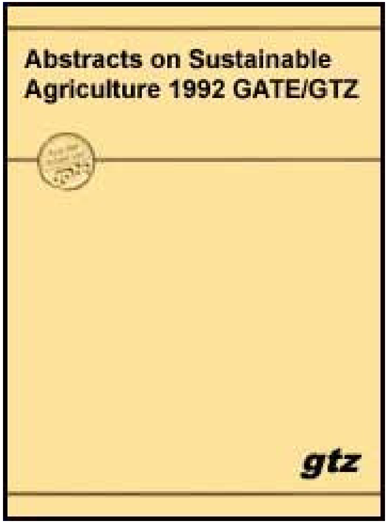
Abstracts on Sustainable Agriculture 1992 GATE/GTZ
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Abstracts on Sustainable Agriculture (GTZ, 1992, 423 p.)

Abstracts on potential crops for marginal lands

1269 92 - 14/30

Potential crops

Latin America, Andes, review, book, root crops, tuber crops, grains, legumes, vegetables, fruits, nuts, research contacts

BOSTID

1. Lost crops of the incas.

Report of an Ad Hoc Panel of the Advisory Committee on Techn. Innovation; Board on Science and Technology for International Development; National Academy Press; USA;

Repr. 1990, 415 pp., ISBN 0-309-04264-X, Price £17.15

This book focuses on 30 of the "forgotten" Incan crops that show promise not only for the Andes, but for warm-temperate, subtropical, and upland tropical regions in many parts of the world.

It is aimed at informing administrators and research scientists in both developing and developed countries of the existence of these 'lost' plants which, in fact, still exist but which have been overlooked by agronomists in recent years, after being cultivated to a high level of efficiency and distributed throughout the Andean region of the Inca Empire.

More than 600 people from 56 countries (see Research Contacts) have directly contributed to this book. A few species described -capuli cherry and zambo squash, for example - are not Andean natives but are included because the Andean types have much to offer the rest of the world.

The main objective of this publication is to contribute to the raising of nutritional levels and the creation of economic opportunities for the further development of these plants. This claim appears to be fully justified for the more than 30 crops covered in the text.

The division of the text into the traditional agronomic groupings of Roots and Tubers, Grains, Legumes, Vegetables, Fruit and Nuts is logical and provides ready reference to the common or vernacular names of the crops.

The text is devoted to roots and tubers, reflecting the importance which still exists in some Andean regions of the numerous members of the Cannaceae, Leguminosae, Cruciferae, Solanaceae, Basellaceae and other families which have edible roots or tubers. The second most important section is the fruits which include many commodities which are now becoming, or are likely to become, important in international markets.

Most crop sections have an introduction which contains general comments on their importance and potential usefulness, followed by lists of species and cultivars, where applicable, the future prospects for the crop, nutrition, agronomy, environmental limitations, harvesting information and research needs.

There are useful appendices which include Research Contacts for individual crops and selected references under specific crop headings.

This report has been written for dissemination to administrators, entrepreneurs, and researchers in developing countries as well as in North America, Europe, and Australasia.

It is not a handbook or scientific monograph: references are provided for readers seeking additional information. Its purpose is to provide a brief introduction to the plants selected, and it is intended as a tool for economic development rather than a textbook or survey of andean botany of agriculture. The ultimate aim is to raise nutritional levels and create economic opportunities, particularly in the Andes. The report, however, deliberately describes the promise of these plants for markets in industrialized nations. It is in these countries (where a concentration of research facilities and discretionary research funds may be found) that many important research contributions are likely to be made.

This book will be of considerable value to anyone wishing to promote the cultivation of these crops which have been overlooked for such a considerable period.

This book has been produced under the auspices of the

Advisory Committee on Technology Innovation (ACTI) of the Board on Science and Technology for International Development, National Research Council. ACTI is mandated to assess innovative scientific and technological advances, particularly emphasizing those appropriate for developing countries.

Since its founding in 1971, it has produced almost 40 reports identifying unconventional scientific subjects of promise for developing countries.

1270 92 - 14/31

Potential crops

Review, article, agriculture, forestry, plants, food crops, legumes, fruits, trees, schrubs, BOSTID

VIETMEYER, N.D.

2. Lesser-known plants of potential use in agriculture and forestry.

Science, 232, 1986, pp. 1379-1384

The purpose of this article is to give a sense of the remarkable plants that still have not been exploited, as well as to highlight particular global problems where underexploited plants seem notably promising. It results from knowledge gained in a small program at the National Research Council, which for the past 15 years has been evaluating under-recognized resources that could help developing nations.

The lesser-known food crops that remain outside the fold of science have not been rejected because of any inherent inferiority. Many have been overlooked merely because they are native to the tropics, a region generally neglected because the world's research resources are concentrated in the temperate zones.

While many food crops are neglected because they are in the tropics, even more are negelected because they are scorned as "poor people's plants". Peanuts, potatoes, and many other common crops once suffered from this same discrimination.

A remarkable collection of poor people's crops also suffering rejection is to be found in the highlands of South America. The Indians there are among the poorest people in the Western Hemisphere and, except for the potato, their crops remain outside the mainstream of agronomic science.

When Francisco Pizarro and the Conquistadores invaded Peru in 1531 they initiated events that 70 years later brought the potato to Europe.

However, they ignored several dozen other crops and these were virtually lost in the collapse of the Inca culture.

This review of some underexploited tropical crops, highlights promising food crops such as the oil palm Jessenia polycarpa, the grain amaranths (Amaranthus spp.), quinoa (Chenopodium quinoa) and oca (Oxalis tuberosa) which have been largely overlooked by research resources in the temperate zones. Among the legumes discussed, the groundnuts (Apios americanum and Voandzeia [Vigna] subterranea), yam beans (Pachyrrhizus spp.), winged beans (Psophocarpus tetragonolobus) and adzuki bean (Vigna angularis) are considered to warrant further development. Notes are given on the potential of some more obscure tropical fruits, including those belonging to the Solanacea and Ammonaceae, arid zone crops including tepary beans (Phaseolus acutifolius) and marama beans (Tylosema esculentum), valuable resource shrubs and such N-fixing trees as Leucaena leucocephala, Acacia mangium, Mimosa scabrella and Calliandra calothyrsus.

1271 92 - 14/32

Potential crops

Review, article, Africa, areals, sorghum, millets, indigenous food, yield, technology transfer, ICRISAT, IDRC, SAFGRAD,NRC

SPORE

3. Sorghum and millet new roles for old grains.

SPORE, 29, 1992, p. 6

As Africa strives to close the gap between population and food production, sorghum and millet will become of increasing importance.

This will be especially so where weather patterns are unpredictable because maize is much less adaptable to inadequate erratic rainfall.

There are two broad categories of sorghum; red or brown sorghums, which often contain bitter tasting tannins in the seed coat, and white sorghums, which do not. The tannins deter predators but must be removed in order to make grain acceptable for human consumption.

Sorghum is both drought-resistant and able to tolerate waterlogging better than maize because of its deep and well-branched root system. It is also remarkably pest-resistant, but unfortunately the compounds that help protect the crop from birds and insects make the grain and the stover less palatable and less digestible for people and livestock.

There are also two major types of millet; finger millet and bulrush millet. They are very different in appearance. The grain of finger millet is contained in a "hand" of digits (hence the name) and the plant seldom grows higher than 1.3 metres. Bulrush millet can grow to 3 metres. Millets are even more drought resistant than sorghum and can give good yields on infertile, sandy soil which would be unsuitable for most cereals. But millets are very susceptible to bird damage and, as more children attend school and are not available to scare birds, this can cause considerable losses. Farmers are also inclined to switch to maize, as has happened in Kenya and Tanzania, because millets and sorghum demand a great deal more work to harvest, store and process.

Sorghum and millet are very similar to maize in their nutritional value.

Traditionally both grains are prepared by pounding to remove the husks but, millet and sorghum flour does not keep well and fresh flour has to be prepared regularly. New techniques for easier processing are urgently needed and there have been some promising developments in mechanical decortication.

A dry abrasive technique for milling of the husk off sorghum was developed from a Canadian design and promoted by the International Development Research Centre (IRDC). About 40 machines were made locally and installed in Botswana, and trials and demonstrations set up in several other SADCC countries. These decorticators proved well-suited to small-scale operations, as the cost of equipment is low. The cost of transportation of grain and products to and from the mill is minimized, employment is created in rural areas and, when milling a reasonably pure strain of white sorghum, a high yield of excellent quality product can be obtained. However, it is more difficult to process mixed crops to acceptable levels of colour and taste.

An alternative technique for semi-wet milling of sorghum has been developed by the UK Natural Resources Institute (NRI). The whole sorghum grain is wetted with up to 25% water and after 12 hours the conditioned grain is milled in a roller mill in the same way as maize or wheat. Even in highly bird resistant varieties of red sorghum the endosperm is normally white, and using this technique the white endosperm is effectively separated, leaving the bran and most of the coloured layers clean and almost intact.

Semi-wet milling is not the answer for all situations, however, since it is unlikely that the process will be economically viable at a throughout of less than two tonnes per hour. Also, the meal produced has over 20% moisture and is unsuitable for long-term storage.

If techniques can be perfected to make sustainable use of much larger quantities of millet and sorghum (particularly red sorghum), which can be grown on the extensive and still under-utilized semi-arid lands of Africa, the consequences will be profound and far reaching: on food security, on rural employment and on agricultural income in many parts of the continent.

Pearl millet (Pennisetum glaucum) f.e. like sorghum was domesticated in Africa but can withstand more heat and drought stress and yet reliably produce a nutritious grain crop. While new advances can be made in the forage crop using recently discovered low lignin bmr genes, pearl millet has many attributes which are being used to transform it into a summer combine grain crop for temperate agriculture. These include a very large and varied germplasm resource base, a high growth rate, efficient nutrient utilization, major dwarfing genes, earliness, good heterosis, and several cytoplasmic-genic malesterile systems for hybrid seed production. Seed is produced commercially in India of semi-dwarf grain hybrids which cover 2 million ha annually. Under optimum conditions, the yield potential of these early maturing (85-90 days) hybrids is high - 5000 kg/ha.

1272 92 - 14/33

Potential crops

Review, book, developing countries, arid regions, saline agriculture, salt tolerant plants, food, fuel, fodder, fiber

BOSTID

4. Saline agriculture - salt-tolerant plants for developing countries.

Report of BOSTID, Nat. Res. Council, 2101 Constitution Avenue, NW Washington DC 20148, USA; ISBN 0-309-04189-9, 1990, 135 pp.

This book covers some of the experiences and opportunities in the agricultural use of saline land and water. It aims to create greater awareness of salt tolerant plants, their current and potential uses, and the special needs they may meet in developing countries.

Salts occur naturally in all soils. Rain dissolves these salts, which are then swept through streams and rivers to the sea. Where rainfall is sparse or there is no quick route to the sea, some of this water evaporates and the dissolved salts become more concentrated. In arid areas, this can result in the formation of salt lakes or in brackish groundwater, salinized soil, or salt deposits.

There are three possible domains for the use of salt-tolerant plants in developing countries. These are:

- Farmlands salinized by poor irrigation practices;

- Arid areas that overlie reservoirs of brackish water; and
- Coastal deserts.

Although irrigation can bring arid land into production, this often leads to salinization. In some countries the amount of newly-irrigated land equals the amount of salinized irrigated land going out of production each year. The use of salt tolerant plants may provide a realistic solution to this problem for many developing countries.

Undomesticated salt-tolerant plants usually have poor agronomic qualities such as wide variations in germination and maturation.

Salt-tolerant grasses and grains are subject to seed shattering and lodging. The foliage of salt-tolerant plants may not be suitable for fodder because of its high salt content. Nutritional characteristics or even potential toxicities have not been established for many edible salt-tolerant plants. When saline irrigation water is used for crop production, careful control is necessary to avoid salt buildup in the soil and to prevent possible contamination of freshwater aquifers.

Most importantly, salt-tolerant plants should not be cultivated as a substitute for good agricultural practice nor should they be used as a palliative for improper irrigation. They should be introduced only when and where conventional crops cannot be grown. Also, currently productive coastal areas (such as mangrove forests) should be managed and restored, not converted to other uses.

All of these limitations are impediments to the use of conventional methods for culture and harvest of salt-tolerant plants and the estimation of their production economics.

Since few crops have been subjected to selection for salinity tolerance, it is possible that variation in this characteristic may also exist.

Conversely, few undomesticated salt-tolerant plants have been examined for variability in their agronomic qualities, and it is even more likely that such characteristics can be improved through breeding programs.

Germplasm collection and classification, breeding and selection, and development of cultural, harvest, and postharvest techniques are all needed. Basic information on the way in which plants adapt to salinity would significantly assist their economic development.

Interdisciplinary communication is particularly important in research on salt-tolerant plants. Cooperation among plant ecologists, plant physiologists, plant breeders, soil scientists, and agricultural engineers could accelerate development of economic crops.

There are four sections in this report. They highlight salt-tolerant plants that may serve as food,fuel, fodder, and other products such as essential oils, pharmaceuticals, and fiber. In each of these sections, plants are described that have potential for productive use. Each section also contains an extensive list of recent papers and other publications that contain additional information on these plants. A list of researchers currently working on these plants or related projects is included at the end of each section.

Although the salt-tolerant plants described in this report typify those that are currently being evaluated or appear to deserve additional attention, the inventory is far from complete. Many other species may have equal or greater potential.

The book is extensively illustrated with black-and-white photographs. It contains much detailed information and tabulated data yet provides an interesting and readable account of the subject.

1273 92 - 14/34

Potential crops

Asia, India, study, field trials, plants, food, indigenous crops

GANGWAR, A.K. and P.S. RAMAKRISHNAN

5. Cultivation and use of lesser-known plants of food value by tribals in north-east India.

Agriculture, Ecosystems and Environment, 25, 1989, pp. 253-267

The study deals with three important lesser-known crops of food value of one of the tribes, the Khasis, at higher elevations of Meghalaya and 8 species of the Nishis, the Hill Miris and the Sulungs of Arunachal

Pradesh in north-east India. This study considers the cropping and yield patterns of these species in the agroecosystem, their nutritive value and the contribution of a nitrogen-fixing legume, towards improved soil fertility.

Of all the 3000 plant species used as food at some time during human civilization, about 150 species are cultivated, of which less than 20 provide over 90% of the food needs. Just about 3 species (wheat, rice and maize) meet over half of the human energy needs. Reliance on such a small number of plants carries great risks, for monocultures are extremely vulnerable to catastrophic failures brought about by diseases or climatic stresses.

In north-east India, under the traditional slash and burn agriculture (locally called jhum), under fallow system (without burning the slash), and under sedentary agriculture, a variety of lesser-known species are cultivated by the farmer. Apart from their food value, many legumes such as Flemingia vestita Benth ex Bax. considered here also fix nitrogen in the soil.

One of the two study sites is located at Shilling spread over a distance of 30 km and considering 40 villages of the Khasis. The other study site is at the Lower Subansiri district of Arunachal Pradesh considering 45 villages in all. The extent of cultivation of the lesser-known species by each tribe is based upon sampling done in these villages. Both the study sites receive an annual average rainfall of 200 cm, with about 80% occuring during May-October. Winter is mild and extends from November to February with average maximum and minimum temperatures of 26 C and 18 C, respectively. During other months, the average maximum and minimum temperatures are 34 C and 25 C, respectively.

In this study Digitaria cruciata (Nees) A. Camus var. esculenta Bor.

Flemingia vestita Benth ex Bax. and Perilla ocimoides L. cultivated by the Khasis at higher elevations of Meghayala, and Amaranthus virdis L., Chenopodium ambrosioides L., Coix lacrymajobi L., Dioscorea spp., Fagopyrum tataricum Gaertn., Panicum miliaceum L., Perilla ocimoides and Setaria italica (L.) Beauv. cultivated by the Nishis, the Hill Miris and the Sulungs of Arunachal Pradesh in north-east India were evaluated from an ecological and socioeconomical point of view. Digitaria cruciata var. esculenta is largely cultivated for manure by composting the biomass, although the grains are also consumed. The role of a lesser-known legume, F. vestita, was evaluated for its ability to improve soil nitrogen status. Mixed cropping with F. vestita was found to give better economic returns, apart from improved soil fertility with a net gain in nitrogen of up to 250 kg/ha-1year-1.

From the point of view of nutrition many of these lesser-known crops such as F. vestita may prove to be superior to traditional ones.

