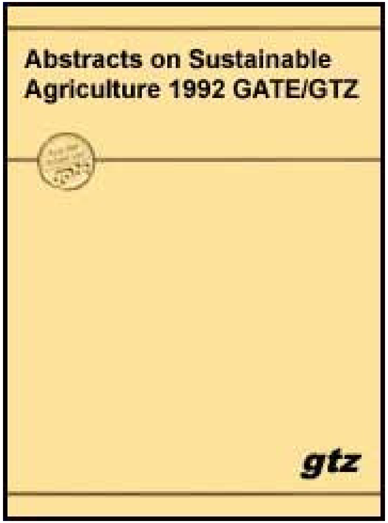
Abstracts on Sustainable
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gtz

- 1. Using indigenous knowledge in agricultural development.
- 2. On-farm sustainable agriculture research: lessons from the past, directions for the future.
- 3. A manual for culturally-adapted market research (cmr) in the development process.
- 4. Environmentally compatible agricultural development. Resource, food and income security as a task for development and structural policy.
- 5. The economics of sustainable agriculture: adding a downstream perspective.

- 1. Green manure crops in irrigated and rainfed lowland rice-based cropping systems in south Asia.
- 2. Comparative evaluation of some inter-cropping systems in the humid tropics of southern nigeria.
- 3. Intercropping improves land-use efficiency.
- 4. A new maize modernizes savanna farming.
- 5. Analysis of the environmental component of genotype x environment interaction in crop adaptation evaluation.

cropping systems: the labour requirements of a mulch rotation system in Kalimantan, Indonesia.

13. Grain yield responses in rice to eight tropical green manures.

14. Utilization efficiency of applied nitrogen as related to yield advantage in maize/mungbean intercropping.

15. Effects of two underseed species, medicago polymorpha l. And scorpiurus muricatus l.,on the yield of main crop (durum wheat) and subsequent crop (teff) under humid moisture regimes in Ethiopia.

16. Characterization and

environment-management relationships in beans and sorghum intercropped with maize in honduras. (caracterizacion y relaciones ambiente-manejo en sistemas de frijol y sorgo asociados con maiz en Honduras.)

17. Production potential of pigeonpea/pearl millet intercropping system in rainfed diara (floodprone) areas of eastern uttar pradesh, India.

18. Effect of mixed cropping lentil with barley at different seeding rates.

19. Yield performance and

complementarity in mixtures of bread wheat (triticum aestivum l.) And pea (pisum sativum l.).

could succeed.

- 14. Natural resources and the human environment for food and agriculture.
- 15. World development report 1992 - development and the environment.
- 16. Species interactions and community ecology in low external-input agriculture.
- 17. Development strategies and natural resource management for humid tropical lowlands.
- 18. Environmental management of the northern zone consolidation project in Costa Rica: strategies for sustainable

utiliss par les petits agriculteurs traditionnels d'Afrique tropicale. (developing appropriate ipm technology for the traditional small-scale farmer in tropical Africa).

5. Biological control in developing countries: towards its wider application in sustainable pest management.

6. Transforming plants as a means of crop protection against insects.

7. Utilization of va-mycorrhiza as a factor in integrated plant protection.

8. Activity of four plant leaf

extracts against three fungal pathogens of rice.

9. A useful approach to the biocontrol of cassava pathogens.

10. Evaluation of the biological activity of flax as a trap crop against orobanche parasitism of vicia faba.

11. Insect pest management.

12. Economic contributions of pest management to agricultural development.

13. The effects of intercropping and mixed varieties of predators and parasitoids of cassava whiteflies (hemiptera:

forecast insect pest outbreaks.

- 24. Manual on the prevention of post-harvest grain losses.
- 25. Evaluation of efficient weed management systems in pigeonpea (cajanus cajan l.)
- 26. Weed management in a low-input cropping system in the Peruvian Amazon region.
- 27. Poblaciones, biomasa y banco de semillas de arvenses en cultivos de maiz zea mays l. Y frijol phaseolus vulgaris l. Efecto de m+todos de control y rotaciones. (Weed population, biomass, and seed bank in maize and bean crops. Effects of control methods and crop

rotations).

28. Effects of groundnut, cowpea and melon on weed control and yields of intercropped cassava and maize.

29. Intercropping and weeding: effects on some natural enemies of African bollworm, heliothis armigera (hbn.) (lep., Noctuidae), in bean fields.

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1. Water management.

2. Crop diversification in

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2. Sustainable uses for steep slopes.
3. Land restoration and revegetation.
4. Economic analysis of soil erosion effects in alley cropping, no-till, and bush fallow systems in southwestern Nigeria.
5. Soil conservation and management in developing countries.
6. Guidelines: land evaluation for rainfed agriculture.
7. Small-grain equivalent of

mixed vegetation for wind erosion control and prediction.

8. A method for farmer-participatory research and technology transfer: upland soil conservation in the Philippines.

9. African bean-based cropping systems conserve soil.

10. Refining soil conservation strategies in the mountain environment: the climatic factor.

11. Conservation tillage for sustainable crop production systems.

12. Caring for the land of the

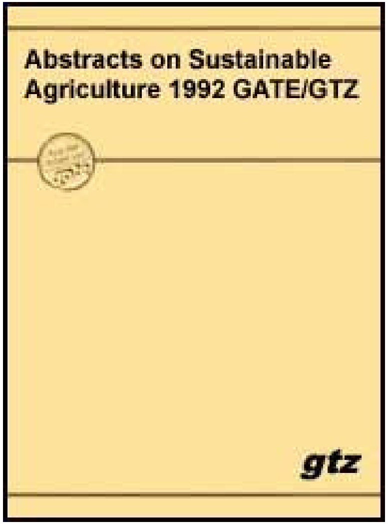
usambaras - a guide to preserving the environment through agriculture, agroforestry and zero grazing.

- 13. Vetiver grass (vetiveria zizanioides) - a method of vegetative soil and moisture conservation.
- 14. Erosion in andean hillside farming.
- 15. Conservation tillage systems.
- 16. Soil erosion, water runoff and their control on steep slopes in Sumatra.

Abstracts on potential crops for marginal lands

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Abstracts on Sustainable Agriculture (GTZ, 1992, 423 p.)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desertification control

Abstracts on potential crops for marginal lands

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GTZ - Gate - Volume 5 - 1992

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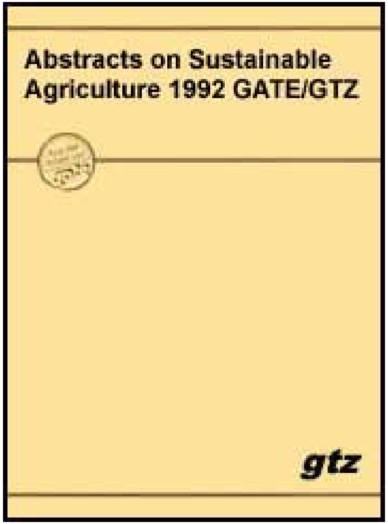


Abstracts on Sustainable Agriculture (GTZ, 1992, 423 p.)

Abstracts on seed production

Acknowledgements

1187 92 - 9/34

Seed production

Review, study, guide, audiotutorial unit, handbook, CIAT, developing countries, tropics, subtropics, bean seed, management, ecology, production, harvest, standards, activities, evaluation

DOUGLAS, J. et al.

1. Good quality bean seed.

Study Guide, CIAT, Apartado A_reo 6713, Cali, Colombia; Series 04eB-12.03, 1981, 36 pp.

An effective seed program comprises many and diverse elements and activities which must be coordinated to attain the principal objective: produce and distribute good quality seed of improved varieties.

Therefore, the success of a seed program is founded on producing and providing a sufficient quantity of good quality seed, at the required time, at a reasonable cost, and at a location where it is needed, so that the majority of the farmers can enjoy the benefits provided by using this seed.

This study guide is complementary material to the audiotutorial unit "Good-Quality Bean Seed". Its principal objective is to provide useful information relating to the practices of production, quality control and processing of bean seed.

The audiotutorial unit is a translation of the Spanish unit entitled "Semilla de Frijol de Buena Calidad" which was produced by CIAT through a special project on the development and utilization of training materials on improved agricultural production technology.

The handbook contains the following chapters:

- Removal of foreign, off-type and diseased plants
- Harvest of the seed
- Steps to follow after harvesting Good Quality Seed
- Drying
- Cleaning
- Treatment
- Sampling
- Evaluation
- Storage
- Transport
- Activities of Different Groups in Obtaining Good Quality Seed
- Seed certification authorities
- Research programs
- Seed growers, seed enterprises and marketing groups
- Evaluation
- Bibliography

This handbook together with the audiotutorial unit provides useful information for the practice of quality bean production.

1188 92 - 9/35

Seed production

Review, book, Africa, Kenya, directory, seeds, trees

TEEL, W.

2. A pocket directory of trees and seeds in Kenya.

Publ. of Kenya Energy Non-Governmental Organizations (KENGO) P.O.B. 48197, Nairobi, Kenya, Repr. 1988, 142 pp.

There was a time, not so long ago, when trees were taken for granted in Kenya. There were so many, often so thick with dense undergrowth that walking through was a hard task.

Today that time has gone. Trees no longer dominate Kenya's high potential land. In areas of lower rainfall and less agricultural potential, trees are disappearing rapidly, being cut for timber, charcoal, or just to clear the land. As they become more scarce, the awareness of just how important trees are, grows.

In the recent past, seed collection and distribution had been centralized through the government's relevant ministries. This continues to be the case for certain species of timber trees, such as Cypress and Pine, to ensure the best provenance selection. These government sources are not always able to deal with the wide variety and extent of today's locally rising demand. To meet this demand, it has been found that a decentralized approach to seed collection and distribution is essential.

Advice is increasingly available f.e., that is part of the function of directories like this one.

This directory is divided into six chapters:

Chapter 1: Questions and answers

A list of questions which are normally asked about species selection and seed collection is compiled. The answers given provide some basic information about choosing which trees to grow, how to collect seeds and briefly, how trees propagate. The section also includes some general information on how to store and treat seeds before sowing.

Chapter 2: Local climate type list

The range within which a tree can be planted is determined primarily by rainfall and temperature. Rainfall and temperature zones overlap but can be differentiated into a total of 33 zones in Kenya, according to the

Agroclimatic Zone map published by the Kenya Soil Survey. For purposes of simplicity, some temperature zones have been combined in the list.

The climatic types are identified with the name of the most representative town found within that type.

Chapter 3: Climate type/tree species list

For each of the climate types, this chapter provides a list of all the trees which grow, or could grow in that area. This is only a selection of trees which may be recommended with priority. It may be possible that some of these trees will grow in areas for which they are not listed.

It is almost certain that all the trees listed under a given climate type can grow in that area, but some will perform better than others.

For this reason an asterik has been placed after those species known to grow best in this climate type which is recognized as the climate zone for these species.

Chapter 4: Individual tree species profiles

This chapter provides information about each of the recommended tree species. It contains a choice of 90 tree species; indigenous, exotical and fruit, listed in alphabetical order by botanical name. Following this, for both indigenous and exotic trees, is a brief look at their uses and even briefer description of the tree itself. The preferred climatic type of the tree is then given and, if known, the most common growing sites. Next, information about the seed is provided. This includes approximate size and weight, estimated seeding time, length of viability and best germinating techniques. Last comes the list of potential seed sources to contact if seed cannot be found in the local area.

Fruit trees, because of their importance as a food source, are listed separately. The information on fruit trees is also treated in a slightly different manner. Seeds and seedling suppliers are listed by province at the end of the section. The list of fruit trees available as seedlings from these suppliers follows the provincial listing.

Chapter 5: References and resource people

This chapter is a list of sources used for the information in this book, as well as others which could be relied upon to provide further information about growing these trees. For most of the indigenous trees information is scarce, limited generally to botanical literature. There is considerable information available about fruit trees.

Chapter 6: Information exchange

This chapter gives information where to go, or whom to ask for answers.

The idea is to help spread knowledge around and this chapter suggests how to do it.

1189 92 - 9/36

Seed production

Review, developing countries, book, practical guide, agricultural crops, varieties, crop production

KELLY, A.F.

3. Seed production of agricultural crops.

Longman House, Burnt Mill, Harlow, Essex CM20 2JE, UK, ISBN 0582-40410, £27.42

It is now recognized that crop production is limited by genetic potential and that improved varieties must be the foundation of any attempts to improve yield. However, not only must seed be of high genetic potential, it must also be harvested, cleaned and stored correctly if it is to retain good germination ability and vigour for seedling growth. Seed testing may also be necessary to determine germination, vigour and presence of disease and seed treatments may be considered to protect seeds from seed - and/or soil-borne diseases.

In 'Seed Production of Agricultural Crops' A. Fenwick Kelly has written a practical guide to the basic requirements for the correct production of seed for agricultural crops and the book contains enough fundamental information to enable readers to understand the reasoning behind the management practices discussed.

The author was Deputy Director of the National Institute for

Agricultural Botany in England from 1970-83, since when he has been active in international organizations dealing with seed matters and has worked as a consultant with the FAO. Although he assumes knowledge of the basic principles of crop production, his book is largely self-explanatory on all major points and will be useful to all those responsible for developing seed production in the Third World.

1190 92 - 9/37

Seed production

Asia, Philippines, case study, seed potato, physiology, pathology, production systems, CIP, GTZ

CRISSMAN, C.C.

4. Seed potato systems in the Philippines: a case study.

International Potato Center, Lima, Peru; ISBN 92-9060-136-1, 1989, 82 p.

This report is one of a series of case studies on seed potato systems in selected countries. The main objective of the individual case studies is to identify strengths and weaknesses in organized seed potato programs.

To do this effectively, the organized potato program must be examined in the context of its environment. Thus a systems approach is adopted in these studies to categorize and evaluate the role of an organized program within the larger seed system.

Potato production in the Philippines is centered in the high and mid-elevation areas of Benguet and Mountain Provinces in the agricultural region of Ilocos in Northern Luzon.

The data show a rapid expansion in production during the last ten years at an average annual rate of 8.3%. Most of that growth is explained by expansion in area and the rest is due to changes in yield.

The government efforts have centered on a cooperative project with the German government to establish a seed production scheme in the highlands of northern Luzon.

The concept of system used in this study stresses function rather than structure as the basic device by which to classify the system parts.

Special attention is paid to linkages between the different agencies which have roles in the organized seed programs and the linkages between these agencies and the informal farmer-based seed system.

The format of the report proceeds from the general to the specific.

First there is a brief discussion of trends in the potato sector and the potato in the Philippine food system in terms of production, consumption and marketing. Next is a presentation of the larger elements which influence the seed system, the physical and socio-economic environment and the government. An overview of the RP German seed potato project is presented in the discussion of government activities.

After this overview the discussion follows the chain of activities found in the Philippine seed system. These steps are:

- provision of adequate varieties

- the initial creation of seed supplies, a step crucial for overcoming the slow rate of reproduction while moving from foundation material to sufficient quantities of basic seed, and

- the building of seed supplies, which includes the organization of farmer cooperators for bulk multiplication but also for quality control.

- Next the work of the private sector is discussed, the components of crop protection and storage are introduced, and an overview and discussion of results are presented.

The gradual build up of diseases in seed stocks obliges farmers to replace their seed stock periodically. In the absence of widespread certified seed, the source of the replacement seed requires careful consideration. In developing countries this usually means that seed from higher altitude zones would be preferred. Thus there often exists a distinctive flow of seed from one location to another. Once on the farm, the farmer can use various methods to slow the rate of degeneration of the seed. These methods include proper post-harvest handling and storage, field or post-harvest selection, and pre-planting treatment.

1191 92 - 9/38

Seed production

Latin America, Brazil, study, field trials, maize, field bean, trace elements

PRIMAVESI, A.

5. Seed enrichment with trace elements.

In: Proc. of the 8th Int. IFOAM Conference, Budapest, Hungary, 1990, pp.131-133

Little or no attention is given to seed nutrition. It is considered that, automatically, seeds, produced by plant breeding, may give rise to healthy, vigorous plants. If this does not occur, soil is improved by heavy NPK application, and agro-toxics have to protect the high yielding crops attacked by pests and diseases.

The author worked with copper enrichment to paddy seeds and found that only plants of treated seed responded to a copper fertilization; seeds of plants fertilized with copper did not respond to enrichment. Paddy with copper gave higher yields, had a better grain quality, breaking on seldom when husked, and had a strong resistance to Pirucularia oryzae.

Even in fields infected with Piricularia oryzae and planted with infected seeds, no diseased plant appeared.

Seed treatment of maize and beans was very efficient. The soil roots of maize, given boron to seeds, are deeper. Spodoptera frugiperda attack was reduced to 2% instead of 55% on the test plots. Nearly all plants had two to three ears. Ears were greater and grains heavier. During storage of six months, no worm attacked. With zinc sulphate there was no attack of Elasmopalpus, which killed 20% of the seedlings on the testplot. Zinc additionally to the soil made the plants more drought resistant.

Seed enrichment to field beans protected them against parasites when followed by two leave applications, whilst the test plants had to be sprayed with pesticides five times. Those plants with seed enrichment and leave fertilization did not need to be protected.

It is assumed that plant protection against parasites by seed enrichment and trace element fertilization may be due to the nutritive effect.

Micronutrients are enzyme activators or part of the prosthetic group or incorporated in the enzyme itself. A stronger enzymatic activity may be assumed as facilitating the formation of organic substances improving the biological value of plants.

The seeds could be treated with a surprisingly high concentration of multi saline solution. It may be supposed that trace elements in balanced proportion with others, like iron-manganese or copper-molybdenum may be used in much higher concentrations without a toxic reaction. On the other hand, even potash is toxic in mono saline solution.

It may be concluded that well-nourished or enriched seeds are more resistant against parasites. Plant health may be improved by seed enrichment and micronutrient fertilization. At the same time this increases yield and biological quality. Crop production with enriched seeds is less expensive and risky than conventional agricultural technology.

1192 92 - 9/39

Seed production

Review, tropics, cassava, planting material, production methods, stakes, cutting methods, mukibat system, handling, chemical treatment, CIAT,

CIP, IITA,UNDP

LEIHNER, D.E.

6. Current practices in the production of cassava planting material.

In: Proc. of a Reg. Workshop, Cali, Colombia, 1983, pp. 41-45

This paper reviews some of the current practices in stake production and points out some elements necessary for improvement.

Selection of stakes:

A conscientious selection of mother plants according to nutritional and health status, followed by a careful selection of stakes from these plants, is hardly ever done in traditional production systems.

In traditional systems, hardly any selection is made with regard to the maturity of the stake. This means that along with stakes of adequate maturity (recognized by a relation of total to-pith diameter of between 2:1 and 3:1), a large number of either too young, i.e., succulent stakes, or too old, i.e., very lignified stakes, are selected. This leads to plant loss and a patchy, uneven sprouting of stakes.

Cutting and preparation:

- Cutting methods:

A great variety of cutting methods are presently practiced worldwide. In one of the common methods, the long stem is placed on a base.

- Stake length:

As with cutting methods, farmers use a great variety of stake lengths in commercial plantings. Stakes as short as 10 cm with only two to four buds may be used by some, whereas others cut and plant stakes of 40 cm or more.

- Mukibat system:

The traditional and rudimentary methods of selecting and preparing cassava planting material stand in contrast to a very careful and elaborate system known as the Mukibat system. A well-selected Manihot esculenta stake is used as a stock onto which a Manihot glaziovii scion is grafted.

Handling before planting:

- Transport:

The majority of cassava planting material is transported in the form of long stems to facilitate handling and reduce moisture loss.

- Chemical treatment:

Chemical treatment of stakes for pest control and protection against soil-and air-borne fungi after planting is not a common practice among cassava producers. Many farmers simply do not know about this way of stake protection.

Concluding cassava planting material is obtained in a very simple manner from low-value raw material and probably for this reason no refined stake production technology has developed among farmers. It is suggested that in order to improve stake production technology, the primary considerations are selection of stakes for healthiness and adequate maturity, non-damaging cutting practices and the use of appropriate stake lengths.

1193 92 - 9/40

Seed production

Review, ideotype breeding, Australia, alternative yield improvement

MARSHALL, D.R.

7. Alternative approaches and perspectives in breeding for higher yields.

Field Crops Res., 26, 1991, pp. 171-190

This paper considers strategies for increasing commercial yields of crops by plant breeding, both directly by increasing yield potential, and indirectly by improving the expression of yield potential in practice.

Little attention was given to crop improvement by considering morphological or physiological traits which could directly contribute to higher yields. Whilst his ideotype approach has generated considerable interest, there has been limited adoption of ideotypes in breeding programmes, and limited success in terms of yield improvement.

The development of model plants or ideotypes has been adopted as a major breeding philosophy by relatively few programmes. The reason for this is that most breeders have formed the view that the ideotype approach offers no advantage over the available alternatives, in terms of yield improvement in their crops. Breeders may have reached this conclusion either because of perceived difficulties or disadvantages with the ideotype approach, or perceived advantages of alternative approaches.

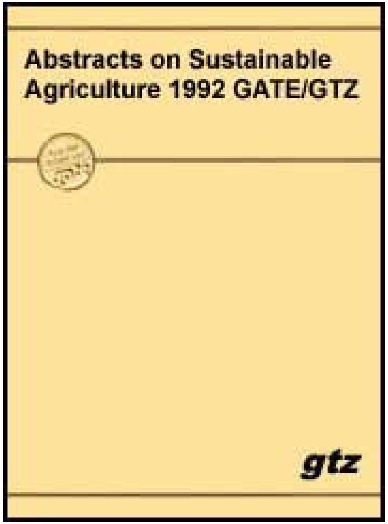
This is discussed in this paper in relation to conceptual and practical difficulties in the implementation of ideotype breeding, including the difficulty of identifying yield-enhancing traits, and the lack of genetic diversity for such traits in some agricultural crops.

Alternative strategies for yield improvement include using techniques such as heterosis in FI hybrids, and the identification and manipulation of individual 'yield' genes (particularly using the recombinant DNA technology of restriction fragment length polymorphisms (RFLP). However, an emphasis on the 'defect elimination' approach to plant improvement will continue to be relevant, as many Australian farm crops yield well below their genetic potential. Substantial progress is likely to be made by addressing the control of air- and soil-borne pathogens, mineral deficiencies and toxicities, appropriate phenology, and resistance to frost damage during heading in cereals.

Increased yield is regarded by most plant breeders as an important, high-priority objective. There are two ways commercial yields can be increased by plant breeding:

- Directly, by increasing yield potential per se above that of standard varieties in the same environment. This may be done by increasing total dry-matter production, or by increasing the proportion of the total dry-matter converted to economic yield, or both; or

- Indirectly, by improving the extent to which the true yield potential of a crop is realized in practice. This may be done by genetically removing or overcoming biotic (e.g. diseases and pests) or abiotic (e.g. frost, drought, salinity, mineral deficiencies or toxicities) constraints on crop production.



harvest: herbicide-tolerant crops and the threat to sustainable agriculture.

3. Chemistry, agriculture and the environment.

4. Mise au point de techniques appropries de lir qui seront utiliss par les petits agriculteurs traditionnels d'Afrique tropicale. (developing appropriate ipm technology for the traditional small-scale farmer in tropical Africa).

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- 8. Activity of four plant leaf extracts against three fungal pathogens of rice.
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- 11. Insect pest management.

en cultivos de maiz zea mays l. Y frijol phaseolus vulgaris l. Efecto de m+todos de control y rotaciones. (Weed population, biomass, and seed bank in maize and bean crops. Effects of control methods and crop rotations).

28. Effects of groundnut, cowpea and melon on weed control and yields of intercropped cassava and maize.

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heliothis armigera (hbn.) (lep., Noctuidae), in bean fields.

Abstracts on Sustainable Agriculture (GTZ, 1992, 423 p.)

Abstracts on plant protection

Acknowledgements

1194 92 - 10/121

Plant protection

Review, integrated pest management, control methods, pest management approaches, sustainable agriculture, transfer of technology model, research, extension, institutional reform, policy aspects, training, IIED

PIMBERT, M.P.

1. Designing integrated pest management for sustainable and productive futures.

Gatekeeper Series No. 29; Int. Inst. for Environment and Development (IIED), London, 1991, 21 pp.

The introduction of commercial pesticides revolutionised pest control.

These modern presticides have helped to control and reduce crop and livestock losses to a remarkable degree.

The use of these pesticides has created some of today's major environmental and health problems: reduction in the abundance and diversity of wildlife, human health hazards associated with acute or chronic exposure to dangerous products in the workplace, and contaminated air, food and water.

The self-defeating nature of the chemical control strategy that dominates today's crop and livestock protection efforts has also become more apparent in recent years. Repeated applications of synthetic pesticides have selected pesticide resistant pests worldwide, and there are now at least 450 species of insects and mites, 100 species of plant pathogens, 48 species of weeds resistant to one or more products. The deaths of natural enemies has allowed previously harmless organisms to reach pest status.

For these reasons, crop protection specialists are increasingly being asked to develop pest control methods that are more compatible with the goals of a sustainable, productive, stable and equitable agriculture. To meet these aims, research must seek to integrate a range of complementary pest control methods in a mutually enhancing fashion, namely as Integrated Pest Management (IPM). IPM focuses on five control areas:

- cultural pest control: the manipulation of sowing and harvest dates to minimise damage, intercropping, vegetation management and crop rotations;

- host plant resistance: the breeding of crop varieties that are less susceptible to pests (insects, diseases, nematodes, parasitic weeds;

- biological control: the conservation of natural enemies, manipulation of natural enemy populations, and the introduction of exotic organisms;

- the wise and judicious use of pesticides: chemical, microbial, botanical pesticides used along with information on economic thresholds;

- legal control: the enforcement of measures and policies that range from quarantine to land and water management practices. This approach to pest management must involve area-wide operations that include many rural households and are enacted for the common good of both farmers and society at large.

Amongst users and promoters of IPM, such as researchers, donors, policy makers, pesticide companies, and extension staff, there are significant differences in emphasis and approaches.

Some of the more fundamental differences are briefly discussed in this paper to identify IPM approaches that reflect and reinforce the goals of sustainable and equitable production systems:

- IPM systemic adjustment or structural change,
- The relative importance given to self-sustaining control methods,

- The stocks of knowledge used by IPM practitioners,
- Research for IPM,
- Changes within IPM science and extension,
- Institutional and policy reforms.

