XIII EROSION CONTROL

230 88 - 13/1

Erosion control
Africa, Nigeria, savanna, field studies, soil erosion, ecology, methods, yield, crop cover, organic matter content, earthworm activity, soil physical properties
SABEL-KOSCHELLA, U.
Field studies on soil erosion in the Southern Guinea Savanna of western Nigeria.
Diss., Technical University of Munich-Weihenstephan, FRG, 1988, 104 pp.

Soil erosion in the tropics adversely affects crop production. A long-term field trial was designed and initiated in the transitional zone between semideciduous forest and the anthropogenic, derived savanna of western Nigeria to measure soil loss of runoff with three cultivation systems: "Traditional", "No-till" and "Plow".
"Traditional", with maize plus yam intercropped in 1983 and maize plus cassava intercropped in 1984, copies most of the subsistence farmers' practices. "No-till" and "Plow", with maize in the first and cowpea in the second season of each year, are also used on a larger scale. "Plow" was disc-ploughed and disc-harrowed at the beginning of each cropping season, whereas "No-till" was mulched with the residues of the previous crop. The crop treatments were replicated twice. A seventh plot was kept "Bare Fallow" to evaluate the K-factor and as a reference for soil loss ratios (SLR). The plots on a 5% slope were each 500 m^2 in area, 50 m long and split into up-, mid- and downslope subplots. The soil, a kaolinitic Alfisol, consists of colluvial sandy loam with more than 40% sharp, coarse sand, underlain at varying depth by a gravel layer upslope and plinthite downslope.
Changes in erosion-related soil properties were monitored over two years. Soil loss was measured for each rain and runoff hydrographs were recorded with flumes and stage recorders in 1984. Rainfall was recorded with an automatic fast-recording rain gauge.
Maize yield was significantly lower for "No-till" than for "Plow", whereas cowpea yield was significantly higher. Maize yield was also significantly lower downslope than upslope, whereas cowpea yield was the same.
The crop cover with "Traditional" was lowest (< 60%) in 1983, due to yam staking and retardation of crop growth by moisture stress. "No-till" consistently had the highest cover (80-100%), due to mulching, whereas "Plow" exposed the bare soil during the most erosive periods of the year.
Earthworm activity was by far highest with neighboring natural vegetation (35 t/ha), zero with "Bare Fallow", and significantly lower with "Plow" than with the other cultivation systems. It was also significantly lower downslope than upslope. The particle size composition of earthworm casts was shifted towards the finer fractions, especially silt and clay relative to the original soil.

Organic matter decreased considerably with "Bare Fallow" (> 50%) but varied with the cultivation system, revealing a seasonal variation.
Bulk density at depths of 0-10 cm increased significantly with all cultivation systems, but most of all with "Plow". Bulk density was also higher for "Plow" between 10 and 40 cm, but did not lead to development of a distinct plough-pan. Rapid subsidence reversed most of the loosening effect of the ploughing within only 2 weeks. Raindrop impact on bare soil compacted the top 10 mm considerably (1.68 g/cm3) and with a high significance ($P < 0.01\%$).
Saturated hydraulic conductivity (SHC) at depths of 0-15 cm was by far highest with natural vegetation, followed by "Traditional" and "No-till", and lowest for "Bare Fallow" and "Plow". Artificial rain sealed the surface of exposed cores and reduced SHC significantly. Drying and rewetting led to air entrapment and reduced SHC further. The removal of the seal increased SHC again.
Infiltration measured with the double ring infiltrometer was highest with natural vegetation. The infiltration with natural vegetation, "No-till" and "Traditional" in one group was significantly higher than with "Bare Fallow" and "Plow". Infiltration in "Bare Fallow" was further reduced by surface sealing. Sealed patches in "No-till" and "Traditional" had significantly lower infiltration rates than mulched ones. The removal of the seal resulted in a steep increase in infiltration rates. Previous wetting of the soil decreased infiltration rates significantly ($P < 0.1\%$) by 50-90%.
Rainwater movement in the profile, measured with tensiometers during a natural rain (20 mm), was much faster with "No-till" than with "Plow" (where it did not reach 10 cm depth until the rain was over). Pore size distribution profiles from pF-curves show that the largest pores were reduced in sealed variants compared to mulched, and in "Plow" compared to "No-till".
A wide range of erosivity factors can be used to characterize the erosivity of tropical rainstorms, including EI 30'AI, KE>25. The high correlation (r^2=0.99) between kinetic energy (E) and rain amount (Ar) even provides the opportunity of replacing the complicated calculation of E simply by Ar. The erodibility of the soil cannot be estimated with the nomogram of the USLE. K varied from 0.09 in the first year to 0.38 in the second, and was 0.23 in the third. The loss of organic matter (OM) and structural breakdown lead to a rapid increase of K in two years. Selective erosion removes the most erodible fractions first and leads to a slow decrease of K in the long run.
Soil loss ratios for all treatments were relatively low (Plow: 1983: 0.047, 1984: 0.059; No-till: 1983: 0.033, 1984: 0.003; Traditional: 1983: 0.065, 1984: 0.007) for both years. Losses were much higher in the first year for "No-till" because the field was burnt, and for "Traditional" because yam provided a low cover and was cultivated up- and downslope.
Soil loss with "Bare Fallow" (24.4, 257.9 t/ha/a) was closely correlated (r^2= 0.96) with runoff (131, 331 mm) in both years. Soil loss from "Plow" (2.6, 10.1 t/ha/a) was higher than the soil loss tolerance for even the deepest soils (2 t/ha/a). This cultivation system should therefore be avoided or improved by additional conservation measures like terracing. "No-till" (2.24, 0.50 t/ha/a)