Flemingia vestita has three times more protein than cassava and twice as much as sweet potato, two of the more widely grown root crops in the tropics. On a world basis, plant sources contribute about 70% and animals about 30% of the human protein needs; amongst the tribals in north-east India considered here this is 60% and 40%, respectively. In many developing countries in the tropics, plant sources could provide up to 90% of the food protein. Despite this and their other uses, as cover crops, green manure, etc. legumes are still minor crops in the existing farming systems of the humid tropics. Possibly techniques can be developed for using edible legumes as inter-crops in rotation with non-legumes so as to reduce significantly the amount of nitrogen fertilizer applied to the non-legumes. With improvement, the lesser-known crops could play an important role not only in the nutrition of the rapidly increasing population but also help in improving soil fertility through appropriate inter-cropping.

1274 92 - 14/35

Potential crops

USA, proceedings, symposium, new crops, policy, politics, international development, regional outlook, crop centers, industrial crops, oilseed crops, fruits, vegetables, landscape plants, aromatics, medicinals, cereals, forages, fiber crops, energy crops, commercialization, research, Purdue University, GTZ

CARLS, J.

6. Conclusions of the national symposium on new crops - exploration, research, commercialization.

Report of the Second Nat. Symposium on New Crops, Indianapolis, Indiana, USA, 1991, 10 p.; Report prepared for GTZ

This Symposium provided a national forum for leading authorities from industry, government, agricultural experiment stations, and academia to discuss the status and future of new crops development. Lectures and panel discussions provided overviews and detailed analyses on a wide range of new crops, including cereals and pseudocereals, forages and grains, oilseeds, fiber and energy crops, fruits, vegetables, floral and landscape plants, and aromatics and medicinals.

The objectives of the Symposium were to:

- determine the status of new crops research and development nationally and internationally;

- explore the potential of new crops, new uses for existing and underexploited crops, and to identify constraints to commercialization; and

- develop strategies for the establishment of cooperative partnerships between organizations.

The Symposium featured seven technical sessions on the following topics:

- New crops: policy and politics

- International developments in new crops

- North American forecast, including industry outlook, regional development, and provincial and state new crops centers.

- Genetic engineering in oilseed and industrial crops

- Status of new crops research (two concurrent sessions):

- fruits, vegetables, floral and landscape plants, aromatics and medicinals, and

- cereals and pseudocereals, forages and grains, oilseeds, fiber and energy crops

- Exploration and new crops

- Industrial crops: routes to commercialization.

New, alternative or underutilized crops were examined which have potential for enhanced production and utilization. Research into these crops may also discover new useful products.

A "new or an alternative crop is either a species new to a region, such as amaranth, adzuki beans, or blueberries, or an existing crop such as millet, buckwheat, or broccoli, which shows increased economic promise".

Plants not only provide food for man and his domestic animals, but also pharmaceutical products and raw materials for industry. Fewer than 20 of more than 13,000 known food plants provide the bulk of man's food needs.

Accelerating population growth, ecological hazards and changes in market supply and demand make it necessary for scientists both to maintain a constant search for improved varieties of the major crops and to diversify production by developing locally grown but underutilized crop plants.

Crop diversification is increasingly recognized as important to the American farm economy. However, much of the potential of presently underutilized crops is not realized because of lack of appropriate research and information on the utilization and marketing of plant products.

The following crops are evaluated internationally, grouped into five categories, based on the primary use of each crop:

- grain crops
- oil crops
- pulse crops
- forage crops
- miscellaneous (fiber, energy crops, root crops, medicinal spices)

The development of new crops involves botany, agronomy, forestry, horticulture and market forces to push a potential crop. An interdisciplinary approach is necessary to address the many - faceted problems facing the introduction of a new crop.

In order to speed up this introduction process "New Crop Centers" have been established in the United States.

For example the "Center for Alternative Plant and Animal Products (CAPAP)" was created to aid in the development of new and alternative crop and livestock enterprises. The Center provides at the University of Minnesota focus for generating, receiving and evaluating new product ideas, facilitating alternative product research and development efforts, and disseminating information to the public on alternative plant and animal products.

1275 92 - 14/36

Potential crops

Review, book, developing countries, aquatic weeds, integrated systems, herbivorous animals, soil additives, animal feeds, fiber products, energy, wastewater treatment, food

BOSTID

7. Making aquatic weeds useful: some perspectives for developing countries.

Report of BOSTID, Nat. Academy of Sciences, Washington, D.C., 1984, 5th

Edition, ISBN 76-53285, 165 p.

This report examines methods for controlling aquatic weeds and using them to best advantage, especially those methods that show promise for less-developed countries. It emphasizes techniques for converting weeds for feed, food, fertilizer, and energy production. It examines, for example, biological control techniques in which herbivorous tropical animals (fish, waterfowl, rodents, and other mammals) convert the troublesome plants directly to meat.

Aquatic weeds have always existed, but in recent decades their effects have been magnified by man's more intensive use of natural water resources.

These plants, among the most prolific on earth, grow luxuriantly in the tropics, weigh hundreds of tons per hectare, and can be a serious hindrance to a nation's development efforts. Eradication of the weeds has proved impossible, and even reasonable control is difficult. Turning these weeds to productive use would be desirable, but only limited research has so far been carried out.

This is a global problem, but it is particularly severe in tropical nations where warm water and increasing numbers of dams and irrigation projects foster aquatic plant growth. Furthermore, the problem is worsened by increasing enrichment of natural waters by fertilizer runoff and by nutrients from human and agricultural wastes.

Aquatic weeds constitute a free crop of great potential value - a highly productive crop that requires no tillage, fertilizer, seed, or cultivation. Aquatic plants have potential for exploitation as animal feed, human food, soil additives, fuel production, and wastewater treatment.

The advantage of weed utilization over chemical and many biological weed controls (e.g., insects and pathogens) is the production of valuable end products: meat, eggs, fish, edible vegetation, fertilizer, animal feed, energy, paper pulp.

The techniques described in this report have been selected for their applicability in less-developed countries, many are also relevant to industrialized countries. Both types of country face a future in which food production will need to depend more and more on the effective management of natural systems, such as waterways.

Each topic is presented in a separate chapter arranged in the following order:

- Description of the technique and of its advantages
- Limitations and special requirements
- Research needs
- Selected readings (significant reviews, general articles)
- Research contacts.

Photographs are provided to give nonspecialist readers who scan the report a sense of its contents; a summary of each chapter is given and, in each chapter, the early paragraphs are nontechnical and discuss the technique and its apparent advantages.

In most chapters the later paragraphs contain more technical information of the kind needed by researchers and technical personnel to decide on the chapter's relevance to their country's specific situation and needs.

In this way, it is hoped that the report can introduce decision makers to aquatic weed utilization, while at the same time, providing their technical advisors with the details they need.

This report confines itself to a technical overview, leaving to the reader the task of weighing the technical prescriptions in light of his country's resources and capabilities.

Reading lists and a list of contacts are given so that readers may explore for themselves the relevance and adaptability of the techniques to their specific location.

This report explores an alternative:the conversion of aquatic weeds to food, fertilizer, paper and fiber, and energy.

1276 92 - 14/37

Potential crops

Europe, Hungary, study, field trials, ecological approach, medicinal plants, ecosystems, plant geography, plant phenology, genetic diversity, agrotechnical needs, plant establishment

MATH+, A.

8. An ecological approach to medicinal plant

introduction.

Herbs, Spices, and Medicinal Plants, 3, 1992, pp. 175-199

The purpose of this review is to emphasize the ecological aspects related to the introduction and domestication of medicinal plants.

Medicinal and aromatic plant introduction began centuries ago and continues today. As the search for new plant-derived products continues, the need for the introduction and cultivation of an increasing number of these species will remain an integral process in the final processing, utilization, and availability. Approximately 50 species have been introduced and are maintained in large-scale cultivation in the temperate zone. The traditional medicinal and aromatic plant-producing appear to be making special efforts to collect and preserve wild plants and to introduce some of the economically significant species into cultivation.

The structure of medicinal plant production, however, has been undergoing substantial change during the past few years. Most apparent is the limitation in the availability of gathered plant drugs, and to some extent, a reassessment of the role of large- versus small-scale production systems. There also appears to be a trend to introduce medicinal and aromatic plants into the less favorable agricultural regions of many countries so as to develop the agricultural base of these areas by providing cash crops or export crops.

Programs such as this type have been established in Italy, Switzerland, and Yugoslavia, and in Czechoslovakia and Poland. In Greece, a country of varied physiographic conditions, 3 centers of aromatic plants have been established with the goal of producing Ocimum basilicum L. (basil), Lavandula spp. (lavender), Melissa spp. (balm), and Mentha spp. (mint).

The introduction of medicinal plants to cultivation is also increasing outside of Europe. Bangladesh and Sri Lanka are producing plants of the genera Rauvolfia and Zingiber (ginger) and others. New Guinea is investigating potential cultivation of Elettaria cardamomum L. Maton (cardamom) and Capsicum frutescens L. (tabasco), and Indonesia is beginning to produce Syzgium aromaticum (L.) Merrill & L.M. Perry (cloves), Myristica fragrans Houtt. (nutmeg), and Curcuma domestica Val.
(turmeric). In South Korea, there are significant increases in the cultivation of Panax ginseng, paeonia spp., Platycodon spp., and Angelica spp. In South Africa, Artemisia spp., Tagetes spp., and Eriocephalus spp. are being cultivated. Cultivation of Duboisia spp. from India and of Heterotheca imloides from the high mountains of Mexico have been introduced to central Europe. In North America the cultivation

of a wide range of medicinal and aromatic plants is being initiated.

Once the basic biological requirements of a species are understood, the agronomist, agricultural engineer, horticulturist, and plant breeder must develop the planting, machinery,and agricultural techniques that will ensure successful plant introduction from both a horticultural and economical aspect. Manageable production procedures involve plant selection and breeding, propagation, cropping systems, pest control, harvest and postharvest handling, and processing. The developing and testing of productive systems of introduced medicinal crops require the growing of the plants under environmental conditions that will simulate the field ecology. Generally, plants are first grown in small field plots and/or within the controlled environments of greenhouses or climatic chambers to establish ecological models. Production is increased as various cultivated systems prove successful in promoting economically viable crop growth, development, and product synthesis.

The introduction of medicinal plants into cultivation will probably remain a high priority and play an increasingly significant role in the quest for homogeneous, high-quality natural plant products for use in the preparation of medicines.

1277 92 - 14/38

Potential crops

Review, crops, humid tropics, arid regions, nuts, cashew, macadamia, kola nut, dika nut, njansan, mongongo nut, ye-eb

SPORE

9. Nuts: multi-purpose and profitable

SPORE, 36, 1992, p.5

Most nuts are highly nutritious and some have a high sale value. Cashew and macadamia are much in demand for export while other kinds of nuts are produced more locally and may be unknown outside a particular region. Some of these also have the potential to become useful, productive and profitable crops elsewhere.

Typically, most nut species are moderate to large trees suitable for planting singly in gardens, hedgerows, orchards or as part of agroforestry. As well as cropping, they provide shade and stabilize the soil. Some have very deep roots and remain productive under surprisingly arid conditions.

The cashew (Anacardium occidentale) is the most widely grown nut, excepting coconut and oilpalm which are in a different crop category. It originated in the American tropics from Mexico to Brazil, but has long since spread successfully to many lowland tropical areas in Africa and Asia. The largest African producers of cashews are Mozambique and Tanzania with smaller amounts being produced in Kenya, Madagascar, Malawi, Nigeria and Senegal. But there is much greater potential for this crop. The nuts have a high export value, while the cashew apple can be consumed fresh or dried. The shell of the nut yields phenol-containing oils which are used for preserving, waterproofing and, after distillation, for brake-linings, inks and cements.

The cashew grows on relatively dry and infertile soils but requires high temperatures and no rainfall during flowering and harvesting in order to produce optimum yields. Since harvesting is by hand, plentiful, inexpensive labour is essential. This is true of most nuts and fruits and may be seen as advantageous since harvesting provides an income opportunity in rural areas. Processing is necessary to remove the cashew shell nut liquid which can blister human skin. In the past, East African output was shipped to India for processing but now processing plants are being built in Kenya, Mozambique and Tanzania.

The macadamia (Macadamia integrifolia) is a more recent arrival in Africa, having originated in Australia. Macadamias require a frost-free sub-tropical climate with at least 125 cm of well-distributed rainfall per year. They will grow on a wide variety of soils if drainage is adequate. However, wind is a hazard: the wood is brittle, and where there are strong winds plantations must be protected by windbreaks.

The kola nut (Cola nitida), dika nut (Irvingia gabonensis) and njansan (Ricinodendron africanum) all grow in wet forest regions but the kola is the most widely grown; it is widely traded as a bitter chewing stimulant. The kola is still mainly harvested from forests but is increasingly planted in orchards, in cocoa plantations and among coffee.

The tree is slow growing and only comes into full production in about the twentieth year.

The dika nut matures in seven years and although exploitation is still limited to self-planted trees the dika seems suitable for planting in hedges, wooded areas, mixed orchards and pure groves. The fruit looks like a small mango and can be eaten in the same way but it is the kernels that are most esteemed: when heated they yield a thick oil. The kernels are also ground to make a paste for thickening stews in the same way as the groundnut and njansan. Njansans are tall trees producing fruits with kernels that have several culinary uses. They can be eaten grilled or ground into a paste and oil can be extracted from the kernels. Most exploitation is from the wild but trees are now being planted deliberately in some regions.

The mongongo nut (Ricinodendron rauteanenii) from the Kalahari and the ye-eb (Codeauxin edulis) from Somalia are staples of local diet in very arid regions and the practicality of these species being planted as desert orchards in their countries of origin and elsewhere is being investigated. Germination and seedling health remain problematic.

An arid land species which is much more widely exploited, although again there have been difficulties, domesticating it as orchard plantings, is the shea butter tree (Butyrospermum parkii). The shea nut is used throughout the Sahel for food and as a raw material for cosmetics and medicines. It has considerable economic potential.

At a time when tree planting is being promoted widely in most parts of the tropics there is ample evidence to suggest that one or more species of nuts may be suitable candidates for selection. Perennial species require little cultural attention and most nut species appear to thrive on poor soils with a little or no demand for agrochemical inputs. They deserve more attention than they have received in the past.

1278 92 - 14/39

Potential crops

Review, Africa, Asia, Latin America, drumstick tree, horseradish, spinach tree, multipurpose tree, food, seed oil, cosmetic industry, water purification, project, GTZ

JAHN, S.A.A

10. Moringa oleifera for food and water purification - selection of clones and growing of annual short-stem.

entwicklung +l_ndlicher raum 23, 4, 1989, pp. 22-25

This paper attempts to provide a rough evaluation of Moringa oleifera germ plasm as well as an assessment of fruit yields of traditionally cultivated trees in various tropical developing countries and aims to indicate possible methods of selection and plant breeding to improve the production of high-quality Moringa fruits. The study is based on recent field observations and water treatment tests within the framework of the supra-regional water purification project with natural coagulants sponsored by the Deutsche Gesellschaft fnr Technische Zusammenarbeit (GTZ) GmbH and on the evaluation of Moringa seed samples generously supplied by colleagues in Togo, Aruba, the Dominican Republic and the Indonesian islands Flores and Timor.

Moringa is grown throughout the tropics, most notably in the Philippines, Haiti and Hawaii. In Africa it is grown along the Nile, in Sudan and in Uganda, Zaire, Cote d'Ivoire and several other countries.

According to the ICRAF database, the tree grows well in the following conditions:

Mean annual rainfall: 366-1177(!).

Annual mean minimum temperature: 18-20ºC.
Annual mean maximum temperature: 31-34ºC.
Absolute minimum temperature:6-8ºC.
Altitude: 0-660 m.

Moringa also grows at higher altitudes, as a specimen tree has grown for many years in the Harare Botanical Garden (1470 m). Echo reports that it grows in Nepal. In the Dominican Republic, it is said to withstand frost and even frozen soil.

Moringa likes light sandy and medium loamy soils with a minimum depth of 50 cm and no water-logging. It will stand some acidity.

The tree can be propagated in several ways. It will grow from stumps, seedlings, natural regeneration, coppicing, air layering, direct sowing and cuttings.

Moringa can be used in a multitude of ways. Its main deficiency compared with many leguminous trees is that it does not fix nitrogen. As it is deep-rooting, it could also be tried in alley cropping.