Concluding, there will be a need to focus on structural changes in agroecosystems, give greater importance to self-sustaining control methods, and draw on the local stocks of knowledge useful for pest management.

Future self-sustaining designs that minimize the need for pest control interventions will require more understanding of complex ecological systems. The move towards system design to minimize pest outbreaks calls for knowledge and decision making as IPM becomes more broadly coordinated with land and water management, conservation of biodiversity, public health protection and soci-economic development.

1195 92 - 10/122

Plant protection

Review, USA, biotechnology, sustainable agriculture, herbicide tolerant crops, human health, environment, economics, sociology

GOLDBURG, R. et al.

2. Biotechnology's bitter harvest: herbicide-tolerant crops and the threat to sustainable agriculture.

A Report of the Biotechnology Working Group, USA, 1990, 73 pp.; available from Environmental Defense Fund, 257, Park Avenue South, New

York, NY 10010; price USD 10.00

The objective of this report is to examine the impacts of herbicide-tolerant crops, trees and to recommend changes that will discourage the development and adoption of such crops and trees in U.S. agriculture and forestry.

Modern agriculture depends heavily on herbicides-chemical plant killers-to control weeds. Nearly 80% of the herbicides used annually in this country are applied in agricultural settings. Consumers, farmers, farmworkers, domesticated plants and animals, wildlife, and their habitats are exposed to weed killers.

Against the background of agriculture's current dependence on herbicides, biotechnology, agrichemical, and seed companies, as well as the U.S. Department of Agriculture and state agricultural institutions, are using genetic engineering to develop crops and trees resistant to herbicides. Widespread adoption of these crops and trees will lead to increased use of particular herbicides.

Biotechnology's Bitter Harvest examines the impact of agricultural biotechnology's first major product - crops genetically modified to tolerate chemical weed killers, or herbicides. Crops are being given genes that will enable them to tolerate or resist the toxic effects of herbicides. A major research focus of public and private research institutions, herbicide-tolerant crops involve most agricultural crops, including a number of food crops, in the United States.

First, the report examines the extent of current herbicide use and the research sponsored by corporations, federal and state governments on crops and trees that tolerate herbicides. Then, it briefly discusses the human health, environmental, social, and economic impacts of herbicides and herbicide-tolerant plants. Next, the report examines the promises against the realities of widespread use of herbicide-tolerant crops, exposing a variety of detrimental effects herbicide-tolerant crops and trees will have on farmers, consumers, and the environment. Finally, it outlines the promise of sustainable agriculture to provide alternative methods of weed control. Based on its analyses, the report makes recommendations to discourage the development and adoption of herbicide-tolerant crops and trees.

To those with high hopes for the environmental benefits from biotechnology, herbicide-tolerant crops are at best a distressing misstep, at worst a cynical marketing strategy. Both industry and the publicly supported agricultural research establishment must direct their considerable talent and resources toward sustainable alternatives for weed management and other pest controls. The risks of prolonging the chemical era of agriculture are far too clear for farmers, consumers, and the environment. Sustainable practices provide an alternative that will never be realized if public research funds are wasted on such misguided products as herbicide-tolerant crops.

'Threat to Sustainable Agriculture' offers a well-researched critique of current genetic engineering efforts to develop herbicide-tolerant trees and crop plants. Written by a consortium of 18 environmental, farm, consumer and religious groups, and the Texas Department of Agriculture, the study emphasizes that herbicide-tolerant crops may lead to even greater herbicide use, further threatening both natural resources and human health.

The author's note, "Perhaps the greatest problem of herbicide tolerance is that it diverts us from the paths that really could lead to reduced chemical dependency in agriculture. As farmers have known for years, and in some cases are learning anew, responsible tillage practices, crop rotations, and intercropping are viable methods of managing weeds."

1196 92 - 10/123

Plant protection

Review, developed countries, developing countries, book, agriculture, wild plants, chemical impacts, agricultural waste, fertilizer, environmental pollution, pesticides, human health

RICHARDSON, M.L.

3. Chemistry, agriculture and the environment.

Publ. of The Royal Society of Chemistry; Thomas Graham House, Science

Park, Cambridge CB4 4WF; ISBN 0-85186-228-4, 1991, 527 pp.

The aims of 'Chemistry, Agriculture and the Environment' are to highlight the essential role of chemistry in evaluating the usage of chemicals in agriculture and their effects on the environment.

The advent of chemical fertilizers leading to improved crop yields and the use of pesticides to protect and control agricultural products was heralded as a major breakthrough in the decades following the war. The problems associated with these developments then became apparent. The impact on the environment was seen to be widespread and led to a very close control in the use of these chemicals, within certain instances the complete banning of their use.

This book reviews the current status of the inter-dependence of the chemistry and ecotoxicity of agrochemicals and related substances. The book brings together the related chemistry and other sciences which are necessary in the multi-disciplinary approach required in minimizing the risk of the use of these chemicals. It explains the problems and their implication for the environment and for human and animal health, and how these problems may be alleviated or overcome.

The emphasis is on a critical assessment with a recognition of the advantages and disadvantages involved. This will help to elucidate the general debate concerning the use of chemicals in agriculture with a true recognition of the difficulties associated with the environment.

The text does provide a very useful insight into many of these problems and in so doing gives a very valuable overview of this very difficult but important interface.

The editors have attempted to minimize overlap between chapters.

However, in dealing with such important topics as: pollution of the biosphere from gaseous emissions; water, nitrates and pesticides; soil pollution from substances as diverse as silage, animal slurries, pesticides; effects on non-target species; and control measures, some overlap is inevitable. Such repetition should enhance the contents of the book in view of the various and diverse experiences expressed by the authors from such countries as Eastern and Western Europe, the United States of America, Costa Rica, India, China, Israel, Nigeria, etc.

Assessment of risk to the environment from the use of agrochemicals is the outcome of a series of processes involving risk identification, estimation, evaluation, and subsequent effective management. It is a matter to be considered seriously by all those having responsibility for producing or handling these chemicals, ranging from those synthesizing agrochemicals to those applying such chemicals to soil or crops; in addition such applicators must also be aware of the potential harmful effects from natural products such as manure, silage, and from straw burning.

Use must be made of the information available in this book, particularly on the underlying chemistry, to minimize any harm and also to understand the mechanisms involved.

1197 92 - 10/124

Plant protection

Review, field trials, Africa, integrated plant protection, small-scale farmer, problem areas, plant protection strategies, plant resistance, biological control, traditional methods, varities

OLOO, G.W.

4. Mise au point de techniques appropries de lir qui seront utiliss par les petits agriculteurs traditionnels

d'Afrique tropicale.(developing appropriate ipm technology for the traditional small-scale farmer in tropical Africa).

FAO Plant Prot. Bull., 38, 2, 1990, pp. 101-104

This paper aims to identify some of the major challenges that crop protection experts need to address in formulating and implementing pest management programmes, and to highlight the advantages of Integrated

Pest Management (IPM) strategies in responding to the needs of the traditional farmer in tropical Africa.

Pest management forms a vital part of the food-production process, both in the field and in farm storage. The pest problem becomes more critical in the farming environment of the resource-poor traditional farmer in tropical Africa.

In principle, the following broad programme of action is advocated for developing IPM technologies for crop protection in Africa:

- identify the major pests and quantify losses caused by them in a given agro-ecosystem;

- study the biology, behaviour and population dynamics of the pests to understand the features that may be exploited for pest management;

- establish the role of local natural enemies and develop mass- rearing, or mass-culture for disease agents on insects;

- study and develop other suitable components of IPM, such as intercropping and other cultural practices;

- integrate these components into an appropriate IPM technology and test for compatibility and efficacy under different ecological conditions; and

- develop a simple protocol for monitoring the impact of IPM technology in the field.

For example, in field trials being carried out by the African Regional Pest Management Research and Development Network (PESTNET) at Katumani, Machakos in eastern Kenya, intercropping an early maturing maize variety (Katumani composite) with cowpea (var. ICV2) under marginal rainfall conditions increased the maize yield by 4.5 times over that of maize in a monocrop. However, intercropping hybrid maize (var. H511) with beans (Mwitimania) at Murinduku, Embu in eastern Kenya, resulted in a yield increase of maize by 1.5 times under only marginal to medium rainfall conditions.

Traditional farmers have for generations applied natural plant products with pesticidal activity for pest control which have the following advantages over synthetic pesticides: the materials are obtained from local plants and are relatively safe, and include wood ash and smoke which are by-products of firewood that farmers use for cooking; other plants such as the neem tree and Tephrosia can be grown easily by the farmer; and if the products were to be processed, they would be used as substitutes for industrial pesticides in situations where chemical control is necessary.

The ultimate solution lies therefore with the farmer who has experienced the problems over generations, sometimes without knowing the cause, and who must be in the front line and a key partner in the fight against crop pests.

1198 92 - 10/125

Plant protection

Review, developing countries, biological control, pest management, biological control agents, constraints and opportunities

GREATHEAD, D.J.

5. Biological control in developing countries: towards its wider application in sustainable pest management.

Med. Fac. Landb, Rijksuniv. Gent, 55 (2a), 1990, pp. 217-223

Biological control is the use of living natural enemies - parasites, predators, pathogens - as pest control agents. The most attractive biological control technique is the introduction and permanent establishment of exotic species for long term pest suppression (known as classical biological control) because once in place no further input is required. Manipulations of the crop environment to enhance the impact of pre-existing natural enemies, referred to as conservation of natural enemies, may also provide long term control. When long term biological control is not possible, periodic applications of natural enemies may be made to achieve short term control by timed releases of native or exotic natural enemies to control pests over a season, or natural enemies may be applied as biological pesticides for immediate reduction of pest numbers. Usually more or less host specific natural enemies are screened to ensure that non-target organisms of economic importance or of conservation value are not harmed. In this way undesirable side effects are avoided and biological control has a minimum impact on the environment.

Biological control can provide a sustainable and environmentally acceptable pest management, often at little or no direct cost to the farmer and so it has many advantages, especially for the resource poor farmer in developing countries who cannot afford costly imported chemical pesticides.

Biological control offers more or less target specific pest control, which may be indefinitely sustainable at little or no recurrent cost.

Therefore, it should be attractive, not only as a means of solving major pest problems of overriding importance but also as one of the central components of pest management in specific cropping systems. World-wide surveys indicate that the adoption of biological control as a pest control strategy varies greatly between regions, countries and crops.

Some reasons for this uneven uptake are discussed in this paper.

Unfortunately biological control research does not receive the level of institutional and financial support given by chemical industry to the development, promotion and marketing of pesticides. The production and distribution of high yielding varieties of major crops is well supported, especially by the International Agricultural Research Centres and by industry.

The different approaches to applying biotic agents in pest control are reviewed in relation to their appropriateness to the various agricultural production systems found in developing countries, e.g., plantations, cash crops, horticultural crops, subsistence farming. Some constraints to the wider application of biological controls are outlined; notably misconceptions over the mode of action of biological control agents and their safety, pressures to rely on chemical pesticides, lack of administrative support to facilitate implementation of biological controls and inadequate investment in research and development. Some current initiatives by various agencies to find ways of overcoming these constraints are discussed.

1199 92 - 10/126

Plant protection

Review, biotechnology, transgenic plants, insect pests, pesticides, crop yield, genetic engineering, inherent resistence

HILDER, V.A. and A.M.R. GATEHOUSE

6. Transforming plants as a means of crop protection against insects.

Outlook on Agriculture, 19, 3, 1990, pp. 170-183

In this paper the progress is discussed which is being made towards producing plants by introducing insect control genes into crops by plant genetic engineering.

Some 13% of the world's crops are lost directly to insect predations, with further losses attributable to plant diseases for which insects act as the transmission vectors.

It is estimated that in 1988 nearly 4 billion US dollars were spent on applying chemical insecticides to protect just three crops - cotton, maize and rice - from their insect pests. These crops account for approximately half the total worldwide insecticide usage.

More than 99.9% of the chemical applied, enters the environment in ways which have a number of undesirable consequences, such as the destruction of beneficial insects, promotion of secondary pests and contamination of food chains. No-one alive today is free from detectable levels of organochlorides derived from insecticides.

The use of crop varieties which are inherently resistant to, or at least tolerant of, insect pests would provide a solution to this problem. Such varieties have the advantages that protection is provided when and where required for maximal control of insect pests, and is confined within the plant, thereby restricting its effect to crop-eating insects. The production of such resistant lines has been a goal of many conventional plant breeding programs. Unfortunately there is often no source of inherent resistance in the germplasm which is available for breeding purposes in a particular crop, even using modern wide-crossing and embryo rescue techniques.

Plant genetic enginering could help to overcome this problem since, once a system for the stable transformation of a particular crop has been developed, genes may be introduced into the breeding lines from any source. Such sources can include unrelated plants, animals, microbes or even wholly synthetic genes. This opens up a virtually unlimited source of germplasm variability from which useful traits may be selected.

Transformation systems have now been developed for most of the major crop species and for many other, locally important ones.

With the transformation system available, the key question becomes that of where to obtain useful genes for transfer. Two logical sources of insect control genes have been exploited so far: insect pathogenic microorganisms and plants themselves.

These sources are discussed in this paper.

The authors conclude that every encouragement should be given to careful attempts to investigate the claims that the approach of transforming plants to insect pest control is:

- user-friendly - there are no application costs or sophisticated technology involved in the use of such material on the farm; genetically engineered seed would be handled in exactly the same way as unmodified seed;

- ecologically-friendly - replacing some of the current pesticide usage with protection which is intrinsically biodegradable, specific to targeted insects, and confined within the plant;

- consumer-friendly - the gene products which have been transferred so far have been derived from the edible parts of food crops.

1200 92 - 10/127

Plant protection

Latin America, Brazil, field trial, VA-mycorrhiza, integrated plant protection, rubber trees

FELDMANN, F. et al.

7. Utilization of va-mycorrhiza as a factor in integrated

plant protection.

Agriculture, Ecosystems and Environment, 29, 1989, pp. 131-135

The natural growth area of rubber trees is the tropical rainforest of Brazil in which very poor soils are present. In preliminary studies it was shown that rubber trees form a VA-mycorrhiza under natural growth conditions. The influence of VAM on plant pathogen interactions has been studied for a number of plants but rarely on woody plant species and therefore no conclusive data for trees like Hevea brasiliensis are available. Young Hevea trees reveal a rhythmical growth pattern, in which leaf flushing occurs. Leaves are produced every 6 to 8 weeks and need about 4 weeks for maturation. Within this phase four developmental stages (A to D) can be distinguished by morphological characteristics.

The leaves are showing an expressed leaf age resistance to fungal attack. Stages A and B are generally susceptible to a high number of fungal pathogens, stage C is of intermediate resistance and stage D is not infectible by biotrophic leaf pathogens. In this study the influence of VAM inoculation, additionally to the indigenous VAM populations, plant growth, leaf development and resistance behaviour against Microcyclus ulei,the causal agent of the South American Leaf Blight, was evaluatd.

VA-mycorrhiza infected rubber trees reveal an increase in resistance against a foliar disease (South American Leaf Blight) caused by the ascomycete Microcyclus ulei. The lesion size and the production of spores of the pathogen were significantly lowered in VAM inoculated plants, whereas the number of lesions remained unchanged. This suggests that the resistance response of the plant is significantly influenced by VAM treatment and demonstrates that enhanced resistance is not due to inhibition of penetration or early growing phases of the pathogen but to the modification of late resistance responses.

The data presented here unequivocally show that the VAM-association causes physiological changes relevant to the resistance reactions in the leaves, even when no macroscopic modification of the plant can be seen.

The enhancement of the resistance of the plant along with the reduction of the pathogens spore production, here caused by a VAM-fungus, is an important epidemiological factor for the control of the South American Leaf Blight in rubber plantations of Brazil. The combination of VAM-inoculum with well designed plant management measures, crown budding, mixed cropping and the use of hyperparasites can lead to a complex system of integrated plant protection in Brazilian rubber cultivation.

1201 92 - 10/128

Plant protection

Asia, India, study, glasshouse, rice, leaf extracts, fungal pathogens

TEWARI, S.N. and M. NAYAK

8. Activity of four plant leaf extracts against three fungal pathogens of rice.

Trop. Agric. (Trinidad), 68, 4, 1991, pp. 373-375

With a view to countering obvious pollution problems in the environment and avoiding the toxic effects of synthetic chemicals on non-target organisms, investigations on exploiting pesticides of plant origin are becoming increasingly important in the field of plant pathology.

Fresh leaves of P. betle, O. sanctum, N. arbor-tristis and C. limon were collected, washed thoroughly in tap water and sterile distilled water, oven dried at 45 _ 2 C and ground to obtain 1 kg dry powder from each.

Each powder was extracted with 95% ethanol and concentrated through a rotary vacuum pump flash-evaporator to a syrupy form weighing 130 g from each powder.

The plants were selected for the present study to screen against the major fungal pathogens of rice in vitro and in vivo.

The leaf extracts were effective in reducing the radial in vitro growth was found to be the best, followed of the pathogens and in checking the spread of blast, brown spot and sheath blight diseases of rice in vivo.

Though the leaf extracts from the other two plant species tested (N. arbor-tristis and C. limon) reduced the radial growth of the pathogens in vitro at a higher concentration, they failed to check their spread effectively in the glasshouse. P. betle and O. sanctum could be used as source of a pesticide of plant origin to combat the above three pathogens of rice in the field.

This is the first record for the control of three rice diseases in vivo using P. betle or O. sanctum leaf extracts.

Much of the plant kingdom still remains unexplored for possible exploitation against major fungal pathogens.

1202 92 - 10/129

Plant protection

Study, cassava, pathogens, biocontrol, CIAT

LOZANO, J.C.

9. A useful approach to the biocontrol of cassava pathogens.

In: Proc. of a Workshop for Integrated Pest Management of Root and Tuber Crops in the Tropics; IITA, Ibadan, Nigeria; Eds. Hahn and Caveness; 1987, pp. 86-94

This paper summarizes the research results obtained during the past 12 years on cassava pathogens, with emphasis on the use of fluorescent pseudomonads as biocontrol agents in different cassava production systems.

Investigations on biocontrol of crop diseases are increasing and are being seriously considered in many plant pathology programs around the world.

Research on the biocontrol of cassava pathogens was initiated at CIAT in 1975. Preliminary results are very encouraging, suggesting a useful, practical tool for controlling several pathological problems of cassava.

Darluca filum reduces disease severity and economic losses caused by Uromyces spp., a rust pathogen. Spray treatments with suspensions of Pseudomonas putida and P. fluorescens have reduced both number of angular leaf spots and leaf blights on susceptible cassava clones, and increased yields 2.7 times over untreated controls. Similar control treatments protected cassava cuttings against Diplodia manihotis and roots against postharvest root rot for 15 days in storage.

More investigation is needed into the practical storage of strains of fluorescent pseudomonads and into the distribution and multiplication of inoculum. Effective strains of these beneficial bacteria are available, and the methodology for their identification is known. Inoculating cuttings with bacteria is feasible in special situations, such as planting fields for material production, in order to control pathogens infesting the cuttings, and to protect against pathogens in infested soils. This technology may not be useful in traditional cassava production systems because the treatment requires technical work and aseptic handling during the production of the inoculum. Further research is also needed on the use of beneficial bacterial suspensions to treat cassava roots before storage in order to identify effective strains and develop treatment systems, giving levels of control similar to those obtained with thiabedazole. A likely development in the near future will be the use of growth-stimulating strains of fluorescent pseudomonads to treat both cuttings or plantlets before planting, for the promotion of root system growth.

1203 92 - 10/130

Plant protection

Africa, Egypt, study, faba bean, Orobanche, trap crop, flax

KHALAF, K.A.

10. Evaluation of the biological activity of flax as a trap crop against orobanche parasitism of vicia faba.

Trop. Agric. (Trinidad), 69, 1, 1992, pp. 35-38

The objective of the present work was to study the efficiency of flax as a trap crop in reducing Orobanche infestation on Vicia faba and the growth stages at which the stimulating germination factor was found in flax.

Crop species which stimulate germination in the seeds of parasitic plants, but are not themselves parasitized, are known as trap crops. In this respect, many investigations have reported that flax, a non-host, is regarded as a crop well suited for the control of Orobanche parasitism under field conditions because it is capable of including the seeds of Orobanche spp. to germinate, without itself being parasitized.

Three Orobanche species, O. crenata, O. ramosa and O. aegytiaca, failed to infect flax roots (Linum usitatissimum) at 30, 45 and 60 days from sowing, but heavy infection was observed with O. crenata on faba bean roots (Vicia faba) at 45 and 60 days from sowing. Flax seed exudates markedly induced the germination of O. crenata and O. ramosa in vitro; germination in O. crenata was much higher (75%) than in O. ramosa (16.6%).

The present work indicates that a stimulant exists in the flax crop non-host at the germination stage only (the first eight days after sowing). Flax roots free of infection by the three Orobanche spp. (O. crenata, O. ramosa and O. aegyptiaca) might be associated with the absence of the active material during the later course of the plant development, or with its fibre root anatomy.

The important views emerging from the present study are that the flax germination stimulus is formed during metabolic seed germination, and is characterized by possessing a broad spectrum of germination activity on numerous parasitic weeds and/or the flax exudates might contain more than one stimulant which differed in their biological response.

Ultimately, such response might support the view that although the flax plants showed a substantial influence in stimulating different parasitic seeds (Orobanche spp. and Striga spp.) in vitro, the flax plants have limited influence in reducing these parasitic weeds under field conditions, since the flax plants secrete the active material in a very limited period (germination stage).

Concluding, flax plants being used as a trap crop for controlling

Orobanche parasitism on faba bean and other hosts must be considered impractical to a large extent under field conditions, since the flax plant exudate the active material only during the germination period.

1204 92 - 10/131

Plant protection

Review, book, insect pest management, integrated pest management, research, monitoring, forecasting, yield loss assessment, insecticides, application methods, economics, agronomic practices, host plant resistance, natural enemies, biological control, quarantine

DENT, D.

11. Insect pest management.

CAB International, Wallingford Oxon OX10 8DE, UK, ISBN 0-851-98-66-8, 1991, 604 pp.

Pest control is probably the single most important factor in maintaining yield in modern farming practice. Pest problems may arise from any number of reasons, such as the adoption of a new farming technique, irrigation, cultivation of a new crop or even insecticide resistance or secondary pest outbreaks. The fact that crops come under attack from so many different types of pest is an additional problem that farmers and pest management specialists have to cope with.

Insect pest management focuses on dealing with insects only, but still recognizes that this is one of many groups of pests that have to be controlled. The book starts with an introduction to Integrated Pest Management (IPM), looking at social and economic factors, as well as research, monitoring and forecasting, yield loss assessment and all forms of control. There is detailed information about a range of insecticides, methodes of application, economic viability, ease of use, targeting and safety.

Cultural controls which need no external input, such as crop rotation, tillage practices and planting date, are examined in detail and shown to be worthwhile practices, as long as they are executed correctly and not relied on too heavily as the sole means of pest control. There are chapters on host plant resistance, natural enemies and classical biological control, interference und quarantine. The final part of the book examines how these techniques can be integrated into an insect pest management programme.

Designed to serve as a textbook, this book provides in-depth coverage of crop protection and applied entomology. Emphasis is placed throughout on the need for socio-economic evaluation of integrated pest management techniques, and detailed examples are taken from both temperate and tropical regions.

This is an useful book for all those working in plant production in general and crop protection in particular.

1205 92 - 10/132

Plant protection

Review, pest management, agricultural development, economics

REICHELDERFER, K.H.

12. Economic contributions of pest management to agricultural development.

Tropical Pest Management, 35, (3), 1989, pp. 248-251

This article focuses on the contribution of pest control inputs and pest management skills to the transformation of traditional agriculture. The topic is covered in a general manner because little empirical evidence is available for use in providing specific illustrations of general relationships.

Increased use of pesticides in developing economies has been associated with an increased incidence of acute pesticide poisonings and potential for chronic health effects, as well as contamination of food and water supplies. These adverse impacts of pesticide use can become a constraint to agricultural development.

Acute and chronic health effects reduce the productivity of the agricultural labour force, thus limiting labour's contribution to agricultural development. High exposure rates to toxic chemicals by the population at large may also reduce the productivity of the urban labour force and limit economic growth. Environmental contamination can reduce the productivity of land - the most basic of production inputs.

Management strategies which lead to the development of pesticide resistance depreciate the value of the crop protection input itself.

Agricultural development and environmental quality are not necessarily incompatible. Protection of the human and natural resource bases is a prerequisite for sustainable growth and development. The principal factor determining whether development efforts lead to environmental degradation or conservation is the focus of agricultural policies and programs.

Access to material inputs, such as pesticides, cannot foster growth and development. Concurrent attention to the development of pesticide safety and pest management skills is required to prevent these inputs from becoming limiting factors for economic growth.

Ideally, the production protection, safety, and environmental aspects of pest control should be simultaneously addressed at early stages of agricultural development. This can only be achieved by increasing farmers' awareness and understanding of the pest control opportunities afforded them, while implementing policies and programs that preclude a unilateral approach to crop production, protection, or environmental quality.

1206 92 - 10/133

Plant protection

Latin America, Colombia, integrated plant protection, inter cropping, predator, cassava whitefly

GOLD, D.S. and M.A. ALTIERI

13. The effects of intercropping and mixed varieties of predators and parasitoids of cassava whiteflies (hemiptera: aleyrodidae) in Colombia.

Bull. ent. Res., 79, 1989, pp. 115-121

In this paper, the responses of natural enemies of cassava whiteflies to different cropping systems and their role in bringing about reduced whitefly load in cassava intercropped with cowpea are reported.

In this regard, the effects of different cropping systems on the whitefly predator Delphastus pusillus (Le Conte) and on the combined action of the parasitoides Amitus aleurodinus Haldeman and Eretmocerus aleyrodiphaga (Risbec) are discussed.

The predator D. pusillus was low in numbers during the intercrop period and was significantly lower in cassava-cowpea plots than in other treatments for much of the trial. Correlation analysis of predators and prey indicated that the beetles displayed a functional response. D. pusillus was abundant for many months but was unable to control whitefly populations. Ratios of whiteflies to predators coupled with information on prey consumption suggest that predators played only a minor role in whitefly population dynamics. Bettle arrival in the field lagged behind that of the whiteflies, and the highest populations of D. pusillus were in the final month of the trial, reflecting a lack of synchronicity between predator and prey.