and "Traditional" (4.86, 1.53 t/ha/a) were in the range of soil loss tolerances for deep and medium deep soils after improvement in the second year, and can therefore be recommended for these soils. Shallow soils have such a low soil loss tolerance (0.05-0.2 t/ha/a) that they should not be cultivated at all.

231 88 - 13/2

Erosion control
Review, booklet, tropics, erosion control, extension, erosion process, agronomic methods, cropping practices, technical methods, operations
AGROMISA
Erosion control in the tropics.
Agrodok 11, 1987, 72 pp., Agromisa, P.O.B. 41, 6700 Wageningen, and CTA, Postbus 380, 6700 AJ Wageningen, Netherlands

Agrodoks are a series of low-priced, simple booklets on agricultural practices in the tropics. This document is a translation of the Dutch version: `Erosie bestrijding in de tropen'. Agromisa is a volunteer organization of the students of the Agricultural University Wageningen in The Netherlands. The organization, established in 1934, aims at improving the position of socially and economically underprivileged groups in developing countries by transferring agricultural knowledge to organizations and persons who devote themselves to these groups.
The booklet contains the following chapters:
- Introduction
- What does erosion look like in the field?
- The erosion process
- Consequences of erosion for agriculture
- Agronomic methods
- Practices in the cropping system
- Technical methods
- Underlying causes of erosion
- Conditions for the success of operations
- Conclusion
- Appendix.

To keep this booklet accessible for everybody, the authors have not assumed previous knowledge. Therefore, the reader will read things he already knows. Some necessary technical terms are used to prevent misunderstandings. Explanations or definitions of the relevant terms are given in the appendix.

232 88 - 13/3

Erosion control
Africa, Rwanda, erosion control, fiche technique, project results
PROJET AGRO PASTORAL DE NYABISINDU
L'erosion et la lutte contre l'erosion (Erosion and erosion control).
Fiche Technique, No. 1, Projet Agro Pastoral de Nyabisindu, B.P.70, Nyabisindu, Rwanda, 1986

This paper, the first of a new publication series of "fiche techniques" from the Nyabisindu Agropastoral Project, is the result of an extensive cooperation between the project sections "Extension and Training" and "Research and Studies". The leading staff of both sections contributed to it.
Two reasons prevailed in choosing erosion as the first theme in the series: firstly, because the extension program for 1984 included erosion, but mainly because of the importance of erosion problems for Rwandan agriculture.
Since many years, the Nyabisindu Agropastoral Project has been engaged in erosion control, making considerable efforts not only in research but also in activities in rural areas. These efforts have just begun to bear fruit, but it will take a long time to solve the problems of erosion.