Moringa oleifera (horseradish or drumstick tree) is a multipurpose tree which can be propagated easily from seeds and cuttings. The tree has been introduced to most countries in the tropical belt. The quality and quantity of seeds which can be obtained from traditionally grown trees varies enormously however both in India, the country of origin and in the other countries. Unfortunately the cultivation has been neglected to a great extent and the fact that the tree has still survived in many places is only due to its admirable resistance and hardiness.

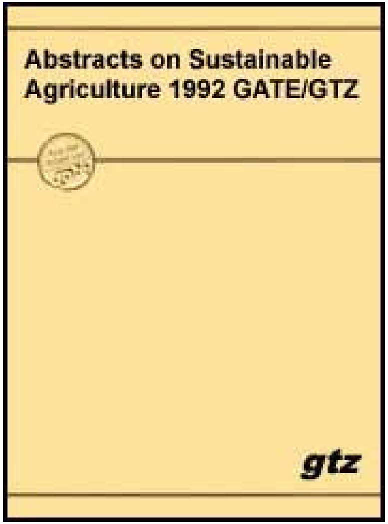
An increasing interest in the quality and yield of the fruits of the Moringa oleifera (horeseradish, drumstick tree, spinach tree) is at present shared by scientists and organisations concerned with improved nutrition, hunger-aid and water supplies in rural areas of tropical countries. Although young pods are edible whole, it seems that there are even more delicious dishes which can be prepared from green Moringa "peas" either removed from the pod when served or cooked like pulses.

In the past, the seed oil known under the trade name "ben oil" was also used for cooking, but now it is principally utilized in small amounts in the cosmetic industry to fix volatile odorous substances.

Moringa seeds, however, also contain polypeptides acting as primary coagulants which can turn turbid and contaminated surface waters into clear, and safe drinking water. For all these uses large healthy unripe or mature seeds and a high annual yield are essential.

For a peasant farmer to grow 20-30 Moringa trees on his own initiative around his compound must mean that the tree has considerable potential.

Much research is needed to find out how its obvious qualities can be used more widely. Farmers could gradually extend tree cultivation, starting with a few around the house and then expanding to a plot for feeding livestock in dry periods, and later planting it all over the farm along contours to prevent erosion or for alley cropping between annual crops.


Abstracts on Sustainable
Agriculture 1992 GATE/GTZ
gtz

land-use system in alentejo, portugal, with special reference to soil tillage (alternative zum traditionellen landnutzungssystem im alentejo, portugal, unter besonderer ber_cksichtigung der bodenbearbeitung.)

- 4. Indigenous farming systems and development of latin america: an amazonian example.
- 5. Socio-economic and institutional considerations in improving shifting cultivation in tropical Africa.
- 6. Traditional agriculture in southeastern Nigeria:

demographic, land tenure, and other socio-economic factors.

- 7. Appropriate land use systems for shifting cultivators.
- 8. The sustainability of the impact of the integrated rural development programme (IRDP) Zambia/nw-province.
- 9. Traditional knowledge about the use of soils in the Solomon Islands.

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

Abstracts On Traditional Land-Use Systems

Acknowledgements

1030 92 - 1/69

Traditional land-use systems
Review, Africa, Sub-Sahara, sustainable agriculture, soil productivity, indigenous measures, research results, methodologies, GTZ

HAILU, Z. and A. RUNGE-METZGER

1. Sustainability of land use systems: the potential of indigenous measures for the maintenance of soil productivity in sub-sahara african agriculture.

Publ. of the Inst. of Agricultural Economics, Univ. of Gttingen, F.R.G., 1991, 111 p.

The primary aim of this paper is to develop a multidisciplinary research design to examine the sustainability of prevailing land use systems in selected agroecological zones in Africa.

Therefore special attention is paid to the understanding and assessment of the systems' dynamics and the potentials embodied in indigenous measures by which farmers try to adjust to changing situations.

The question of sustainable agricultural development has increasingly drawn the attention of many international development research institutions and scholars particularly concerned with the challenge imposed on prevailing production systems in the developing world. The main objective is twofold: the incorporation of sustainability as an objective in the traditional set of goals of agricultural development research; and to develop and use sustainability as a measurement criterion to design and evaluate alternative systems by investigating and analyzing the reasons why existing systems are no more capable of perpetuating agricultural growth.

Conventional research approaches, both in their general objective and choice of performance criteria, very seldom put emphasis on the long-term performance of the systems they investigated.

Most studies describe the process of physical, chemical or economic degradation. Consequently, measures to combat the process of degradation were mainly technical solutions which very often failed completely. This is primarily due to the failure to include sociological and political influential factors which directly or indirectly determine the decision making process of rural farm households. Because of this misconception decisive variables have been neglected in the analysis of production functions. Socio-economic variables like

- tenure arrangements (common property problem),
- externalities (free rider problem),
- national and international price policies (wrong

incentives),
- institutional and organizational arrangements and
- intergenerational equity (determination of the correct discounting rate) as well as
- personal awareness and subjective judgements also have an impact on the choice of technologies and the productivity of a land use system. Therefore, a research program designed to assess the problem of land degradation should not limit itself to the investigation of the physical changes as such, but must go further and identify the root causes that lead to these physical changes.

Agricultural production systems should be viewed as complex dynamic agroecosystems that are determined by the interaction of a set of geophysical, biological, socio-economic and cultural factors.

A sustainable agroecosystem is one that

- maintains or enhances environmental quality,
- satisfies future demands of society for food and fibres, and
- assures the economic and social well-being of producers.

An assessment of sustainability should simultaneously consider all important dimensions of an agroecosystem - namely the environmental, economic and social aspects with the view of exploring the factors that make a system unsustainable in the long run. This simultaneous consideration should be based on a thorough understanding of the inter dependencies and pattern of interaction between the different aspects in specific areas and development stages. Most of all, the interrelationships between the natural environment and the agricultural production process need to be well understood.

An important aspect of the sustainability concept is the question of finding an appropriate analytical tool to measure a system's sustainability over time. According to the comprehensive definition of sustainability a sound methodology has to consider the environmental, economic and social aspects of sustainability.

1031 92 - 1/70

Traditional land-use systems

Review, Africa, Kenya, Tanzania, Uganda, pastoral areas, dryland, indigenous knowledge, agroforestry, ICRAF

BARROW,G.C.

2. Building on local knowledge - the challenge of

agroforestry for pastoral areas.

Agroforestry Today, Oct.-Dec. 1991, pp. 4-7

For generations, the lives of pastoralists in dryland Africa were shaped by one thing: an unforgiving climate. With the threat of drought always as near as the next season, pastoral communities built up knowledge about the vegetation in their harsh environment and evolved complex strategies that gave them resilience to the consequences of unreliable rainfall.

An expanding population, penetration of the cash economy, loss of dry-season grazing land to cropping, and a national emphasis on crops and settlements have brought a different set of challenges. Despite the long-term sustainability of pastoral land-management systems, they are now in danger of breaking down.

Attempts to help pastoralists adapt to their new circumstances, through agriculture or agroforestry, were often unsuccessful. In many cases, this lack of success can be linked to the fact that scientists and planners failed to discuss problems and potential solutions with the recipients of research and development.

The pastoralists' knowledge of their environment was usually ignored or, at best, simply not understood.

A brief description of three pastoral communities: the Pokot and Turkana of Kenya and the Sukuma of Tanzania gives some answers on how they utilize plants and manage their land.

Concluding, the capacity of the people and the land to recover from drought is linked to a mobile population, availability of large and diverse grazing lands, access to dry-season fodder including trees, low to moderate stocking rates per unit of land, moderate to high stocking rates per person, use of wild fruits and other fonds from trees, and limited production of dryland crops such as sorghum.

A second lesson from these pastoral societies concerns the vital link between resilience and risk. For pastoralists, decreased resilience can dramatically reduce the chances of surviving a period of drought. In this context, changes in land use, such as the cultivation of areas traditionally used for dry-season grazing, may significantly reduce resilience and increase risk. By retaining trees in crop and grazing land, agroforestry could help to migitate this threat.

One other lesson is an appreciation of the importance of traditional knowledge coupled with a strong community structure. The knowledge provides a thorough understanding of the environment and the production system.

Concluding researchers and planners must first identify valuable aspects of the traditional natural-resource management system. They must then work with local people to help them adapt their practices to changing socio-economic and environmental conditions.

Research and develop priorities will naturally vary from region to region, but given the vastness of many dryland areas, it makes good sense to develop a system-wide framework that emphasizes conservation and sustainable utilization of natural resources.

Within such a framework, specific strategies could incorporate:

- The conservation and management of existing trees, shrubs and grasses, including natural regeneration
- The inclusion of a water-resource management policy to coordinate tree planting, natural regeneration, crop

production and other activities that require water
- The use of existing natural-resource management strategies as a basis for further development
- A deliberate policy to increase awareness of natural-resource management, including shifting responsibility to local people
- The enhancement and reinforcement of the traditional land- management system through collaboration with resource users
- At the same time, the dissemination of promising new practices that have been thoroughly researched and tested.

Some recent approaches to research and development tend to be more enlightened than those of the past. There is now an extensive literature that strongly advocates the use of indigenous technical knowledge and that argues for participatory research as a basis for the development of appropriate interventions.

This movement towards participation in research and extension is part of a shift towards involving local people more actively in setting research priorities and planning their own development. These participatory programmes are yielding valuable information about existing systems, their potentials and constraints, problems and possible solutions.

By incorporating local people in the process of project planning and technology development, indigenous skills and knowledge can be expanded and preserved rather than lost through attrition.

People can maintain some degree of control over the changes that occur and they can gain a better understanding of alternative technologies and management practices.

1032 92 - 1/71

Traditional land-use systems

Europe, Portugal, Alentejo, field trials, land-use system, mechanization, history of development, soil productivity, traditional tillage, cropping system, cost reduction, cereals, fodder, sunflower, soil parameters

BASCH, G.

3. Alternatives to the traditional land-use system in alentejo, portugal, with special reference to soil tillage (alternative zum traditionellen landnutzungssystem im alentejo, portugal, unter besonderer ber_cksichtigung der bodenbearbeitung.)

Gttinger Beitrege zur Land- und Forstwirtschaft in den Tropen und Subtropen, 31, 1988, 188 pp.

The present paper deals with the problems of the land-use system currently applied in Alentejo which have arisen since agriculture has been mechanized. A review of the history of development of land use in southern Portugal gives the background for understanding the severe problems that faces agriculture in this region.

In field trials on two sites with different levels of soil productivity, a comparative study of the traditional tillage and cropping system, with two alternatives each, was made. The choice of alternatives aimed at reducing the costs for cereal production and exploring the possibilities for improving fodder production in cereal crop rotations. For this purpose, conservation tillage methods, on the one hand, and clover and forage crops, on the other, were compared with the traditional tillage and cropping system. Supplementary investigations of soil-related parameters, herbicide use and cultivation methods for sunflower provided additional information about the possibilities and limitations of the reduced tillage methods.

On average over the three experimental years, the different tillage treatments (ploughing, scarifying and direct drilling) had little effect on cereal yields and forage and pasture dry matter production. However, marked differences in cereal yields between tillage treatments could be detected for single years, weed infestation being the main factor in producing these differences. In contrast to the sandy soil, the triple-disc direct drilling system revealed some problems in assuring a satisfactory cereal plant stand on the heavy clay soil. Yet it was on the light-textured soil where the reduction of tillage intensity tended to produce slightly lower yields.

The triple-disc system proved not to be an appropriate direct-drilling unit for the seeding of sunflower on heavy clay soils. An adequate plant density could only be achieved with seedbed preparation. However, in a trial in which seeding was done by hand without preceding tillage operations, it was found that the direct drilling method itself can be successful in producing sunflower on clay soils.

Early sowing of sunflower is possible and may result in a considerable yield increase. Early sowing in winter, however, is possible only on non-tilled soil. Variation in plant density proved to have little effect on sunflower yield. No differences in the yield of sunflower were observed between fertilized and non-fertilized plots.

Certain crop rotation effects could already be observed after three years of experimentation by considering the effects of the preceding crops on the following ones. To some extent, these effects varied between tillage treatments. On the more productive clay soil, it was mainly the forage crop that showed positive effects, due to the suppression of weeds, whereas on the sandy soil it was the following wheat crop, mainly after ploughing. The regrowth of the green fallow was dependent not only on the soil tillage treatment but also on the herbicide level used on the preceding cereal crop. After one or two years of cereal production, ploughing resulted in a pronounced delay of pasture regrowth and in a reduced total dry matter production. The plant group most affected by ploughing were the legumes.

The higher the herbicide level, the lower the total dry matter production measured. The reverse was true for legume yield. A considerable decrease in surface runoff and an even greater increase in eroded soil was observed in small erosion trials when tillage intensity was reduced.

The investigation of physical, chemical and microbiological parameters of the soil as affected by the tillage method revealed, in some cases, large differences between tillage treatments.

Reduction in soil tillage led to a marked decrease in the nitrate content of sandy soil. The reverse was observed with respect to the soil respiration rate in the top surface layer. Oxygen concentration in the atmosphere of the topsoil under water-logging conditions was found to be less under direct drilling. However, no correlation could be found between oxygen concentration and plant growth.

Small or no differences between tillage treatments were detected in the root development of wheat, bulk density, soil temperature and soil water content at the end of the vegetation period of wheat.

The results are discussed with regard to the comparison of the traditional tillage and cropping system with the chosen alternatives and in the context of results obtained in tillage studies reported by other authors. The study concludes with a comparison of the economics of the different tillage methods, indicating an increase of soil productivity if reduced cultivation or direct drilling are properly performed.

Finally, prospects for changes needed in plant production in the Alentejo are given, and further research subjects, such as weed control and the suitability of other soil types for reduced cultivation, are proposed.

1033 92 - 1/72

Traditional land-use systems

Latin America, Brazil, tropical lowlands, Amazonia, indigenous farming systems, study, land tenure, deforestation, potential plants, agroforestry, non-farm activities, rural industry, employment, DESFIL

HIRAOKA, M.

4. Indigenous farming systems and development of latin america: an amazonian example.

In: Proc. of the Humid Tropical Lowlands Conference, Panama, 1991, pp. 1-24

This paper discusses the possibilities and limitations of adopting indigenous farming systems for sustainable development of the moist tropics of South America. Specifically, the study proposes to

- ascertain whether indigenous farming models can be devised for adoption in the region;
- assess the economic role of traditional farming among market- oriented farmers;
- explain the relationship of indigenous agriculture to other forms of land uses, especially fallows and agroforests;

- define the scale of indigenous farming operations and target groups; and
- discuss the relevance of autochthonous practices as models of sustainable agriculture for the humid tropics of South America.

The study is based on preliminary surveys carried out among non-tribal, long-time residents of the Amazon estuary in Brazil. The agricultural systems practiced by various tribes are described.

An evaluation is made of the possibilities and limitations of indigenous farming as models of ecologically sustainable and viable land use.

The continued deforestation and attendant environmental degradation of newly opened humid tropical lowlands of Latin America have led to a search for ecologically sustainable, and economically viable, management systems. Recent research suggests that indigenous management systems may serve as alternatives to the current, short-sighted practices.

The skilful handling of diverse forest ecosystems among the indigenous people has shown to produce a variety of items including fruit, seeds, resins, fiber, and timber, as well as fauna that satisfies the inhabitants' basic subsistence needs. Utilization of a vast number of products requires detailed site-specific experience and familiarity with local biophysical elements and their interrelationships. The numerous products also are subjected to various degree of management and their output rates, seasonality of use, and amounts are influenced by diverse cultural controls encoded in myths, folklore, and community rules and regulations.

Concluding, the author states that the great variety of traditional crops associated with indigenous systems does not necessarily contribute to income generation. Crop specialisation and the large number of varieties that characterize caboclo farms may be important as repositories of genetic variability, and as sites for supplying subsistence production, but they are unable to contribute meaningfully to enhance the inhabitants' income.

The role of farming in the inhabitants' economy has tended to become of secondary importance. As less demanding, socially acceptable, and economically regarding alternatives have been devised, agriculture's share of the economy has declined. One conclusion that emerges is that indigenous farming will continue to produce a number of subsistence items for the caboclos, to earn supplemental income, to provide raw materials for rural industries, and to contribute to equalize household labor distribution during the year. The small scale family farms will essentially be an adjunct to non-farming activities. From an ecological viewpoint, the combination is desirable since the pressures on the environment will be lessened, and a large part of the land will continue to be covered by forest, albeit an anthropogenic one.