D. pusillus attacks a range of whitefly species, but within the systems employed in this study it can be considered a relative specialist because neither cowpea nor maize provided alternative hosts. D. pusillus was never observed on the associated crops, suggesting that they did not provide nectar or pollen to this bettle. However, the presence of cowpea and maize intercrops may have enhanced the activity of this predator. A functional response strongly suggested by beetle distribution in the postintercrop period was not in evidence when intercrops were in the field, and predator: prey ratios were highest in cassava-cowpea systems at this time.

Parasitism of A. socialis was a far more important mortality factor than predation. The role of parasitism in this species was even more important on CMC 40, where predator populations were very low, than on MCOL 2257. Rates of combined parasitism of A. socialis by Amitus aleurodinus and E. aleyrodiphaga were equal between treatments. Overall mortality of the pupal stage was also similar across cropping systems.

Parasitism of T. variabilis was negligible, and for this whitefly D. pusillus was the most important natural enemy.

Intercropping cassava with cowpea reduced populations of the cassava whiteflies Aleurotrachelus socialis and T. variabilis. The effect of the intercrop was residual, with lower populations persisting for six months after cowpea harvest. However, predators were opportunistic, with higher populations correlated with greater numbers of prey in monocultures.

Parasitism levels were independent of cropping system. Therefore, the natural enemies hypothesis can be rejected in explaining the lower populations of whiteflies found on intercropped cassava. Furthermore, the residual effect of the cowpea intercrop on whitefly populations cannot be explained by a build-up of natural enemies in this system during the intercrop period.

A. socialis and T. variabilis larvae suffered substantial mortality in addition to the effects of predators.

Differences in whitefly populations in various cropping systems, including residual effects, cannot be attributed to mortality factors.

In this regard, the effects of different cropping systems on the whitefly predator Delphastus pusillus (Le Conte) and on the combined action of the parasitoids Amitus aleurodinus Haldeman and Eretmocerus aleyrodiphaga (Risbec) are discussed.

1207 92 - 10/134

Plant protection

Africa, Nigeria, study, rain forest belt, lowlands, root crops, diseases, integrated pest management, traditional methods, agronomic practices, IITA

ODURO, K.A. et al.

14. Prospects for traditional and cultural practices in integrated pest management of some root crop diseases in rivers state, Nigeria.

In: Proc. of a Workshop for Integrated Pest Management of Root and Tuber Crops in the Tropics; IITA, Ibadan, Nigeria, 1987, pp. 185-187

In this paper evaluation was made of the role of traditional and cultural practices in controlling yam storage rot and cassava stem cutting rot in the soil in Rivers State.

Rivers State lies in the lowland rain forest belt of south-eastern Nigeria. The environment also creates favorable conditions for the development and spread of numerous plant pathogens.

Healthy, fairly uniformly-sized and newly harvested whole yam (Dioscorea rotundata var. Gboko) and palm oil were purchased from the local markets. Five of the yams were cut transversely into ten equal halves.

Each of the ten cut surfaces was thoroughly smeared with 5 ml unsterilized palm oil and kept in an upright position for about 60 min to prevent the oil from dripping. To serve as the control, the remaining five tubers were similarly cut but the surfaces were left untreated.

They were also held in a vertical position for 60 min.

All the tubers were later randomly spaced horizontally inside a wire-netted wooden box in the laboratory for protection against cockroaches and rodent attack. Observations were made of biodeterioration in the yam samples and at the end of 10 weeks each half-tuber was cut vertically into two to measure the depth of rotting.

Yam tubers which were treated with unsterilized palm oil resulted in less rotting by supporting fewer pathogens and by preventing formation of cracks which could serve as entry points for pathogens. Thus palm oil apparently had properties which protected stored yam tubers from rot.

Concluding the traditional and cultural control of the root crop diseases discussed in this paper could be adopted to supplement other control measures in farms and stores. These methods are cheap and feasible and within reach of peasant farmers.

1208 92 - 10/135

Plant protection

Africa, Nigeria, IITA, survey, cowpea, farming practices, insect pest control

ALGHALI, A.M.

15. Studies on cowpea farming practices in nigeria, with emphasis on insect pest control.

Trop. Pest Management, 37, (1), 1991, pp. 71-74

This survey was undertaken to gain an insight into current farming practices for cowpea, and to understand farmers' perceptions of the impact of insects on cowpea production, thus facilitating the development of appropriate IPM strategies that would be economic, efficient and feasible.

Cowpea was grown on smallholdings, mostly as an intercrop.

In the intercrop plots the proportion of cowpea was mostly below 50%; it was grown either for grain or fodder or both. Most of the grains were for household consumption and the small excess sold in the market. Cowpea haulm was used as fodder for feeding animals and livestock. This would suggest that cowpea as currently grown is a secondary crop requiring low inputs.

There is a large deficit for cowpea grains, particularly in southern

Nigeria where it is an important component of human diets. This deficit is offset by imports from the north, and from neighbouring countries such as Chad, Cameroun and Niger. Cowpea can be grown throughout Nigeria, and the potential for increasing yields on farmers' fields is enormous. A major constraint limiting grain yields was identified by the farmers as insect pests. But the farmers were incapable of taking positive action against the pests for various reasons. These included lack of capital to purchase costly inputs, access to improved seeds with some levels of resistance to insect pests, and lack of education on pest problems and control measures. Therefore, a rational pest control approach should be integrative and include:

- educating the farmers about available control tactics;

- identifying and developing IPM strategies that are low cost;

- creating an awareness in regional administrations of the necessity for IPM inputs to be readily available and affordable.

Most of the farmers interviewed planted their cowpea as intercrops with other food crops. The majority of farmers were unaware of the beneficial implications this may have for insect pest management. If cowpea production remains at subsistence level, with low inputs, farmers should be encouraged to continue with this cropping system, i.e. intercropping.

In Minjibirr, 80% of the farmers interviewed reported that cowpea was grown for fodder to feed cattle and livestock. In the Sudan savannah, with little and infrequent rainfail, vegetation for livestock feed is hard to get. The inhabitants in this area keep large herds of livestock and wander over long distances in search of feed during the dry periods.

Therefore, fodder from crop residues is very important for the inhabitants. The emphasis on fodder in this area is in conflict with IPM practices aimed at increasing grain production. Several workers have shown that cowpea plants become more vegetative as a result of insect attack in the early growth stages. Hence, more fodder is produced when the plants are damaged by insect pests. Therefore, in breeding cowpea cultivars for this area, emphasis should be on dual purpose for both grains and fodder, and pest control strategies should focus less on reducing direct insect damage. The focus should be on selecting cultivars with ability to compensate vegetatively for damage, and also translate some of their compensatory vegetation into grain yields, thus providing moderate fodder and grain yields. The farmers' preference for early-maturing cowpea in this area minimizes crop hazards resulting from the sparse and erratic rainfall.

1209 92 - 10/136

Plant protection

Africa, Senegal, field trial, pearl millet, insect pests, fertilizer, FAO, USAID, CILSS

GAHUKAR, R.T.

16. Effect of various fertilizers and rates on insect pest/pearl millet relationship in Senegal.

Trop. Agric. (Trinidad), 69, 2, 1992, pp. 149-152

The work described in this paper was done in Senegal to study the relationship between infestation of stalk borer and spike worm and fertilizer application in traditional and improved pearl millet cultivars.

At present, economical and practical control measures are not available.

Studies on the effectiveness and uses of cultural practices, resistant cultivars and natural enemies had been initiated. Among agronomic practices, application of chemical fertilizer is often used on high-yielding cultivars.

Experiments were conducted on a sandy-loam soil in a randomized block design with four replicates.

Application of complete fertilizer at 50-300 kg ha-1 to two pearl millet cultivars, Souna and IBV-8001, or urea at 50-200 kg ha-1 to cv. Souna, resulted in significantly increased levels of stalk infestation and larval abundance of the stalk borer, but superphosphate when applied at 50-200 kg ha-1 reduced stalk infestation. Urea applications reduced spike infestation caused by the spike worm, and larval numbers were lower in plots receiving urea or superphosphate than in non-fertilized plots.

Stalk borer incidence was greatest in plots receiving nitrogenous or complete fertilizer which may have caused the stalks to be more liable to attack.

Urea fertilization resulted in less spike damage and lower abundance of H. albipunctella larvae and superphosphate reduced only larval densities.

In Senegal, the pearl millet crop is systematically rotated with groundnut in some regions and nitrogenous fertilizer is generally not applied to the next crop after the legume. Application of complete or nitrogenous fertilizer may be avoided in southern regions where stalk borer attack is often severe, whereas these fertilizers would be advantageous in central and northern Senegal because spike worm is an economically important pest. At present, fertilizers are supplied by Government at subsidized prices or free of cost to farmers. The cost should be an important consideration in forthcoming recommendations because pearl millet is a subsistence crop in the Sahel. Thus, the influence of fertilizer application on insect abundance and plant damage should be considered in pest management strategies, particularly in improved/introduced high-yielding cultivars which are being tested in multilocational trials prior to their release to growers.

1210 92 - 10/137

Plant protection

Asia, India, study, survey, intercropping, agroforestry, oil palm, insect pests

DHILEEPAN, K.

17. Insect pests of intercrops and their potential to infest oil palm in an oil-palm-based agroforestry system in India.

Trop. Pest Management, 37, 1991, pp. 57-58

In the present study insect pests of various intercrops in the oil-palm-based agroforestry system were surveyed and their potential to infest oil palm was assessed.

The oil palm is usually grown as a monocrop. In small oil palm holdings the available wide interspace (9 m x 9 m) is used for interplanting of various shade-loving food crops. Similarly, interplanting of perennial crops such as cacao, coffee and rubber with oil palm has also been attempted. Intercropping of various forest trees such as Albizzia,

Eucalyptus, Casuarina and Australian black wood, as well as cacao with oil palm in an oil-palm-based agroforestry system, was initiated.

The major problem in growing intercrops with oil palm is that they are susceptible to attack by a wide range of insect pests. There should be no risk of an intercrop pest attacking the oil palm and developing into a problem.

An on-going oil-palm-based agroforestry trial was surveyed at monthly intervals between 1985 and 1988, and the insect pests of intercrops as well as oil palm were recorded.

Among the seven species of crops grown as intercrops with oil palm, no pest incidence was noticed on Eucalyptus and Australian black wood. Pest incidence was noticed in all the other intercrops, and the attack was f.e. greater in cacao and Albizzia. In Casuarina the incidence of insect pests was occasional and less severe.

Insect pests of intercrops such as Albizzia and Casuarina are host-specific and do not infest oil palm.

Among the seven species of intercrops only cacao shared a common pest complex with oil palm.

1211 92 - 10/138

Plant protection

Asia, Philippines, IRRI, rice, weather, forecasting, insect pest outbreaks

PERFECT, T.J.

18. Using weather data to forecast insect pest outbreaks.

In: Proceed. of the Int. Workshop on the Impact of Weather Parameters on Growth and Yield of Rice, IRRI, Philippines, 1987, pp. 139-146

In this paper it is examined how weather influences the bionomics of migrant pests and the application of this examination to forecasting outbreaks is discussed. The situation for rice pests is considered, particularly the application of weather data to forecasting outbreaks of brown planthopper.

The development of forecasting systems to manage outbreaks of migrant pests is becoming increasingly important. Such systems normally are based on integrating meteorological and entomological data into a conceptual model that relates the probability of occurrence of outbreaks to a particular series of events which can be monitored. The advantages of this approach to forecasting are both tactical and strategical: those concerned with pest control can plan ahead to ensure that appropriate resources and the means to deploy them effectively are available where and when they will be needed. A strategic advantage of major importance is the potential for limiting the spread of outbreaks through timely control of early infestations, reducing the production of further migrants.

The author states that there is great potential for using weather data to forecast outbreaks of insect pests, particularly because other ability to access and process information from remote-sensing systems is increasing rapidly.

It appears that weather parameters are a critical factor in outbreak development, and thus a good predictor, only in situations where they represent a population-limiting factor. This is seen most frequently with temperature in the temperate zone and rainfall in the tropics.

In many situations, weather may play a very important part in determining the precise epidemiology of an outbreak, although it is not in itself a determinant of the outbreak. Rice leafhoppers and planthoppers and the virus diseases they transmit are an example.

The study of weather systems against the background of the ecology, behavior, and physiology of the insect pest and the distribution of the host plant can lead to improved predictions of dispersal patterns. This type of information can be of value in developing appropriate management strategies. The development of computer-based migration and population models for particular insects will be important in exploiting that forecasting potential.

1212 92 - 10/139

Plant protection

Africa, Kenya, insect pest management, survey, sorghum, maize, cowpea, crop borer, intercropping, agronomical practices, plant resistance, biological control farmer, socio-economic conditions

SAXENA, K.N. et al.

19. Insect pest management and socio-economic circumstances of small-scale farmers for food crop

production in western Kenya: a case study.

Insect Sci. Applic., 10, 4, 1989, pp. 443-462

The survey reported here involved interviews with 150 farmers in Western Kenya and was based on a questionnaire which comprised six sections.

Five sections covered the farmers' background, farming practices, pest problems and their control, socio-economic conditions, and accessibility/willingness of the farmers to participate in the project.

The last section included field observations on the insect pests of sorghum, maize and cowpea.

On the basis of the information obtained on above-mentioned aspects, criteria were defined for selecting 25 farmers in each division for on-farm trials.

Concluding, the following measures that need to be taken to counter the limitations and thereby assist the farmers in increasing food production can be recommended:

- Cultural practices like early planting, intercropping of appropriate crop combinations and destruction of crop residues help to suppress borer attack.

- Destruction of crop residues, though practised by some farmers, is not practised by the others, either because they are not aware of the advantage for pest control or because they use the crop residues in other ways. It is, therefore, important that the farmers in the project area are fully informed about the benefit of proper disposal of crop residues.

- Growing cultivars resistant or tolerant to pests is another important and widely accepted component of insect pest management. But most of the cultivars in use have little resistance to the borers.

There is an urgent need to make the farmers fully aware of the existence of resistant cultivars and to provide seed for cultivation.

- Pesticides are hardly used by most farmers in the project area. In view of their hazardous effects, and the dangers of misuse due to poor information, their use by the farmers should be discouraged.

1213 92 - 10/140

Plant protection

Latin America, Mexico, study, semi-arid zone, highlands, agroecosystems, rodent communities

MELLINK, E.

20. Rodent communities associated with three traditional agroecosystems in the San Luis potosi plateau, Mexico.

Agriculture, Ecosystems and Environment, 33, 1991, pp. 363-375

This paper analyzes the rodent richness and abundance of the farmed and unfarmed areas of three agroecosystems in the San Luis Potosi Plateau, Mexico.

Increases in weed cover are generally associated with increases in rodent richness. Farms with weedy vegetation between buildings were found to hold larger and more diverse rodent populations than clean farms.

The variation in the rodent communities of agroecosystems is due to the structural differences of the latter. Understanding the relationship between the characteristics of the agrohabitats and the rodent communities should be useful for developing new principles of environmental management which must be the basis of new methods of rodent pest regulation.

The following conclusions can be drawn from this study:

- The simple agroecosystems had fewer species than their unfarmed counterparts, in contrast with the most diverse agroecosystem where no impoverishment occured. Only the simple system with abundant resources was subject to a population outbreak. This supports the hypotheses of structural heterogeneity-diversity and diversity-stability. The adoption of diverse agroecosystems might help to reduce rodent pest outbreaks.

- There was no clear edge effect. The edge was richer only when it included the structurally diverse agroecosystem and the very contrasting unfarmed area. Otherwise, it could be different only in numbers, due to a particular habitat found in the edge, but not as a result of the farming operation.

- The croplands had distinct rodent faunas, but although they tended to be more similar to each other than their unfarmed counterparts. No exclusive "farmland species" could be defined.

- Changes in the rodent communities could only be explained by a combination of multiple factors whose changes were a result of the rainfall pattern.

1214 92 - 10/141

Plant protection

Review, book, Africa, Zimbabwe, survey, grain storage losses, strategies, traditional methods

KETERERE, M. and D. GIGA

21. Grain storage losses in Zimbabwe.

ENDA, P.O.B. 3370, Dakar, Senegal, ISBN 0850-8526, 1991, 101 pp.

Within any rural region, the daily demand for food changes very little during any given year, but the food supply is seasonal and is very uneven on a month-to-month basis. Among other solutions, such as local food imports, storage is an important means of trying to match the uneven supply of food to demand. In areas where transport is poorly developed, storage is even more important.

The two strategies usually selected for coping with present and future demands of food are increasing food supplies by increasing production through allocation of more resources to agriculture, and reducing future demand by slowing population growth. A third, and complementary strategy, is that of reducing and preventing post-production food losses by improving the efficiency of storage. Reducing food losses means that less of the rural families' disposable income need be spent on food imports.

This book is the outcome of a survey of traditional farmers' grain storage in that country. It looks at methods of measuring damage during storage as well as measuring its reduction by improving storage facilities which nevertheless remain as close as possible to the traditional granary model. Results showed that farmers store maize for shorter periods because of high losses experienced as the storage period increases. The level of losses was also related to the type of grain being stored. Traditional maize varieties are more resistant to pest attack than hybrids and traditional storage structures were designed for traditional varieties. There is no point in encouraging farmers to grow improved, hybrid varieties in order to increase yields, if the extra yield is rapidly lost in storage.

The book ends with a number of recommendations, details of an improved traditional granary, and appendices which set out percentage damage against time after a variety of treatments.

Abstract from SPORE, altered.

1215 92 - 10/142

Plant protection

Review, USA, California, weed control, row crop systems, vegetable, flower

LEAP, J.

22. Controlling weeds without chemicals.

The Cultivar, 9, No. 2, 1991. pp. 1-3

Herbicides make up 69% of the 700 million pounds of pesticides applied each year in the U.S. Thus, finding alternative methods for controlling weeds is critical to decreasing the use of synthetic chemicals in farming systems.

Weeds can be controlled in small-scale vegetable row crop systems without the use of herbicides and with a minimum of hand hoeing by using an integrated approach. This includes well-managed ground preparation and planting techniques, and timely cultivations. Planting and cultivation techniques that large-scale growers have used successfully for many years can be easily adapted to small- and medium-scale systems for effective weed control.

Small-scale vegetable growers - especially those who are producing for direct-market, roadside, or specialty markets - often must produce a variety of products over a period of time to maintain a customer base and maintain diversity.

One of the best ways to deal with multiple crops on a small scale is to develop a system where all crops are planted on the same row width. The same planting and cultivating units can then be used for all crops without a loss in time due to change-over. A common technique, which can be traced back to the horse cultivar, is to plant cultivate on a single line per bed with beds spaced 30 to 38 inches center to center. This technique allows for the greatest crop diversity and ease of mechanical weed management in a ridge-tilled system. If beds are formed, pre-irrigated and then cultivated prior to planting, weed pressure can be minimized and planting and cultivation simplified.

Vegetable crops most suited to between-row spacings of 30 to 38 inches include sweet corn, beans, potatoes, peppers, broccoli, cauliflower and cabbage. With the proper planting equipment, sweet corn, beans and peas can be easily direct-seeded to moisture by knocking down the beds at planting time (this entails pushing dirt off of the top of the bed to reach moist soil; seeds planted into moist soil don't require irrigation for germination). Peppers, tomatoes and the brassicas mentioned above are ideally suited to transplanting, provided quality transplants are used. Tomatoes, which require a wider spacing, can be grown on every other bed and the same cultivation equipment used. If perennial weeds are not a serious problem, and with proper management, these crops can all be produced in a relatively weed-free system with minimal hand labour and no herbicides.

One of the most effective tools for post-irrigation bed preparation and post-emergence crop cultivation in a ridge-tilled system is the ground-driven rotary cultivator, also known as a lilliston cultivator.

For the initial cultivation, while the crop is still small, reversed disc-hillers can be used to cut soil away from the plants, and sweeps and knives can be used to cut weeds off just below the soil surface.

Timing in terms of weed size and soil moisture are critical at this stage for optimum weed suppression: ideally, weeds should be small and the soil dry enough to that weeds don't re-germinate, but moist enough to avoid crusting.

The following practices are the most important factors to include in a non-chemical weed control strategy:

- Allow an initial fallow period with repeated discing during summer months to bring perennial weed populations to manageable levels.

- Rotate cool-season and warm-season crops and rotate crops that compete well with weeds and those that are poor competitors.

- Prevent annual weed seed maturation in and around fields.

- Pre-irrigate after bedding-up to germinate weed seeds prior to planting.

- Carry out timely shallow cultivations to destroy weed seedlings during and after emergence.

- Plant to moisture to allow crops to get a jump on weeds.

- Transplant where practical to get a jump on weeds.

- Manage irrigation effectively.

By adhering to and integrating the above-mentioned agronomic practices, and by using rotary ground-driven cultivators in a single-line system, weeds in vegetable crops can be controlled effectively and economically without the use of herbicides.

1216 92 - 10/143

Plant protection

Review, book, weed management, ecological approaches

ALTIERI, M.A. and M. LIEBMANN

23. Weed management in agroecosystems: ecological

approaches.

CRC Press, USA, 1988, 354 pp. 15 pp. index

In this book nineteen authors explore many aspects of weed control without toxic herbicides. Altieri's usual comprehensive grasp notes not only impact of weeds, but also their uses and roles. Detailed description of weed physiology tied to ecological notations comes next.

Seed data: seed banks, viability, loss, sources, germination, density, timing are all tied to individually important seeds. How do weeds get here? What makes some so invasive? What kinds of environments trigger or spread them? What natural enemies do they have?

Genetics are the basis on how weeds adapt to their environment.

Allelopathy makes a strong impact; many weeds utilize this trait, but the trait may be turned against them, too. Techniques for this are discussed.

Consider environmental factors. What does water do, or light, or availability of nutrients? Then there are indirect effects of light, temperature, evaporating moisture, changes in nutrients, allelopathy interactions, changes in soil microorganisms.

Vegetation can be analyzed, so one can see that there is a set pattern of change in plants, and a choice of crops successions, rotations, harvesting equipment, drainage decisions, tilling times and depths.

Take a look at the farmer's point of view. Just how much damage comes from weeds? How can you lessen this? What techniques really work and where? Is there a way to get some good out of weeds?

What are the commercially available biological controls? Many are not yet on the market, or are still being studied. Insect response is another item; it is not always true that a diversified ecosystems has fewer pests. A pest may need 2 hosts, so a weed is not always to blame, nor the primary host. You may be thankful for some weeds that house natural enemies.

The last chapters concentrate on organic methods of weed control, special strategies for small scale farming and general guidelines.

This book is crowded with valuable hints.

This is a book one must have.

Abstract by Bargyla Reteaver.

1217 92 - 10/144

Plant protection

Review, book, post-harvest grain losses, GTZ

GWINNER, J. et al.

24. Manual on the prevention of post-harvest grain losses.

Publ. of GTZ, Postf. 5180, D-6232 Eschborn 1, Germany, 1990, 294 pp.

The knowledge and experience accumulated in over a decade of advisory work by the GTZ Post-Harvest Project has now been collected and summarized in a new handbook, 'Manual on the prevention of post-harvest grain losses'. This has been written to provide practical instruction and assistance to storekeepers, plant protection technicians, agricultural extension and quarantine staff and all those who are concerned with storage problems in their daily work. Particular attention has been paid to the storage of cereals and legumes.

Throughout the book, simple, low-cost facilities and storage methods have been described, appropriate to the requirements of developing countries.

In recent decades significant changes have taken place as a result of increased crop yields, the cultivation of new varieties that are often more susceptible to attack by storage pests than traditional ones, and the spread of new pests. These changes have diminished the effectiveness of established storage systems and there is now a need to adapt traditional practices and develop new alternatives. This handbook provides a practical link between old and new ideas.

The effects on stored produce of different climatic conditions, such as temperature and relative humidity, are explained. Farm and village level storage containers and buildings are described and illustrated as well as the construction of larger, centralized storage and stacking systems.

There are details of the fungi and insects which damage stored crops, together with methods of control by insecticides, fumigation and integrated pest management techniques. Particular attention is given throughout to the safety measures which must be taken when using chemicals. The manual ends by addressing the problems of dealing with larger pests, such as rats.

1218 92 - 10/145

Plant protection

Asia, India, field trials, weed management systems, manual, chemical, biological, pigeonpea, economics, sole crop, intercropping

MADHIYAZHAGAN, R.

25. Evaluation of efficient weed management systems in pigeonpea (cajanus cajan l.)

J. Agronomy & Crop Science, 168, 1992, pp. 65-68

An investigation was undertaken to evolve effective and economic weed management practices for the sole and for intercropping systems involving pigeonpea. Field experiments were conducted to evaluate the different systems of weed management in pigeonpea.

Treatments consisted of three weed management systems namely manual (hand hoeing twice at 20 and 40 DAS) chemicals (fluchloralin, pendimethalin and oxadiazon) supplemented with one hand hoeing and biological (growing inter crops) combined with one hoeing along with unweeded check numbering twelve treatments replicated four times in randomized block design.

The results clearly show that the unweeded check plots recorded the highest total weed population of 132 and 165 m-2 respectively. At the early stages of observations there was significant reduction in weed population over unweeded check under the treatments receiving herbicides. The manual method of weed control was consistently weed free throughout the crop period. Among the three herbicides pendimethalin 0.50 kg ai ha-1 was superior to fluchloralin and oxadiazon in reducing the total weed population. Intercropping combined with one hand hoeing significantly reduced the weed population over intercropping alone.

The results clearly indicate that the highest grain yield was recorded under herbicide treated plots over unweeded check.

The severe weed competition in the unweeded check was responsible for the low yield in pigeonpea. Manual weed control method is as effective as chemical methods. However, the herbicides are more effective in controlling the weeds at the early stages of the crop growth.

Pre-emergence application of pendimethalin 0.50 kg ha-1 with hand hoeing registered the highest grain yield compared with other herbicides.

The highest net return of Rs. 6483 and Rs. 5231 was realised by the intercropping of pigeonpea coupled with one initial hoeing. Among the herbicides tested pendimethalin 0.50 kg ha-1 supplemented with one hand hoeing fetched the net return of Rs. 5024 and Rs. 4450 ha-1 during two seasons respectively.