233 88 - 13/4

Erosion control
Africa, Tanzania, survey, highlands, soil erosion, extension approach, M&E
WOYTEK, R. et al.
Soil erosion control and agroforestry in the West Usambara Mountains.
Schriftenreihe des Fachbereichs Internationale Agrarentwicklung der TU Berlin, 1987, ISBN 3-924333-68-8; distributor: Buchversand J. Margraf, Postf. 105, D-Weikersheim, FRG, DM 19.00

This report is a result of a 3-month survey carried out by a study team from the Center of Advanced Training in Agricultural Development of the Technical University of Berlin. All team members, except the team leader, are participants of the Center's 25th one-year training course which prepares junior professionals for assignments in bilateral and multilateral development organizations. The team was composed of two agronomists, an animal production specialist, an agricultural economist, a land-use planner and a sociologist.
The study was conducted on the request of and in close cooperation with the TIRDEP Soil Erosion Control/Agroforestry Project in Tanzania (SECAP). The project, which started in 1981 with a pilot phase and entered Phase II in 1984, is introducing its full extension package to 24 villages. Its objective is the propagation of soil erosion control and agroforestry land-use practices in order to contribute to an ecologically sustainable and economically via-

ble utilization of the potential of the land in the West Usambara Mountains. The village community as a whole and the peasants as individuals are the target groups of the project's efforts.
The technical package offered to villages and farmers is a combined set of recommendations in the fields of agriculture, livestock and (agro-)forestry. The main activity in agriculture is establishing macrocontour lines to halt or reduce erosion. Other activities aim at improving crop husbandry, organic fertilization, diversification of crops, and crop rotation. With respect to livestock, the measures are to establish a zero-grazing system at the farm level, to give advice on dairy husbandry and to upgrade local cattle breeds by supplying one or two improved bulls to each village. The basic task of the forestry section of SECAP is to secure the supply of appropriate agroforestry and afforestation trees for the farmers and villages when and where required. It gives advice and support to the decentralized village and school nurseries.
Empirical data for the study were based on surveys conducted in five participating villages and one non-participating village in the West Usambaras. Additionally, extension staff and project management were interviewed.
For monitoring and evaluation (M&E) a special unit was established in the beginning of 1987. M&E is based on data reported by the field staff and from surveys conducted by the M&E Unit. Evaluation is mainly done by the project management. The ease of accessibility of the M&E system is a problem, partly because of section-wise filing. Qualitative indicators of success have not been developed. Quantitative adoption at the on-farm level has not been comprehensively monitored.
Generally, the farmers have confidence in the extensionists. The problem orientation of their extension work, however, seems to be insufficient. The advisors usually do not come to ask about problems. The emphasis lies rather on checking, advising or following up previous advice. A teacher-pupil attitude towards the farmer prevails.
The farmers have an ecological problem awareness. All interviewees noticed decreasing soil fertility and yields, increasing soil erosion, and hydrological and climatic changes. They developed causal connections between deforestation and unreliable rainfall and the deteriorating water balance.
Degrees of adoption of the agroforestry package was measured by an adoption index. According to this index, out of 100 interviewed farmers in five participating villages, 24 were high adopters, 25 medium adopters, 33 low adopters and 18 were non-adopters. Average farm size continually decreased from high adopters through medium and low to non-adopters. There was also a relationship between educational levels of farmers and adoption of recommendations. There was no high adopter who could not read or write. Extension frequency declined from the high and medium class of adopters to the non-adopting class.
An overwhelming majority of farmers saw their main problems in agriculture and strongly requested more advice in this field. The livestock and forestry sectors, respectively, followed in importance.

In its daily extension the project still has a "livestock bias". Extension efforts (with individuals and groups) are concentrated on credit receivers. The contents of the technical package was and, to some extent, still is a constraint in itself to reaching a larger proportion of farmers. A diversification of the technical package is essential.
Extension efforts have been mainly directed to men although women are important agricultural producers. The methodological approach basically fails to reach women. Males face cultural restrictions in advising female farmers. The extension activities, as organized in the present way through mixed meetings, are not suitable for advising women farmers.
In spite of a well-functioning formal integration into the district, the project represents a powerful and materially independent parallel structure. In order to achieve sustainablility in project results, the eventual discontinuation of foreign support should be considered.