Agriculture and agroforestry should be viewed as integral segments of indigenous resource management systems. As is true among indigenous farmers elsewhere in the humid tropics of Latin America, the different phases of land use are not seen as different agricultural types, but components of an overall forest management system.

A further difficulty is that indigenous farming is site specific. No single agricultural system is applicable over an extensive area. In response to numerous combinations of environmental and cultural variables, indigenous agricultural systems show great spatial diversity.

Site-specific solutions have been devised by taking into account the ecological differences in relief, climate, soils, drainage, and natural vegetation characteristics, as well as the distinctive cultural features, such as local dietary preferences, accessibility to markets, historical events, local market niches, and personal choice. Thus, standard sets of procedures and crop combinations are uncommon.

1034 92 - 1/73

Traditional land-use systems

Africa, review, tropics, shifting cultivation, socioeconomics, institutions
KAMAJOU, F.

5. Socio-economic and institutional considerations in improving shifting cultivation in tropical Africa.

In: FAO Soils Bulletin No. 53; FAO, Rome, Italy, 1984, pp.

117-120

The traditional peasant in the tropics has adopted bush fallow or shifting cultivation in response to declining soil fertility and sparse population density, with its implied unlimited land supply. The multiple cropping system to accomodate subsistence production is linked to several factors: the prevailing closed economy, a limited work force, and the low level of technology available. These cropping systems ensured that all the food products the family required or wanted were grown simultaneously on the same plot of land. In addition, these systems allowed the family to reduce the size and number of plots needing clearing. This enabled them to save limited labour for other important household tasks, as well as for leisure. These mixed cropping systems also provided biological disease and pest control.

Today the practice or adoption of shifting cultivation, like other farming systems, results from a combination of factors. Some of these are socio-economic; others are physical, including land, labour, technology, and all forms of capital; still others are institutional, such as cultural values, land tenure systems, social organization, traditional and new or modern institutions, input and output price policy.

Among the inherent disadvantages of these systems a few are listed below:

- The low remuneration of shifting cultivation, relative to its labour requirements and to the shifting cultivator's labour supply. It is also low because shifting cultivators cannot get a good price for their produce, because there are no markets for it.
- The massive and systematic destruction of forests and forest products and the degradation of forest soils which accompany shifting cultivation. This destruction

constitutes a tremendous loss of valuable resources.
- Low investment capabilities characteristic of shifting cultivation.

This results from the low remuneration which makes all investments economically unappealing; this in turn leads to low productivity (thus completing a vicious circle).

The disadvantages imposed on shifting cultivation by various socio-economic and institutional changes relate to two phenomena: growing population and a growing need for cash income.

Traditional practices, with their low productivity, cannot produce enough to raise the peasant's consumption above the subsistence level or satisfy new needs which depend on cash.

Shifting cultivators today need more and more cash to buy new goods and services not produced by the family including transistor radios, gas lamps, sugar, schools, medical bills, security, etc. Peasants are finding it more difficult to practise classic shifting cultivation while producing the marketable surplus necessary to meet these new needs.

The major constraints to improving shifting cultivation in the African tropics are, by and large, the same constraints that limit agricultural development generally in those regions. The constraints in this paper deal with socio-economic aspects of the problem.

- Government assistance (financial and otherwise) should be made available to peasants. This will enable total output, per family and per caput, to increase.
- In order to speed up the recovery of initial, costly investments, cleared land could be used simultaneously for tree crops.

- Legislation instituting flexible family or individual land ownership with limited transfer or sales' rights could encourage shifting cultivators to invest more inland, thus increasing their productivity.
- Land settlement schemes used primarily to relax population pressure on over-populated areas could also be used as an indirect means to introduce continuous cropping needing fewer inputs.
- Governments and research institutions, at both the national and international levels, should give top priority to reearch in agronomy, agricultural mechanization, animal husbandry, agro- forestry, and socio-agroeconomics, especially when this research is oriented to the problems and the needs of more intensive exploitation of small-scale farms in tropical forest conditions.

1035 92 - 1/74

Traditional land-use systems

Africa, Nigeria, traditional methods, survey, study, land tenure, socio-economy, inheritance, organization of farming, income of farmers, credit, government aid, on-farm diagnostic research

ESHETT, E.T.

6. Traditional agriculture in southeastern Nigeria: demographic, land tenure, and other socio-economic factors.

Beitr. Trop.Landw. Vet. med.,28, 1, 1990, pp. 5-17

The food crisis currently experienced in Nigeria underscores the great need to understand the production system of the small farmers who produce the bulk of the food consumed. Therefore, considerable attention has been devoted to study different forms of farming systems practised across the country with a view to identifying the constraints involved and finding ways and means of alleviating these constraints, within the small farmers' socioeconomic setting.

A reconnaissance survey was first undertaken in June 1984 in the 3 target areas in order to obtain an overview of the type, organization, and functioning of the prevailing farming systems, to appraise the land resources and the physical environments under which the small farmers operate.

The study was carried out to investigate the influence of demography, land tenure, credit and other socio-economic factors on the traditional bush fallow agriculture. In spite of large land resources, there was a strong influence of existing tenurial practices on the farming system.

Land tenure exists in various forms as co-operative (communal) property, permanent private property, and land leasing, the latter utilized in contract farming. One third of the farmers were members of cooperatives, others of peer groups, but both types of farming are not very effective.

There were considerable differences in the gross income. Government support for the farmers was minimal. 93% of all farms investigated had not received any government credits and only 20% had been able to make use of plant material supplied by the government.

It is concluded from this study that:

- Although arable lands were generally plentiful and population densities low, achievement of higher productivity per farm family was hampered by lack of evolution of modern, improved farming techniques, by rigid and unprogressive organizational and land tenurial practices which discouraged long-term investments by external cultivators, and by absence of credit facilities to farmers and farmers' aversion to cooperation societies.

- Farmers' off-farm engagement helped to diversify and stabilize traditional revenue bases and bring about some measure of self- sufficiency in local manpower which in turn was of economic significance, especially in remote communities which did not benefit from government developmental activities.
- The strength of the traditional farmers lay in their ability to cope with large farm families (used essentially as traditional labour sources), to adapt their agricultural activities to the dictates of a rather weak and ineffective agricultural extension system, and above all, their ability to wrest an income/farm productivity level that guaranteed a stable domestic economy, with enough food resources to sustain an

extended family system, leaving a reasonable surplus to sustain rapidly expanding urban populations.

1036 92 - 1/75

Traditional land-use systems

Asia, Malaysia, study, project, shifting cultivation, technology, institutions, community development, participatory approach
NEUNH-USER, P. et al.

7. Appropriate land use systems for shifting cultivators.

Schriftenreihe des FB 15 der TU Berlin, Nr. 138, 1991, pp. 99 +

Appendices;
ISBN 3-924333-78-5;
Verlag J. Markgraf, Weikersheim, F.R.G.

This report is the result of a three-month mission carried out by a research team from the Centre for Advanced Training in Agricultural Development (CATAD), The Technical University of Berlin.

The research was conducted at the request of and in close cooperation with the Malaysian-German Forestry Research Project (MGFRP) especially with its Sabah complement in Sandakan.

This study was carried out under the Sabah component of the Malaysian German Forestry Research Project through the Sabah Forestry Department (SFD), supporting the latter in defining a concrete concept for the Rural Community Development Programme (RCDP). It was the SFD's intention to include agroforestry supporting measures under this programme.

The objective of the Malaysian-German Research Team was to develop a proposal for an economically and socially viable, as well as environmentally sound pilot project to be carried out in the hill area of Koromoko and Tg. Batu Darat in Kota Marudu District. Using this project as an example, designing experiences were extracted and a "model" was formulated which henceforth will serve to disseminate future

RCDP projects in other areas.

Methodologically, the study was divided into the orientation, the survey and the planning phases.

The orientation and survey phases were carried out in parallel with farmers and institutions. In the planning phase both parties were brought to one table as often as possible, leading to a "Memorandum of

Understanding" on how to proceed with the final planning and the further implementation of the project.

For the selection and application of methods throughout the study, the MGRT tried to follow a participatory approach, being defined as the ensured representation of the interests and influence of all parts of the different target groups.

The orientation and survey phases resulted in a comprehensive description and constraint analysis of the present land use system (LUS) in the target area and its determining factors.

The major problems regarding the present LUS are the low and inconsistent yields. They are caused by low to medium potential of the soils, insufficient regeneration periods for the soils, erosion and pests. There is a lack of wo/manpower mainly while slashing. Labour is unevenly distributed which leads to a high labour burden especially for women. One important limitation which is a part of these problems is the lack of knowledge about agricultural cropping techniques and livestock management. The access to external inputs for the farmers is limited due to their unavailability, as well as lack of cash income, transport and information.

Based on the constraints of the present LUS and the ideas, needs and interests of the farmers, some low external input LUSs were proposed.

Although the project proposals are based on low external inputs, great efforts towards an improved extension service are required. Apart from their specialized skills, each extension worker should also have basic technical knowledge about integrated farming systems.

Most institutions at district level were open-minded about the participatory and integrated approach although their strategies to enforce rural development were quite different. They showed a great interest and strongly supported the MRGT carrying out the research.

To what extent the commitment of the departments involved, towards better interagency cooperation and communication, will last or possibly spread remains uncertain.

The enthusiasm of many villagers gives reasons to believe that at least on project level, new approaches do have a chance of future success.

1037 92 -1/76

Traditional land-use systems

Africa, Zambia, shifting cultivation, farming systems, study, cassava, based systems, sorghum based systems, adaptive research planning, cropping systems, soil fertility, horticulture, firewood production

RAUCH, T.

8. The sustainability of the impact of the integrated rural development programme (IRDP) Zambia/nw-province.

A Publ. of the Centre for Advanced Training in Agricultural Development, TU, Berlin; Nr. 116; 1988, 257 + annexes

The traditional farming system practised in Kabompo and in Zambezi Districts is described as the "Luvale System" of semi-permanent hoe and ox-plough cultivation. The staple crop is cassava. Traditionally the farmers prefer to clear virgin bush for the cultivation of new cassava fields, except in areas of increasing land pressure. The clearing is mainly carried out between March and June. The trees and shrubs are stacked in piles ready for burning in October. Cassava is either grown on the flat, on ridges or on mounds. During the first year of cultivation it is intercropped with groundnuts, sweet potatoes, beans, local maize, calabashes, cucumbers, water melons, pumpkins and rosella.

Cassava can be harvested after the first year, but it usually remains in the ground for at least two or three years, sometimes even longer.

Generally the cassava plant is easy to cultivate. In recent years, however, its cultivation has become more and more difficult in some areas, due to the cassava mealy bug (Phenacoccus manihot) which has spread into the project region. The population of mealy bugs is continuing to increase causing serious damage leading to problems in securing cuttings for the planting season.

The sorghum based farming system called "Kaonde-system" is found in Chizela District. It is a shifting cultivation system based on a sorghum-field, called "bujimi" in Kikaonde.

After clearing the bush at the beginning and the burning at the end of the dry season the "bujimi" is cultivated. The dominant crop is sorghum.

Minor intercrops include maize and pumpkins, grown by a majority of the farmers, and to a lesser extent beans, water-melons and cucumbers. On some "bujimi" there are also patches where finger-millet and sweet sorghum are grown. The field is entirely cultivated for three to six years, before it is again abandoned. There is no crop rotation during the years in which it is cultivated. Some minor intercrops such as beans and cucumbers, however, are often no longer cultivated on the older fields.

In addition, there are other small separate fields of groundnuts and sweet potatoes. Usually, grass fallows are used for these fields. The grasses are hoed up into mounds on which the crops are planted. Often these fields are only used one year.

In the cassava based shifting cultivation system, maize is usually grown after several cycles of cassava or on cleared secondary bush. The cash-crop fields tend to be close to the village. Maize is cropped continuously or sometimes rotated with sunflower or groundnuts. Little consideration appears to be given to planting maize on new land in the belief that the fertilizer will restore the fertility of the cassava lands. Six years after this survey, however, the question arises whether these findings still reflect the reality.

The high participation rate and the increase of the cash-crop production is one of the achievements of the programme. But the high percentage of maize cultivation suggests a high degree of maize monocropping.

If the farmers are monocropping pure stand maize on the same fields for several years, the sustainability of the programme is endangered. Maize monocropping leads to the deterioration of the soils in the long run and to a rapid decrease in yields. Due to the inpact of these risks they are discussed in detail in this paper.

1038 92 - 1/77

Traditional land-use systems

Pacific, Solomon Islands, case study, indigenous knowledge, soil use, plant productivity, CTA, IBSRAM
WAIRIU, M.

9. Traditional knowledge about the use of soils in the

Solomon Islands.

In: Proc. of a IBSRAM Workshop "Soil Management and Smallholder Development in the Pacific Islands"; IBSRAM Proc. No. 8; 1989, pp. 225-231

This case study was conducted to gather information from local people about their knowledge of the soils they use, particularly with regard to the use of different soil types which are classified in their own languages. Some of the things investigated in this study are the local classification of the soils, and the people's views on the use of the soil.

The investigation was conducted on a questionnaire/interview basis. The questionnaire was used as a guide during discussions with the local people. During the discussion session, the interviewer recorded all the necessary information the farmer put forward. Following the interview, a personal soil data sheet was used to record features of the identified soil types as additional information.

Agricultural production in the Solomon Islands has been developed independently by Solomon Islanders over thousands of years. They fish, forage, hunt, and cultivate for their own livelihood. Over the years of continuous shifting cultivation, each tribe or language group in the Solomon Islands has identified different soil types which suit a certain crop.

This case study shows five different soil types which are classified using the traditional system. The local classification system is based mainly on the soil colour and texture, as the local names imply.

The five different soil types identified have different crop suitability. Most of the crops grown are the traditional root crops, which include yam, taro and sweet potato, tree crops (such as coconut), and others like banana and sugarcane. This does not mean that only the crops listed under each soil type are suitable for that particular soil type. Other crops may be suitable, but the people themselves have not tried them out. That is why introducing a new crop cannot be easily accepted by the farmers, since they may think it will not perform well on a particular soil type.

This way of thinking among local people highlights the need for recorded information on traditional soil knowledge so that a better land-utilization programme can be organized. It is important that there should be a two-way system of soil information transfer between both the local farmers and modern agriculturalists, which is one way in which agricultural development may be speeded up especially at the smallholder level.

This will be possible if more organized land-use planning and land-suitability assessments are undertaken.

A close liaison between traditional knowledge and modern knowledge is required in order to make the best use of the land.

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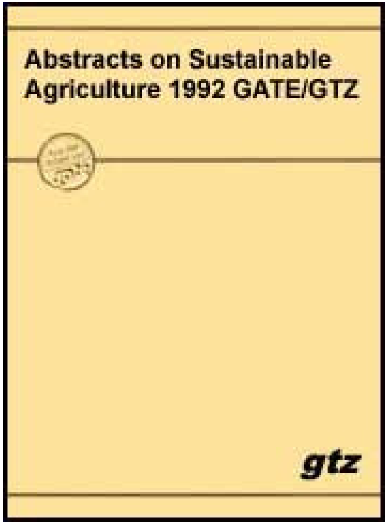

2. On-farm sustainable agriculture research: lessons from the past, directions for the future.

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.

6. Monitoring and evaluation in

mere neglect.

- 21. Accelerating technology transfer by means of atta (advanced technologies in traditional agriculture).
- 22. Projects with people: the practice of participation in rural development.
- 23. Technological innovations in latin american agriculture.
- 24. Agricultural compendium - for rural development in the tropics and subtropics.
- 25. Guidelines for designing development projects to benefit the rural poor.
- 26. Participatory education and

grassroots development: the case of rural appalachia.

27. Approaches that work in rural development: emerging trends, participatory methods and local initiatives.

28. Participatory rapid rural appraisal in wollo: peasant association planning for natural resource management.

29. Farmers' knowledge of agricultural practices: a sri lankan experience.

30. The sustainability of the impact of the integrated rural development programme (irdp) zambia/nw-province.

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

Abstracts on farming systems research and development

Acknowledgements

1039 92 - 2/123

Farming systems research and development

Review, book, indigenous knowledge, agricultural development, case studies, projects, decision-making systems, concepts, social systems, resource management, World Bank
WARREN, D.M.

1. Using indigenous knowledge in agricultural development.

World Bank Discussion Papers 127, Washington, D.C., USA,

ISBN 0-8213-1884-5, 1991, 34 p. + references

The success of a development project often depends on local participation. Familiarity with indigenous knowledge can help change agents understand and communicate with local people, enhancing the possibilities for participatory and sustainable approaches to development. This enables project staff and local people to work as partners in planning and implementing development activities.