1219 92 - 10/146

Plant protection

Latin America, Peru, humid tropics, study, weed management, cropping systems, low-input system, herbicides, mulches, shifting cultivation, forest clearing

PLEASANT, J.M.

26. Weed management in a low-input cropping system in the Peruvian Amazon region.

Trop. Agric. (Trinidad), 69, 3, 1992, pp. 250-258

A weed-control study in a five-crop sequence (rice-rice-cowpea-rice-cowpea) following forest clearing in the Peruvian

Amazon was carried out.

Previous work has established that continuous cropping systems in the Peruvian Amazon are viable alternatives to shifting cultivation if appropriate amounts of lime and fertilizers are supplied. Herbicides have provided effective but costly weed control in these intensively managed (high-input) systems.

Low input systems are based on acid-tolerant cultivars and rely on moderate amounts of fertilizers and careful recycling of crop residues to maintain soil fertility. But weed control in this management system poses special problems. Complete reliance on herbicides is unacceptable because of the cost, and hand labour is often unavailable.

Weed control in a low-input system must focus on cultural practices that increase the crop's ability to compete with weeds and thereby eliminate some of thecostly control measures needed to maintain yields.

The results of this study revealed that tilled plots had more weeds than untilled in the first crop but fewer in the fifth. Mulching residues had little weed-controlling effect, and crop yields were always higher when residues where incorporated. High planting density reduced weed levels and increased crop yields. Herbicides were as effective as hand weeding in controlling weeds, but herbicide costs sharply limit their use in low-input systems. Rice yields fell by 54-100% in the absence of weed control but were reduced by less than 30% for cowpea. Sedges comprised 84% of the weeds in the first crop following forest clearing, but grasses dominated (79%) in the fifth crop.

As has been shown in other environments a practical and effective weed-management programme for continuously cropped systems must combine cultural practices with chemical and manual methods of control. The observations suggest that a similar integration of control measures is needed during this transitional period that bridges the time-span between forested land and the cultivatable fields of a permanent agriculture.

1220 92 - 10/147

Plant protection

Latin America, Mexico, weed control methods, crop rotations, maize, bean, intercropping

CHAVEZ, C.M.

27. Poblaciones, biomasa y banco de semillas de arvenses en cultivos de maiz zea mays l. Y frijol phaseolus vulgaris l. Efecto de m+todos de control y

rotaciones. (Weed population, biomass, and seed bank in maize and bean crops. Effects of control methods and crop rotations).

Tesis Maestria, Chapingo, Mexico, Colegio de Postgraduados, 1987, 192 pp.

The changes in weed population and groups in maize, beans, and maize/beans in rotation were assessed for the 4th consecutive yr, using 3 weed control measures:

- chemical control (linuron plus alachlor) in beans and atrazione plus metolachlor in maize;
- mechanical control (hoeing), and
- unweeded check.

In 1982 and 1983, Amaranthus hybridus was the dominant species as to population and DM, but in 1984 and 1985 Simsia amplexicaulis dominated.

In 1985 (the 4th yr), S. amplexicaulis and the group of Gramineae were the most abundant under chemical control and Simsia and Chenopodium album in the unweeded check. Total DM of these species at crop harvest accounted for approx. 87 percent of total weed DM. Under mechanical control, the most abundant species were Galinsoga parviflora and the group of Gramineae, represented by Eleusine multiflora, Eragrostis mexicana spp. mexicana, and Cynodon dactylon; the DM of the group accounted for approx. 35 percent of total weed DM. Parameters used to evaluate the structure of the group of Gramineae were species diversity and equity. Forty-four species (7 more than in previous yr) were recorded. Results of diversity and equity indicated that the structure of the group was unaltered by weed control methods, since greater diversity occured under mechanical control and less diversity in the unweeded check. The highest bean seed yield was registered under mechanical control. The highest maize yield was obtained in the rotational scheme, yield increase being attributed to the increased soil fertility resulting from soil-N fixation by beans planted in the previous cycle. The highest density and wt. of weeds was registered in beans; competition therefore affected this crop more than it affected maize. Amaranthus and Chenopodium were the most abundant species found in the soil of the seed bank. The correlation between the no. of seeds in the soil with the no. of seedlings that emerged indicated a correlation between Eleusine seeds in bean and maize plantings (P less than 0.01); a correlation was also found between Simsia seeds in bean crops (P less than 0.05), indicating that it is possible to predict the presence of weeds in these crops.

1221 92 - 10/148

Plant protection

Africa, Nigeria, study, weed control, cassava, maize, cowpea, melon, groundnut, intercropping

ZUOFA, K. et al.

28. Effects of groundnut, cowpea and melon on weed control and yields of intercropped cassava and maize.

Field Crops Research, 28, 1992, pp. 309-314

The objective of this study was to examine the effectiveness of groundnut, cowpea and melon as smother crops in the control of weeds in a cassava/maize mixture.

The traditional method used by peasant farmers to control weeds is hoeing, using household labour since hiring labour is expensive. For such farmers, use of herbicides is hampered by high cost and non-availability of chemicals. It is therefore imperative to find alternative methods of weed control acceptable to them.

Groundnut, cowpea and melon could serve as smother crops, help to reduce erosion, improve yield of crops, enhance the nutritional status of the growers' diet and bring additional income. Their ability to suppress weeds depends on cultivar, plant density, rate of growth and establishment of canopy cover, competitive ability, and fertility and moisture status of the soil.

The experiment discussed here consisted of three crops (Groundnut cv. DS 569, Cowpea cv. Ife Brown, and Melon cv. Western Local), each grown at two populations (20,000 and 40,000 plants ha-1) with cassava + maize intercrop together with controls of cassava + maize intercrop and sole crops of each species.

The results show that intercropping cassava and maize with

20,000 plants ha-1 of smother crops gave the best weed control, highest total yields and land equivalent ratio.

At the higher population, not only vegetative growth but also seed yields were reduced.

Of the three smother crops, groundnut gave the best weed control, followed by cowpea and melon, although the differences observed in the weed weight were not significant.

Yield of sole cassava was significantly higher than that of intercropped cassava in the early season. Generally, intercropping reduced yield of cassava with or without smother crops in both seasons. For maize, there was a general increase in intercrop yield over that of the sole crop when smother crops were included in the mixture in the late season. In the early season, maize yield increased only when 20,000 groundnut plants ha-1 were used as the smother crop.

Intercropping cassava and maize with smother crops improved the yields of both crops over when they were intercropped without smother crops.

This was probably due to better weed control achieved by the presence of the smother crops.

Further studies would be required to determine if such increases are due only to better weed control or also to better nutrient uptake or water conservation.

Considering only land-equivalent ratio (LER), there was a yield advantage in intercropping, and up to 55% and 104% more land would be required under sole crops to produce the yields achieved in mixtures in the early and late planting seasons, respectively.

Based on these results, 20,000 plants of groundnut, cowpea or melon ha-1 can be used as smother crop in cassava + maize mixture to give good weed control and high mixture yield.

1222 92 - 10/149

Plant protection

Africa, Ethiopia, weed control, intercropping, bean

ABATE, T.

29. Intercropping and weeding: effects on some natural enemies of African bollworm, heliothis armigera (hbn.) (lep., Noctuidae), in bean fields.

J. Appl. Ent., 112, 1991, pp. 38-42

Intercropping is an age-old practice that has been used by subsistence farmers in the tropics to suppress pests and to increase crop yield. One advantage of diverse environments, such as intercropped and weedy fields, is that they result in greater natural enemy numbers because they provide shelter and alternative food sources for natural enemies.

In general, natural enemy numbers are known to be greater in diverse environments than in monocultures.

The objective of the experiment discussed here was to determine the effects of intercropping and weeding on pests and natural enemies.

The effects of strip-cropping haricot bean (Phaseolus vulgaris L.) with maize (Zea mays L.) under weedy and weed-free conditions on the abundance of tachinid parasitoids and a predatory wasp that are associated with African bollworm were studied at Awassa, southern

Ethiopia, during the 1987 and 1988 crop seasons.

Results of the experiments described above demonstrated that tachinid parasitoids and Tiphia sp. were more abundant in diverse bean plots than in bean monoculture. This may give one possible explanation for the low level of Heliothis armigera numbers and hence less pod damagae in haricot bean strip-cropped with maize in previous experiments. Increases in natural enemy numbers in diverse environments are consistent with reviews and reports by several authors. It is possible that the availability of other food sources, such as pollen and nectar, are responsible for increased numbers of natural enemies in diverse environments.

Increase in natural enemy numbers, and consequently decreases in pest numbers, brought about by the presence of weeds are not usually adequate, at least in the short-run, to offset yield losses caused by weeds, especially when more than one pest species are important in a particular crop. If properly managed, intercropping and weed management have a great long term benefit in the integrated management of Heliothis armigera and other pests in bean fields.

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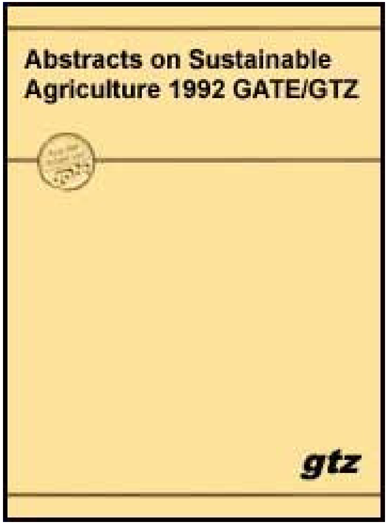
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hydrique en zone Soudano-Sahelienne: comptes rendus d'un Atelier international) the Dominican republic.

Abstracts on Sustainable Agriculture (GTZ, 1992, 423 p.)

Abstracts on water management

Acknowledgements

1223 92 - 11/44

Water management

Review, water conservation, irrigation management, drainage, reclamation, environmental management, water supply

CARR, M.K.V. et al.

1. Water management.

Outlook on Agriculture, 19, 4, 1990, pp. 229-235

In this paper, water management issues in the rural sector are considered under five main headings: making the best use of rainfall or water conservation, irrigation water management, drainage and land reclamation, environmental water management, and rural water supplies.

Each of these topics is considered in turn, using examples from research and consultancy projects to illustrate some of the issues of current international concern.

Traditional engineering disciplines recognize that water must be managed in sustainable and environmentally friendly ways. This requires bridge building between specialist subject areas including ecology as well as agronomy, soil science as well as soil mechanics, hydrology as well as hydraulics, and sociology as well as economics. These values have implications in terms of research priorities and educational needs, as well as for the policies of governments and international agencies.

The unreality of imposing engineering solutions on water management problems without taking into account the social consequences of such action, the ease of operation and maintenance and the expected environmental impact are recognized. A favourable cost-benefit analysis on its own is no longer enough to convince a funding agency, the client or the general public that the solution proposed is the correct one.

Sustainability has become the new watchword.

For the vast majority of the world's farmers, irrigation is not an option: they depend on rainfall for successful crop and animal production, and for survival. In areas of the world where rainfall is marginal or unreliable, the priority is to optimize the use of the rain through the use of appropriate, usually low cost, crop husbandry techniques.

Concluding, each of the topics discussed is of international concern: water does not recognize national boundaries, and neither does the pollution with which it may be associated. The relative importance of different issues varies from place to place and from country to country.

What can be afforded also varies, but appropriate solutions can be found, providing the complexity of the systems is recognized, as well as the self-interest of human beings.

1224 92 - 11/45

Water management

Review, article, developing countries, irrigated agriculture, crop diversification, water management constraints, crop water requirements, irrigation systems, soils, irrigation canals, cultivation methods, water delivery, World Bank

PLUSQUELLEC, H.

2. Crop diversification in irrigated agriculture: water management constraints.

In: Proc. of the Seventh Agric. Sector Symposium Sustainability Issues in Agricultural Development; World Bank, Washington, D.C., USA, ISBN 0-8213-0909-0, 1987, pp. 313-319

This paper reviews first the different water requirements of paddy and upland crops and reviews the general technical features of the two dominant surface irrigation methods, basin and furrow irrigation used in developing countries. Then the paper discusses the issue of improving irrigation facilities to make possible the shift from paddy cultivation to other crops and/or the adoption of mixed cropping. This review is limited to the aspects relevant to crop diversification and does not pretend to fully cover the above subjects.

Besides marketing considerations, diversification from rice paddy to non-paddy crops in irrigated agriculture is constrained by several physical and institutional factors such as soils, farmers' experience, credit, extension services and irrigation facilities. The issue of crop diversification is limited to surface irrigation which is the predominant method used for more than 90 percent of the 275 million ha currently irrigated in the world. In the vast areas of lands irrigated in Asia, surface irrigation methods are used almost exclusively for both paddy and upland crops.

The precise water control needed for diversified field crops requires in general extension of the tertiary networks, improvement and modernization of the main and distribution system, and in some areas, improvement of the drainage and flood control conditions.

The issue of improvement/modernization of irrigation systems to permit crop diversification has been complicated by the sharp drop in projection rice prices that occurred since 1982.

The 1990 rice price projections dropped from about 600 US$ in 1982 to 339 US$ in 1984/85 and recently below 250 US$. Most of the rice irrigation projects were viable in the early 80s including those for which all the infrastructure from storage or diversion works down to the on-farm water delivery works had to be built. Under the 1984/85 economic conditions, the viable investments in rice projects were those taking advantage of sunk costs in existing infrastructure.

In the case of Thailand a fast method for screening viability of projects was developed for the Irrigation Subsector Review issued in April 1986. It was found that development of the tertiary system at a low cost of US$ 600/ha is viable with only a modest paddy yield increase of 0.5 ton/ha in each season assuming a cropping intensity of 150%. To justify the investment required for an intensive tertiary system including land levelling (US$ 1000/ha) a yield increase of at least 0.8 to/ha for each season should be achieved.

With the most recent price projections, a detailed analysis of each project would be needed because of the sensitivity of the rate of return at these low rice prices. Investments required to improve the tertiary system together with improvement of the distribution system may no longer be justified unless there is a substantial increase in yields (above 1 ton per ha) and/or an increase in cropping intensity by making use of the water saved through more efficient operation. The conclusion is that in a number of cases the improvement of irrigation systems at both the tertiary and distribution level may not be economically justified for increasing rice production alone, without diversification to higher value crops. The investments required for crop diversification would have to be undertaken only when there is sufficient indication that all the other preconditions for crop diversification are met: market, marketing facilities, extension services, etc. The same conclusion may be valid for other rice surplus countries.

1225 92 - 11/46

Water management

Review, watershed management, stream corridor system, water resource quality, land-use impacts, costs and benefits, USAID, DESFIL

DICKINSON, J. and F. TRACY

3. Steam corridors in watershed management

Publication of DESFIL; prepared for USAID under contract number 527-0000-C-00-7841-00; Development Strategies for Fragile Lands, 7250 Woodmont Avenue, Suite 200, Bethesda, Maryland 20814; 1989, 15 p.

Increasing human pressure on the land has accelerated soil erosion, reduced production and income levels, and created scarcities of wood and loss of natural systems. In practice, watershed management has focused on reforestation of degraded areas, on-farm soil conservation, and "works of art".

Interventions are rarely based on an integrated management plan addressing whether or where they are needed, if they are cost effective, or how they fit into an integrated management plan. Failure to distinguish in the field between relatively uncontrollable natural erosion processes and those that are accelerated by human activities can be costly and threatens the credibility of management approaches.

This paper specifically addresses the management of stream corridors.

Sediments from uplands, together with materials excavated by streams themselves, move through a network of stream corridors. How these corridors are managed is critical to the achievement of both local and downstream benefits from overall watershed management activities.

Stream corridors form the transitional zone of significant interaction between a terrestrial and an aquatic ecosystem.

Stream corridor management includes the maintenance of riparian and instream vegetation and maintenance of overall channel morphology with its obstructions, rapids, meanders and adjacent wetlands. These actions together result in:

- Filtering of sediments contained in overland runoff;
- Reduction in bank erosion;
- Attenuation of flood peaks;
- Control of eutrophication in headwater streams;

- More productive fisheries; and
- Maintenance of the diversity of stream corridor ecosystems.

Stream corridor management is most effective in delivering these benefits if integrated into an overall program of watershed management.

Effective management of headwater streams offers higher benefits per stream segment affected. If headwater stream corridors are neglected, management of river segments in the lower reaches of a watershed will be less effective.

Financial resources are never sufficient to permit all possible management interventions in watersheds thousands of hectares in extent.

Scarce resources must be allocated to those activities which together contribute most to overall system maintenance, the well-being of local populations, and to downstream water resource users. Stream corridor management, particularly along smaller streams in both upper watersheds and lowlands, can be a cost-effective contribution to a watershed management program.

An integrated two-step ecological engineering approach to stream corridor management is recommended. First is the establishment or preservation of the filtering capacity of the corridor vegetation that serves as the buffer between the stream itself and the rest of the watershed. Second is the maintenance of the biological and physical integrity of the stream ecosystem itself. This involves protecting the stream from such direct impacts as channelization, waste dumping, and livestock watering. If both steps are effective in maintaining the integrity of the corridor with its riparian and aquatic components, then the maximum range of goods and services of local or downstream value (fisheries and wildlife, recreation, water for domestic, agricultural and industrial use, and waste removal and treatment) can be provided.

Smaller streams, because they compose a major proportion of the length of channels in a watershed, serve as the major area of interface between stream corridors and the surrounding watersheds.

The purpose of this paper was to demonstrate how stream corridor management plays an integral role in the management of watersheds for sustainable development. Stream corridors are among the most fragile elements of upper watersheds, both in mountainous areas and in the upper reaches of streams in the wet tropical lowlands. In addition to the multiple values represented by stream corridors, these areas are a magnet to conflicting uses. How human needs for food can be met while maintaining other values both on site and downstream has been our concern. Among the use strategies advocated for fragile lands has been the modification of existing small farm production activities by introducing tree-based agroforestry and silvopastoral systems to produce food and raw materials from combinations of annual and perennial cropping and livestock. These uses are complementary to, and may even be included among, the uses advocated for stream corridors.

1226 92 - 11/47

Water management

Review, Mexico, India, Iran, Pakistan, Australia, water harvesting systems, case examples, catchment areas, water storage, water harvesting constraints, water harvesting strategies, water quality, sources of water, precipitation, knowledge gaps, FAO

THAMES, J.L.

4. Water harvesting.

In: Proc. of the FAO Expert Consultations on the Role of Forestry in Combating Desertification, Saltillo, Mexico, 1985; FAO Conservation Guide No. 21, 1989; ISBN92-5-102802-8

The earliest evidence of the use of water harvesting are the well publicized systems used by the people of the Negev Desert perhaps 4000 years ago. Hillsides were cleared of vegetation and smoothed in order to provide as much run off as possible; the water was then channeled in contour ditches to agricultural fields and/or to cisterns. By the time the Roman Empire extended into the region, this method of farming encompassed more than 250,000 hectares.

Water harvesting is a technique of developing surface water resources that can be used in dry regions to provide water for livestock, for domestic use, and for agroforestry and small scale subsistence farming.

Water harvesting systems may be defined as methods whereby precipitation can be collected and stored until it is beneficially used. The system includes a catchment area, usually prepared in some manner to improve run off efficiency and a storage facility for the harvested water, unless the water is to be immediately concentrated in the soil profile of a smaller area for growing drought-hardy plants. A water distribution scheme is also required for the systems devoted to subsistence farming for irrigation during dry periods.

A successful system must be:

- Technically sound, properly designed and maintained.

- Economically feasible for the resources of the user.
- Capable of being integrated into the social traditions and abilities of the users.

Water harvesting offers methods of effectively developing the scarce water resources of arid regions. As contrasted to the development of groundwater, which is usually a finite water resource in arid zone, the method allows use of the renewable rainfall which occurs, even though in limited amounts. It is also a relatively inexpensive method of water supply that can be adapted to the resources and needs of the rural poor.

It is necessarily small scale, and as such it can provide stability and improve the quality of life in small rural communities and that of small land holders who are several stages removed from the benefits of large scale development projects. It involves some risk, dependent upon the vagaries of climate. New skills, though simple, are required, maintenance is a constant necessity, and good design is imperative.

There is no universally "best" system of water harvesting. However, there will be some type of system that can be designed to best fit within the constraints of a given location. Each site has unique characteristics that will influence the design of the most optimum system. All factors, technical, social, physical and economic must be considered.

During the past two decades, there have been many water harvesting systems constructed and evaluated at a number of different places in the world. Some of the systems have been outstanding successes, while others were complete failures. Some of the systems failed, despite extensive effort, because of poor design or the materials used. Other systems failed despite good design and proper materials because social factors were not integrated into the systems. These systems failed because of poor communication and lack of commitment by the local people both in planning and financing the projects.

Sufficient knowledge and experience has been accumulated to put into operation water harvesting projects throughout the arid lands of the world. Empirical information and documentation is needed from successes as well as failures on which to build a more exact technology.

1227 92 - 11/48

Water management

Case study, USA, irrigation systems, costs and benefits, cotton production

LETEY, J. et al.

5. An economic analysis of irrigation systems.

Irrigation Science, 11, 1990, pp. 37-43

The objective of this paper is to determine the economically optimal irrigation system for a set of conditions which are specified.

Irrigation systems are evaluated based on their performance and costs in relation to cotton production and drainage volumes. The latter factor is becoming increasingly important in some irrigated lands such as in the San Joaquin Valley of California where appropriate disposal of subsurface drainage water may become very expensive because of the total dissolved solids and presence of toxic elements in the drainage water.

Cotton was selected as the crop for analysis because it is a major crop on irrigated lands and it is amenable to irrigation by several systems.

Furthermore, it is a principal crop grown in the western San Joaquin Valley of California which will serve as a case study for the report.

An array of irrigation systems are available which can be broadly classified as being gravity flow or pressurized. Pressurized irrigation systems provide better control on the amount of applied water and, in most cases, better irrigation uniformity than gravity flow systems. They also have a higher initial capital cost than gravity flow systems and an analysis is required to determine whether the improved performance of pressurized systems justifies the additional costs. An economic analysis was done on several irrigation systems which included consideration of farm management costs associated with a given irrigation system, shifts in crop yield and drainage volumes associated with the optimal management of each irrigation system, and costs associated with disposal of drainage waters. Irrigation uniformity is a significant determinant to the results. Although irrigation uniformities can be highly variable based on design, maintenance and management, a typical uniformity for each irrigation system was selected. For the conditions of the analysis, gravity flow systems were calculated to be more profitable than pressurized systems if there was no constraint on the amount of drainage water generated or cost for its disposal. Imposition of costs for drainage water disposal induced a shift whereby pressurized systems became more profitable than gravity flow systems.

Irrigation systems can be broadly classified as being either gravity flow or pressurized.

Because of the limited number of irrigations, a furrow system might be very difficult to manage in a manner to obtain the desired drainage volume without missing the mark considerably resulting in either higher or lower drainage volumes and profits. One advantage of the pressurized irrigation systems is that they can be managed to obtain maximum yields and yet produce low drainage volumes.

In conclusion, the economic advantages of a given irrigation system depend on an array of factors. Variations in farm management costs associated with a given irrigation system must be considered in addition to initial capital investment costs. Furthermore, shifts in yield and drainage volumes under optimal management for different irrigation systems can provide additional costs or benefits associated with a given irrigation system. Imposition of costs on drainage water could induce a significant shift in profitability associated with a given irrigation system.

1228 92 - 11/49

Water management

USA, Mexico, arid regions, semiarid regions, field trials, crop production, microcatchments, desert-strip-farming systems, rainfed production

FLUG, M.

6. Production of annual crops on microcatchments.

In: Rainfall Collection for Agriculture in Arid and Semiarid Regions;

Publ. of CAB, UK; ISBN 0-85198-486-X, 1981, pp. 39-42

Water harvesting for agriculture is an ancient art with proven usefulness for producing food in arid and semiarid regions of the world.

Water is often the limiting natural resource in these regions. The greatest potential for augmenting available water supplies rests in the collection and conservation of precipitation. An estimated 95% of precipitation in arid and semiarid regions of the world is lost to evaporation. A small reduction in these evaporation losses would substantially increase the quantity of water available to agricultural, industrial, and municipal concerns. Agriculture is by far the largest consumer of water, and therefore, conservation in agriculture or substitution of harvested water for traditional water sources in crop production would release large quantities of water to other sectors of society.

Although natural precipitation in an area may be inadequate to raise a crop, enough water can be collected from an entire region for ample crop yields on a portion of the region. Water harvesting enables a greater percentage of precipitation to be put to beneficial use in a water efficient agricultural system.

Some of the simplest water-harvesting systems collect 20% to

40% of the precipitation for later beneficial uses, while a more elaborate system can collect more than 90%.

A number of water-harvesting systems have been developed to suit given regions, crops, and rainfall patterns. Desert-strip-farming experiments to grow two crops per year began in 1978 at the University of Arizona Page Trowbridge Experiment Farm (Page Ranch). Desert-strip-farming is similar to conservation bench-terrace farming and conventional dryland-strip farming in which crops are planted along contours. An important difference, however, is that the fallow areas are used as catchments. The catchment area is often cleared of vegetation shaped, smoothed, compacted, and even treated with sealants to increase runoff efficiency. Furthermore, the adjacent cultivated area, which is formed by leveling a swath along the contour, has a small dike on the downhill side to trap runoff water. Another difference is that unlike dryland-strip farming, where the ratio of fallow to crop is usually 1:1, desert-strip-farming is based on % ratio that varies with the environmental conditions of each specific site. Other variations among systems derive from different methods of treating catchments and storing water.

An important concept in understanding water-harvesting systems is the ratio of catchment area to cultivated area (CCAR). The CCAR depends upon the runoff efficiency of the catchment area, the crop moisture requirements, and the expected quantity and temporal distribution of precipitation. Moisture requirements are determined from consumptive use data for the particular crop and are adjusted to the date of planting and associated considerations.

1229 92 - 11/50

Water management

Africa, developing countries, Transkei, Ciskei, irrigation projects, case studies, management, human factors, agricultural production, institutional constraints, socio-economy, culture, tradition, inputs, research needs

BEMBRIDGE, T.J.

7. Problems and lessons from irrigation projects in less developed countries of Africa.

Development Southern Africa, 3, 4, 1986, 19 pp.

This paper reviews important constraints to the development of small-holder irrigation schemes in less developed areas of Africa. It is based on two case studies from Southern Africa and experience elsewhere on the continent. Lessons from past experience and the institutional and human development considerations required for successful projects are discussed.