234 88 -. 13/5

Erosion control
Review, dictionary, English, German, soil erosion, soil conservation
ZOBISCH, M.A.
Wörterbuch der Erosion und Bodenerhaltung (Dictionary of soil erosion and soil conservation).
Topics in Applied Resource Management in the Tropics, 1987, 169 pp., ISBN 3-9801-686-0-3; distributor: DITSL, Steinstr. 19, P.O.B. 1652, D-3430 Witzenhausen 1, FRG

This dictionary has been developed from a selection of technical terms collected for the students of the Faculty of International Agriculture of the University of Kassel to assist them with their study of Englisch technical literature.
The terminology of soil erosion and soil conservation draws upon terms from an array of different technical disciplines, e.g. agriculture, soil science, geomorphology, soil and water engineering, sociology, economics etc. Therefore, the selection of the vocabulary presented created some difficulties as to its functional relevance. Some common translations have been revised to suit special soil and water conservation applications. The author would be grateful to the users of this book for any comments and suggestions as to errors and improvements of its contents.
An extension of the vocabulary to the whole field of soil science and soil management in the tropics and subtropics and an inclusion of French and Spanish terms is being prepared.

235 88 - 13/6

Erosion control
Latin America, Brazil, review, book study, erosion control, mulch, direct planting, soil management, soil conservation
DERPSCH, R. et al.
Erosionsbekämpfung in Paraná, Brasilien: Mulchsysteme, Direktsaat und konservierende Bodenbearbeitung (Erosion control in Paraná, Brazil: mulch systems, direct planting and soil conservation).
Schriftenreihe der GTZ Nr. 205, 1988, 117 pp., ISBN 3-88085-357-6; distributor: TZ-Verlagsgesellschaft, Postfach 1164, D-6101 Roßdorf, FRG

In the years 1977-1985, the Governments of the Federal Republic of Germany and Brazil carried out a project in the field of erosion control in the Federal State of Paraná in southern Brazil.
This book addresses scientists and practitioners dealing with plant production in the tropics and subtropics, and is meant to serve as an advisory aid for quicker propagation of erosion control policies in Brazil.
The authors regret to see that methods of soil management from temperate zones are repeatedly applied without the required adaptation to the tropics and subtropics. The soil is left open, without its protective plant cover. Soil exposed in such a manner to the weather is surrendered to erosion and soil degradation. In the past and present, there are many examples of soil exhaustion, leading to field losses, soil destruction and risk of erosion. However, erosion control means not only maintenance of soil productivity and fertility for future generations; it also conserves jobs and prevents rural depopulation. For this reason, effective protection against erosion is extremely important.
This manual passes on experiences and instructions for an economical and effective protection against erosion in Paraná. Tillage systems investigated were no-tillage (NT), minimum tillage with a chisel plough (CP) and conventional tillage with a disc plough (CT). It was found that under NT, as compared to CT and CP, the total pore volume and coarse pore volume were lower, bulk density in the upper soil layer was higher, available moisture was higher, temperature was lower and infiltrability was higher. Percentage of soil cover was the main factor governing infiltration rate. Without soil cover, the infiltration rate under NT was the same as under CP and CT. The use of cover crops and crop rotations had a marked positive effect on maize, soybean and bean yields. Yields of wheat and soybeans were higher under NT and CP. It is concluded that, in Paraná, no-tillage in combination with adapted cover crops and crop rotations represents a production system which is efficient in reducing water runoff and consequently soil erosion, and in increasing crop yields.

236 88 - 13/7

Erosion control
Study, erosion control, oil palm, plantation, mixed cropping, smallholders
HAMEL, P.
Evaluation des risques d'érosion en jeune plantation de palmiers à huile, conduite en association avec des cultures vivrières à partir de l'équation de Wischmeier et Smith (Evaluation of erosion risks in young oil-palm plantations managed in mixed cropping according to the Wischmeier and Smith equation).
Oléagineux, 41 (10), 1986, pp. 419-425

A theoretical calculation formula of erosion on cultivated plots is presented. Application examples of this formula are given in different contexts to find out the most favorable duration of mixed cropping under rows of oil palms, in order to prevent risk of erosion.
Thereafter, recommendations about erosion control are given, especially for smallholders. This article, illustrated with numerous tables, accentuates the interest of a scientific approach to appropriate antierosive practices.
Abstract from Alternative Agricol (GEYSER)

237 88 - 13/8

Erosion control
Book, proceedings, soil erosion, crop productivity, ecology, economy, sociology
FOLLET, R.F. and STEWART, B.A.
Soil erosion and crop productivity.
ASA Headquarters Office, 677 S. Segoe Rd., Madison, Wisconsin 53711, USA, 1985, 533 pp.