This paper reviews three types of project scenarios: projects where local knowledge provided an improved approach to managing natural resources than proposed project technologies, projects that inadvertently ignored indigenous structures, and those projects whose success at meeting their objectives can be linked to the incorporation of indigenous knowledge components.

The World Bank, as well as numerous other development agencies, has been actively seeking ways of ensuring participatory decision-making, strengthening development capacity at the individual and institutional levels, and assuring long-term sustainability of the development process.

Ethnic groups in dozens of ecological zones have generated a vast body of indigenous natural-resource management and agricultural knowlege.

Collectively they represent a dynamic information base that has supported an immense population by adapting to constantly changing circumstances. These indigenous knowledge systems have been largely ignored in many developing countries.

Indigenous knowledge is a knowledge that is unique to a given culture or society. It is the basis for local-level decision-making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities. Such knowledge is passed down from generation to generation, in many societies by word of mouth.

Indigenous technologies used effectively by one society can be used to solve problems faced by another society in a similar agroecosystem located in another part of the world.

Research indicates that the farmers' decisions to reject an innovation are often rational when viewed through the indigenous system.

Indigenous knowledge should result in an improved development, such as the higher incomes resulting from increased crop production due to better soil and water conservation resulting, f.e. from the use of Vetiveria grass.

Several types of indigenous knowledge and decision-making that are useful for development are outlined in this paper:

- Mixed cropping and forest gardens
- Indigenous technical knowledge of tree management
- The role of indigenous organizations in decision-making for development
- The management of common property natural resources
- Incorporating farmers' knowledge in international rice research
- Ethnoveterinary medicine
- Indigenous crop pest management
- Agriculture in Iowa

There are several key areas where development agencies can take a leading role in promoting use of indigenous knowledge for development.

These include support to systematically record and preserve indigenous knowledge for development efforts at national resource centers, provide training opportunities to incorporate indigenous knowledge components into educational institutions, conduct participatory research on indigenous knowledge systems, and establish systems for global networking and electronic exchange of indigenous knowledge. The following suggestions are discussed in more detail in this paper.

- Biodiversity and indigenous knowledge
- Global network of indigenous knowledge resource centers
- Research on indigenous knowledge systems
- Global networking for indigenous knowledge and development

Particulary global networking as carried out f.e. by ILEIA is an important method to incorporate indigenous knowledge systems and enhance the technology transfer.

1040 92 - 2/124

Farming systems research and development

Review, on-farm research, case studies, surveys, USA, sustainable agriculture, low-input systems, strategies, holistic approach, sustainable practices, sample selection procedures
TAYLOR, D.C.

2. On-farm sustainable agriculture research: lessons from the past, directions for the future.

J. of Sustainable Agriculture, 1, (2), 1991, pp. 43-87

The unique roles of on-farm research in assisting with the development of sustainable agriculture are outlined in this article.

On-farm research, as used in this article, pertains to scientifically-designed investigations undertaken on the field of commercial farmers. The research may pertain to only some or all crop and livestock enterprises on particular farms. On-farm research is intended to be distinct from on-farm demonstrations in which improved technologies developed on-station are tried out on farmers' fields.

Demonstrations usually do not involve formal replications or other required features for the statistical analysis of data collected.

In detail the following aspects are dealt with in this paper:

- Systems nature of sustainable farming

- Strategies to effectively address issues in sustainable agriculture
- Unique roles of on-farm research in assisting the development of sustainable agriculture
- Documenting existing sustainable practices and experiences
- Experimenting with new sustainable practices/enterprises
- Issues for consideration in the next generation of on-farm research
- Comparative tests of sustainable and conventional farms
- Partnership among university specialists, private organizations, and farmers in the design and conduct of on-farm research.

Applied to sustainable agriculture, on-farm research can be used for

- documenting the sustainable practices and experiences of commercial sustainable farmers and
- experimenting with new sustainable practices/enterprises on the fields of commercial farmers.

The systems nature of sustainable agriculture requires the strategic use of:

- multidisciplinary research teams;
- whole-farm, holistic analasis;
- long-term research programs
- and "synthetic" as well as analytic approaches.

1041 92 - 2/125

Farming systems research and development

Review, manual, developing countries, market research,

sustainable development, culturally-adapted research, sociology, economics
EPSTEIN, T.S.

3. A manual for culturally-adapted market research (cmr) in the development process.

Publ. of Grant, 40 Babbage Road, Roseville Chase, N.S.W.2064, Australia; 1991, AD 12.00 + AD 2.00 for postage

This manual outlines how CMR promotes participatory development by eliciting the views from the ultimate users of developmental activities.

It concentrates on adapting established market research methods to the setting of different Third World cultures. In doing so it should help to fill the gap which presently exists in the available development literature relating not only to user research but also how to make it culture-specific.

Apart from international, national and non-governmental developmental agencies, the manual will be of interest to administrators and implementors of development programmes, development planners, politicians, educationalists and Third World market researchers.

The manual is organized as follows:

> Part I discusses not only the reasons why CMR has to become an integral part of the development process, but also why existing evaluation procedures have largely failed to increase the rate of project successes and how CMR can help to improve project efficiency.
>
> Part II outlines relevant established market research methods and provides guidelines for their use in the

development process.

Part III sets out by means of key cultural variables how market research can be culturally adapted.

Part IV suggests a model structure to integrate CMR into developmental activities.

1042 92 - 2/126

Farming systems research and development

Review, book, environment, natural resources, holistic approach, soil fertility, development policy, resource degradation, stabilization, strategies, price policy, subsidies, fiscal policies, land tenure systems, agricultural trade, GDI
OTZEN, U.

4. Environmentally compatible agricultural development.

Resource, food and income security as a task for development and structural policy.

Publl. of German Development Institute (GDI); Berlin; 1992, 56 p. + notes

The disastrous combination of rapid population growth, under development and dwindling resources on the one hand and advancing industrialization and climatic change due to pollutants on the other calls for a change of attitude towards nature.

The value attached to nature and the organization of economic activities that use its dwindling resources need to be reconsidered. Given the multicausal linkages, this needs to be done at all levels of the economy and in almost all spheres of life in both industrialized and developing countries.

The application of purely economistic and, therefore, reductionist models to land development in the tropics and subtropics with their particularly fragile ecosystems, has had devastating effects on the natural balance, causing erosion, soil salination, soil and landscape degradation, disastrous droughts or flooding. The economic, social and demographic consequences of such anthropogenic processes of land destruction and of the climatogenic processes closely associated with them are declining yield capacities, increasing poverty and the uprooting of sections of the population, as more and more people flee the effects of environmental destruction to seek food and a living elsewhere.

Production and consumption should therefore increasingly form part of substance and energy cycles which preserve resources and that agriculture should again develop more as a form of site-specific production based on regional comparative economic-ecological cost advantages.

Agricultural development, whether in the South, where its destructive impact on the land tends to be determined by the system, or in the agricultural economies of the North, whose adverse effects on the environment tend to be compulsive, is causing rising environmental costs. In the former case, these largely consist of on-farm costs in the shape of losses of yield and output due to sheet erosion, soil salination, soil degradation or nutrient leaching; in the latter case, they consist largely of "external costs" in the shape of surface and ground water pollution, land clearance, the loss of species or the contamination of food products with chemical residues. In the debate on global warming the agricultural economies of both North and South are, moreover, accused of increasing emissions of carbon dioxide and methane due to mechanization, large-scale livestock farming and the growing of lowland rice.

If there is to be an economic-ecological and innovative-organizational move towards the progressive application of ecological standards in agriculture and forestry, a number of basic conditions will need to be met at national and international level. These conditions are outlined in this paper.

Resource stabilization and food and income security are unlikely to be achieved with individual promotional instruments, but rather as a complementary task of measures taken under price, innovation, structural and trade policies. Agricultural development policies that are socially, economically and ecologically balanced may therefore emerge from the interplay among:

- national reforms of agricultural structures and prices based on economic-ecological principles,
- international commitments to internalize environmental costs in agriculture and
- a local commitment by each producer to use

resources in a way that is compatible with the environment.

Agricultural development policies compatible with nature will therefore be able to prove themselves in practice only in the long term, in keeping with the general demand for globally responsible thinking and conception and locally responsible action to the benefit of the environment and international society.

Author's summary, shortened.

1043 92 - 2/127

Farming systems research and development

Review, USA, sustainable agriculture, downstream perspective, soil erosion control, property rights
HITZHUSEN, F.J.

5. The economics of sustainable agriculture: adding a downstream perspective.

J. of Sustainable Agriculture, 2, 1992, pp. 75-87

The objectives of this downstream perspective and assessment of the economics of sustainable agriculture in this paper are:

- to explain to a general audience (broader than economists) that sustainability from an economic perspective as a minimum requires accounting for both on and off-site effects of economic activity;
- to focus on soil erosion and related water quality impacts (including changing property rights) as the major sub-set of downstream economics of alternative farming systems, and
- to present some empirical results and policy implications of Ohio downstream impacts which would

seem to be generalizable to many other settings.

More empirical evidence is needed regarding on-site and downstream costs (particularly groundwater contamination) and returns of alternative tillage and rotation systems if socially optimal systems are to be identified. The evidence to date suggests that on average downstream costs of soil erosion are not trivial and that they exceed the average on-site costs of soil erosion. This implies that some form of tax, subsidy, technical assistance or regulatory intervention may be appropriate and necessary. The evidence also suggests that downstream costs per unit of soil loss can vary dramatically from site to site.

This points to the extreme importance of targeting control measures.

The empirical evidence on the economics of soil erosion to date suggests the following for consideration:

- Further research and extension of information to farmers on sustainable reduced tillage and expanded rotation systems which reduce downstream costs without reducing profitability to the farmer.
- More comprehensive research on downstream costs of soil erosion and related chemical contamination of water and identification of any strong correlated or proxies, e.g., population, existence of harbors, density of private wells, etc. for these impacts.
- Taxes on the inputs, such as nitrogen (e.g., N without inhibitors) and selected pesticides (e.g., Atrazine) which have been most problematic in surface and groundwater contamination to at least provide revenues for further research.

In sum, more comprehensive economic assessment, particularly of the downstream costs and benefits of alternative farming systems, is likely to favour those systems that are less erosive and chemically intensive.

This in turn leads to the need to reassess the entitlements and property rights related to alternative farming systems and their downstream impacts. Evidence to date suggests shifts in favour of the impacted downstream users and these trends will probably continue. Thus, sustainable agriculture is an idea that is currently ecologically, and in many cases, economically attractive. In addition, its future economic attractiveness is likely to increase.

1044 92 - 2/128

Farming systems research and development

Review, agricultural research, monitoring and evaluation, impact assessment, guidelines, evaluation concepts, terms, ISNAR

MCLEAN, D.

6. Monitoring and evaluation in the management of agricultural research.

ISNAR Working Paper No. 14; Int. Service for Nat. Agric. Research (ISNAR), The Hague, Netherlands, 1988, 29 pp.

This paper introduces the general topic of monitoring and evaluation, including a brief definition of terms, and the functional roles of different types of evaluation in research systems.

It provides the framework for the development of a series of materials on the comprehensive topic of monitoring and evaluation.

Research managers have become increasingly aware of the importance of installing M/E procedures into their organizations, but the successfulness of these efforts has been mixed.

Monitoring and evaluation are not new concepts. Yet research institutes have had little success in integrating effective M/E into their organizations.

Many different terms are used in the literature to describe the methods and techniques used in program evaluation. The central features of all these approaches are that they are analyses of program processes, not just program content. They have implications for improving efficiency and effectiveness. They include quantitative and qualitative techniques.

Most research programs in developing countries are responsive to larger development objectives. A comprehensive program evaluation should include, therefore, representatives from development and extension organizations, and a mechanism for bringing user feedback into the process. Program evaluations may also include representatives from planning and finance ministries, depending on the size and importance of the program.

The best key indicators of project performance are objective, quantifiable, and unambiguous. They can be verified if necessary. A good monitoring system is not more time consuming than the benefits justify, collects no superfluous data, is timely in data analysis, interpretation, and feedback, and is useful to researchers.

This paper does not attempt to cover the monitoring and evaluation procedures associated with personnel appraisal and financial and administrative management. These topics are considered in other ISNAR papers on human resource management and in general management literature.

This paper underlines the importance of integrating monitoring and evaluation into routine management practices, so that they are viewed by both those conducting evaluations and those being evaluated as tools for improving research.

In addition to the main text there is an annex which more thoroughly discusses the evaluation of ongoing research, largely through annual reviews and comprehensive program reviews.

The annex has tried to illustrate the importance of integrating monitoring and evaluation activities into day-to-day management practices in national research organizations. It concentrated on the internal monitoring and evaluation which should take place for ongoing research, and focuses primarily on the necessary reporting requirements of the researchers themselves.

The ISNAR working papers series is a flexible instrument for sharing analysis and information about relevant organization and management problems of the agricultural research systems in developing countries.

1045 92 - 2/129

Farming systems research and development

Review, Africa, agricultural development, institutions, colonial period, post independence period, national agricultural research, sustainability, ISNAR
EICHER, C.K.

7. Sustainable institutions for african agricultural development.

ISNAR Working Paper No. 19; Int. Service for Nat. Agric. Research (ISNAR), The Hague, Netherlands, 1989, 26 pp. + annex

The thesis of this paper is that after a third of a century of independence, many African states are several generations behind Asia and Latin America in terms of their stage of scientific, political, and institutional maturity.

It is hypothesized that the stage of institutional maturity of individual African states will play a critical role in determining the type, amount, and sequence of foreign aid that can be absorbed with integrity. But most donors normally ignore the stage of institutional maturity of individual African states and prepare a continent-wide strategy to strengthen institutions such as a national agricultural research system or a national extension service.

What flows from Africa's agricultural research history over the past 60 years is the simple but powerful proposition that current institution-building strategies and lending approaches that are effective in Asia and Latin America will have to be sharply modified to fit the earlier stage of development of many countries in Africa. In addition, because of the differential stages of development between

African countries, institution-building approaches in middle-income countries in Africa, such as Zimbabwe and Cameron, are likely to fail in Guinea, Chad, Burundi, Somalia, Uganda, and Ethiopia.

A subregional strategy should be prepared to strengthen the three core national agricultural services--research, training, and extension--for each of the five major agroecologies: Sahel, coastal West Africa, Central Africa, Eastern Africa and the Horn, and Southern Africa. Each strategy should include basic concepts research networks to link researchers in NARS with regional and international institutes.

The subregional approach to research planning has the potential of capturing research spillovers. But to implement such an approach, African states and donors must deal with some complex political issues limiting the development of sustainable institutions.

The paper is organized as follows:

Summarizing this paper presents some thoughts on the development of sustainable institutions for African agricultural development. The focus is on strengthening the three core institutions research, training, and extension that form the institutional base of agriculture. Primary attention is devoted to strengthening national agricultural research systems (NARS), and secondary attention, to training and extension.

The ISNAR working paper series is a flexible instrument for sharing analysis and information about relevant organizational and management problems of the agricultural research systems in developing countries.

1046 92 - 2/130

Farming systems research and development

Review, human resource management, agricultural research, planning, training, ISNAR
SACHDEVA, P.S.

8. Human resource management for national agricultural research: lessons from ISNAR's experience.

ISNAR Working Paper No. 18; Int. Service for Nat. Agric. Research, The Hague, Netherlands; 1988, 18 pp. + annex

This paper reviews ISNAR's experience in helping national agricultural research systems (NARS).

Thebetter manage their human resources and identifies key lessons from that experience.

The paper is intended for the generalist agricultural research manager and discusses some key concerns and lessons. The underlying premise is that all managers and supervisors need to become adapt in effectively and efficiently managing their human resources.

This paper is divided into three parts:

- Overview and highlights of ISNAR's experience by major area,
- lessons from this experience, and
- conclusion.

The diversity of approaches used by ISNAR is illustrated by a few examples.

In many of these countries, the conditions of service of researchers have been reviewed in detail, with attention given to such items as grade structures, personnel costs as a proportion of the recurrent budget, salary differentials etc..

ISNAR has recently documented fresh evidence that the number of researchers in developing countries has more than doubled in the past 20 years, well ahead of the growth in recurrent expenditures for agricultural research during the same period. In many countries the need for additional scientists remains substantial, but the potential supply from academic institutions is variable in quality and quantity as well.

In the future, it will be essential that the NARS first undertake strategic planning and then set priorities, formulate programs, and estimate manpower requirements.