A survey of the literature on Third World irrigation projects, and in Africa in particular, shows that with few exceptions the economic success of irrigation projects falls far short of the expectations of planners, politicians and development agencies. Even on the few relatively successful projects, there appear to be increasing social and ecological problems which will eventually have negative economic effects.

At present, irrigation plays a rather insignificant role in African agriculture. Of Africa's 150 million hectares of cultivated land, only about 9 million hectares are under irrigation. Of this, approximately 75 per cent is in Egypt, the Sudan and Madagascar. Small-holder irrigation in Africa is generally characterized by low productivity. Persistently low performance on irrigation projects poses one of the biggest problems for planners, policy makers, financing agencies, managers and participants alike. As African nations face a continuing decline in per capita food production, increasing priority is being given to irrigation development. National development plans of countries such as Kenya and Zimbabwe, as well as some of the independent South African states, such as Ciskei, Transkei and Venda, emphasize the role of small-holder irrigation development for food as well as rural development.

By its very nature, irrigation development is particularly prone to human problems. This is because the introduction of irrigation commonly necessitates a change in the way of life of those participating in irrigation projects, making it difficult for planners to predict future human behavior.

This review, faced as it was by space considerations, has been somewhat too generalized to make sweeping conclusions. However, considering available literature and the two case studies reviewed in this paper, it can be concluded that success depends on integration between technology, management, participants and the socioeconomic situation. Poorly planned projects suffer from lack of such integration, especially in the field of management, organization and implementation. The institutional environment in which irrigation takes place has received little attention from irrigation planners. Infrastructural development and economic constraints are rarely so bad as to cause collapse of the project.

The causes of the lack of success of individual irrigation projects in Africa are complex. One of the problems is the one-sided emphasis on the technical components of projects. At the basis of this is the attitude of many project planners and managers who primarily measure the success of projects according to physical development and agricultural production. Such a viewpoint neglects the fact that projects have not only a technical but also an equally significant socioeconomic character. In view of this, it makes sense to regard development projects as socio-technical systems which can only be deemed to be successful when all persons and groups concerned co-operate effectively and satisfy their objectives. This co-operation will vary according to the type of project.

On the basis of this review and experience in Africa, certain prerequisites for successful small-holder irrigation development have been defined:

- Institutional requirements
- Human development

The importance of engineering, agronomy and soils' research are not being minimized; nevertheless this paper has shown that in less developed countries institutional, social and economic aspects are generally responsible for poor performance and therefore require more research.

Retrospective studies of management and performance could be integrated into any technical or socioeconomic rehabilitation which may be required.

In the long run, there is a need for integration of evaluation research at successive stages of a project. It is vital that mechanisms be developed for proper assessment and evaluation to modify projects when necessary, as well as avoid unnecessary expenditure on projects which are doomed to failure.

1230 92 - 11/51

Water management

Asia, Pakistan, study, sample villages, irrigation organization, irrigation management, water supply, water resources, water distribution system, water allocation, maintenance operations

MIR KALAN SHAH

8. Irrigation organization and management.

In: Stability and Changes in Rural Institutions in North Pakistan; Ed.

W. Manig; Alano Edition Herodet, F.R.G., 1991, pp. 141-153

The present study is an effort to investigate the nature of water distribution and its management in the six selected villages in Peshawar

District.

Water is one of the basic components of modern agricultural input used in Pakistan. Therefore, the development of irrigation and improvement of irrigation systems both at the micro and macro level are crucial for Pakistan's agricultural development. The availability of additional water helps in extending the area under cultivation and enhances the cropping pattern from low to high value crops. Improved management can probably do more towards increasing agricultural production both of food and other crops in the irrigated areas of the world than any other agricultural practice. In an agrarian economy, irrigation may be a good source of employment. It raises both the employment and income of the land and adds to capital formation.

For the investigation a questionnaire was prepared. The survey of all of these villages was carried out in order to have some basic information.

Purposive sampling methods were used for the selection of 110 farmers.

On the other hand, discussions were held with the officials from the irrigation department and their ideas were included to substantiate the study.

The irrigation system in Pakistan has undergone a remarkable change in present times. The old, customary field practices have been replaced by modern technology to ensure proper management of water. Efficient water management should be an essential feature of the irrigation planning.

Integrated development of water resources, an efficient method of conveyance and distribution of water on the farm, a judicious method of water application, and a cropping pattern for high water-use efficiency, a specific time for irrigation, and removal of excess water are important aspects of a comprehensive irrigation development programme.

Efficient water management largely depends upon selecting the methods best suited to local conditions because irrigation management systems differ from region to region in a country.

Concluding, water is one of the primary inputs for crop production.

Proper timing and a judicious amount of use of this input along with scientific methods of application are important for achieving a good yield when properly combined with other inputs. One aspect of the poor performance of irrigation schemes has been defective methods of water distribution between the farmers at the head and the tail ends of the water courses and inefficient management of the irrigation department.

The current system has a history and tradition. The water rights were built up over the years. They cannot be easily changed, even by providing the equity element. No change in the system of water distribution has been reported by any farmer in the project area. The system of warbandi (water by turn) has prevailed for a very long time.

It was very clear that the farmers were in favour of water-users'organizations, but they have not been motivated for this purpose. It will require government incentives, assistance, and education and extension services in order to initiate such organizations. Additionally, the land-tenure system will also play an important role in such organizations.

The government of Pakistan is aware of the need for organizing the farmers at the "grass roots" level. The major problem at present is that the farmers have not been given the necessary information on a large scale, or incentives to improve their own farm irrigation systems. The time has come for a national emphasis or programme to involve the farmers in the improvement of their system and the optimal utilization of irrigation water. But it is important for the farmers to be allowed to work out their own organizational procedures which fit their particular situation. No attempt should be made to pressurize them to adopt a particular scheme that is foreign to their understanding. Thus, improvement and development must be carried out by and for the farmers themselves.

1231 92 - 11/52

Water management

Africa, Niger, Sudano-Sahelian Zone, soil water balance, state of the art, soils, soil water monitoring, ICRISAT

SIVIKUMAR, M.V.K. et al.

9. Soil water balance in the Sudano-Sahelian zone: summary proceedings of an international workshop. (bilan hydrique en zone Soudano-Sahelienne: comptes rendus d'un Atelier international)

Proc. of an Internat. Workshop, Niamey, Niger; ICRISAT, Patancheru, A.P. 502 324, 1991, 42 pp. LDC: 6.68 USD, HDC: 15.48 USD

This workshop aimed at evolving an effective synthesis of the state of water balance research in the Sudano-Sahelian Zone. It brought together scientists from different disciplines to share their experiences and to contribute to discussions.

Participants at the workshop discussed the issues concerning soil water balance in five technical sessions: Current Research and Future Implications; State of the Art of Soil Water Balance Research; Soils of the Sudano-Sahelian Zone; Soil Water Balance Studies in the Sudano-Sahelian Zone; and Operational Applications of Soil Water Balance

Monitoring and Prediction.

This volume presents summaries of the five sessions, reports of the planning groups that dealt with the main issues for future research and collaboration - new systems and sites, measurements and analysis of weather, crop, and soil data, modeling, technology transfer, and management - and 21 recommendations for action covering future studies on water balance, definition of minimum data sets, collection and dissemination of information modeling, and training.

1232 92 - 11/53

Water management

Review, book, dryland, water conservation, soil conservation, erosion, wells, water lifting, surface water storage, organization for action

CHLEQ, J.L. and DUPRIEZ, H.

10. Vanishing land and water.

Macmillan Publishers/Terres et Vie, 1988, 117 pp., ISBN 0-333-44597-X; distributor: CTA, P.O.B. 380, 6700 AJ Wageningen, Netherlands

Rains are infrequent in the semiarid regions such as the Sahel and Sudan savanna zones, which stretch across Africa from the west coast to the horn of Africa in the east and which include the Kalahari and Namib areas of southern Africa. The rains last 3-4 months of the year and are often erratic and torrential. Man is powerless to alter the rate of precipitation. On the other hand, he is not powerless when it comes to holding back, storing and using sparingly the rainwater that falls on his fields. Using methods to trap water and stop the loss of soil around the village, he can ensure water penetration for the benefit of crops, store water for periods of drought, and make sure that fertile clay stays in the settlement.

This book sets out to show how artisan crafts dealing with water supply problems can play an important role in village life in dry lands. Water crafts are direct and indirect sources of revenue. They are a direct source of income for water craft artisans and an indirect source of income for cultivators and pastoralists who benefit from the water resources on their land, thanks to the advice and skills of local artisans.

This book was inspired by village schemes in Sahelian Burkina Faso. They extended over a long period and involved close collaboration between villagers, artisans and technicians. These people worked together to find solutions to the problems of water runoff, and the use and exploitation of water resources. The techniques described are limited.

Many other techniques exist and have been described in other publications. But what is striking about the experience of the GARY (Groupement des Artisans Ruraux du Yatenga = Group of Yatenga Rural Artisans) is that the level of practical skills acquired by villagers is quite high.

This book advocates cooperation between all the people concerned. The technical aspects, sometimes described in great detail, are only meaningful if they are accepted as something to be thought about by water technicians and their village partners. In other words, this book is not designed just for technicians. Its whole aim is to spark off useful discussions between the parties concerned. If this exchange is initiated, technical solutions will be found - maybe the solutions put forward here, or maybe others inspired by these solutions.

The Land and Life Series is aimed at practitioners and students of agriculture and rural development and associated vocational and technical skills. The books in the series treat topics according to appropriate, small-scale and affordable technology taking into account traditional ways but adding relevant modern improvements. For training, they can be used in secondary schools and vocational training centres and colleges up to the diploma and degree level, but they are chiefly meant to be used in the field, in practice. They are ideal for self-help, adult education and rural extension projects. They are written in a clear and highly illustrated style and thus can be used equally by those for whom English is a second language and by non-specialists. All the titles in the series are designed and produced as low-cost editions. Although based on African practice, the books are relevant to similar climatic regions in other continents.

The Land and Life Series is co-published with Terres et Vie, from whom French language editions are also available. Translation from French to English was financed by CTA.

233 92 - 11/54

Water management

USA, field studies, water use, legumes, soil water, cropping systems

BADARUDDIN, M. and D.W. MEYER

11. Water use by legumes and its effect on soil water status.

Crop Science, 29, (5), 1989, pp. 1212-1216

To make informed decisions on whether to include legumes in cropping systems, information is needed on water use by legumes and its effect on soil water availability to subsequent crops. The objectives of this study were to determine the water use, water use efficiency (WUE), and soil water depletion pattern of four grain legumes and three green-manure or forage legumes. Field studies were conducted on a Fargo silty clay (fine, montmorillonitic, frigid Vertic Haplaquoll) at Fargo and on a Perella-Bearden silty clay loam (fine-silty, mixed, frigid Typic Haplaquoll; fine-silty, frigid Aeric Calciaquoll) at Prosper, ND in 1986 and 1987. Soil water to a depth of 2.2 m was determined by the neutron attenuation method at 15-d intervals. Legume crops used 10 to 25% more seasonal water than wheat (Triticum aestivum L.) across environments, but WUE (kg dry matter ha-1 mm-1 of water) of legumes was 0 to 25% greater than that of wheat. Green manure and forage legumes generally had greater water use and WUE than grain legumes, and this was associated with their longer growing season and higher dry matter production. Cumulative water depletion during June to September by green-manure, forage, and grain legumes was 70, 63, and 43 mm greater, respectively, than that of a fallow check, and was not significantly different from that of wheat in two of four environments. However, an increase in soil water content occurred at the 0- to 0.3- m soil depth for all treatments in the following spring across three environments.

Soil water content in the spring following a legume was not significantly different from that following wheat and was only about 30 mm greater than that of fallow across environments. These results indicate that growing some legumes in cropping systems may not substantially affect the soil water content compared to continuous cereal cropping or to fallow.

1234 92 - 11/55

Water management

Asia, India, Himalayas, irrigation project, environmental impact assessment, sustainable development, water demand

AHMAD, A. and P.P.SINGH

12. Environmental impact assessment for sustainable development: chittaurgarh irrigation project in outer Himalayas.

AMBIO, 20, 7, 1991, pp. 298-302

This study covers the Chittaurgarh irrigation project, situated in the outer Indian Himalayas. The main purpose of the study was to assess the positive and negative impacts of the ongoing project, on the physical, biological, socioeconomic and cultural environments and to ensure the continuation of natural resources.

The construction of a dam and canals have had a serious impact on flora and fauna in this project. Agricultural and grazing lands have been lost by utilization of 405 ha Himalayan forest-land upstream and 212 ha of cultivated land downstream of the project. Impacts expected after canal operation include: rise in watertable; waterlogging; increased salinity, due to clay dominated soils with low permeability, and high watertable (0.43 m) during post-monsoon period; fuelwood and fodder crises due to deforestation in the catchment area; weed infestation, crop pests; and human diseases, e.g. malaria, poliomyelitis, filariasis and goitre.

Positive impacts include: flood control, increase in agricultural production (mainly rice, 25,330 t/yr-1) and improvement in socioeconomic conditions.

The investigations made on Chittaurgarh Irrigation Project clearly indicate that negative impacts are of serious concern.

The following guidelines have been proposed to eliminate the negative impacts of irrigation projects to ensure ecologically sustainable development.

- The catchment area in the watershed upstream of the dam should be afforested by mixed vegetation of native species mainly Haldu (Adina cordifolia), Shisham (Dalbergia sissoo), Khair (Acacia catechu), Teak (Tectona grandis) with good shrub cover to reduce erosion.

- Silt loads should be trapped before reaching the dam in order to eliminate sedimentation problems. The whole dam should be afforested with fast-growing trees like Eucalyptus camadulensis and Eucalyptus globulus, to absorb moisture; Populus ciliata for fodder and fuelwood, and Acacia nilotica with good cover of grasses, viz. Cynodon dactylon, Vetivera zizaniodes, Dichanthium annulatum for binding soil particles and checking erosion.

- The tree belt should be developed at an appropriate location on the canal embankment. Plantations should be introduced on the basis of the needs of the location. If a canal is close to a village, the tree belt should be planted to fulfil the requirements of fuelwood and fodder of the villagers. Strict regulations should be set for the cutting of trees; only mature trees should be cut. Subsidized alternative fuels should also be arranged to reduce dependence on trees. Planting trees on the canal bunds, besides yielding fuelwood and fodder, will help to suppress excessive growth of species like Typhia augustifolia and Eichhornia crassipes. The most suitable tree species are Populus ciliata, Dalbergia sissoo, and Acacia nilotica.

- Tanks and equalizing reservoirs should be carried out as an additional project and should be developed at appropriate locations in the area.

- Some of the low-lying swampy areas are unfit for agriculture and should be developed for fisheries. Cyprinid species are best suited for the area.

- The indiscriminate use of insecticides and fertilizers should be minimized in the project area. Integrated pest management (IPM) strategies should be popularized among farmers.

- A suitable infrastructure, involving the participation of farmers should be developed, such as irrigation cooperatives at village level for the distribution of water, at the microlevel, and for water management in general.

- Proper infrastructural facilities should be developed to meet the requirements of increased crop production which result from intensive irrigation farming. This includes farm power (electricity), seeds/seedlings, fertilizers, crop processing, storage, transport, marketing, rural credit, etc.

- Complementary education and training programs should be introduced for all professional levels involved in water management. High priority should be given to improving the understanding of decision-makers, including mid-level and senior officials, in regard to the special problems of water management. Public awareness should be improved in the villages through education of farmers and villagers.

1235 92 - 11/56

Water management

Latin America, Peru, field trials, pot trials, desert area, water use, food crops, fodder crops, alfalfa, maize, Rhodes grass, potatoes, transpiration coefficient, dry matter production, soil types, leaching of salts

ALBERDA, TH.

13. Production and water use of several food and fodder crops under irrigation in the desert area of southwestern Peru.

Agricult. Res. Rep. 928, Pudoc, Wageningen; ISBN 90-220 0869X, 1984, vi + 50 p.

This report describes the results of a research project in the desert of southwestern Peru that was carried out jointly by researchers from Peru, Israel and the Netherlands.

The main purpose of the project was to investigate dry matter production and water use of the most important crops in the region under irrigated conditions and fertilizer application. To facilitate the necessary measurements and analyses, an existing laboratory was improved and measuring instruments were purchased.

In addition to field trials, pot trials were carried out, mainly to determine the transpiration coefficient (TRC), i.e. the amount of water transpired per unit of dry matter produced.

The crops mainly studied were alfalfa, maize and potatoes, which are the most important crops in the region, and Rhodes grass for comparison. All crops were sprinkler irrigated, but in a few cases trickle irrigation was used for comparison. By periodic harvesting - usually at weekly intervals - data for growth curves, the time course of the leaf area index, light interception and dry matter partitioning were compiled. In addition, the water supply to the crop was measured as well as the soil water content before and after watering. The results obtained were compared with those obtained elsewhere, sometimes also with simulation programs.

The rate of growth of an alfalfa sward varied with the season; it was higher in summer than in winter. A ceiling yield was reached earlier in the year and was more pronounced than at the end of the year. The local variety Tambo gave higher yields than the Californian variety Moapa, mainly due to higher ceiling values. Under the prevailing conditions, fertilization with P and K was not necessary; N fertilization resulted in slightly higher yields, but without fertilization an amount of N of about 700 kg per ha per year was fixed by Rhizobia bacteria. No clear relation could be demonstrated between the rate of regrowth and the amount of reserve carbohydrates left in the remaining plant parts after cutting. There was a relation between regrowth in the light and in the dark, indicating that, in some way, carbohydrate reserves are important.

Maize in the project area had a slower initial growth under optimal conditions than elsewhere in the world, but in the linear phase growth rates were comparable to those in other arid zones, leading to yields of around 25 tonnes of harvestable dry matter per ha.

Rhodes grass formed such a very dense sward that weeds were not able to penetrate. During the summer months, yields were high enough to be able to compete with other foddercrops, but during winter, growth virtually stopped, mainly due to the low night temperatures. For this reason, large scale use of Rhodes grass is not recommended on the desert plains of Peru.

Potatoes, well supplied with water and nutrients, yielded around 70 tonnes of fresh tubers per hectare - comparable to yield levels elsewhere in the world. Again the Peruvian variety yielded more than a Dutch variety, but as the latter had a more homogeneous tuber size, the marketable yield was about the same.

The relationship between the amount of dry matter produced and water received at increasing distances from a single sprinkler irrigation line was established by measurement.

For potatoes this relation was linear, almost up to the highest amount of water applied.

For alfalfa a comparable relation was found. When more than 250 mm water was applied, the crop did not show a response; below this value the relation was linear, down to about 50 mm water.

Both with alfalfa and with maize, experiments were carried out in which the amount of water applied to different plots was varied in relation to the evaporation of a Class A pan. For alfalfa, this resulted again in a rectilinear relation between dry matter production and water application up to about 250 mm water applied for both varieties and in all seasons.

Application of an artificial mulch gave a better utilization of the irrigation water.

The relation between dry matter production and the amount of water evapo-transpired could be calculated from the soil water measurements.

For maize, the results were less conclusive, partly because the trial was carried out in the unfavourable season.

The highest yield was attained when water was applied at a high and constant rate for the lower plant density. Trickle irrigation instead of using sprinklers saved a considerable amount of water, however, due to the higher costs, a trickle irrigation can only be profitable if it can also be used for other crops.

Some different soil types of the pampa were tested on their water holding capacity in a lysimeter experiment with alfalfa as the test crop. When well watered and fertilized, all soils were able to give good yields. However, some soils needed to be irrigated every other day, which would require too much labour in normal practice to use them economically.

The value of the results for farming in the regions is discussed.

Author's summary, shortened.

1236 92 - 11/57

Water management

Latin America, Dominican Republic, study, on-farm project, evaluation methods, agriculture, land-tenure, land-labour relationship, irrigation systems, irrigation organization, finances, institutions, DESFIL

HANRAHAN, M. et al.

14. Evaluation of the on-farm water management project in the Dominican republic.

Publ. of Development Strategies for Fragile Lands, 7250 Woodmont Avenue,

Suite 200, Bethesda, Maryland 20814, USA; 1990, 67 p. + appendix

This report documents a fundamental change in the institutional arrangements for irrigation management in two large irrigation systems in the Dominican Republic.

The On-Farm Water Management Project (OFWMP), sponsored by the U.S. Agency for International Development, was implemented with the Instituto Nacional de Recursos Hidraulicos (INDRHI) of the Dominican Republic. The project sought to strengthen INDRHI capacity to plan for and to manage irrigation systems, to increase irrigated agricultural productivity, and to improve lands affected by waterlogging. The two project areas, Azua (YSURA) and Santiago (PRYN Contract I), total 14,400 hectares, and serve 6,000 farm families.

To accomplish project objectives, the OFWMP made physical improvements to the two irrigation systems, assisted in formation of local organizations to manage the irrigation systems, and facilitated turnover

- the transfer of responsibility for system operations and maintenance (O&M) from a public sector agency to private sector associations known locally as Juntas de Regantes. These three steps are linked. Major rehabilitation of facilities coupled with organization of farmers enabled turnover to succeed.

Recommendations have been made by the evaluation team:

The evaluators recommend that, in their initial years of operation, the Juntas Directivas concentrate their human and financial resources on a core set of functions.

These functions should be defined and carried out with the full, democratic participation of farmers.

The Juntas Directivas have shown interest in activities beyond core functions. Examples include marketing, credit, and agricultural extension. These activities are compelling and reflect legitimate and urgent farmer concerns. However, at least in the early and financially uncertain years, the evaluators recommend that the juntas generally restrict such activities because it will spread too thinly the limited financial resources and managerial capacity of the juntas.

Perhaps the greatest accomplishment of the project has been to deliver water reliably to a large number of tail-end farmers in the two systems.

But the project has not established ways to monitor actual water flows to the various parts of the systems and to compare these with allocated amounts. The project should obtain measurements of water delivery equity.

The expenditure of remaining OFWMP funds for pilot area development would be detrimental to organizational efforts and should be a low-priority item. Money spent in pilot areas could be used to rehabilitate portions of the systems that are in disrepair or not completed. This could attract additional farmers into joining the juntas and paying fees. Further work on construction in pilot areas should be halted. Decisions regarding future construction work in pilot and other areas should be made with participation of the juntas.

In future assistance to the Dominican irrigation sector, USAID should take a proactive stance concerning the sustainable use of natural resources. The evaluators recommend that USAID allocate funds for the study of project side-effects, such as increased pesticide use, and use the results of these studies and other accumulated knowledge to program requisite abatement technologies into future assistance to the Dominican irrigation sector. Sustainable environment and natural resource management is not contradictory to the goal of rural income generation or to resource use. Sustainable, resource-conserving, and income-enhancing technologies for soil and water use exist and, under

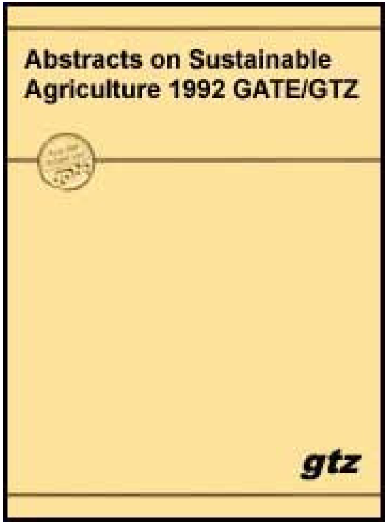
Agency policy, should be used.

As experience in the Dominican Republic shows, irrigated agriculture may be associated with potential negative environmental impacts. Misuse of irrigation water can result in significant declines in the productivity of land and water resources through soil erosion, waterlogging, and salinization. Agricultural inputs may be indiscriminately applied, and can lead to build-up of resistant pest populations and toxic chemical residues and to runoff.

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Abstracts on Sustainable Agriculture (GTZ, 1992, 423 p.)

Abstracts on soil fertility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tropics.

7. Green manuring with vetch on acid soil in the highland region of Rwanda.

8. Tropical lowland rice response to preceding crops, organic manures and nitrogen fertilizer.

9. Pearl millet and cowpea yields in sole and intercrop systems, and their after-effects on soil and crop productivity.

10. Influence of some characteristics of bean seed and seedlings on the tolerance to low phosphorus availability in the soil. (Infuencia de algunas

caracteristicas de las semillas y plantulas de frijol Phaseolus vulgaris L. sobre la tolerancia a la baja disponibilidad de fsforo en el suelo)

1237 92 - 12/63

Soil fertility

Review, tropics, symposium, soil fertility, plant production, soil constraints, sustainability

TARC

1. Soil constraints on sustainable plant production in the tropics.

Trop. Agric. Res. Series No. 24; Trop. Agric. Res. Center (TARC), Tsukuba, Ibaraki, 305 Japan; ISSN 0388-9386, 1991, 216 pp.

Generally it is recognized that the tropical and sub-tropical countries and regions are faced with various kinds of soil constraints on sustainable plant production in cultivated lands, pastures and agroforestry schemes, which are presumably caused by fertility, acidity and salinity, erosion, micronutrient deficiency or excess, physical, chemical and biological limitations.

On behalf of the Symposium Organizing Committee of the Tropical Agriculture Research Center (TARC), the "International Symposium on Soil Constraints on Sustainable Plant Production in the Tropics" under the co-sponsorship of the TARC, Ministry of Agriculture, Forestry and Fisheries, Japan, was held.

The TARC was established in 1970 with the objective of contributing to the development of agricultural technology in the tropical areas in undertaking research programs.

The TARC activities cover a fairly wide range of research fields such as crop production, soil and water management, plant protection, pasture and animal husbandry, agriculture and food engineering, forestry and agroforestry.

In the symposium discussed here, the causes of the constraints are evaluated based on scientific data. The establishment of relevant measures for their alleviation with emphasis placed on low-input and sustainable plant production, in taking account of the preservation of the co-systems and environment in the tropics and sub-tropics are discussed.

This book is organized in country reports, technical reports and closes with a general discussion.

The book provides an overview of soil-based constraints which are limiting the sustained productivity of agriculture. It covers the research activities on characterization, genesis and amelioration of soil-related physical, chemical, and biological constraints. Some of the constraints are natural whereas others have arisen due to human interventions. Waterlogging and salinization in irrigation commands of arid and semi-arid regions, overmining of nutrients, and excessive exploitation of underground fresh waters have decreased the productivity of crops in several regions of the tropics. Alternative methods of soil management for improvement of degraded land qualities, and maintenance of environment and productivity of the soil resources are discussed.