Soil and crop scientists, engineers, sociologists and economists interested in soil erosion shared current research findings on erosion and productivity at a symposium sponsored by the American Society of Agronomy, the Crop Science Society of America and the Soil Science Society of America. The papers and summaries of 28 reports are included in this book.
In the preface, the editors indicate that erosion is a complex ecological problem and thus it is difficult to measure accurately the effects on crop yields of the wide array of interrelated factors that influence productivity. Some of the ways soil erosion affects productivity are by reducing nutrient supplies, water infiltration, soil water-holding capacity, soil tilth, soil aeration and rooting depth. Loss of organic matter was not mentioned, although it, too, is interrelated to several of the factors listed. The information presented ranged from erosion rates in different parts of the nation and the effects on productivity to political and sociological causes of erosion, the economic costs of erosion and conservation practices.

Most of the papers focused on just one aspect of the complex erosion problem, such as the impact of reduced soil depth on crop productivity, while excluding, for example, water runoff. Models based only on reduced soil depth generally concluded that erosion has a minor adverse effect and that yearly productivity is only being reduced about 0.1% by soil erosion. Although this effect is cumulative, the overall impact of reduced soil depth on productivity over 10 years seems relatively minor.
Several of the papers noted that the impact of reduced soil depth on productivity also depends on whether added fertilizers and irrigation were used. However, with the ample use of fertilizers and irrigation, yields were statistically different. This study illustrated the point made by others that increasing the use of fertilizers and irrigation masked the effect that erosion has on most crops. Using this strategy is simply substituting a nonrenewable resource (oil) to offset the degradation of a renewable resource (soil).
Without oil, crop productivity generally declines with erosion. Mannering et al. demonstrated that corn yields in Kansas decreased by about 50% from 1867 to 1924, when no commercial fertilizer or irrigation was available. Similar reduction in corn yields was reported for southern soils by Langdale et al. even when some fertilizer had been used. However, both groups of scientists pointed out that the effects of erosion on crop productivity are influenced by soil type as well as by initial depth of soil.
Another factor that influences soil quality is the amount of organic matter present. According to Reid, increasing organic matter in soil from 2.5 to 4.3% increased bean yields by nearly twofold. Similar results were reported for other crops on different soil types. Organic matter is more susceptible to erosion than the heavier soil particles. The removal of organic matter has complex effects on crop production, because it not only influences water infiltration and water-holding capacity, but also diminishes soil nutrients and soil biota. Each of these, alone or in combination, has major influences on crop productivity.
Although soil organic matter and nutrients are directly related to reduced crop productivity when soils are eroded, water runoff and water availability are equally important. For example, several of the papers emphasized that using conservation practices such as contour planting conserves moisture and may more than double yields of some crops, including grapes. Also noted was that using no-till on a heavy, wet soil for conservation may actually reduce yields. The various research results clearly illustrate the complexity involved in measuring the impact of soil erosion and soil conservation practices on crop productivity.
Despite the complexity and controversy of effects of erosion on crop productivity, a farmer provided a practical perspective when he said, "We must develop an ethic based on acknowledgement of the source of our wealth. We must understand that it [our heritage] does not `trickle down' in spite of the bungling of some bureaucratic entity, but `percolates up' from the earth, by our labor. Products of the soil, the waters and mines are the only source of real wealth."

Although the papers contain valuable information, this reviewer would have welcomed a chapter that integrated the individual findings on erosion and productivity. Without such integration of complex effects of erosion, the impact of erosion on productivity ranges from no effect to major effects. An integrated perspective would have helped to reduce the confusion and controversy mentioned in the preface.
Overall, the book contains a wealth of well-documented information and data that will be helpful to students, scientists and policy makers who have an interest and concern about soil erosion, agricultural productivity and quality environment. This book is strongly recommended.
Abstract by D. Pimental

238 88 - 13/9

Erosion control
Africa, study, soil erosion, desertification, drought problem, sustainable development, soil conservation
COMMONWEALTH SECRETARIAT
Conservation for sustainable development.
Commonwealth Secetariat, Marlborough House, Pall Mall, London SW 1Y 5AX, UK, 1985, 70 pp.

