well as outside FAO, was to apply North American and European philosophies in the identification and treatment of soil erosion problems.

1. WCED, 1987

However, it became apparent that the problems, although similar in developing countries, often required quite different and more delicate solutions. In general, the industrialized countries' approach to treating soil erosion in developing countries has not been as successful as hoped.

The activities seen now in retrospect, seem to be a combination of oversights. Not only have some important sociological aspects been overlooked, but the whole socio-technological strategy seems to have had a negative slant, "Horrible things will happen if you don't follow our advice"; a positive approach might have been, "We can show you how to increase your farm offtakes, lessen your risks and improve your living conditions".

The Farmer

In order to stimulate thought and provoke change, the Group needed strong facts and associated arguments to convince governments, their policy-makers and economists, and the most important link in the chain, the FARMER.

The farmer, after all, is the one who takes the final decisions about what he will allow to happen on his land, no matter what outside pressures are brought on him. If he is not convinced that a new solution is best for him, then he will not adopt that solution.

If the solution does not include his becoming better off, having greater security, greater income stability and a better life style, then the solution is not for him. Finally, the solution must bring about a rapid change in his situation, to be of interest.

This is where soil conservation has often failed to get maximum support in the past, because techniques were mostly physical, longer term, and "for the good of the community" rather than meeting the farmer's needs.

Some of the past solutions which have met with low success rates, are:

- bank and waterway systems (which remove 10% or more of the farmer's land from production);
- reforestation, which takes more of his land (trees were produced for the nation, not for him);
- fencing off gullies and badlands; more of his land gone.

But worst of all, in earlier times, he was not only expected to participate both physically and financially in the building of these structures; the final insult to his intelligence was that he was also asked to maintain the structures after they were built. If he refused, he was often liable to be fined or even put in prison. Such was his obligation to the "community".

This was a lack of perception, which we now see with hindsight. Now, we have better definitions of the farmers' physical and socio-economic problems, as well as of the mechanisms of erosion that affect him most, so we are in a better position to understand and help him.

Problem for Governments

Many Governments are facing serious financial problems after battling with droughts and other disasters, and being faced with falling agricultural export prices.

To meet external debts, some countries have cut back expenditure on agricultural development and especially research, have reduced imports including improved seed, fertilizer and agricultural chemicals.

One other problem is that Governments are often dealing with small farm holdings and large population concentrations with high birth rates on the limited "good" land.

In consequence, some Governments believe they cannot afford major reform; very often, farmers cannot afford engineering-type conservation works. Additionally, donors have become more interested in developing long-term low-maintenance solutions to these obviously complex problems.

Studies

Agricultural productivity is falling in several countries, despite attention paid to prevention of soil erosion. The loss of soil on sloping land does pose a physical threat to crop production. However, when the land is terraced, it was generally believed that productivity would automatically rise and continue rising. In some cases the reverse was the case, so something was indeed wrong.

A commissioned study is being examined, to relate soil loss to loss of productivity from the land.[2,3,4] For one country, early results projected to the national scale show losses estimated in millions of US dollars (often in foreign exchange) to replace the annual erosion loss of phosphorus and nitrogen. This is a calculated cost, not necessarily related to overall conditions.

2,3,4. Stocking, 1984, '86, '88

In fact, even if it did take place, much of this replacement would be immediately lost again. In Zimbabwe, it was concluded that three times the amount of fertilizer applied by farmers is lost annually by erosion. However, non-replacement could result in millions more being lost in potential export earnings; this is a strong incentive for governments to put things right.

Another study is at present under way to try to quantify the soil losses and silt movement in major river systems on a global basis.[5] This study is already showing that the situation is getting worse, but at a much faster rate than anticipated; the effective life of many larger water storages may have been seriously over-estimated on the basis of earlier hypotheses by some hydrologists.

In the past, much emphasis was placed on quantities of soil lost, expressed usually in tonnes per hectare per year; it is now apparent that this figure, even when projected on a national scale, only causes bewilderment and disbelief in the Third World.

The third current study is an evaluation of the causes of success or failure rate of soil conservation projects around the world.[6] The provisional results indicate more failures than successes and thus are not encouraging; the reasons for failure are often predictable.

A positive effect is that a list of "do's and dont's" can be extracted from the analyses, to aid in better future project design.

Techniques

The results of these three studies, as well as on-going contact with field projects actively engaged in various types of soil conservation projects, have radically influenced our thinking on the actual techniques and the necessary strategies for attacking soil conservation problems.

At the same time, a swing towards "biological" conservation has taken place in recent international soil conservation seminars and workshops. Draft guidelines[7] for new conservation orientations have been produced.

Much discussion centres around "farming systems" and "packages" at this time and in this context; we are quickly realizing that the biggest current problem is the lack of basic research, to assemble the ingredients of workable soil conservation packages which take all of the relevant socio-economic, physical and political aspects into account before any adjustment to a system is proposed.