Recent ISNAR experience indicates also a few concerns, which are outlined in this paper.

In terms of the broader areas, problems of efficiently managing growth of manpower, research programs, and training institutions are likely to remain high on the agenda of most NARS.

Under conditions of scarce financial resources coupled with the pressing need for producing and delivering useful research some hard choices involving shifts in strategy, reduction of marginal programs, redeployment of personnel, restructuring of organizations, and rationalization of research station networks will be inevitable.

1047 92 - 2/131

Farming systems research and development

Review, agricultural research, technology transfer, developing countries, linkage mechanisms, evaluation criteria, political factors, technical factors, oganizational factors, ISNAR
KAIMOWITZ, D.

9. A conceptual framework for studying the links between agricultural research and technology transfer in developing countries.

ISNAR LINKAGES Theme Paper No. 1; Int. Service for Nat. Agric. Research, The Hague, Netherlands; 1989, 28 pp. + references

This paper synthesizes the contributions of seven papers commissioned by ISNAR as part of an international project to study the links between agricultural research and technology transfer.

In particular, the paper addresses four basic questions:

- What linkage mechanisms exist and what are their characteristics?
- What contextual factors influence which linkage mechanisms are appropriate to use and how?
- Which of these contextual factors can be controlled or influenced by policy makers and leaders of research and technology transfer institutions?
- What limitations do contextual factors impose upon the use of linkage mechanisms?

ISNAR initiated a major international comparative study on the links between agricultural research and technology transfer in developing countries. This study was developed in response to requests from agricultural research managers for advice in this area.

Many institutions have noted the problem of poor links between research and technology transfer in developing countries.

This framework is the subject of this paper, and represents the first phase of the ISNAR study. It is the result of 18 months spent synthesizing the experts' contributions and reviewing the available literature.

This framework should help leaders of research systems find out what paths exist and where they lead. The specific routes to guaranteed improved performance are not yet known, but this paper gives some indications of their general direction. It opens with an elaboration of the key concepts of the framework, and then discusses the criteria for evaluating performance. This is followed by analyses of the political, technical and organizational factors which affect linkage mechanisms in the development and transfer of agricultural technology.

Experience has shown, however, that it is impossible to come up with a set of general recommendations which would be appropriate in all circumstances. Solutions which work well in one context perform poorly in others.

1048 92 - 2/132

Farming systems research and development

Case studies, Africa, Asia, Latin America, on-farm research, extension, linkage problem, sustainability, ISNAR
EWELL. P.T.

10. Linkages between on-farm research and extension in nine countries.

OFCOR Comparative Study No.4; Int. Service for Nat. Agric.

Research, The

Hague, Netherlands, 28 pp. + references

ISNAR initiated a major study on the organization and management of on-farm, client-oriented research (OFCOR) in national agricultural research systems (NARS).

In this study, OFCOR programs are analyzed in terms of the functions OFCOR can perform within the larger research and extension process.

The intention is to provide a body of practical experience upon which research managers can draw as they strive to strengthen OFCOR as an integral part of their research systems.

The study focuses directly on the issues of implementation and institutionalization.

By region, the countries studied are:

- Latin America: Ecuador, Guatemala, Panama
- Africa: Senegal, Zambia, Zimbabwe
- Asia: Bangladesh, Indonesia, Nepal

The case studies provide important insights and lessons on the general issues, as well as specific guidance for research policy and the organization and management of OFCOR in their countries.

The cases reflect a variety of institutional settings and strategies for introducing and developing OFCOR. They also reflect the broad range of models used in the organization and management of OFCOR. The profiles outlined highlight the features of each case.

The study is organized as follows:

- In Chapter 1, the relationship between on-farm research and extension is contrasted in three countries - Guatemala, Nepal and Zambia.
- Chapter 2 draws on evidence from all nine countries to analyze the experience with six mechanisms for linking on-farm research and extension.
- Chapter 3 points out the lessons that emerge from the case studies for research managers using on-farm research as a means of strengthening the links between research and extension.

The case studies report several examples of links between research and extension that have not lasted.

The most successful cases of institutionalization are those where links have been forged simultaneously at several levels of the administrative hierarchies of the organizations involved. Good cooperation at the field level is impossible to sustain unless regular opportunities to meet and work together are actively supported by management.

1049 92 - 2/133

Farming systems research and development

Review, agricultural research, resource-poor farmer, farmer participation, research management, ISNAR
BIGGS, S.D.

11. Resource-poor farmer participation in research: a synthesis of experiences from nine national agricultural research systems.

OFCOR Comparative Study Paper No. 3; Int. Service for Nat. Agric. Research, The Hague, Netherlands; 1989, 34 pp. + references

This paper is a result of a collaborative group effort. It is based on the case studies prepared for the ISNAR study on organization and management of on-farm client-oriented research in national agricultural research systems.

This paper reviews the experiences of resource-poor farmer participation in the agricultural research process and draws out lessons for agricultural research managers. Participation in this context is seen as the involvement of farmers in research activities as clients, colleagues, partners, planners, and evaluators in the research process.

The paper reviews the experiences of nine national agricultural research systems: Ecuador, Guatemala, Panama, Senegal, Zambia, Zimbabwe, Bangladesh, Indonesia, and Nepal. In these countries, resource-poor farmers have been designated as major clients of research and all have had major on-farm client-oriented research (OFCOR) efforts in operation for several years. One of the principal objectives of these programs has been to promote participation of resource-poor farmers in research. This has been stressed because it increases the cost-effectiveness of research and helps keep research priorities focused on the clients.

The analysis is divided into four chapters. The first chapter looks at the types of farmer participation in research in the country case studies. A typology of four modes of participation (contract, consultative, collaborative, and collegial) is used to differentiate the ways in which resource-poor farmers participate in research programs.

The typology has implications for management and some of these are briefly described. The OFCOR programs in the country case studies are then described, with particular reference to the nature of participation. Modes of participation are subject to development policy, national agricultural research policy, institutional context, and changes in research methodology. Some of the ways in which these factors have contributed to changes in programs are considered.

Chapter 2 discusses the levels at which resource-poor farmers and scientists interact, looking in particular at the village, national, and regional levels. The complex and often difficult circumstances at the village level have implications for managers; and several aspects of these are discussed, including bias, the status and role of scientific staff, local politicians, community representatives, and the staff of extension and development agencies. These factors contribute to the way in which a research program is implemented; they are crucial to the nature and extent of resource-poor farmer participation.

A major part of chapter 3 discusses meetings between researchers and resource-poor farmers as an important complement to trials and surveys.

Such meetings require careful design and clear objectives if the resources allocated to working with farmers are to be used efficiently and effectively. Farmers can be involved in meetings in a number of ways. These are set out, bearing in mind the location-specificity and nature of the research program. The case studies show considerable experimenting with different types of meetings to improve farmers participation; some of those at the village and national level are described.

The fourth chapter draws out lessons and implications for research managers. It concludes by placing emphasis on the need to support local research practitioners in finding ways to develop new methods and techniques for increasing the participation of resource-poor farmers.

One of the most important findings from this study is that research practitioners have been innovative and have developed a wide variety of mechanisms to involve farmers in the research process.

Support must be given to local researchers, and funds must be allocated for communicating experiences with farmer participation among researchers in different regions and in different countries.

1050 92 - 2/134

Farming systems research and development

Review, Africa, Asia, Latin America, Senegal, Zambia, Zimbabwe, Bangladesh, Indonesia, Nepal, Ecuador, Guatemala, Panama, case studies, on-farm research, organisation, management, ISNAR

EWELL, P.T.

12. Organization and management of field activities in on-farm research: A review of experience in nine countries.

OFCOR Comparative Study No. 2, Int. Service for Nat. Agric. Research, The Hague, Netherlands, 1988, 42 pp. + annex

ISNAR initiated a major study on the organization and management of on-farm, client-oriented research (OFCOR) in national agricultural research systems (NARS).

The objective is to analyze the critical organizational and managerial factors which influence how national research institutes can develop and sustain OFCOR programs to realize their specific policies and goals.

This paper is one of a series comparing and analyzing the concrete experiences with OFCOR of national institutes in the nine countries studied. It is focused on how the field staffs have been organized, both in relation to other parts of the system and internally. It analyzes how the research process has been managed, and the procedures used for planning, programming and review. The organizational implications and management requirements of different methodologies are discussed, although it has not been a goal of the study to evaluate the effectiveness or efficiency of different research methods, or to assess their impact.

Closely related topics are analyzed in separate papers: the linkages between on-farm and on-station research, the experience of the participation of farmers, and the linkages between OFCOR and extension institutions.

This paper has concentrated on a limited set of issues directly related to the organization and management of the field research personnel and their activities. General lessons drawn from the experience of the case studies are summarized in this paper:

- Improving focus on the targeted clients
- Selecting collaborators
- Maintaining an interdisciplinary perspective
- Sustaining feedback
- Administering field operations
- Providing leadership

On the basis of the experience it is accepted that no package of technology, no matter how high its yields or economic returns on an experiment station, will necessarily out-perform current varieties and practices under farmers' conditions. A technology which is heavily dependent on inputs from outside of the immediate region, and which is very sensitive to hazards and variations in the environment will not be sustainable on small farms.

1051 92 - 2/135

Farming systems research and development

Africa, agricultural development, analysis, socio-political model, land holding systems, demographic aspects, housing, food, land exploitation, education, extension, research, administration, social integration, CTA
KAVADIAS, G.V.

13. Social and human dimensions of agricultural development in africa in the perspective of the year 2000 (dimensions sociales et humaines du developpement agricole de l'Afrique dans la perspective de l'an 2000.).

In: Agriculture in the Year 2000 - The Case of ACP-Countries;

Proc. of an Int. Forum: Green Government and CTA, Netherlands, ISBN 92-9081-0440, 1990, pp. 99-104

A theoretical analysis of this phenomenon has already shown that the economic - technological approach to development is insufficient if there is no concurrent reference to the socio-political framework, because development efforts are essentially social actions geared to a certain type of society which they are trying to change.

Experience has shown how important the above mentioned dimensions are since they are decisive for development, particularly in agricultural regions of a traditional nature, as is the case in Africa.

With other words, in every development effort in sub-Saharan countries, the social and, more generally, the human dimensions of the undertaking constitute a fundamental problem. In agricultural areas, and taking into account the specific local context, these aspects constitute a key problem.

And yet, the social and human factors are always more or less neglected, at the same time, nearly all the attention is focused on the financial, technological and technocratic factors.

The author explains that it is thus impossible to speak specifically about social and human dimensions of agricultural developement as evidenced by the historical reality of each African country.

The only thing that is attempted, is to try to approach the problem within the context of an abstract socio-political model of a qualitative nature elaborated in stages and based on common or related features of the countries in question. The practical utility of such a model lies in the fact that it represents a reference value. By comparing the model with the situation prevailing in a given country differences and similarities to the model enables observations on the fabric and internal dynamics of the social structures of the country. Furthermore by comparing the existing social structures of the society in question with the social infrastructure dictated by the chosen type of development, it is possible to ascertain discrepancies and identify the necessary measures to be taken in order to reconcile the two.

Such an attempt calls for a multi-dimensioned analysis.

The levels of observation and analysis necessary to the construction of an integrated rural development model in Africa are described.

This model emphasizes the distance between North and South which is increasing. If this gap is not closed, not only will the misery of poor nations persist, but there will be greater danger for world peace through new wars.

The theoretical sociological model of their current development conditions which has been described allows:

- a description of their deficiencies and needs which have to be faced, from the sociological angle,
- the formulation of a series of measures which are required by social and human considerations and which can contribute to the general effort in connection with economic, organizational and technological measures,
- the confirmation that action for development must follow efficient planning.

The planning must prescribe measures for the development of every sector of life, as well as measures for the appropriate combination of their dynamics.

This paper is rather theoretical and the whole effort described above is difficult to accomplish.

1052 92 - 2/136

Farming systems research and development

Review, book, Africa, Ghana, study, ethnic group, social system, traditional society, ecology, religion, spiritual interaction, cooperation
RIEHL, V.

14. Nature and society.

Diss. Univ. Mnnster, FRG; Verlag P. Lang GmbH, Abt. WB, Postf. 940225, DW 6000 Frankfurt/M. 90; ISBN 3-631-45235-7, 1993, 264 pp.; price DM 74,--

The Tallensi, an ethnic group of 60.000 people who are mainly farmers on a subsistence level, are considered as a paradigma for a stateless society, which organizes its social life on a highly decentralized basis

- a "tribe without rulers".

This was the research result of the widely known British social anthropologist Meyer Fortes who did his field research among the Tallensi in the mid 30s of this century. Since then British colonial rule and since 1957 the state of Ghana were established. The Tallensi were confronted with the effects of development aid and christian mission became significant not only for the Tallensi but for all the other ethnic groups in the semiarid parts of Northern Ghana.

What impact did all these changes have on the political system of the Tallensi?

This was the main question the author had when he started a

32-months research stay among the Tallensi in 1986. During that time he was living in a local extended family, doing participant observation.

With this work the question has been answered how the Tallensi were able to keep up their political system and egalitarian social structure and to fit it into changing social situations. By a detailed description of the Tallensi-Festivals he works out the significance of "nature" (hunting, fishing, food) as a counterpart to "culture" (agriculture, village life, clan relations).

This work gives an interesting view "from inside" how an ethnic group has developed certain social techniques of keeping the social and economical equilibrium. The book offers an important contribution to the discussion wheather stateless societies are per se ecological societies which live "in harmony with nature and environment". One of the social effects is that egalitarian societies can only keep up their social system by religious and spiritual interactions which are based on a solidarical and equal cooperation of all the segments of the ethnic group.

This book is clearly written and well worth the attention of those interested in traditional societies which live in harmony with nature and environment. The book is highly recommended for scientific audiences and practicioners looking to extend their general awareness of this exciting area.

1053 92 - 2/137

Farming systems research and development

Review, Latin America, Peru, Caribbean, Haiti, sustainable development, theory and practice, key terms, fragile lands, poverty, policy, technology, institutions, interventions,

watershed development, integrated approach, environment education, extension, conservation,
USAID, DESFIL
GOW, D.

15. Development of fragile lands: theory and practice.

Publ. of Developm. Strategies for Fragile Lands (DESFIL), Washington, USA; prepared for U.S.Agency for Int. Development, USA; 1988, 21 pp.

In this paper the author attempts to synthesize an integrated approach to the sustainable development of fragile lands.

The paper is divided into four sections:

- In the first the author deals with the problem of terminology and suggest definitions that will capture the breadth and complexity of the issues under discussion.

- In the second section, the causal factors in the creation of fragile lands will be briefly described.
- In the third, the DESFIL approach is presented, in both theory and practice, recent experience in Latin America and the Caribbean is discussed.
- In the final section, a set of guidelines for an integrated approach to the resolution of fragile lands issues, specifically, the sustainable development of such lands, is provided.

Concluding, the integrated approach is briefly outlined. Such an approach includes:

- Political commitment, policy, and planning:

If such an approach is to have any chance of success, there must be a commitment on the part of national governments. Such a commitment must be demonstrated through the enactment of appropriate policies and development strategies and provision of the necessary resources to implement them.

- Technological interventions, adaptive research, and monitoring:

Enough is known about technological interventions, using both western and indigenous models, to improve the sustainability of present land-use systems. Many of the possible technical interventions are site-specific and must be adapted to the prevailing environmental conditions. There is no standard technical package that can be extended, just as there is no standard way of disseminating these interventions, since they must be adapted to prevailing social and political conditions. Of equal importance, however, is the need to monitor the effectiveness of these technological interventions and, whenever it is necessary, to modify them.

- Institutional strengthening and coordination:

Public sector institutions dealing with fragile lands issues are often weak and fragmented - whether they are in the Ministry of Planning, the Ministry of Agriculture, or the Ministry of Natural Resources. The necessary conditions for their strengthening include political commitment, the availability of resources, as well as the required technical competence.

- Enhancing local organizational capacity:

Local organizations of farmers and their families fulfill important functions in the sustainable development of fragile lands by acting as vehicles. Equally important in this connection are the NGOs working in natural resources management, which often serve an intermediary function as indigenous grassroots support organizations.

- Environmental education and extension:

This is the most realistic and practical way of disseminating what is known about fragile lands issues to those most affected by them. It is also the first step in translating this knowledge into action.

- Conservation and development:

There is no essential contradiction between sustainable economic development and conservation of the natural resource base.