The possibility of action being taken by the Secretariat to assist Commonwealth Africa in tackling the problems of drought and desertification was first raised at the Senior Commonwealth Officials Meeting in Barbados, December 1984. It figured extensively in the deliberations of the Commonwealth Action Group on the Economic Crisis in Africa. The Group's report, "African agriculture: building for the future", was presented to the Commonwealth Heads of Government Meeting in Nassau, October 1985. This study was carried out by the Secretariat together with consultants.
This study underlines the vast scope of action necessary at the local, national and international level. In this perspective, the need for Commonwealth action is virtually unlimited. But the prerequisite to any such action is the need for recognition and commitment at the policy-making level that conservation of natural resources and the promotion of good land-use practices are issues of the highest priority. The severity of the problems of soil erosion, drought and desertification are not always recognized, and adequate resources have not been made available for tackling the problems. There are, of course, many short-term preoccupations. But the issue of environmental degradation is of such importance and such urgency that these short-term preoccupations should not be allowed to obscure them.
The interdisciplinary nature of the Commonwealth Secretariat and the method of operation of the Commonwealth Fund for Technical Cooperation facilitate the type of approach which is necessary in dealing with this range of issues. No one country has the means to defeat the problem of its own. But the resources of the Commonwealth as a whole can be drawn on as part of the wider international effort. Chapter 1 of this study contains a survey of the

problem both globally and in the context of Commonwealth Africa. Chapter 2 illustrates the scope for Commonwealth action in response to the problem. Annex 1 outlines in tabular form the situation in African member countries with respect to desertification and the pressure on the agricultural resource base. Annex 2 summarizes the international and donor response to the problem. A number of detailed project proposals are contained in Annex 3. The recommandations are set out in the following paragraphs. There is a modest role for the Commonwealth to play.

239 88 - 13/10

Soil erosion
Review, book, world, guidelines, soil degradation, population, land use, land development, soil conservation, institutional aspects, policies, actions, references
FAO/UNEP
Guidelines for the control of soil degradation.
FAO/UNEP, Rome, 1983, 36 pp. ISBN 92-5-101404-3; available from: FAO, Publications Division, Via delle Terme di Caracalla, 00100 Rome, Italy

Soil degradation in its broadest sense is one of the major problems facing the world at this moment. Every five days, the human population of the planet increases by more then one million. It is expected to double between 1980 and 2015 AD. Today, 450 million people, roughly one in nine, do not have enough to eat. This figure is expected to rise to 600-650 million by the end of the century. Every day, more than 40 000 young children die from malnutrition and infection.
The soil is, and will be for the foreseeable future, the basis for food production. Will there be enough of it to feed twice as many people just one generation from now? Obviously, there is going to be much greater pressure on the land. Even now, many thousands of hectares go out of cultivation annually because they have become too eroded, too saline, too swampy or too infertile, and on millions more the basic production potential is progressively decreasing towards the same condition. It is probably no coincidence that most of those parts of the world which anciently supported the most advanced civilizations of their time, and the highest concentrations of population, are now desert wastes. The same process is operating at this moment, but faster and over an immeasurably greater proportion of the globe.
Land must be carefully managed if its productivity is to be maintained or increased. If it is not well managed or if it is used in a way which is beyond its potential, some soil degradation inevitably occurs. At present, as the pressure on the land increases, large areas are being misused. The results of poorly managed land can be seen in various expressions of soil degradation such as desertification, erosion, salinization, toxicity and waterlogging. In spite of this knowledge, not enough is being done to control degradation. The reasons for this neglect include the need for greater awareness of the problems and their possible solutions

with, at the same time, a lack of the necessary action to be taken.
These guidelines are therefore addressed mainly to policy makers, to planners and administrators. They are not a technical manual or textbook but rather a document which will help create an awareness of the existence and consequences of the soil degradation problem and which will provide a framework for the necessary administrative actions which are required for its control.
These guidelines complement the principles already laid down in the World Soil Charter and the World Soil Policy and are issued in the hope that they will assist UN-member governments in establishing long-term policies for the sound development and management of their land resources.