5. Abernathy, 1987
6. Hudson, 1987
7. Puerto Rico Group, 1987

Falling Productivity

A recent realization is that productivity is falling because plant nutrients are the most mobile fractions in the soil; their loss, along with organic matter, constitutes a much more serious threat to farm productivity, than the more spectacular loss of arable soil by wind or water erosion.

There are relationships between the "invisible" loss of specific nutrients and of soil in the mass, but the techniques used to retain nutrients and productivity in the farm field, are often quite different from those designed to retain soil.

Strategies

The social aspect of soil conservation has, in the past, drawn too little attention. The new concept has to take into consideration the need to help the farmer to:

- feed himself and his family;
- provide sufficient water for the household and his livestock;
- provide fuel for cooking, and sometimes, heating, lighting;
- provide sufficient fodder for his domestic animals;
- in general, meet his daily living needs, and gradually upgrade his habitat.

Only when these prerequisites have been met, can we begin to interest him in questions of expenditure of effort or cash on soil conservation which, in the previous form, had not been shown to lead to direct increase in productivity.

From the point of view of improving techniques, we are beginning to understand that erosion results not only in soil removal and silt deposition down the catchment, but from the farmer's angle, soil productivity drops dramatically as a result of poor soil management techniques. The result is often a loss of soil structure, compaction and lowering of water-holding capacity, in addition to the loss of nutrients.

The soil loses its "resistance" to erosion.

It has to be carefully demonstrated and explained that some small, plus other radical changes will have to be made in his management techniques; other, and often more drastic changes will have to be made by Governments, with respect to agricultural and land policies, marketing, pricing, tax, and a whole range of additional measures.

All the same, each farm is different in physical and socio-economic structure, and will, to a certain extent, have to be considered individually.

This takes an enormous amount of government extension agent time and ultimately cannot be done solely as the typical detailed watershed planning exercise; the burden must be borne by all of the rural development ministries as an integral part of their ongoing, or programme activities. Progress will not be rapid from government side, which could also mean that the message takes a long time to filter through to the farmer.

a. The main principle now being applied, is that of "bottom-up" planning with the farmer, before any action is taken. This implies a good knowledge of sociology, economics, agronomy, soil management and tillage techniques, plus a basic knowledge of livestock and their needs. Such a combination of knowledge is rare in developing country extension agents.

b. So, ultimately, we should be talking about conservation of nutrients and water in the soil profile and maintaining a vegetative or mulch cover on the soil. Rain falling on this vegetation or mulch, will have a greater chance to (i) infiltrate or (ii) run off gently over a rough and protected surface.

c. If we concentrate on raising the productivity for the farmer and therefore increasing the amount of vegetation covering the soil at any one moment, as well as increasing the time that the soil is protected by vegetation during a season or succession of seasons, we will at the same time be increasing resistance to soil loss.

   This is theory; in practice, it is much harder to convince the small-scale farmer that we are keeping his interests to the fore.

d. Sometimes, production of the main crop will have to be compromised, compensated in theory by diversity in agricultural enterprises within one farm, even on the same field, with combinations of livestock, annual, perennial crops and even non-agricultural uses. This should raise the per-hectare total production, while bringing some income stability, to lessen the effects of weather or other excesses and deficits.

What is now being described is total land resource integration, or "land husbandry", to use the Malawi terminology; this is probably a more comprehensive and understandable approach than the term "soil conservation", which is often misunderstood.

This approach, to be successful, must satisfy the physical, social and other needs of the farmer, the community and the administration.

Pre-planning

FAO HQ has certain new tools and technologies to assist in the early stages of the definition of problems and the initial planning.

A major tool is the Geographical Information System (GIS) which is gradually being built around the Soil Map of the World (FAO-Unesco) and the derived Agro-ecological Zonation maps (AEZ) which shows suitability classes of all areas for 11 major crops grown.

The Remote Sensing Centre of FAO has access to old and new satellite images from Landsat and Spot, with a comprehensive collection of Meteosat tapes to analyze climatic and vegetation data.

Additionally, food production statistics are coming from all parts of the globe on a regular basis.

A large collection of thematic maps is stored in FAO, and linked with a comprehensive library, a large amount of data (admittedly mostly at the smaller scale) can be prepared before the field surveys begin.

For the field personnel, strategies, guidelines and manuals are in various stages of preparation. Important reference libraries are being built up on such subjects as shifting cultivation. In summary, FAO is a focal-point on associated areas in land resources, management and conservation, as well as the established specialities of irrigation and fertilizer use.

We are beginning to operate networks on various subject matters in the regional offices.

Above all, work has started on a draft Soil Conservation Strategy for Africa, the priority region in this regard.

World Soil Charter

The FAO Conference, in November 1981, adopted the World Soil Charter.[8,9] This Charter establishes principles and calls for the cooperation of governments, international organizations and land users, to manage the land on a long-term basis.

Briefly, the Charter points out that soil degradation affects agriculture, forestry, the economy, the environment, industry and commerce; conservation is therefore a high priority, and land utilization must be planned with the users.

8. World Soil Charter, 1982
9. "Protect and Produce", 1984

Incentives to farmers, a sound technological, institutional and legal framework, are basic conditions for good land use.