1238 92 - 12/64

Soil fertility

Europe, review, soil pollution, agricultural practices, plant nutrients, fertilizer, pesticides, animal excreta, water athmosphere

PAIN, B. et al.

2. Impact of agricultural practices on soil pollution.

Outlook on agriculture, 20, 3, 1991, pp. 153-160

There is a growing appreciation of the need to preserve soils and their chemical status.

There is an urgent requirement to understand and quantify the various inputs and outputs in order to devise protection policies for this key resource.

This paper focuses on the problems that result from high inputs of plant nutrients, from fertilizers or animal excreta, and from the pesticides that are associated with intensive production. Concern is not only about the direct effects on soils but also on leakages to both water and the atmosphere.

Soils are the base resource for food production.

Their physical and chemical properties are wide-ranging, allowing them to act as sinks or sources in complicated cycles and buffer changes in the flows of materials to other compartments of the ecosystem.

Man's activities can disturb the equilibria involved through

- manufacturing and energy-related activities, resulting in atmosheric inputs of sulphate, acidity, nitrogen (N) and trace metals, for example, or indeed accidental inputs of radio- nucleides,

- urbanization, resulting in direct losses or changes due to recreational activities and

- agricultural manipulations.

The effects of agriculture can be physical, induced by mechanically working the soil in an inappropriate way to result in, for example, soil compaction or erosion, or they may be chemical.

This article is concerned with some of the problems associated with chemical changes.

In detail, the effects of fertilizers, slurries and manures from housed livestock and pesticides are discussed.

1239 92 - 12/65

Soil fertility

USA, field study, greenhouse study, organic biostimulants, low-input agriculture, forestry, horticulture, plant growth, stress resistance, fertilizer application, organic agriculture

RUSSO, R.O. and G.P. BERLYN

3. The use of organic biostimulants to help low input sustainable agriculture.

Journal of Sustainable Agriculture, 1, (2), 1991, pp. 19-42

Organic farming maintains soil quality better and reduces contamination of air, water, soil, and final food products, but much research is needed to determine how to maximize the integration of organic practices.

Methods of increasing fertilizer efficiency must be investigated.

The approach to increasing crop productivity is the development of non-polluting organic biostimulants. These compounds increase plant growth and vigor through increased efficiency of nutrient and water uptake. Definitions for biostimulants vary greatly and there are still some arguments surrounding these compounds. However they are defined as on-fertilizer products which have a beneficial effect on plant growth.

Many of these biostimulant materials are natural products that contain no added chemicals or synthetic plant growth regulators. The initial empirical image of these compounds is changing.

An overview of some of the individual components of the biostimulant blend is given in this paper.

Studies were aimed to test different concentrations (dilutions) of the biostimulant.

Research at the Yale University School of Forestry and Environmental Studies has developed, a new biostimulant

(ROOTS). The product consists of a mix of humic acids, algae extracts, a non-hormonal reductant plant metabolite, and vitamins. This blend greatly increases root and top growth of plants, while decreasing fertilizer requirements up to 50% in a number of species (coffee, several grass species, pines, Douglas-fir, Gliricidia). The biostimulant also increases resistance to low soil water potential and possibly residual herbicides in soil.

The organic biostimulant, ROOTS, seems to offer a significant opportunity to increase plant growth, according to findings from current university research and field trials. Improved root and shoot growth, better root growth potential, and better stress resistance seem to be consistent with other results. The most important possibility for the future of this organic biostimulant, may be its ability to cut down chemical fertilizer without affecting growth. Preliminary research showed that in the presence of the biostimulant, coffee seedlings treated with the half amount of fertilizer yielded the same shoot biomass and higher root biomass than those fully fertilized.

1240 92 - 12/66

Soil fertility

Europe, Netherlands, field study, high input agriculture, low external input agriculture, nitrogen cycling, nitrogen balance, nitrogen mineralization, nitrogen immobilization, denitrification, microbial biomass

VAN FASSEN, H.G. and G. LEBBINK

4. Nitrogen cycling in high-input versus reduced-input arable farming.

Netherlands J. of Agric. Sc., 38, 1990, pp. 265-282

In this paper, N1-balance calculations covering the growing season will be discussed as well as changes in soil N mineralization rate, in N uptake by the crop, and in N losses due to changes in management. A conventional farming system was compared with two integrated systems, each system with the same rotation of winter wheat, sugar beet, spring barley and potatoes on a silt loam soil. Soil physical conditions and meteorological data necessary to account for some of the differences in overall N budget are discussed.

Field work was carried out at an experimental farm on a calcareous silt loam soil.

A previous experiment at the experimental site, in which three different input regimes of organic matter were compared, was taken as a starting point.

Agroecosystems are inherently more 'leaky' than undisturbed natural ecosystems where vegetation is continuously present. Increased inputs of nitrogen into agriculture have greatly increased crop (N) outputs, but they have also increased N losses to the environment.

Integrated management might give lower crop yields than conventional management, but because of lower costs, the profitability to the farmer could be similar.

Nitrogen balance sheets for the growing seasons of 1986-1988 showed N deficits of 0-170 kg ha-1, suggesting substantial N losses to the environment.

The uncertainty about actual N losses mainly depended on the uncertainty of estimated net N mineralization. Periods with much rainfall in 1987 and 1988, inappropriate use of animal manure and soil compaction may partly account for the heavy N losses in all farming systems. Potential rates of N-cycle processes were studied over the years to observe effects of changes in management.

The following conclusions can be drawn from these studies:

- The uncertainty about actual N losses mainly depended on the uncertainty in the calculated net N mineralization for field conditions. Especially uncertain was the contribution of the layer 40-100 cm, with a rather high organic matter content, to N supply of the crops.

- The soil organic matter and total-N contents showed a tendency to differentiate from their original two levels, into four levels as a result of changes in management. The next years will show which new steady-state levels will eventually result from integrated or conventional management.

- Correlations between N mineralization rates and biomass-N flush of soil samples were found to be situation-dependent.

- On fields with initial organic matter levels of 2.2% and 2.7%, crop yields under integrated management were on average 83% and 88%, respectively, of crop yields under conventional management.

- In the integrated system, the spring application of pig manure had to be changed to autumn application of spent mushroom compost, to prevent N loss by NH3 volatilization and by denitrification. The use of compost is also needed to maintain a high level of soil organic N.

- To minimize the risk of N losses to the environment, soil inorganic N concentrations should be kept low, especially in periods when no active crop is present and N losses are most likely to occur.

1241 92 - 12/67

Soil fertility

Review, symposium, rice farming, green manure, cropping systems

IRRI

5. Green manure in rice farming.

Publ. of the International Rice Research Institute, Los Banos, Philippines, 1988, 378 pp., USD 12.30

This book embodies the proceedings of a symposium on sustainable agriculture held in 1987, at the International Rice

Research Institute (IRRI), Los Banos, Philippines.

Some 92 scientists from over the world participated in the conference.

Topics include the use of green manures in China, southern Asia, parts of Africa, USA and other areas, as well as topics on woody species, N transformation, soil redox dynamics, and others dealing with general principles.

This book contains a wealth of valuable information on perennial and annual legumes as a N source and for soil improvement in upland and lowland rice production. Basic concepts and practical applications are covered well.

Discussion of N transformation, crop uptake, losses and residual is handled in an thorough manner.

Several of the writers pointed out, the value of green manuring is greater than N supply per se, e.g., several physical and chemical properties are also modified beneficially.

Contributions of N by food-crop grain and food-crop legumes were presented as an important consideration, since the economics of appropriating land and time for N production is often not cost effective due to the cost constraints of labour, land opportunity and seeds. These constraints forced a steep decline in the use of green manures in rice production everywhere as N fertilizer became available and affordable.

The first chapter of the book, nine pages, consists of the recommendations that emerged from the symposium discussions, including research needs and proposed research areas.

Advantages und disadvantages of green manure use are listed.

The papers and discussions during the symposium reconfirmed that - broadly defined - green manure does increase rice yields. Moreover, empirical evidence and theoretical considerations strongly suggest that green manure can contribute to the sustainability of tropical agricultural systems in which rice is a major crop.

The information is presented in 25, generally well-written, edited and documented chapters.

The book is a valuable resource and the information is presented interestingly.

It is an excellent reference to those involved in rice production and possibly a textbook in courses in soil management and sustainable agriculture, especially looking to the future.

1242 92 - 12/68

Soil fertility

Africa, Nigeria, humid tropics, field trials, maize, cassava, low-input agriculture, green manure, IRRI

VAN DER HEIDE, J.

6. Role of green manure in low-input farming in the humid tropics.

In: Green Manure in Rice Farming; Proc. of a Symp. on Sust. Agriculture, IRRI, Philippines, 1988, pp. 186-191

The use of cover crops is particularly relevant in the humid tropics, as high rainfall generally has depleted the soil of nutrients, especially nitrogen, which leaches easily. Levels of soil-organic matter are generally low, and there is a rapid and persisting weed growth, which is one of the main reasons why farmers have to abandon their plots.

Cover crops have been used for a long time by small farmers in the tropics in their crop rotations, mostly as a cheap source of biologically fixed nitrogen, for the recycling of leached nutrients, for protection against erosion, for the build-up and maintenance of soil organic matter and for the suppression of weeds.

Field experiments under humid tropical conditions in southeastern Nigeria for several years studied N requirement and utilization of upland cropping systems, with and without legumes and with low-input management on acid, low-activity clay soils. Total N utilization over several cropping systems was assessed. Quantities of N removed from the soil and left behind as crop residues after harvest and residual effects of N fertilizers and legumes included in the cropping systems were determined.

Although the data presented were obtained in the first years of a long-term experiment, the results indicate that, from the first year after clearing, considerable differences occur in N use and conservation of intercropped or sequentially cropped systems of non-irrigated agriculture in the humid tropics. In three of the four systems studied, more N was removed by harvest products than was returned after harvest with the crop residue, even at the high N fertilizer levels applied in the experiment. This also occurred if pigeonpea or cowpea were included in the cropping system.

A green manure planted after monocropped maize in the second season did not have a significant effect on yield of the following maize crop compared to cowpea, substantially more nitrogen was returned to the plot than was removed by harvest products.

After continuous cropping for 4 yr, the inclusion of a legume in the crop rotation, in particular as a second season cover crop, showed an important residual effect on N supply to monocropped maize. No residual effects were observed from N fertilizer applications.

Cassava utilizes substantial amounts of fertilizer N. Removal of stems from the field after harvest removes large quantities of N from the cropping system. After the basic requirement of cuttings has been satisfied, ways should be found to restore the N in the stems to the soil without harmful side effects. Including a green manure in traditional cropping systems appears to be the best alternative to attain sustained crop production in low-input agriculture, as far as the supply of N is concerned.

Including a green manure crop such as mucuna in the minor season did not result in better performance of maize than of second season cowpea, but did have a pronounced residual effect on the succeeding maize crop.

Detailed studies on the relationship between the inclusion of cover crops and the buildup and maintenance of soil organic matter, and the processes that control the availability of plant nutrients in the low-activity clay soils in the humid tropics are needed.

Since many green manures cannot be used for human consumption, other benefits should become obvious to the farmer after one or two cropping cycles. Grain legumes, although providing immediate economic benefit, tend to accumulate nutrients in the grain which is harvested, so that their effect on the performance of the following crop is usually low.

Nitrogen-fixing cover crops can be an excellent way to supply a substantial quantity of nitrogen and recycled nutrients to the annual crop rotation, by returning the total biomass produced to the soil, just before planting one, or a combination of food crops in the following season. Leguminous forage crops to provide feed for cattle can have a double function.

1243 92 - 12/69

Soil fertility

Africa, Rwanda, highlands, acid soils, field trials, beans, wheat, vetch, green manuring, yield, soil fertility, FSRP

YAMOAH, C.F. et al.

7. Green manuring with vetch on acid soil in the highland region of Rwanda.

Biol. Agric. and Hort., 7, 1991, pp. 303-310

The purpose of this study is to assess the value of vetch used as a green manure crop on acid soil prevalent in the highland region of Rwanda. Bean (Phaseolus vulgaris) and wheat (Triticum aestivum) yields and soil chemical analysis following incorporation of vetch were used to evaluate success in the improvement of soil fertility.

The study was carried out during four cropping seasons.

The soils are classified in the USDA system as Oxisols.

The advantages ascribed to legume green manuring are numerous and include: improvement in soil fertility, increased cation exchange capacity, increased water retention, enhanced microbial activity and improved soil structure.

Vetch (Vicia sativa L.) is a potential green manure crop in the East-Central African highland region where soils are generally acidic.

In this area, vetch grows relatively fast, assumes a quick soil cover to check ground erosion and produces high biomass.

Incorporation of 5-month old vetch lowered soil pH as well as raising exchangeable Al and H and reducing exchangeable Ca, Mg, and P.

Consequently, bean and wheat yields for the subsequent season were reduced by 71 and 33%, respectively. There was no response to fertilizer N on either main treatment. There were no significant yield differences for either crop with respect to vetch treatment during the second season. Third season crop yields were superior on the control plot, with that of beans being significantly different. Application of lime raised exchangeable Ca, K and reduced exchangeable Al. Bean was more affected by exchangeable Al than wheat. Half-life for decomposition of the vetch was 3.5 weeks and nutrient release pattern followed the order: K>N>P>Ca indicating that liming may be required to supply Ca and to neutralize soil acidity at the initial stages of decomposition.

Concluding, it can be stated that in the Rwandan highlands vetch grows rapidly and provides a quick cover to control erosion. Its use for green manuring on the acid soils in this region must be treated with caution.

Decomposing vetch material initially made the soil acidic and crops which immediately followed vetch incorporation suffered severe yield losses. It may be advisable to allow three to four weeks after incorporation before seeding food crops. Similarly, lime application may be necessary to counteract adverse effects of soil acidity during early stages of decomposition and also to supply Ca.

1244 92 - 12/70

Soil fertility

Asia, Philippines, humid tropics, lowland, field experiment, cropping systems, preceding crops, organic manure, nitrogen fertilizer, mungbean, sesbania, green manure, rice, maize, yield, residual effects

MEELU, O.P. et al.

8. Tropical lowland rice response to preceding crops, organic manures and nitrogen fertilizer.

Trop. Agric. (Trinidad), 69, 1, 1992, pp. 96-100

This study determined the effects of alternative crops grown late in the dry season on fertilizer N response of wet season irrigated rice and residual effects on dry season irrigated maize.

The experiment was initiated in 1984 on the farm of the International Rice Research Institute, Philippines, and repeated in 1985.

Five cropping sequences were examined:

- Green manure (Sesbania cannabina [Retz] Poir)
- rice (Oryza sativa L.)
- maize (Zea mays L.)
- Fallow [farmyard manure (FYM)] - rice - maize;
- Fallow - rice - maize;
- Mungbean (Vigna radiata [L.] Wilczek) - rice - maize; and
- Maize fodder - rice - maize.

The experiment was laid out in a strip plot design with strips of crops in one direction and strips of N levels in the other. The treatments were replicated four times. Crop sequence and N level strips were re-randomized for each of the four replicates.

The soil of the experimental field was clay.

Mean rice grain yield without fertilizer N was maximum (4.5 t ha 1) after Sesbania and minimum 2.7 t ha-1) after maize fodder. Mean yields of unfertilized rice after FYM, fallow, and mungbean were intermediate, decreasing in that order. Yields of unfertilized rice grown after Sesbania, the aboveground biomass of which accumulated 70 kg N ha-1 (1984) and 98 kg ha-1 (1985) in 60 days were comparable with rice yields in fallow plots to which 44 and 96 kg ha-1 fertilizer N, respectively, were applied. FYM (15 t ha 1) supplied 68 kg N. The efficiency of N from FYM in combination with different N levels on rice ranged 31-51%.

Significant residual effects of FYM and green manure on the succeeding maize crop were not detected. Soil organic C and total N after wet season rice in 1985 were higher when Sesbania and FYM preceded rice compared with maize fodder, mungbean or fallow.

Crops in the tropics are often grown in a particular sequence.

Fertilizers and manures applied to one crop can affect the response of the succeeding crop.

To estimate optimum N fertilizer rates for crops grown in sequence, the effects of the preceding crop species and application of farmyard and green manures should be considered.

1245 92 - 12/71

Soil fertility

Africa, Niger, semi-arid tropics, drylands, farm practices, field trials, pearl millet, cowpea, intercropping, soil fertility, crop productivity

REDDY, K.C. et al.

9. Pearl millet and cowpea yields in sole and intercrop systems, and their after-effects on soil and crop productivity.

Field Crops Res., 28, 1992, pp. 315-326

The objective of this study was to compare the productivity and effects on soil fertility by rotations of these common crops in Niger.

A 4-year field experiment was conducted in a Psammentic Paleustalf in Niger to determine the continuous cropping effects of pearl millet (Pennisetum glaucum (L) R.Br.), cowpea (Vigna unguiculata (L.) Walp.) and three pearl-millet/cowpea intercrop systems with cowpea planted 1, 2, and 8 weeks after millet planting on soil and crop productivity.

Crops were grown for grain on the same plots under rainfed conditions in 1986, 1987 and 1988 crop seasons and all crop residues were removed from experimental plots.

For three years preceding the experiment, millet was continuously planted in association with cowpea at low densities on these plots, similar to much of the dryland farm practices in Niger.

It can be concluded that millet/cowpea intercrop systems showed better land-use efficiency than sole millet or cowpea systems. On a total grain-yield basis, sole cowpea was more productive. Continuous cropping of sole cowpea with residue removal significantly increased soil Mg and OM over sole millet or millet/cowpea intercrops. Test-crop millet produced significantly higher dry-matter yield and N uptake in PCS sole cowpea than other treatments. Test-crop millet N uptake after previous intercrop treatments was significantly greater than previous sole millet. This leads us to believe that cowpea inclusion in sole or intercrop systems would make extra soil N available to following cereal crops such as millet. From a practical point of view, introduction of sole cowpea or cowpea-based intercrop systems in place of traditional millet-dominated intercrop systems may be advantageous.

Pearl millet (Pennisetum glaucum (L.) R.Br.) is planted principally for grain on about 10 million ha in West Africa. Generally in this region, millet is grown on infertile sandy soils in association with cereals such as sorghum and/or with legumes such as cowpea or groundnuts. Of all the combinations, the millet/cowpea association is the most widely used in the Sahelian zone of Niger, extending up to 50% of the country's cultivated area (about 2 million ha).

In recent years, farmers in Niger and other West African countries increased land area under millet cultivation to meet food needs by effectively decreasing the fallow period or replacing the traditional shifting cultivation with continuous cropping of millet-dominated intercrop systems.

As the application of fertilizers is not always economical in the semi-arid tropics of Niger, non-fertilizer-based methods to improve soil conditions, such as legume use, deserve special attention. In spite of a tremendous knowledge base in this area from Asian and Western countries, crop rotation on the impoverished soils of West Africa is not practiced.

This and other improper cultural practices are leading to a large-scale degradation of soils in this area.

1246 92 - 12/72

Soil fertility

Latin America, Colombia, field trial, phosphorus availability, bean seed tolerance, seedlings, mineral deficiences, roots, leaves, stems, starch, content, protein content, CIAT

SADEGHIAN, K.S.

10. Influence of some characteristics of bean seed and seedlings on the tolerance to low phosphorus availability in the soil. (Infuencia de algunas caracteristicas de las semillas y plantulas de frijol Phaseolus vulgaris L. sobre la tolerancia a la baja disponibilidad de fsforo en el suelo)

Tesis Universidad Nacional de Colombia, Bogota, Colombia; Ing. Agr. Palmira: 1991, 81 pp.

The influence of certain quantitative characteristics of bean seed on the capacity of seedlings to tolerate low available P in the soil was determined. The starch, protein, phytic acid, and different P fractions of the seed were determined in 23 bean genotypes during the 1th phase of research. Results indicated that the reduction in total biomass production of the seedling and in tissue P concentration was pronounced at 16 days after planting, as a direct consequence of soil P deficiency.

However, this reduction was more pronounced in the leaves since a greater amount of photosynthates were invested in root production, thus increasing the relative extension of the root system in the soil. The no. of main roots proved to be a variety characteristic that is unmodified by soil P levels. On the other hand, the size of endodermical cells was significantly increased by the low P treatment, possibly due to a nutritional physiological adaptation mechanism; however, no significant differences were found among variety. Seed weight and size of cotyledon cells showed a positive, highly significant correlation with seedling vigor. The coefficients of correlation obtained in the low P treatment were higher than those of the high P treatment, indicating that the nutritional dependence of the seedlings is more pronounced under P deficiency conditions. Variance analysis showed that cotyledon reserves satisfied the nutritional needs of the seedlings more less up to 12 days after planting, after which significant differences in growth rates occurred. Although total biomass production was directly related to seed size, it did not affect the duration of reserves. Although the experiments attempted to minimize the variations existing between environments (pots and tubes) and between replications, statistical analysis revealed significant differences due to these factors. Root analysis in modified PVC tubes was useful in the study of overall genotype performance, but maladjustments occurred that affected the final results of P treatment.

1247 92 - 12/73

Soil fertility

Asia, India, field trial, legumes, arid areas, phosphate application, soil nitrogen, pearl millet

KATHJU, S. et al.

11. Evaluation of diverse effects of phosphate application on legumes of arid areas.

Trop. Agric. (Trinidad), 64, 2, 1987, 91-96

Low organic matter and low N in most soils of arid and semi-arid parts of Rajasthan present the opportunity for the adoption of a low-input approach towards improvement of fertility through the cultivation of legumes. It is also felt that soil N, thus augmented, might contribute much towards the yield improvements of subsequent cereal crops, particularly of pearl millet, grown extensively in these parts. In this regard, the importance of phosphate fertilization to legumes for the improvement of their performance and N2 fixation has been documented in a number of reports. Although mungbean, moth bean and clusterbean are widely cultivated in these parts, there seems to be little knowledge regarding the effects of phosphate fertilization on these legumes and succeeding cereal crops. Such an assessment, moreover, is particularly needed because of the uncertainty of monsoonal rains and the drought-prone nature of the region; the effects of P on the growth, yield and water-use of legumes in different rainfall situations assume importance. Again, the implication of P application on soil N enrichment and the consequent yield improvement of the succeeding cereal crop warrant special consideration in view of the reports of beneficial effects of P on soil N status, even in situations where the performance of the legumes was not influenced. This paper relates some findings in these areas.

Mungbean (Vigna radiata), moth bean (Phaseolus acontifolius) and clusterbean (Cyamopsis tetragonoloba), grown over three successive years under low and variable rainfall on loamy sand soils of arid western Rajasthan, did not reveal any marked effect of phosphate application (0, 20, 40, 60 and 80 kg $P_2O_5ha^{-1}$) on the consumptive use of moisture. The effects on dry matter production and seed yield were marginal, but not significant. Uniform distribution of precipitation during the growing period, rather than its quantum, had the more favourable influence on plants. P application induced a small increase in the available P status of the soil and also in N and P uptake. But the weight of nodules per plant and root CEC progressively increased with increasing level of P up to 40-60 kg $P_2O_5ha^{-1}$. Phosphate application also led to an increase in soil N, particularly of the hydrolyzable organic-N fraction. Effects on mineralized N were marginal. The amount of N_2 fixed was greater in mungbean and moth bean than in clusterbean but the mineralized and hydrolyzable organic-N fractions increased more under clusterbean. While the phosphate levels did not have any effect on the succeeding pearl millet (Pennisetum typhoides) crop, the legumes significantly promoted its yield equivalent to > 80 kg N ha-1, despite the prevalence of acute drought conditions. The beneficial effect of clusterbean was found to be greatest, followed by moth bean and mungbean. It seems that the beneficial effect of legume cultivation arose not only from the total N2 fixed but also from the level of mineralized and hydrolyzable organic N contributed by plant residues left in the soil.

1248 92 - 12/74

Soil fertility

Asia, India, dryland agriculture, field trial, clay loam soil, cropping systems, fertilizer, pigeonpea, sorghum, sole cropping, intercropping

PANDEY, R.C. et al.

12. Effect of n and p fertilizers on sustainability of pigeonpea and sorghum systems in sole and intercropping.

IPN, 15, 1992, pp. 12-15

This paper attempts to identify nutrient management in sole and intercropping systems which improves the soil environment and maximizes productivity on a sustained basis.

Three cropping systems, sole pigeonpea, sole sorghum, and pigeonpea intercropped with sorghum (1:2) were tested under two sets of fertilizer regions.

The sustainable yield index (SYI) and the sustainable value index (SVI) were computed to analyze the comparative performance of sole and intercropping systems with respect to fertilizer use.

The data indicate among others that sole pigeonpea gave maximum pigeonpea seed equivalent yield followed by pigeonpea + sorghum intercropping at all levels of N under study. Enhancing the application of nitrogen from 15 to 60 kg ha-1 increased the yield by 40% for sole pigeonpea and sole sorghum, and by 54% for pigeonpea + sorghum intercropping system in terms of pigeonpea seed equivalent over the lowest dose. This showed that an intercrop of pigeonpea + sorghum was beneficial and efficient compared to sole cropping in respect of nitrogen uptake. The maximum LER (1.24) was obtained in pigeonpea + sorghum intercropping system at 60 kg N ha-1.

The superiority of intercropping over sole cropping in terms of insurance from risk, better resource use, and higher return has been highlighted by many workers. But sustainable fertilizer management in an intercropping system is not yet well understood. Under dryland situations, land, water, and crop management systems which guarantee sustained production and productivity over a wide range of environments or over many years in the same location would qualify to be called sustainable agricultural systems.

1249 92 - 12/75

Soil fertility

Review, book, humid tropics, acid upland soils, Oxisols, Ultisols, plant nutrients, organic matter, soil management systems, fertilizer, crop production, FAO

VON UEXKULL, H.R.

13. Efficient fertilizer use in acid upland soils of the humid tropics.

FAO Fertilizer and Plant Nutrition Bulletin, 10, ISBN 92-5-102387-5,

1986, 51 pp. + references

The largest reserves of potential arable land still available in the world are located in the humid tropics.

Significant advances have been made in the characterisation and management of acid soils in the uplands of the humid tropics. The aim of this bulletin is to review the experience already acquired and to summarise the research findings which have recently become available.