240 88 - 13/11

Soil erosion
Review, tropics, farming systems, soil erosion
LAL, R.
Impact of farming systems on soil erosion in the tropics.
XIII Congress of the International Society of Soil Science, Hamburg, FRG, 1986, pp. 97-111

Traditionally in the tropics, farming systems are based on the extensive use of land, labour and hand tools. These systems have only occasionally been augmented with animal draft power in a limited number of ecologies. The two basic ingredients of traditional farming systems are land and labour, both of which are becoming scarce. Shifting cultivation and related bush fallow systems which rely entirely on long forest fallow for soil fertility restoration are least dependent on purchased inputs. These systems have been suitable in land-surplus economies. With mounting pressure on land resources, it is necessary to transform the resource-based systems to science-based systems. This transition phase has been marked by a widespread food deficit, particularly in tropical Africa. The introduction of intensive land-use systems has also resulted in severe degradation of resources. A principal cause of soil degradation in the tropics is accelerated soil erosion.
Based on the duration of the growing season (when rainfall exceeds potential evapotranspiration) there are three principal ecologies in the tropics: humid, subhumid and semiarid. The vegetation of these ecologies changes whenever the existing vegetation is disturbed for intensive land use.
This paper, a state-of-the-art review, describes soil erosion hazards in relation to some tropical farming systems. The farming system affects soil erosion through its interaction with biophysical and socioeconomic parameters. Runoff and soil erosion losses are generally low, if the traditional systems are based on short periods of cultivation followed by long periods of natural fallow and are practised on relatively deep soils on gentle slopes. Shifting cultivation practised on marginal soils of steep gradient causes severe erosion. Improved components and subsystems, being

developed and piloted to control erosion for systems based on intensive land use, are outlined. Erosion-induced productivity decline is described for some tropical crops, and research and development priorities are listed.

241 88 - 13/12

Soil erosion
Review, tropics, soil erosion, research, priorities
LAL, R.
Priorities for research in soil erosion.
XIII Congress of the International Society of Soil Science, Hamburg, FRG, 1986, pp. 451-454

Review papers presented herein indicate that research in soil erosion by water over the past 50 years has made substantial progress in understanding mechanisms and processes in soil detachment and transport. The relative magnitude of forces involved in soil detachment and its transport downslope are now better understood than ever before. The energy supplied by impacting raindrops, overland flow, and the interaction between them can be computed from basic principles.
Despite the very impressive research achievements to date, a considerable amount of work has yet to be done to understand the basic principles, develop erosion control measures, and to plan suitable methodologies for soil conservation. Some research priorities are briefly outlined below,:
Erosivity and the role of overland flow:
The role of overland flow in soil detachment and transport needs to be studied. What is the depth of overland flow (in relation to drop size, soil properties and slope characteristics) that causes the maximum entrainment and transport? What is the threshold velocity for different slope gradients at which a soil of known physical characteristics begins to detach? The processes leading to transition from rill to gully erosion are not understood. Erosivity in relation to drop size, rainfall interception by canopy of different heights and foliage characteristics, and interaction between rainfall and overland flow need to be studied. Runoff generated by the snow-melt and its effects on susceptibility to erosion when the soil is already saturated are not known. The least is known regarding the erosive capacity of a wind-driven rain and of a rain accompanied by a hail storm.
Rain of soil renewal and soil loss tolerance:
The rate of new soil formation depends on a multitude of interacting factors and is hard to measure. Weathering, as studied by geologists and geomorphologists, is only a part of the complex process of soil formation. There is a need to understand how to convert the denudation rates of large river basins as studied by geomorphologists into the rates of new soil formation at the farm level. It is difficult to evaluate soil loss tolerance without a precise knowledge of the rates of weathering and of new soil formation. The effects of climate, parent material, landforms,

land use and vegetation on rate of soil formation need to be investigated.
In addition to the rate of soil formation, soil loss tolerance also depends on the erosion-induced alterations in crop productivity. It is important to understand erosion-induced alterations in soil properties and how these affect its life-supporting processes. The relationship between soil and climatic parameters and productivity should be established.
Landscape:
Through its effect on microclimate and hydrology, landscape plays a dominant role in soil development, soil properties along a toposequence, rate of weathering and soil formation, the overland flow and its velocity, and sediment entrainment and deposition. The effects of landscape, slope characteristics, and land use on delivery ration are least understood. There is also a question of the scale, especially in relation to the delivery ratio, and in extrapolating the data from small plots to watershed and vice versa.
Soil erosion prediction:
Numerous models have been developed in the recent past to predict soil erosion from agricultural lands, and from watersheds of varying sizes and physical characteristics. There are few conceptual models that have a simplistic approach and require little data. Few attempts have been made to incorporate the advances made in the understanding of erosion processes into a simple and easy-to-use model. The data requirements for most available models are prohibitively large.