Potential activities include nature tourism, natural-forest management, game cropping, and sustainable extraction of minor forest products.

1054 92 - 2/138

Farming systems research and development

Review, book, agricultural research, network effects, sustainable development, national agricultural research systems, ICRISAT, IDRC
FARIS, D.G.

16. Agricultural research networks as development tools: views of a network coordinator.

Copublication of the Int. Development Research Ottawa, (IDRC), Canada and the Int. Crops Res. Institute for the Semi-Arid Tropics; India; ISBN 92-9066-205-0, 1991, 108 pp., LDC: USD 7.50, HDL: USD 18.30

An Agricultural Research Network (ARNET) is a cluster of scientists or institutions linked together by a common interest in working dependently or interdependently on an identified shared problem or problems. ARNETs are popular with agricultural research scientists, administrators, and donors as tools to strengthen the research capability of national agricultural research systems (NARSs) and to identify, address, and solve farmers' problems.

An effective network will overcome isolation, facilitate sharing of research information and ideas, help reduce unnecessary duplication, provide the critical mass of effort needed to give quick answers to pressing problems, and hasten scientific breakthroughs.

ARNETs have five important components: membership, research, coordination, communication, and assets.

Networks are dynamic and responsive to changing needs in agricultural systems.

There are many types of ARNETs depending on the problems that need to be addressed, the membership and its requirements, the extent of coordination available or needed, the research strategy developed, and the assets available.

The author shares in this book the results of his search to understand the workings, benefits, costs, and pitfalls of networks and he provides information from his own experience and that of others to help those wishing to organize and operate ARNETs.

This book is highly recommended for all those working in international development.

1055 92 - 2/139

Farming systems research and development

Review, book, economics, price distorsions, market intervention, protection measures, income gap measures, aggregation, sensitivity, domestic resource costs, policy relevance, FAO
SCANDIZZO, P.L.

17. Measures of protection: methodology, economic interpretation and policy relevance.

FAO Economic and Social Development Paper No. 84; FAO, Rome, Italy; ISBN 92-5-102859-1; 1989, 58 pp. + appendices

This paper analyzes the properties and the policy significance of the measures of protection currently used by economists in a variety of national and international situations.

The main objective of the paper is to define a set of operational rules to measure the extent and the consequences of government market interventions, with a view to provide guidance for the evaluation of structural adjustment policies involving movements to freer trade. This objective is pursued through a survey of the different measures and of the underlying theoretical constructions and a review of their implications for economic policy.

The paper is oganized as follows: the first section describes the problem area and the possible theoretical approaches and classifies the measures into the three categories of the "price gap", income gap" and "real income gap", according to whether they measure price, incomes or welfare differences due to protection. These three gap measures are reviewed in the second, the third and the fourth section.

Summarizing and concluding the following has been stated:

- Measures of protection have been devised with the two-fold objective of quantifying trade distortions through the measurement of its effects on several economic variables: prices, value added, exchange rates, producers and consumers welfare, government income. More recently general equilibrium models have attempted to measure effects on wages, employment and growth.

- All the measures were born conceptually within the single country context. That is, they measure the effects of single or multiple government interventions by comparing the level of a single variable (e.g. domestic price of a particular commodity) after the intervention with the level that the same variable would have taken without the specific intervention.

- Measures of protection can also be classified in the two categories of "ex ante" and "ex post" measures, according to whether they refer to presumptive or first round effects, or to real comparisons with and without protection. The "ex ante" measures can be easily performed only for tariffs, taxes and subsidies, while the "ex post" ones, based on real price comparisons, can be used for all government interventions, including quantitative restrictions.

Measures of protection can be a valuable tool for policy making, provided that they are used with caution. Both ex ante and ex post measures should be used in the policy process of structural adjustment for different tasks: the ex ante measures to agree on the removal of tariff levels and other specifications, the ex post measures to evaluate priorities and set monitorable targets.

1056 92 - 2/140

Farming systems research and development

Review, bibliographies, Africa, Botswana, Lesotho, Malawi, Zambia, women, development CTA

18. Women in development in southern africa; an annotated bibliography.

Publ. of the Centre Technique de Cooperation Agricole et Rurale (CTA), Postbus 380, 6700 A.J. Wageningen, Netherlands.

VOL.I BOTSWANA COMPILED BY L. RAMORE 82 pp., ISBN 92 908-1082-3;

VOL. II LESOTHO COMPILED BY M.M. CHADZINGWA, 46 pp., ISBN 92 908-1083-1;
VOL. III MALAWI COMPILED BY G.W.P. KISHINDO, 114 pp., ISBN

92-908-1084-X; VOL. IV ZAMBIA COMPILED BY M. MISENGO AND K.L. CHANDA, 78 pp., ISBN 92 909-81085-8

Women in development in Southern Africa is the series title of a four-volume bibliography which covers Botswana (Volume I), Lesotho (Volume II), Malawi (Volume III) and Zambia (Volume IV). The proposal to compile a bibliography of women in development was made in 1987 at the workshop on Agricultural Information Sources held in Malawi and sponsored by CTA. Participants, conscious of the growing awareness of the indispensable role of women in development, expressed interest in undertaking this project, a project which CTA agreed to sponsor.

Each volume contains an annotated list of authors. There are over 300 entries in the Botswana volume which include both published and unpublished material. The entries have been divided into eleven broad subjects including agriculture, health and welfare, legal rights, economic development and education. Within each subject area the entries are arranged alphabetically according to the author. Each entry is numbered and contains detailed bibliographic information and, in most cases, this is followed by a description of the publication. The other three volumes follow the same basic format.

The bibliographies are aimed at researchers, extension workers, development personnel, teachers and trainers. They bring together all the available material on issues concerning women and development in the four countries.

1057 92 - 2/141

Farming systems research and development

Review, book, developing countries, industrialized countries, resource guide, women, organization, rural development, health, migration, tourism, education, communication
ISIS

19. Women in development: a resource guide for organization and action.

ISIS Internat. Inf. and Comm. Service; Intermediate Technology Publications Ltd., 103-105 Southampton Row, London WC1B 4 HH, UK; ISBN 1-85339-105-0, 1991, 226 pp., UKL 12.95, paperback

For too long now policy-makers and decision-makers attempting to consider women's needs where development plans and policies are concerned, have ignored a basic principle. They have failed to consult the organizations and groups that have been set up for and by the women themselves. In the past this has led to development which has at best neglected or, at worst, been detrimental to women.

Women's experiences of development, their struggles for rights, for the adequate supply of basic needs such as food, water, shelter, health and education, and their continued ability to mobilize and organize themselves successfully in order to execute change, must be recognized if any serious debate on the issues surrounding women and development is to take place.

'Women in development' is a guide which offers some answers written by women, for women, in both developing and industrialized countries. It examines the insights that women themselves have brought to the debate, with specific attention to the following areas: multinationals; rural development;

health; migration and tourism; education and communication.

Abstract from SPORE

1058 92 - 2/142

Farming systems research and development

Africa, women, economics, rural areas, income generation, employment, poverty, FAO, UNESCO
NTIRI, D.W.

20. Income generation and african rural women: choice or mere neglect.

In: FAO Economic and Social Development Series No. 44, FAO, Rome, Italy, 1988, pp. 143-154

This article aims to examine the economic outlook and conditions of rural areas in Africa, with particular attention to the income/employment and attitudes of women. It explores those critical issues that deal with the continuing and long-term impact of unemployment and underemployment and poverty, as well as examining those forces that play a part in the development of the rural woman's image and status.

Women in Africa actively pursue economic endeavours in related farm-and non-farm activities to supplement the little they receive from farming.

Women's rural non-farm activities are generally aimed at income or employment generation and are visible all over the continent. Trading and marketing constitute two key areas of these economic pursuits.

Modern economic parameters have assigned women to inferior placements in the rural framework, primarily as a result of the process of modernization.

In addition to the obstacles of modernization, limited access to land and related resources; lack of control over their own labour; and lack of mobility because of family responsibilities and social and cultural restrictions have to be mentioned.

A set of recommendations for income-generating projects are mentioned:

- It is essential for women to change their attitudes and venture into more lucrative areas that are at present taboo.

- For example, the West African "market mammies" are famous for their economic control in the fishing industry.

- Capital or credit facilities must be created to help women with economic initiatives.

- Expanding income opportunities for skills/trade for women means expanding indigenous productive skill areas or popular skill attractions (tailoring, poultry-keeping, dairy production) through more systematic and organized marketing schemes. This is because markets do not expand fast enough and new markets must be sought.

Traditional skill areas will have to be therefore more vigorously enriched and organized (quality control, production schedule, product-symmetry-shape, size, colour) to serve as real income-generating projects.

- Women require and should obtain more training in terms of mental change, and also to meet the required managerial and technical expectations of the programme (bookkeeping, clerical skills).

Grass-roots training should be given priority.

1059 92 - 2/143

Farming systems research and development

Case study, Asia, Israel, traditional agriculture, technology transfer, development approach, social structure, infrastructure, agricultural technology, agronomy, economy, crop budget, tomato, cucumber, melon
RYMON, D. and U. OR

21. Accelerating technology transfer by means of atta (advanced technologies in traditional agriculture).

J. of Sustainable Agriculture, 2, (1), 1991, pp. 103-118

This paper adopts the approach to increase agricultural production in order to supply growing food requirements.

Over the past 20 years a rapid adoption process of agricultural technology has taken place in the Jiftlik Valley, west of the Jordan

River in Israel.

This case study covers close to two decades of development from the end of the 1960s until the mid-1980s. During that relatively short period the traditional agriculture of the region underwent a dramatic change as a direct result of the introduction of a new agricultural technology based on drip irrigation. Increased yields, and the corresponding increase in farmers' incomes have resulted in capital accumulation and further development; in this sense the technology has played a key role in upgrading the lifestyle of the local population.

Vegetable production has increased more than tenfold and net income of most of the farmers has increased by an even greater factor, thanks to the improved quality of the produce. This dramatic change can be attributed to the innovativeness and full participation of the farmers.

At the start of the technology transfer process the study population was characterized by two socio-economic features: a traditional but stable social structure, and the existence of a continuous market demand for the high-value crops it produced.

Against this background the main elements contributing to the development were:

- suitable agricultural technology;

- the physical support system, e.g., credit and infrastructure;

- a balance of privately and publicly supplied extension services; and

- backing in the form of appropriate intervention by the government.

The overall objective was to replace the traditional technology by an appropriate modern one, as a package of techniques. Accordingly, the following components were introduced:

- Earth-built water ponds to enable provision of the water supply according to crop needs, independently of the traditional allocation based on water rights.

- Drip irrigation system including all of its peripheral components.

- Seeds (usually hybrid varieties) and seedlings.

- Plastic sheeting (used for mulching, low tunnels, etc.).

- Chemicals (fertilizers, insecticides, fungicides, etc.).

The Valley population has enjoyed a stable social structure for decades.

The traditional collaboration between landlord and farmers has not been altered during the period of adoption of the new technology.

The main lesson to be learned is that accelerating technology transfer to a farming community - as opposed to a step-by-step approach - is a viable option; this without the prior development of a complete infrastructure comprising all of the required "software" and "hardware".

The ATTA approach (Advanced Technologies in Traditional Agriculture) may therefore offer an economically and socially acceptable way to overcome shortages of relatively high-value food crops in the growing metropolitan centers of developing countries.

A stable social structure is an important factor. In assessing the sociocultural elements that may affect the introduction of an advanced technology.

Farmers' participation and organization are extremely important for successful, and rapid technology transfer. At the outset, participation requires initiative on the part of the farmers, and their involvement will increase as their confidence builds up.

1060 92 - 2/144

Farming systems research and development

Review, book, projects, people, participation, experience, key elements, development, ILO
OAKLEY, P.

22. Projects with people: the practice of participation in rural development.

Publ. of the Intern. Labour Office (ILO), CH-1211 Geneva 22, Switzerland; ISBN 92-2-107282-7, 284 pp., paperback, 32.50 Swiss francs

Experience - as the author points out - has shown the importance of involving rural people in decisions concerning their own development.

His book presents a convincing case for encouraging participative processes, not as a manageable element of a project, but as the fundamental dynamic of the project itself. He stresses that participatory development must be consciously based on people, their needs, their analysis of issues and their decisions. It must trust that people, whatever the condition of their poverty and oppression, can progressively transform their environment with the help of, but not dominated by, external agents.

The author provides us with descriptions of some experiences in participative efforts which show - in his judgement - successes and failures, but also different concepts of the nature of participation, and the gap between participation as an objective and its actual implementation. Although he also provides useful insights into key elements concerning the practice of participation, and suggests possible methods and activities, he fails to address this gap directly.

Participation of rural people in development projects is not a smooth simple process where people speak freely and honestly about their problems and the alternatives they visualise, where decisions are taken regardless of local problems, of loyalities, differences and silences.

Conflicts are an everyday issue, and they help forge the process in a more "participative" but messy way. This means that one cannot speak naively of "the village" or "the rural poor", as if they were a homogeneous category, as the author often slips into doing.

The author assumes that by incorporating the felt needs of the people, by encouraging their participation, these projects will be incorporate.

However, this is not an automatic process. One wonders why participation is hardly ever conceptualised the other way around: to include the participation of the outsider in the projects of the local people.

Abstract by M.V. Martinez, shortened.

1061 92 - 2/145

Farming systems research and development

Review, book, Latin America, agriculture, technological innovations, debt crisis, public sector, research, private sector, biotechnological revolution, IICA
JANVRY, A. DE et al.

23. Technological innovations in latin american agriculture.

Program Papers Series No. 4 of the Inter-American Institute for Coop. on Agriculture (IICA), San Jos_, Costa Rica; ISSN 0046-0028; 1987, 86 pp + appendices

This paper discusses some of the issues in the field of biotechnology within the context of the debt crisis in Latin America and its effects on the region's agricultural sectors. In analyzing the issues, the authors highlight their effects on the behaviour of the region's technological systems. More important, they also point out their implications in terms of the agricultural technology policy options open to Latin American countries at this time.

This report is written to identify a feasible strategy that attributes to agriculture a key role in the reactivation of the Latin American economies and, to technical change, a key role as an important source of growth and of dynamic comparative advantages.

The paper is organized as follows:

- Technological discontinuities: Adjustment to the crisis and biotechnology

- Latin American agriculture in the context of the debt crisis

- Technological change in Latin American agriculture

- Public sector research

- Role and performance of the private sector

- The biotechnological revolution

- Implications for agricultural technology in Latin America

In more detail the paper starts by reviewing in Part 2 the implications of the debt crisis for Latin American agriculture, most particularly for market prices and government expenditures. The authors then analyze in Part 3 the past patterns of the rate and bias of technological change, contrasting the periods before and since the beginning of the debt crisis. In Part 4, they look at the organization of public sector research and how it has been affected by the crisis. Part 5 is devoted to the role of several agents in the private sector in the generation, transfer, and diffusion of technological change. This includes input suppliers on the side of backward linkages, agroindustries on the side of forward linkages, and producers' associations. Finally, in Part 6 the authors identify several major features of the biotechnology revolution and discuss how they create both opportunities for and threats to Latin American agriculture. Finally the paper concludes in Part 7 with a number of important policy implications.

Concluding, there is little question that biotechnology will transform agriculture in the next 30 years.

Because biotechnology will speed up the technological treadmill, increase production, and put downward pressure on prices, peasants will become increasingly marginal producers without assistance.

Biotechnology will not solve the social problems of Latin American agriculture; unless considerable effort is given to mitigating its impact, it will clearly worsen inequality, flowing only to those who can afford to adopt it.

For technology to play its role and contribute effectively to agricultural development and economic growth, action is required in terms of policy design as well as funding, organization and management of the technological process.

1062 92 - 2/146

Farming systems research and development

Review, reference book, agricultural compendium, tropics, subtropics
EUROCONSULT

24. Agricultural compendium - for rural development in the tropics and subtropics.

Elsevier Science Publishers, Amsterdam, The Netherlands; 1989, 740 pp.; USD 65.75, Dfl 125.00

When it first appeared in 1981 the Agricultural compendium was widely welcomed as a very comprehensive and authoritative reference book on every aspect of agriculture in the tropics and sub-tropics. It was an interdisciplinary work, directed not to the specialist but rather to field workers, with limited local resources, who needed to collate information in several different fields. It assumed a university or college background.

A second edition with minor revisions appeared in 1985, but in this third edition the work has now been thoroughly revised and updated, much new material added, and published in a larger format. A sign of the times, some graphical material is now presented as formulae, acknowledging the almost universal availability of pocket calculators.