On the uplands, acid soils predominate and agriculture at a low level of inputs is only possible through shifting cultivation, in which the land is cropped for a few years in alternation with long periods of fallow.

In most cases crop growth in acid soils can be directly correlated with Al saturation or Al concentration in the soil solution. High H+ concentrations in the soil solution, however, favour weathering of soil minerals, resulting in the release of Al3+ and the leaching of ions such as K+, Mg2+, Ca2+ and Mn2+.

Poor crop growth on acid soils is usually caused by aluminium and/or manganese toxicity and/or by deficiencies of phosphorus, calcium and magnesium.

Most of these soils are at present under virgin rain forest, with smaller areas under savanna, tree crops and shifting cultivation. The main reason for lack of development of these soils is that a high standard of management and costly inputs are needed to bring them into permanent arable cropping.

Most of the acid upland soils of the humid tropics are classified as Oxisols (Ferrasols) and Ultisols (Acrisols). Both groups are very acid with low base status, their mineral horizons containing small amounts of most nutrients.

When cropped without proper management, most acid soils of the humid tropics deteriorate, chemically and physically, so quickly after clearing that after a few years no crop can be grown on them. With adequate inputs and proper care, the annual productivity of these soils can far exceed the productivity of most fertile soils in temperate regions.

Where population pressure is low, shifting cultivation is often still the most appropriate land use system.

Better techniques of forest clearing are being developed. Zero-burn techniques in which the felled forest biomass is broken down under a short term leguminous cover crop followed by moderate applications of lime and P fertilizer show considerable promise.

Three levels of intensity can be distinguished and are discussed in this book:

- shifting cultivation with no lime or fertilizer inputs, relying on long fallow periods for regeneration;

- continuous cultivation with moderate applications of lime and P fertilizer, using leguminous cover crops or alley crops to provide biologically fixed nitrogen and organic matter;

- intensive continous cropping with large and continued inputs of NPK fertilizer, lime and other nutrients, a system that is capable of reaching and maintaining very high levels of productivity.

With good management once infertile acid tropical soils can produce annually the equivalent of 15 to 20 t/ha of grain. The availability of high yielding and disease resistant cultivars means that maize yields in excess of 10 t/ha per crop are now obtainable, while acid tolerant and disease resistant soybean cultivars can yield 2.5 to 3 t/ha per crop. It will usually take several years of good management to achieve these yield levels.

High rates of fertilizer are recommended by the author to maintain production when three crops are taken.

The rates are very similar to the rates used by many temperate region farmers aiming for comparable yields.

When high inputs are used the risks involved must be minimised. For acid upland soils this can only be done by conserving organic matter.

Organic matter, lime, and P are the three main factors on which a successful soil management and crop productivity programme for acid tropical soils can be built.

The agronomic practices adopted must supply a correct balance of organic manure and additional mineral fertilizer.

1250 92 - 12/76

Soil fertility

Review, book, Latin America, Colombia, CIAT, mycorrhiza management, agronomic importance, cropping systems, practical technologies

SIEVERDING, E.

14. Vesicular-arbuscular mycorrhiza management.

Publ. of GTZ, 6236 Eschborn, Postf. 5180, Germany, ISBN 3-

88085-462-9, 1991, 371 pp., pbk

Increasing crop production and land productivity in the tropics is essential if the food demand of the growing population in these areas is to be met. Of all the soil-related constraints on crop production, low soil fertility is the most severe on more than half of the arable land in the tropics. Infertile soils are acidic and may be deficient in phosphorus, nitrogen and potassium. On these soils crop production can only be improved when fertilizers, in either organic or inorganic form, are applied, and when soil amendments are combined with improved crop production technologies. This is explained by Ewald Sieverding in his book Vesicular-Arbuscular Mycorrhiza Management, in which he describes the role these fungi can play in improving soil fertility.

The author explains that until about 20 years ago, vesicular-arbuscular mycorrhizal (VAM) fungi were virtually ignored by most soil and plant scientists. However, under controlled greenhouse conditions it has been demonstrated that VAM fungi increase phosphorus uptake. They also play a role in the uptake of other plant nutrients as well as in the biological nitrogen fixation of Rhizobium, the biological control of root pathogens, and the drought resistance of plants.

In 1980 a Mycorrhiza Special Project was initiated at the Centro Internacional de Agricultura Tropical (CIAT), in Cali, Colombia. The general objectives of this project were to test the agronomic importance of VAM in tropical crop production systems and to develop practical technologies to utilize VAM fungi as a biological resource to enhance phosphorus uptake and utilization.

Although the content of this book relates directly to South America, with particular reference to cassava, the principles of the VAM technology presented can be transferred to other crops and to conditions in tropical Africa and Asia, provided that the technology is adapted to the prevailing ecological and socio-economic conditions.

1251 92 - 12/77

Soil fertility

Germany, study, greenhouse conditions, mycorrhiza, pigeonpea, phosphorus fertilizer, plant growth

DIEDERICHS, C.

15. Impact of tropical va mycorrhizae on growth promotion of cajanus cajan as influenced by p sources and p levels.

Publ. of the Institute of Agronomy in the Tropics, Univ. Gttingen, Germany. Presented at the Int. Symposium on

Management of Mycorrhiza in Agric., Hortic. and Forestry, Perth, Australia, 1992

The aim of the present paper revolves around the following questions: Are there differences between various VA mycorrhizal fungi in improving P uptake from different P sources with varying solubility? Do different P fertilizers exert an effect on the interaction of VA mycorrhiza and rhizobium? Does pigeon pea take advantage of a dual symbiosis?

The contribution of legumes in tropical cropping systems to maintain/restore soil fertility is gaining increasing importance. The most important aspect of tropical legumes is their ability to fix P in association with rhizobium atmospheric dinitrogen which becomes available to subsequent crops in rotational cropping systems. This is true for pigeon pea (Cajanus cajan) which fits into many agronomic management systems because of its multipurpose use. However, unfavorable soil conditions in the tropics often impede development of pigeon pea and phosphorous is considered to be the most limiting factor. Studies indicate the need for application of between 20-100 kg/ha of phosphorus.

This, however, is a luxury most farmers in the tropics with very limited financial resources can ill-afford. Consequently, seeking other possibilities to overcome this problem deserves special attention. In this context, the management of effective VA mycorrhizal fungi could become a promising tool to increase the efficiency of applied P fertilizers and thus reducing financial expenses.

The present research work was conducted under greenhouse conditions using a non-sterilized P fixing soil. Three P sources were applied at the following rates (kg P/ha): single superphosphate 10, 30, 60; and two rock phosphated from Brazil; Patos de Minas (total P, 10.7%): 50, 150, 300; and

Arax (total P, 12.1%): 50, 150, 300. The soil contained 2 native species of Glomales: Glomus albidum and Glomus intraradix. The mycorrhizal inoculum consisted of an air-dried mixture of soil/roots/spores and was applied at the rate of 2g/pot. Four VAM species originating from the Cerrado Ecosystem of Brazil were tested:

Glomus clarum, Glomus pallidum, Entrophospora colombiana, Acaulospora rehmii and Glomus manihotis from CIAT/Colombia (C-1-1). Cajanus cajan plants were not fertilized with N but inoculated with a peat-based inoculum of effective strains of rhizobium also from the Cerrado region.

The present results clearly indicate a strong dependency of pigeonpea on VAM fungi under P stress and Glomus clarum proved to be the most effective fungus irrespective of the P source and P level. In general, mycorrhizal infection rate was not influenced by the P source. However, with the exception of

Glomus clarum, infection rate tended to decrease with increasing P levels. P uptake of inoculated plants corresponded well with the plant development and a similar tendency was observed with N uptake. With inoculated plants a significant relationship between P uptake/nodule formation and nodule formation/shoot dry weight was found, in particular with rock phosphate (Araxs). This relationship decreased with increasing solubility of the P source. The present results bear evidence that the fertilizer efficiency of low grade rock phosphates is dependent on an effective VA mycorrhiza. With Cajanus cajan an additive interaction of effective VA mycorrhiza and rhizobium was observed resulting in: improved P and N uptake, increased nodule formation and, enhanced plant growth.

1252 92 - 12/78

Soil fertility

USA, study, greenhouse experiment, sorghum, genotypes, mycorrhiza, phosphorus efficiency, cost/benefit analysis

RAJU, P.S. et al.

16. Benefit and cost analysis and phosphorus efficiency of va mycorrhizal fungi colonizations with sorghum (sorghum bicolor) genotypes grown at varied phosphorus levels.

Plant and Soil, 124, 1990, pp. 199-204

This study was conducted to determine benefit and cost analysis and P efficiency (dry matter produced/unit P absorbed) of Glomus fasciculatum colonization with sorghum roots when genotypes were grown at different soil P levels.

Sorghum [Sorghum bicolor (L.) Moench] was grown in a greenhouse in a low P (3.6 mgkg-1) soil inoculated with the vesicular-arbuscular mycorrhizal fungi (VMAF) Glomus fasciculatum and P added at 0, 12.5, 25.0, and 37.5 mgkg-1 soil to determine the effects of VAMF-root associations on plant growth, and P efficiency (dry matter produced/unit P absorbed).

Root associations with vesicular-arbuscular mycorrhizal fungi (VAMF) normally benefit plant growth, particularly through enhanced P uptake.

Host plants must provide carbohydrates to VAMF for development and growth.

In this study root colonization with VAMF and shoot growth enhancements decreased with increased soil P applications. Mycorrhizal plants were less P efficient than nonmycorrhizal plants. Shoot dry matter differences between mycorrhizal and nonmycorrhizal plants were considered the benefit derived by plants from VAMF-root associations.

Shoot dry matter differences between mycorrhizal and nonmycorrhizal plants with similar P concentrations were considered the costs paid by plants for VAMF-root associations. Values of benefit and cost analysis for VAMF-root associations were highest when soil P was lowest and decreased with increasing P applications. Genotypic differences for calculated costs were pronounced, but not benefits. Benefit and cost analysis may be helpful to evaluate host plant genotypes and VAMF species to optimize efficiencies of VAMF symbiosis in different soil environments.

VAMF associations with plant roots not only benefit growth and mineral element uptake, but VAMF infected plants can give greater tolerance to root pathogens, drought, low soil temperatures, adverse soil pH, and transplant shock. VAMF-root associations have great potential in land reclamation and agriculture practices on arid and acid lands, where drought, low soil fertility (especially P deficiency), and high soil salinity and/or toxicity elements can be major constraints to crop production.

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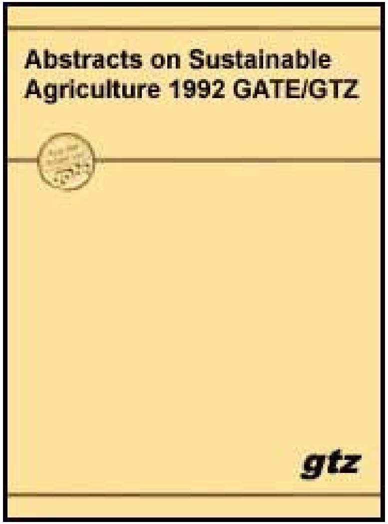

slopes.

3. Land restoration and revegetation.

4. Economic analysis of soil erosion effects in alley cropping, no-till, and bush fallow systems in southwestern Nigeria.

5. Soil conservation and management in developing countries.

6. Guidelines: land evaluation for rainfed agriculture.

7. Small-grain equivalent of mixed vegetation for wind erosion control and prediction.

8. A method for farmer-participatory research and

Abstracts on Sustainable Agriculture (GTZ, 1992, 423 p.)

Abstracts on erosion and desertification control

Acknowledgements

1253 92 - 13/51

Erosion and desertification control

Review, Africa, indigenous methods, soil and water conservation, ethno-engineering, maintenance, project interventions, research needs, policy requirements, IIED

REIJ, C.

1. Indigenous soil and water conservation in Africa.

Gatekeeper Series Nr. 27; Int. Inst. for Environment and Development

(IIED), London, 1991, 32 pp.; price £2.50 inc. p and p

The objective of this paper is to assess the current knowledge of indigenous Soil and Water Conservation (SWC) in Africa and to identify research needs and policy requirements in the field of African indigenous SWC.

Many parts of Africa are experiencing annual population growth rates between 2 and 4%, degradation of the natural resource base, recurrent droughts and a growing dependence on food aid as well as the import of cereals to cover food deficits. During the last two decades increasing financial outlays for agricultural research in Africa have neither produced significant breakthroughs nor led to agricultural growth.

Numerous reports have warned against the disastrous effects of increasing erosion, land degradation, desertification, mismanagement of natural resources due to increasing demographic pressure, and as a result, soil conservation emerged as a central concern in East Africa.

In many African countries considerable efforts have been made during and since colonial times to conserve soil and water resources. Yet most soil and water conservation projects in sub-Saharan Africa have failed. A major argument is that what has been constructed - often at great expense - has seldom been maintained by the "benficiaries".

The most important reasons for these failures in African soil and water conservation (SWC) include a dominant top-down approach, the use of techniques which are complicated to design and expensive to maintain both in terms of labour and capital, and therefore are not replicable by farmers, a neglect of farmer training, a heavy reliance on machinery for the construction of conservation works and an indiscriminate use of food-for-work.

Partly as a reaction to the disappointing results of integrated rural development programmes (IRDP's) with their strong emphasis on "transfer of technology", the 1980's have seen a growing awareness of the importance of indigenous environmental knowledge.

As part of this trend, the awareness of the importance of indigenous SWC techniques has also increased.

Three major issues are explored in this paper:

- The first demonstrates that despite a growing awareness of its importance, African indigenous SWC continues to be neglected.

- The second analyses present trends in indigenous SWC. Are indigenous techniques increasingly abandoned and if so, why?

- The third briefly examines the effect of project interventions. Some examples will be given of project interventions damaging indigenous

SWC and of others improving the efficiency of indigenous SWC techniques.

Concluding, the author states amongst other that slowly but surely, a certain consensus is emerging that indigenous SWC techniques could be used and have a role to play. This trend reflects a feeling of disappointment with or even despair about the failure to narrow the gap between food needs and food production in Africa and the inability to create conditions for sustainable rural development.

A marriage between indigenous and modern techniques may be required to increase the technical efficiency (coping with degradation) as well as the returns to labour (higher incomes).

Indigenous SWC techniques are not well known and require some research.

Experiments should be designed to improve their technical efficiency, and several techniques should be tested at village level and evaluated by technicians and villagers. It may take

3-5 years before the best and most acceptable technical package is identified, hence tangible results can rarely be obtained before 5-10 years have elapsed. It is essential that donor agencies and governments accept these time frames for projects.

1254 92 - 13/52

Erosion and desertification control

Latin America, Ecuador, proceedings, workshop, DESFIL, USAID, sustainability, slopes, agriculture, methods, strategic planning institutions, incentives, DESFIL, USAID

HANRAHAN, M.S.

2. Sustainable uses for steep slopes.

Workshop Proceedings "Sustainable Uses for Steep Slopes", Vol. II; DESFIL in coop. with USAID, USA; 1987, 47 pp. + annex

During the Inca period, the Andean highlands were home to 20 million persons, and sustained an efficient agriculture, evidently sufficient to support this population, indeed with excess production to trade with lower areas. The historical record left by these peoples attests that it is possible to practice efficient and sustainable agriculture in the region.

Therefore, a workshop for applied development practitioners, was held 1987. The workshop had two general purposes:

- To report experience in implementation and applied research on the development and the intensified but sustainable uses of fragile, steeply sloped areas; and

- To draw conclusions and lessons learned from past experience for the design and management of future development on fragile, steeply sloped areas.

Presentations were made by persons and institutions that had attempted project implementation or had concluded applied research projects based on steep slopes, could document what happened, and could draw lessons learned, implications for policy, and recommendations for the design and management of future projects from these experiences.

The working groups emphasized sociocultural themes and community participation. Those present, most of whom were not social scientists, were overwhelmingly of the opinion that effective technical measures for degradation control - such as terraces, windbreaks, living barriers, diversion or infiltration ditches, mulching techniques, crop rotation, cross-slope farming, and so on - proved under on-farm conditions, existed.

Farmers, however, and many personnel in public sector institutions and donor agencies were unaware that degradation was a problem, did not immediately perceive or pay for its effects, and were thus reluctant to apply or continue to apply the efficacious, available control measures.

The sociocultural deficiencies that the working groups identified in development projects and programs in fragile areas are, in general, that local participation was not included in development efforts and that the talent, leadership, and traditions of the native communities and of the national-regional technicians community were not called upon. In addition, projects are usually designed to cover relatively short time spans, and so do not provide for postproject continuity of degradation-control programs.

In the design and management of natural resources projects, the working groups signaled a need for an interdisciplinary focus on the multiple phases and effects of the degradation problem.

Workshop participants noted the existence of certain problem-prone areas, such as pramos, dormant volcano craters, and very high cloud forests, which nevertheless offer development potential. The key to the development of these areas is multiple, non-intensive, non-agriculturally based uses (such as a combination of forestry, tourism, and public education programs, or the non-intensive exploitation of indigenous species). Basic data on the identification and sustainable uses of such zones are lacking.

1255 92 - 13/53

Erosion and desertification control

Africa, review, land restoration, revegetation, agro-silvicultural methods, shelterbelts, plantations, rangeland, forests, woodlands, case studies strategies, constraints, control measures, intervention methods, knowledge gaps

ELHOURI AHMED, A.

3. Land restoration and revegetation.

In: FAO Conservation Guide No. 21, "Role of Forestry in Combating

Desertification"; FAO, Rome, 1989, pp. 253-265

This paper deals with the objectives of land restoration and revegetation, the strategies and practices carried out to realize the objectives within the context of the constraints, and arrives at recommendations of lines of action to deal with the problem.

The broad objectives of land restoration and revegetation are:

- to restore the land and vegetation for increased food production.

- to enhance food production and also to generate income and to improve the quality of life through resource conservation and development.

The specific goals are:

- Protection of the soil from wind and water erosion and maintenance of its fertility.

- Protection of catchment areas and perennial and seasonal water courses to assure regulated flow of water both in quantity and quality. Also efficient and wise use of the scarce resource of water.

- Enhancement of the productive role of the vegetation to realize maximum production of fodder, wood, fibers, medicinal products, tannins, perfumes, gums and other products.

Land restoration and revegetation is carried out through execution of corrective measures on land where the degradation has occured. The current measures usually executed are summarized in this paper such as:

- On cultivated land:
- Agro-silvicultural methods
- Shelterbelts
- Plantations on seriously degraded irrigated or rainfed crop land
- On rangeland
- On forests and woodlands
- On bare land: sand and sand-dune fixation

The case studies discussed illustrate what happens when vegetation is destroyed by imbalanced use of land.

The following conclusions and recommendations are drawn:

Land and vegetation degradation is essentially a land use problem and the key to success for restoration and revegetation centres on:

- Integration of land use within ecological context.

- Active peoples' participation, through various means, as no government can cope with these problems.

- Building and strengthening the staff base at all levels to execute these programmes, and filling the present gaps in knowledge.

- Integration of all available knowledge into working practical models that can solve the problems.

No effort on land restoration and revegetation can achieve its objectives without the active participation of the people. This cannot be done without motivation. That coercion through laws alone has largely failed needs no illustration. There is a need for studies to evolve methods of motivation, coercion and others that can lead to sound practices of efficient utilization and conservation.

1256 92 - 13/54

Erosion and desertification control

Africa, Nigeria, study, IITA, land-use, shifting cultivation, soil erosion, alley cropping, bush fallow system, no-tillage system, economic analysis

EHUI, S.K. et al.

4. Economic analysis of soil erosion effects in alley cropping, no-till, and bush fallow systems in southwestern Nigeria.

IITA Research No. 3, 1991, pp. 1-5

Based on a simulation model, this paper uses a capital budgeting approach to determine how land-management technologies are compared with each other and with traditional bush fallow systems in southwestern

Nigeria, taking into account both the short-term and long-run impact of soil erosion on agricultural productivity and profitability.

The analysis is also conducted under two population density scenarios (high and low), which permits to verify the hypothesis that there exists a positive correlation between population density and agricultural intensification. This study thus differs from previous economic analyses in that the productivity effects of soil erosion and population growth rate are assessed.

Five land-management technologies in maize production are evaluated in the study.

They are continuous alley cropping systems with leucaena (Leucaena leucocephala) hedgerows planted at 2-m and 4-m intervals, continuous no-till system, and two traditional bush fallow systems with 25% an 50% farming intensities.

Shifting cultivation is typical of traditional agricultural systems in tropical Africa.

The International Institute of Tropical Agricultural (IITA) has concentrated its research efforts over the past two decades on developing sustainable soil management technologies, which enhance food production and preserve the natural resource base.

Although some economic analyses are available on the viability of improved land-use systems in sub-Saharan Africa, none of them accounts for the erosion process with its resultant long-term impact on costs and returns.

These results confirm the hypothesis that there exists a positive correlation between intensity of land use and population density. The argument is that for given agroclimatic conditions, increases in population density will gradually move the agricultural system from forest fallow to annual cultivation. Thus intensive cultivation of permanent fields in the frontier, using labour-demanding technologies (such as the 4-m alley cropping) or external input demanding technologies (such as the no-till system), becomes the norm only when arable land is exhausted. It can, therefore, be concluded that where land value rises due to land shortages, farmers with lower discount rates are likely candidates for the adoption of the 4-m alley cropping system compared to the no-till. For those farmers exhibiting high discount rates under high population density conditions, research should focus on reducing the establishment cost of the 4-m alley cropping system to make it competitive with the no-till system.

To test if the technologies fit into the farmers' production plan, economic analysis based on a whole-farm modeling approach is necessary.

Whole-farm models reflect the basic production processes involved in agricultural (e.g., nitrogen-fixing capabilities of leguminous trees) as well as many of the resource characteristics and constraints with which farmers must work (e.g., labour, land, and credit, to name a few). This further research should now be a priority.

1257 92 - 13/55

Erosion and desertification control

Review, book, developing countries, soil conservation, conservation practices, watershed management, grassland management, research, organisation, education, extension, environment

FAO

5. Soil conservation and management in developing countries.

FAO Soils Bulletin No. 33, ISBN 92-5-100430-7, 1985, pp. 208 + appendices

The purpose of this book was to re-examine the question of soil conservation and management in the developing countries, bearing in mind socio-economic aspects, administrative structures, technology and financial resources.

The discussions concluded that there are problems in the organization of soil conservation and management and possible solutions were suggested.

Soil conservation in the past was commonly equated with the mere prevention of erosion or with the restoration of areas in which accelerated erosion has already taken place. The modern thinking however, assigns to soil conservation a more comprehensive and more positive role, in that sustained improvement complemented by the preservation of available resources should form the central concept.

Soil conservation is not merely a technical problem.

The basic concept of a multi-disciplinary approach to the solution of the problems has unfortunately been overlooked in most cases.

The following general recommendations were made amongst others:

- Soil erosion, and consequently the need for conservation, is not confined to land under arable use; it frequently affects grazing lands, and can be associated with mining, road construction, forestry and other kinds of land use.

- Soil conservation refers not only to mechanical protection measures but includes all aspects of land use planning, development and management which contribute to the maintenance and improvement of soil resources.

- Soil conservation is an interdisciplinary subject, which involves agronomy, soil science, range management, forestry, ecology, hydrology, engineering, geography, economics, sociology and other disciplines.

- The damage caused by severe soil erosion is frequently irreversible.

It is consequently desirable to take conservation measures to prevent onset of erosion rather than acting after it has commenced.

- Detailed knowledge of the nature and distribution of land in an area are the basic pre-requisites of any conservation programme.

- Soil is a basic resource, for the present and the future. As such, the value of its conservation extends beyond that which can be expressed in monetary terms.

Conservation education and extension are areas where particular attention must be directed in the developing countries. Many countries transfer without due consideration to socio-economic factors, conservation education methods from other environments with the pious hope of solving their own problems.

The organizational set-up is often uncoordinated with the general machinery of other Government Departments. This has in many cases resulted in ineffective, disorganized programmes which failed or even, in some cases, perpetuated the problem. There are examples in many countries of expensive soil conservation structures which are not properly maintained and which result in a worsening of the situation. In many of these countries, techniques need not always be complex. Such simple practices as contouring and terracing, constructed with the farmers' own tools, may in the aggregate, contribute as much as the more spectacular large scale development.

Specific guidelines are made for:

- research
- education
- extension and
- practical and technical aspects.

As a general principle, it is suggested that the contribution of FAO should be directed towards the coordination and dissemination of results and assistance to individual countries; and that individual countries and institutions should concentrate on work related to their local or regional circumstances.

1258 92 - 13/56

Erosion and desertification control

Review, book, land evaluation, rainfed agriculture, soil resources management, land utilization types, land-use, land-use requirements, crop requirements, land qualities, agroclimatic zones

FAO

6. Guidelines: land evaluation for rainfed agriculture.

FAO Soils Bulletin No. 52, FAO, Rome; ISBN 92-5-101455-8, 1984, 191 p. + appendices

The principal objective of land evaluation is to select the optimum land use for each defined land unit, taking into account both physical and socio-economic considerations and the conservation of environmental resources for future use.

The need for optimum use of land has never been greater than at present, when rapid population growth and urban expansion are making land available for agriculture a relatively scarce commodity. The increasing demand for intensification of existing cultivation and opening up of new areas of land can only be satisfied without damage to the environment if land is classified according to its suitability for different kinds of use.

These "Guidelines" are intended to assist field staff in carrying out land evaluation for rainfed agriculture according to the principles of the FAO Framework for land evaluation. The present publication is an expansion of the basic concepts of the framework giving procedures and methods necessary in evaluation for rainfed agriculture. It provides practical guidelines on the planning and execution of the various steps in land evaluation, from interpretation of basic data to the final recommendations which form a basis for land use planning and project implementation.

The "Guidelines" refer only to crop production. Both annual crops (arable farming) and perennial crops (tree and shrub crops) are included.

The procedures are applicable at all levels of scale, ranging from continental or national, through regional and district scales, down to detailed or intensive surveys for local projects, village-level schemes and farm planning.

These "Guidelines" occupy a position intermediate between the "Framework for Land Evaluation" and detailed local manuals on evaluation. The "Framework" gives the principles and basic concepts on which land suitability evaluation is based, and indicates overall strategies for their application. The "Guidelines" provide a detailed methodology for carrying out the strategies.