The document lays out action guidelines for the development of policies and principles, for assessing development alternatives, for supervising and monitoring of soil conservation works, the need for public education, and for generally creating favourable socio-economic conditions for rational land use.

Plans and Implementation

At country level, a methodical sequence of events takes place. This could include:

a. collecting essential background information on soils, making land suitability assessments, planning and costing of works and socio-economic surveys. This data would be supplemented from headquarters by GIS, remote sensing information and so on.

b. establishing overall soil and water conservation policies including institution-building and drafting appropriate support legislation for a soil conservation programme.

c. carrying out research and appropriate demonstrations; training staff to carry the appropriate extension messages from research results (including organic manuring, nitrogen-fixing plants, tillage practices, improvements to shifting cultivation and saline soil reclamation).

d. an information programme to reach all levels of the scientific community.

e. an inbuilt monitoring and evaluation system to appraise and redirect.

Finally, properly-oriented rural development should conserve soil, which is a country's most precious resource. Ill-treatment of soil can undermine a country's agricultural base. Without a sound agricultural base, national development plans rarely succeed. Soil conservation can, therefore, be considered as an insurance for future generations.

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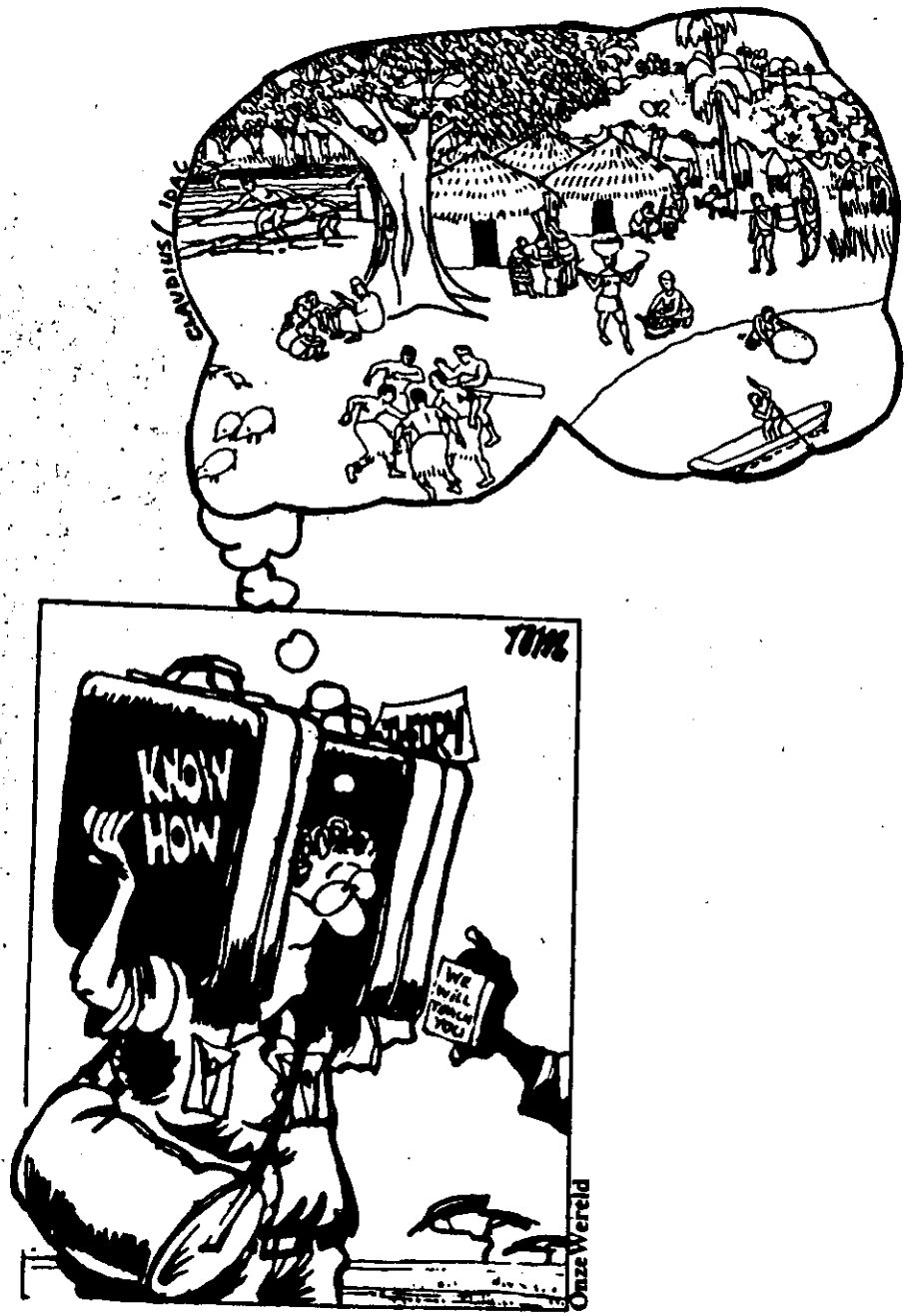

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