In attempting to be fairly comprehensive, the Guidelines present the maximum range of procedures or aspects to be covered. Some procedures are covered only briefly. Similarly, the checklists are intentionally long to ensure that no relevant aspect is overlooked.

1259 92 - 13/57

Erosion and desertification control

USA, study, wind erosion, mixed vegetation, control and prediction

SKIDMORE, E.L. and R.G. NELSON

7. Small-grain equivalent of mixed vegetation for wind erosion control and prediction.

Agron. J., 84, 1992, pp. 98-101

The purpose of this analysis was to examine this discrepancy and derive an improved expression to determine the small-grain equivalent of mixed vegetation.

Control and prediction of wind erosion requires knowledge of the effectiveness of surface vegetative cover. Scientists realized early the value of crop residue for controlling wind erosion and reported quantitative relationships.

Amounts of wheat (Triticum aestivum L.) straw needed to protect most erodible dune sands and less erodible soils against strong winds were determined. Standing stubble was much more effective than flattened stubble. Standing sorghum

(Sorghum bicolor (L.) Moench) stubble controlled wind erosion more effectively with rows perpendicular to wind direction than with rows parallel to wind direction.

Siddoway et al. (1965) quantified the specific properties of vegetative covers influencing soil erodibility and developed regression equations relating soil loss by wind to selected amounts, kinds, and orientation of vegetative covers; wind velocity; and soil cloddiness. They found a complex relationship among the different kinds and orientations of residue in terms of relative effectiveness.

The relative value of kinds and orientations of residue in controlling erosion must be quantified by soil, wind velocity, and variable characteristics of the residues.

Therefore, control and prediction of wind erosion require knowledge of the effectiveness of surface vegetative cover.

The effectiveness is usually referenced to as small-grain equivalent. The procedure used to convert mixed vegetation to small-grain equivalent was found faulty.

Improper weighting of regression coefficients caused the conversion procedure to predict that adding crop residue decreased small-grain equivalent. Therefore, the purpose of this analysis was to improve the conversion of mixed vegetation to a small-grain equivalent. The new expression derived for this purpose gave a logical conversion where the previous procedure failed. It did not predict a decreasing small-grain equivalent with increased soybean (Glycine max (L.) Merr.) residue in the 0 to 300 kg/ha range as did the former method. Applied to the same data that were used for testing the previous procedure, the new procedure reduced the error by almost 50%. The new procedure improves the conversion of mixed vegetation to small-grain equivalent.

1260 92 - 13/58

Erosion and desertification control

Asia, Philippines, survey, technology transfer, farmer-participatory research

FUJISAKA, S.

8. A method for farmer-participatory research and technology transfer: upland soil conservation in the Philippines.

Expl. Agric., 25, 1989, pp. 423-433

This paper discusses farmer-to-farmer technology transfer and the participation of resource-poor farmers in the adaptation of agroforestry technologies, as well as a range of interlinked, mostly agronomic and biophysical, research issues.

The research was done on volcanic plateau and alluvial plain sites with moderately well drained acidic clay soils of pH 3.9-5.2.

Although rice, maize, cassava and perennials are grown throughout the area, there are three distinct zones which correspond roughly to increasing altitude and rainfall. Upland rice-fallow rotations and cassava are the main cropping patterns in the lowest altitude area (400-500 m). Maize-maize and maize-fallow rotations predominate in the middle area (500-650 m). Maize, vegetables (especially tomato) and perennials dominate the upper area (650-950 m).

The interdisciplinary research involved scientists from IRRI and the DA.

Efforts to incorporate a farmer perspective used methods from agricultural anthropology to understand farmers' practices, perceptions and technical knowledge, to link this to appropriate research into technology development and to incorporate both into farmer technology adaptation and dissemination.

Initially, 55 farmers were selected at random and informally interviewed using open-ended, interactive and structured guide questions which had been selected after a period of exploratory research had determined some of the key issues facing farmers.

Concluding, the author states, that in terms of farming systems methodologies, the experience shows that a simple alternative method for on-farm research and technology transfer might consist of first understanding farmer practice, perception and technical knowledge; using this and farmer experiments to help identify technical possibilities and research issues; back-up research on a combination of alternatives that integrates farmer and researcher concerns and contributions; and transfer of technology from adaptor-adopters to farmers who want solutions to problems addressed by the technologies.

This work supports the idea that participation is a two-way process and that a participation 'paradigm' should progress from the obsolete view that 'the experts know best' to the increasingly fashionable concept that 'the local people know best' and on to the realistic and helpful idea that 'both experts and local people have unique areas of expertise which collectively provide a better basis for development than either alone'.

1261 92 - 13/59

Erosion and desertification control

Africa, review, bean production, soil fertility, varieties, technology

CIAT

9. African bean-based cropping systems conserve soil.

CIAT Annual Report 1989, pp. 49-52

Low soil fertility is as important as disease in limiting bean production in Africa. This is especially true in areas of high population growth. More people to feed means that land that once could be left fallow and allowed to recover its nutrients must be constantly used. Less good land to farm leads to more cultivation of steep slopes and marginal soils.

In response to the need to increase production and conserve the soil, CIAT is strongly promoting sowing climbing beans in the Great Lakes area. These beans generally yield higher than traditional bush beans; and when climbing beans grow upward rather than spreading across the ground, the plants are better protected from soil-borne pathogens and the damage caused by standing water.

But climbing beans need something to climb on. Having enough vegetative material suitable for making stakes is a major impediment to farmers growing this kind of bean. Appropriate kinds of trees are needed to plant to solve the stake shortage.

These trees or bushes would have several purposes: they would serve as stakes; they would conserve the soil by fixing nitrogen; they would produce organic matter which would be used as green manure or animal feed; and they would counter erosion by stabilizing the soil with their roots and by providing windbreaks.

Research conducted on Rwandan farms has shown that timely manure applications are important in increasing yield and reducing erosion.

Studies show that if manure is applied at a certain stage of growth of the bean plants - the third trifoliate stage - yields can be increased by 60%. This can help farmers maximize the benefit of their limited fertilizer resources.

Traditional soil conservation practices are studied so that accepted methods can be used as guidelines for proposing improvements. For example, in Zambia, farmers concentrate soil fertility through dirt mounds consisting of organic compost. On the other hand, Tanzanian farmers dig pits and compost grass to enrich the soil. In other areas, farmers grow their crops on contoured ridges which reduce erosion.

But population pressures on land are threatening these traditional systems and, in turn, increasing soil erosion. Finding solutions to these problems is vital so that the demands on the land do not ultimately destroy the very foundation of farming: the soil itself.

1262 92 - 13/60

Erosion and desertification control

Latin America, Ecuador, study, soil conservation strategies, mountain environment, climatic factor, basic terms, farmer practices, socio-economic factors, DESFIL, USAID

STAVER, C.P. et al.

10. Refining soil conservation strategies in the mountain environment: the climatic factor.

DESFIL Publication; prepared for USAID, USA; 1990, 36 pp. +

appendices

The overall objective of this report is to establish simple procedures for the use of climate, soil, and slope data during the design phase of conservation projects with small farmers in the Latin American highlands. Use of these procedures can greatly facilitate the initial selection of soil conservation measures that might be employed.

The authors discuss briefly, but do not analyze, the role of socioeconomic and institutional factors, as they relate to the successful adoption of appropriate soil conservation measures. They set as their task in this report the development of a simple method for determining appropriate soil conservation technologies in areas of steep slopes. They are cognizant of constraints such as patterns of land tenure, social organization of labour, traditional crop preferences, existing traditional technologies, market patterns, and local perceptions of risk and costs versus benefits - to name a few of the more obvious socioeconomic variables - on the successful adoption of non-traditional technologies, no matter how appropriate from a strictly technical standpoint they may be.

The hill and mountain regions of Latin America represent the fragile land resource for innumerable families on small farms. A major threat to their survival is land degradation resulting from soil erosion. Soil conservation projects directed toward this problem have been implemented throughout the region with mixed results, and the design of such projects is the subject of this report.

Section 2.0 begins with a summary of contemporary soil erosion problems in Ecuador, followed by a brief introductory discussion of erosion and sedimentation process in Section 3.0. Section 4.0 provides a summary of the team's field and desk analyses conducted in Ecuador; the resultant decision tree, designed to assist the field manager in the preliminary selection of regionally appropriate erosion control techniques, is discussed in Section 5.0. Socioeconomic parameters of importance to a more effective use of the decision tree are discussed in Section 6.0, followed by a discussion of the study's major conclusions and recommendations in Section 7.0. Appendix 1 shows the average monthly water balance for 12 stations in the Ecuadorian highlands; Appendix 2 provides a method for approximating annual water balance by month; and Appendix 3 discusses a number of soil loss quantification techniques of potential use to ongoing and future projects. A model monitoring plan is also discussed. A brief description of contemporary soil conservation techniques is shown in Appendix 4.

To achieve site-specific project, implementation must take a learning approach. During the initial period, the project must learn what works.

This is a period of testing and validation to identify effective soil conservation interventions, effective institutional arrangements, and effective means to collaborate with farm families and communities. In the second phase learning should focus on efficiency, while in the later phases the project must learn to expand and achieve wider coverage. Many projects attempt wide coverage initially, and only by chance identify what works late in project life. Efficiency may never be achieved.

The study includes a decision tree which integrates rainfall, slope, and soil factors in the choice of conservation measures; a discussion of farmer practices and economic and social factors in soil conservation measures; and an appendix on techniques for monitoring soil loss as well as a discussion of monitoring programs.

Given the wide range of physical and social factors of influence to accelerated erosion processes, conservation projects should logically employ a site-specific approach. The development of additional procedures for the systematic consideration of socioeconomic, community, and institutional variables, in conjunction with the technical procedures described here, is highly recommended.

1263 92 - 13/61

Erosion and desertification control

Africa, Zimbabwe, project, land-use pattern, institutional framework, training, research approach, on-farm trials, GTZ

VOGEL, H.

11. Conservation tillage for sustainable crop production systems.

Project Res. Report, No. 4, Departm. of Agricult. Technical and Ext. Services, Zimbabwe; 1992, pp. 22

"Conservation Tillage for Sustainable Crop Production Systems" is a collaborative programme between the Department of Agricultural Technical and Extension Services (AGRITEX) of Zimbabwe and the Deutsche Gesellschaft fnr Technische Zusammenarbeit (GTZ) GmbH of Germany.

The primary objectives of this technical co-operation project are:

- to assess the soil and water conservation merits and yield potentials of several conservation tillage techniques based on animal traction and/or manual labour,

- to select appropriate cropping systems with smallholders.

Ultimate project purpose is to make adequately tested tillage and cropping technologies available to resource-poor farmers in the Communal

Areas of Zimbabwe. This will be done on the basis of synthesized results of complementary on-station and on-farm trials.

In addition to the technical programme, the project also comprises a staff development scheme for Zimbabwean counterparts by providing funds for post-graduate studies overseas and offering on-the-job training.

A major factor causing soil erosion in Zimbabwe is clean tillage involving the mouldboard plough which is often used too late (after the onset of the rainy season) and/or done too shallow (approx. 125 mm) because of a general lack of (suitable) draught animals. In order to alleviate this problem, communal agriculture requires conservation tillage systems which reduce runoff, soil loss and draught power and are both practical and acceptable to the farmer. Although techniques are available, they are yet to be tested and validated for the different agro-ecological regions and the prevailing socio-economic conditions.

A two-pronged approach of complementary on-station and on-farm trials has been adopted by the project, because there is widespread understanding that, in order to assist in the development and adoption of sustainable farming practices, comprehensive approaches are required that interlink the aspects of sustainability (technical and agro-ecological factors) and acceptability.

During the early stages of project formulation, three main treatments were selected for investigation, namely: mouldboard ploughing, ripping into bare ground and no-till tied ridging.

The results of three seasons (1988/89 to 1990/91 of on-station trials showed that no-till tied ridging was best from a soil conservation point of view. Except on one occasion, sheet erosion rates were in the order of only 0,1 to 0,3 t/ha/yr at both research sites. Higher soil loss (2,2 t/ha/yr) from ridge tilled plots was measured in 1989/90 at Domboshawa, when approximately 800 mm of rain fell in a period of just six weeks. At the same time, 9,6 t/ha/yr were lost from the fields ploughed with the mouldboard plough.

The results also revealed that the seasonal influence on yield levels was highly significant. In addition, topsoil depth and soil profile and/or physical characteristics were highly related to maize yield. This interaction was particularly evident with no-till tied ridging.

From the first three years' results it would appear that, in the dry region, tied ridging will meet the criterion of equal or improved yield levels compared to mouldboard ploughing only if existing management practices, in particular with respect to timely planting and first weeding, are improved.

The paper provides an insight into the multiple problems associated with on-farm research, which not only demand close cooperation between the farmers and researchers involved, but also require skills in communication by the researcher and a strong interest in working closely with farmers.

1264 92 - 13/62

Erosion and desertification control

Africa, Tanzania, highlands, technical aspects, soils, crops, macrocontour lines, plant protection, animal traction, agroforestry, livestock keeping, extension, nutrition, integrated approach, GTZ

SCHEINMANN, D.

12. Caring for the land of the usambaras - a guide to preserving the environment through agriculture, agroforestry and zero grazing.

Publ. of TIRDEP-Soil Erosion Control and Agroforestry Project (SECAP), Part.I, Tanzania; GTZ, Eschborn, 1986, pp. 261 + appendices

This book is about farming in the Usambara Mountains, but the suggested techniques are applicable to similar situations in other developing countries. Primary consideration has been given to providing guidance for specific situations encountered by village extension workers in Lushoto District.

The West Usambaras are a mountain range in the north-east of Tanzania.

They vary in altitude from 1,400 metres above sea level in the valleys up to about 2,200 metres on the upper mountain slopes. The surrounding lowland plains are only a few hundred metres above sea level. Much of the area was formerly covered with dense forests but over the past decades these have been largely cleared.

Intervention is based on establishing macrocontour lines which run across farmers' fields at prescribed intervals depending on the steepness of the slope. This line of permanent crops (usually fodder grasses and legumes like guatemala, desmodium, and leucaena), and trees provides a solid erosion control structure which slows the speed of run-off rainwater and traps soil particles. The line produces economically valuable outputs like fodder, fruits, firewood, and building materials.

Annual and biannual crops are planted between these macrocontours and these are called microcontours. The project strongly advises all farmers to plant permanent and annual crops across hillsides along contours and never to plant in rows running up and down slopes.

Farmers are also advised to increase soil fertility and improve soil structure by applying organic manures like compost, cow dung, and green manure and to practice mixed cropping since this provides diversification and reduces the risk of crop failure due to drought, pests, or disease.

The goal of the livestock program is to create an economically viable alternative to traditional livestock keeping which, through over stocking and grazing has caused serious erosion problems. The production and output of local animals is very low and they now graze on hillsides since the traditional valley grazing areas are now used for intensive vegetable production.

This alternative is the zero grazing system, whereby animals are confined to a stall and are fed with fodder grown on a macrocontour line. Improved crossbred dairy cattle generate considerable income from milk sales and provide manure which is used to improve soil fertility and improve crop yields.

Forestry included 2 programs; afforestating overgrazed eroded village pastures and planting multipurpose agroforestry species along macrocontour lines and in fields.

Monitoring and evaluation of the work carried out by the community nurseries tends to be insufficient.

This guide is well written.

Specific information on laying contour lines, managing nurseries, planting fruit trees, etc. is presented in easy to read form completed with supporting illustrations. There are also short sections on fish farming, biogas, rabbit rearing, and human nutrition.

The information and advice in this book was collected from farmers, extension workers, researchers, development workers, publications, and by personal observations. The book has been flexibly designed so additions can be made, as necessary.

1265 92 - 13/63

Erosion and desertification control

Review, book, Asia, India, soil and water conservation, farmer practices, vetiver grass

GRIMSHAW, R.G.

13. Vetiver grass (vetiveria zizanioides) - a method of vegetative soil and moisture conservation.

Publl. of World Bank, Agriculture Divison, New Dehli; 1988, 72 pp.

Soil conservation is a world problem.

Soil erosion has reached crisis proportions in India. Over half of India's crop land is losing productivity because top soil is being washed or blown away faster than natural forces can replace it. Reducing the topsoil layer causes part of the subsoil to be cultivated, meaning that plants will have reduced access to essential nutrients and water.

Changes in farming practices have accelerated this erosion in recent years, as farmers switched from traditional rotations to continuous row cropping in response to a growing need for grain.

Top level policy makers recognize the problem exists and have already spent Rs. 1,200 M on earthworks as preventative measures. But this has only covered a few million of India's 328 M hectares, 90% of which is afflicted with soil erosion.

The costs of constructed soil conservation measures would outrun the short-term benefits by three or four times, and these practices not only cost money, they also cut production. Farmers do not look kindly on these practices.

On the other hand, vegetative soil and moisture conservation measures are not only extremely cheap (less than 1/10-1/100 the cost of constructed banks and waterways) but the farmers can do the work themselves, and, if they have the planting material, at no cost. Once vegetative hedges are established (this usually takes two to three seasons) they are permanent. When they are followed as contour guidelines for cultivation and planting, the resulting "in-situ" moisture conservation increases yields by at least 50% over traditional methods.

Vegetative conservation measures hold the runoff water on the slopes longer than other methods, giving it a chance to soak in over a wide area and recharge the aquifers: Constructed measures are designed to dispose of runoff as fast as practicable, thus reducing any change of recharge. Dams rarely recharge aquifers; if they did, it would be considered that they were leaking.

The farmers regard the fodder value of vetiver grass as an additional merit. 3-4 cuttings can be obtained at an interval of 45 days, mainly during and shortly after the monsoon, yielding enough green fodder for two animals for 6 months in a year.

The farmers have developed their own ways of multiplying and propagating the grass. On sloped land, they form small section bunds across the slope and plant 2-3 slips per rill 20-30 cm apart on the upstream side.

In flat fields, the slips are simply planted in the plough furrow. In either case, they chop off the top of the plant and avoid planting inflorescence axles. The grass establishes well if planted after the first monsoon shower. Even without irrigation, the lines form hedges in about year. The slips for further planting are taken from 3-year-old bunds. When waste-weirs or drop structures are to be treated, even clumps of the grass are taken and placed at appropriate locations.

Vetiver has long been used by Indian farmers, but most scientists are still unaware of this. The indigenous knowledge of Indian farmers has not been appreciated. The knowledge they have gained in dealing with khus-based soil conservation systems needs to be documented and the other uses of khus, e.g. for fodder, should be studied.

This handbook has been prepared to support field workers and farmers in developing appropriate soil and moisture conservation measures using vegetative systems. Experience in India and in other countries has shown that conventional earth bunding systems on small farms have been expensive to develop and have in many cases proved ineffective.

Vegetative systems of soil and moisture conservation have proved cheaper and more effective when implemented correctly.

1266 92 - 13/64

Erosion and desertification control

Latin America, Colombia, Andes, hillside farming, water erosion, cassava, cropping systems, small scale agriculture, CIAT

REINING, L.

14. Erosion in andean hillside farming.

Hohenheim Tropical Agricultural Series 1; Verlag J. Margraf, P.O.B. 105, 6992 Weikersheim, FRG; ISBN 3-8236-1211-5; 1992, 219 pp., price DM 35,00/USD 27.00

The investigations reported here were carried out to provide some basic information on characteristics of soil erosion processess in the Andean zone of Colombia. The effect of cultural practices in cassava cultivation systems on the process of soil erosion was investigated.

The research reported here aims to collect basic information on the characteristics of erosion processes in a defined area of the Andean zone of Colombia. Furthermore, conventional and improved cassava cropping systems adapted to local smallholder conditions were to be tested to obtain knowledge based on the influence of management practices on erosion processes. Erosion trials were established on slopes with a gradient of 7-20% at two locations in southern Colombia.

As expected, the greatest soil losses were found in the clean tilled fallow system. However, at the beginning of the growing period the greatest soil losses were measured where rill erosion was predominant.

This was especially evident in plots with cassava on ridges down the slope where greater soil losses were recorded during the first months after planting than in the plots with clean tilled fallow. These results show that soil conservation measures must be directed especially towards the reduction of surface runoff during the first months after planting.

In this context those cropping systems were the most efficient which reduced the velocity and the quantity of runoff by physical barriers.

This is especially evident for the contour ridges and to a limited extent also for the contour grass strips. Also, a high initial percentage of ground cover reduced effectively the surface runoff and prevented rill erosion.

Based on these site characteristics, a tolerable amount of a yearly soil loss of 1-5 t/ha-1 was calculated.

Under the test conditions the cropping systems with sole cropped cassava and cassava planted between contour strips of grass produced relatively high yields.

The results suggest that management practices such as planting on contour ridges or contour strips markedly reduce soil loss while producing optimum cassava yields.

This book is well worth the attention of those working with soil and water conservation in mountain areas. All chapters are well, documented and the conclusions drawn are verified by the text, graphs and tables.

1267 92 - 13/65

Erosion and desertification control

Review, USA, soil and water conservation, tillage systems

UNGER, P.W. and T.M. MCCALLA

15. Conservation tillage systems.

Adv. Agron., 33, 1981, pp. 58

Conservation tillage systems are systems of managing crop residue on the soil surface with minimum or no tillage. Other names are stubble mulching, ecofallow, limited/reduced/minimum tillage, no-tillage and direct drill. Leaving crop residues serves water and wind erosion control, conservation of soil and water and reduction of energy use. The review is limited to the salient points that have been researched over the last twenty years and is limited to the United States. For our purposes general remarks in the sections on seed bed preparation and crop seedling, control of wind erosion, control of water erosion, weed control with tillage and the three sections on soil temperature and the same number on soil structure and other physical properties are of most importance. On wind erosion, after a general introduction the wind erosion equation is dealth with. Tillage has a direct bearing on the factors I, soil erodibility; K, soil surface roughness and V, equivalent quantity of vegetative cover. Surface residue influences V, tillage proper influences mainly I and K. partial (de)coverage of a field would influence L, equivalent width of field (maximum unsheltered distance across the field along the prevailing wind erosion direction). Kind, amount, texture, height and orientation of surface residue all influence wind erosion. Tillage operations that minimize soil pulverization and smoothing are effective for maintaining K and keeping clodiness for maintaining I. Examples are given from the USA. A comparable approach is followed in the chapter on water erosion, using the influence of residue and tillage effects on the Universal Soil Loss Equation. The section on soil temperature deals with the effects of surface residue: changing the radiation balance accompanied with an insulation effect, and with residue factors involved in these effects: residue age (decoloration; decomposition), color, geometry, distribution and amount. Again some examples. Finally its biological effects on crops are dealt with. After dealing with soil aggregation, porosity and density as affected by tillage, other soil physical factors dealt with as influenced by tillage operations are soil texture, crusting, hydraulic conductivity and water storage capacity. Tillage reduction in the USA can't be considered without the rapid technological advances in the use of herbicides. It is estimated to serve from 5 to 15 cm of additional water to rain-fed agriculture. Only more interdisciplinary knowledge will advance this field of soil science.

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Erosion and desertification control

Asia, Indonesia, highlands, study, water runoff, erosion control practices, small plots, steep slopes

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16. Soil erosion, water runoff and their control on steep slopes in Sumatra.

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In this paper soil erosion research and water runoff rates under conventional cultivation (i.e., without soil conservation practices) and when several soil conservation measures were used on steep, intensively-cultivated slopes in Sumatra, Indonesia are examined.

Erosion-inducted effects on selected soil physical and chemical properties and on crop yields were also examined. Based on these results, recommendations were developed for the introduction of appropriate soil conservation measures.

This study was conducted in the highland valley of Kerinci, Sumatra, Indonesia. Irrigated rice cultivation is the dominant land use in the valley; annual and perennial cash crops are cultivated on the hills above the valley floor. Most farmers in Kerinci cultivate both a rice field and one or more hillside farms.

Soils in Kerinci are complex red-yellow podzolics.

Soil erosion and water runoff losses associated with conventional and conservation farming practices were measured on enclosed runoff plots, using a randomized complete block design with three replications.

Five practices (treatments) were selected for study:

- control by conventional cultivation (corn planted two seeds per hole at 75 cm intervals) with no soil conservation measures employed;

- conventional cultivation at increased planting density (corn planted one seed per hole at 25 cm intervals) and NPK fertilizer application (groundnut, with 100 kg TSP ha-1 and 50 kg KCl ha-1; corn, with 100 kg urea ha-1, 100 kg TSP ha-1 and 50 kg KCl ha 1);

- level bench terraces, with three terraces per 10 m plot, risers 75 cm tall and planted to Setaria sp. grass at 30 cm intervals;

- grass contour bunds, with three bunds per plot, each 15 cm tall and planted to double rows of Setaria sp. at 30 cm spacing; and

- grass and Gliricidia sepium (Jacq.) Kunth ex Griseb. (an N- fixing leguminous tree) contour bunds with mulch, two bunds per plot, each 15 cm tall and planted to one row of Setaria sp. and one row of G. sepium, each at 30 cm intervals. Mulch cover was maintained at approximately 50% ground cover by periodically adding G. sepium leaves following an initial application of 0.5kg m-2 (5000 kg ha-1).

A variety of soil conservation practices are used on small farms throughout the tropics. Some of the more common practices include: contour ploughing, conservation tillage, the use of cover crops and mulches, grass and leguminous shrub plantings along the contour, grassed runoff channels, contour bunds, ditches and bench terraces.

Agronomic soil conservation techniques are generally preferred to engineering methods (e.g., bench terraces) by low-income or subsistence farmers because of lower capital and labour requirements. The construction of bench terraces can result in reducing crop yields where shallow topsoils overlie undesirable subsoils.

In this study, the use of bench terraces, grass bunds and grass plus Gliricidia sepium bunds with mulch resulted in significant ($P<0.05$) reductions in soil loss and water runoff in comparison with conventional cultivation methods on steep hillside farms in Sumatra. No significant differences in soil erosion rates were observed between conservation treatments.

No significant differences in mean groundnut yields and total above ground biomass production were observed between the conservation or control treatments (on a per plant basis).

This research suggests that agronomic soil conservation practices known to be effective on gentle (less than 15%) slopes may also be suited to some steep tropical slopes. Simple agronomic conservation farming measures warrant careful consideration and empirical field-testing in soil conservation and watershed management projects throughout the tropics.