Although the revision is comprehensive, the most important revisions are in the chapters relating to climate; soil and land classification; water control; land improvement; crop production; animal nutrition and fisheries; and sociology.

This is an entirely Dutch enterprise, commissioned by the Ministry of Agriculture and Fisheries; produced and edited by EUROCONSULT of Arnhem; and with advisers drawn from institutions in the Netherlands, largely Wageningen Agricultural University. All concerned are to be congratulated on producing an internationally indispensable reference book.

Abstract by T.I. Williams

1063 92 - 2/147

Farming systems research and development

Review, book, guidelines, rural development projects, target groups, critical elements, process approach, project design, decision making, project components
FAO

25. Guidelines for designing development projects to benefit the rural poor.

Food and Agriculture Organisation of the United Nations (FAO), Rome, Italy; 1986, 76 pp. + annex

The overriding objective of development initiatives is to generate self-sustaining improvement in human capabilities and welfare. This task has proved difficult, especially when development investments are to benefit economically, socially, and politically disadvantaged people in rural areas, as mandated by the World Conference on Agrarian Reform and Rural Development (WCARRD).

Empirical evidence proves that rural development projects with high degrees of organization and participation at the local level are more successful in accomplishing their objectives than those that lack these characteristics. Therefore, the participation of the rural poor in project design and implementation, as well as in monitoring and evaluation, has been given substantial scope in these guidelines.

These guidelines are not meant to provide an universally applicable blueprint for poverty-oriented rural development projects.

These guidelines are directed at the design of rural development projects.

These guidelines have been prepared to help implement the WCARRD policy framework and Programme of Action. For that reason, individuals will find them particularly useful in countries where governments are already committed to the WCARRD Programme of Action.

The primary WCARRD goal is to improve the standard of living and the quality of life of the rural poor in a self-sustaining manner. This entails generating improvements in human capability and well-being, without nurturing dependence on external assistance. The WCARRD policy framework recognizes that long-term economic progress will not occur without the full involvement and commitment of the rural poor themselves. They constitute a major resource for development.

The need for this manual is demonstrated by evaluations of agricultural and rural development projects. These evaluations show the frequent failure of project designs to identify the intended beneficiaries adequately or to adapt project activities to local conditions. The designs also often lack either realistic implementation plans or adequate monitoring and evaluation systems. These design problems usually result in serious implementation problems and a failure to achieve the desired long-term benefits.

In this sense, these guidelines are a complement to the "UNDP Guidelines on Project Formulation" which give less attention to people's participation, target group identification, alleviation of rural poverty, and the process approach.

This manual is organized as follows:

- Purposes of the guidelines

- Defining rural development projects
- Applying these design guidelines to different types of projects
- Identifying the target groups
- Critical elements in projects that benefit the rural poor
- The "process approach" to project design and development
- Functions of a good project design
- The steps to follow
- Specifying project objectives
- Specifying project components
- Determining project management and organizational arrangements
- Structuring the project design
- Phasing project interventions
- Relating project analysis to key feasibility issues
- Preparing a realistic implementation plan

- Designing a monitoring and evaluation system

These guidelines are most relevant for projects that intervene directly to help rural people in specific geographic areas. These range from sector-specific projects, such as the testing of new seed varieties, to large-scale multi-sector projects.

1064 92 - 2/148

Farming systems research and development

USA, case study, participatory education, grassroots development, regional development strategy, rural economic crisis, alternative strategy, IIED
GAVENTA, J. and H. LEWIS

26. Participatory education and grassroots development: the case of rural appalachia.

Gatekeeper Series No. 25; IIED, 3 Endsleigh Street, London WC1H ODD, UK, 1991, 13 p.

The failure of the traditional trickle-down methods of development is now well documented. Though better recognized in Third World countries, it is also central to the steady erosion of livelihoods in rural, resource-poor regions of the industrialized countries. Perhaps nowhere is it more evident than in rural Appalachian communities of the United States of America.

The Appalachian region refers to the mountainous region in the middle eastern part of the United States, stretching from as far north as western New York state, and running through parts of Pennsylvania, West Virginia, Kentucky, Tennessee, Virginia down to Alabama and Missisippi.

Historically, the region has contained some of the poorest socio-economic conditions of any region in the country. It is one of the least developed in the United States in factors including agriculture, unemployment, housing, urbanization, poverty, economic diversity, etc.

The economic crisis in the egion poses a crisis for traditional economic development policy. Historically, the development model for the region has been based on creating a favourable 'business climate', which in turn could be used to lure industry into the region. In the name of maintaining the business climate, workers received low-wages, and communities provided tax and other concessions to industry. Based upon a traditional understanding of 'trickle down' economics, the assumption was that what was good for business was good for communities and local livelihoods. To some extent, within its own definitions of success, the 'business climates' model of development worked. Thousands of industrial plants came to the region. The overall standard of living grew.

A number of methods were used which were similar to those employed in participatory research and extension approaches such as Rapid Rural Appraisal, Rapid Assessment Procedures, and Farmer Participatory Research. A central point was the emphasis upon the development of peoples' knowledge, and peoples' research and analysis as an important part of the process of beginning to reverse the pattern of dependence upon external economic forces. These methods include those described below:

- Oral histories
- Community surveys
- Community mapping and drawings
- Decision-makers interviews
- Videos and readings
- Brainstorming and feasibility studies
- Cultural components

The definition of successful development expands to include criterion broader than jobs and income, but also community participation, democratic participation and dignity. Community development - economic, cultural and social - flowers when people value themselves and their neighbours, and begin to work together in common endeavours.

As important as these may be, these case studies and the experience suggest a broader view, especially if one is interested in participatory development. In the latter approach, the development of 'infrastructure' includes human development, an education for creativity, regaining and understanding popular knowledge and history, democratic decision-making, and consciousness of religous and political symbols. With this investment, people can become better equipped to rebuild their own communities and economies.

1065 92 - 2/149

Farming systems research and development

Review, book, rural development, participatory methods, development practice, community development, cultural impact, grassroot movements, future directions
BURBIDGE, J.

27. Approaches that work in rural development: emerging trends, participatory methods and local initiatives.

IERD Series No. 3; K.G. Saur Verlag, Mnnchen, F.R.G.; ISBN 3-598-21043-4; 1988, 414 pp.

The approache in this volume is a dialogue between local initiatives in development practice and emerging trends in the wider development community. In Part I, the focus is on broad development trends. One of the most prominent of these is the increasing importance being attached to the role of non-governmental organizations in development and the need to enhance their institutional capacity. Another is the desire to find ways for all, to talk, plan and work together.

Part II describes the processes or methods whereby various approaches to rural development have led to successful results. The intention here is to share some of the more of recent development experiences, from a variety of perspectives and a number of different countries.

These include participatory planning and problem solving, people-centered evaluation, training of trainers and innovative conferencing.

In Part III, the emphasis is on what is happening at the grassroots and its impact on the development process. There is an increasing acknowledgement that the grassroots is the basic building block for effective and lasting development. Not only is there an awareness of the need to strengthen indigenous institutions but village-based initiatives themselves are calling for more attention and support. This key area from the perspective of the individual, small-scale projects, organizations and networks is examined.

The concluding chapter weaves together some of the insights contained in the three parts of the book and points to new directions for the future of development. The last part of the book contains appendices which list activities, programmes and resource materials that have been used in the third phase of the project.

An additional feature of this volume is the publication of interviews with six participants in India 1984. These six profiles acknowledge the critical contribution such people make to the entire development process.

Abstract from ATSAF-Circular

1066 92 - 2/150

Farming systems research and development

Africa, Ethiopia, review, workshop, participatory rapid rural appraisal, natural resource management, peasant association, IIED

SCOONES, I. and J. Mc.CRACKEN

28. Participatory rapid rural appraisal in wollo: peasant association planning for natural resource management.

Publ. of the Int. Institute for Environment and Development (IIED), London, UK, 1989, 86 pp.

This report is the result of a Rapid Rural Appraisal (RRA) exercise carried out in Ethiopian Red Cross Upper Mille and Cheleka Catchments

Project (UMCC-DPP) in Wollo Province.

The concern for the protection and management of natural resources in Wollo is central to the Ethiopian government's strategy in the highland areas. The Ethiopian Highland Reclamation study that was carried out following the 1984/5 famine claimed that vast areas of the highlands will be lost for cultivation and grazing due to accelerated soil erosion.

This report is divided into nine sections. Following an introduction to RRA methods and the approach taken in the training workshop, the information derived from the RRA Peasant Associations (PAs) is presented. A general profile of each PA is given followed by a summary of attitudes of different groups within the PA to issues of natural resource management, water, health, etc. This information, derived from the use of a range of RRA techniques, is then used to generate a list of problems and opportunities in the PA. These give rise to a series of 'Best Bets' for development which are formulated in a preliminary way and then taken back to the community, tested and revised in a series of group discussions. The finalized 'Best Bets' then are the basis for further practical action - from policy review, to research to project implementation. Within nine days of field and workshop work the RRA teams, in consultation with a range of groups within the community, came up with a series of practical options for future action. These are presented in the report and are supported by information derived for the environmental, agricultural and attitudinal profiles of the PAs.

The final sections of the report provide a comparison of outputs between the two PAs, a list of recommendations for immediate follow-up and a review and evaluation of the training workshop by the participants.

The final session of the workshop was used to discuss what the participants felt they had learned and achieved as well as the problems and limitations theyhad encountered in the work. Finally they discussed what the next steps should be in applying the RRA approach elsewhere.

There was general agreement among the participants that they had learned much from the exercise and had been able to fulfill many of the objectives which they had set themselves on the first day.

1067 92 - 2/151

Farming systems research and development

Asia, Sri Lanka, study, farmers' knowledge, agricultural practices, high-yielding varieties, seed treatments, chemical fertilizer, pests, diseases, weed control, yield

WIJERATNE, M.

29. Farmers' knowledge of agricultural practices: a sri lankan experience.

Beitrege trop. Landw., Vet. med., 29, H3, 1991, pp. 283-287

This study investigates farmers' knowledge level for selected agricultural practices in order to understand how the dissemination process works under field conditions.

The study was carried out in one of the southern districts of Sri Lanka which comes under the low country wet zone.

The case materials were obtained through participation in different formal sessions established in the reformed extension system and conducting indepth personal interviews with extension officials as well as with farmers. The farmers were selected randomly; the sample contained 100 of them.

The agricultural practices were grouped as follows:

- high-yielding rice varieties (HYVs)
- pre-seed treatments
- plant establishment practices
- chemical fertilizer applications
- pests, diseases, and toxic conditions
- weed control
- weights and measures.

The Training and Visit (T&V) System of Agricultural Extension was introduced to developing countries since the mid-seventies, especially to strengthen the knowledge of the dissemination process.

The route from research to farmer involves several steps, especially on the route through the extension sub-system and farmer sub-system. In the latter part of the dissemination process, the message transmitted to the professional extension agent through the bureaucratic organizational structure and is handed over by him to a set of untrained communicators for further dissemination at the village level. It is evident that message distortion takes place in the process, often through levelling, adding, highlighting and modifying, in addition to the total loss of the knowledge or information.

It can be concluded that generally farmers were unable to gain sufficient knowledge for the innovations which are complex for their technical competence. On the other hand, some of the innovations are very costly. Hence, farmers do not show much interest to utilize such innovations in their fields. As a result, they do not demand knowledge.

The findings indicate that farmers have a medium level of overall knowledge on rice cultivation, so that there is a potential for further advancement of knowledge at the utilizer level.

The extension system has made efforts to advance farmers' knowledge mainly by launching training programmes for extension workers and extending the knowledge to a selected number of farmers by making time-bound regular extension visits. It is evident that the extension approach is effective for simple and low-cost innovations. For complex recommendations, alternative extension methods should be applied depending on the field situations. Further, recommendations must be cost-effective at the utilizer level and care has to be taken to provide the other elements of the development mix.

1068 92 - 2/152

Farming systems research and development

Africa, Zambia, study, rural development project, project effects, sustainability, cultivation systems, work oxen, commodity supply, cooperative development, self reliance, associations, beekeepers, craftsmen, institutions, SLE

RAUCH, T. et al.

30. The sustainability of the impact of the integrated rural development programme (irdp) zambia/nw-province.

Schriftenreihe des FB Internationale Agrarentwicklung of the Techn. Univ. of Berlin Nr. 116, Berlin, ISBN 3-924333-70-X; 1988, 257 pp + annex

This report is the result of a three-month survey carried out by a study team from the Centre of Advanced Training in

Agricultural Development

(CATAD) of the Technical University of Berlin.

The study was conducted on request of and in close cooperation with the

Integrated Rural Development Programme/North Western Province in Zambia.

The book is organized as follows:

- Chapter I: Impact of the IRDP on non-participants and reasons for non-participation
- Chapter II: Sustained cultivation systems
- Chapter III: Sustainability of joint utilization of work oxen
- Chapter IV: Supply of relish
- Chapter V: Commodity supply

- Chapter VI: Cooperative development
- Chapter VII: Village self-reliance
- Chapter VIII: Associations of beekeepers and craftsmen
- Chapter IX: Observations on institutional sustainability
- Chapter X: Summarizing conclusions

The Integrated Rural Development Programme (IRDP) in Zambia's

North-Western Province was inaugurated in 1977. Its major goal has been to improve the living conditions of the majority of the small-scale producers (farmers, bee-keepers, craftsmen) mainly by increasing their productivity and production. The approach has focused on providing these small-scale producers with access to inputs, credit and markets and to institutionalize such a mass-oriented service system after it has proved to be feasible and attractive for the target groups.

The aspects of sustainability analyzed in the study are so manifold that it is not easy to extract generalizing conclusions on the sustainability of the IRDP.

Meanwhile the major targets in terms of number of participants and production have been achieved. More than half of the rural households are actively involved. The services have been handed over to local agencies.

The IRDP has managed to make the masses of the small-scale producers the decisive factor for the regional economy (they are providing 80% of the supply, using most of the fertile land and investing their manpower in their own production activities), which can hardly be neglected anymore.

The small-scale producers are, to a certain degree, in a position to identify problems on the farm and village level on their own and to undertake problem-solving action (as far as they are provided with the necessary minimum of external support). They depend on institutions for certain means of production and for access to external markets, but they do not as much depend on support in terms of motivation, mobilization, organizational promotion and advice.

Concluding, the efforts of the IRDP to safeguard sustainability through introducing more adjusted cultivation patterns and new organizational structures have been too ambitious. The recommended intercropping packages are too sophisticated. The attempts to promote organizations which do represent the interests of the poorer sections would require massive interventions into social processes on the village level which are beyond the scope of a regional project covering 55 wards with more than 10,000 participating small-scale producers.

The IRDP's interventions directed towards the sustainability of its impact on the village level should be limited to a support of the people's own attempts by improving the information flow. This can be done without creating new, artificial structures by using the existing communication channels.

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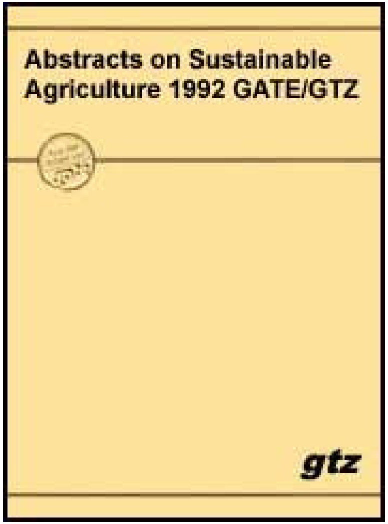

Abstracts on Sustainable
Agriculture 1992 GATE/GTZ
gtz

the development of integrated crop-livestock-fish farming systems in the tropics.

- 16. Goats/fish integrated farming in the philippines.
- 17. The sustainability of aquaculture as a farm enterprise in Rwanda.
- 18. Double-cropping malaysian prawns, macrobrachium rosenbergii, and red swamp crawfish, procambarus clarkii.
- 19. Rice/fish farming in Malaysia: a resource optimization
- 20. Biotechnology in fishfarms:

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

Abstracts on integrated systems

Acknowledgements

1069 92 - 3/119

Integrated Systems

Latin America, Colombia, study, tropical deforestation, livestock production, cattle, small livestock, biomass

production systems
MURGUEITIO, E.

1. Intensive sustainable livestock production: an alternative to tropical deforestation.

AMBIO, 19, 1990, pp. 397-400

Extensive cattle grazing is the principal production system employed by the colonizers of rain forests and has been, and still is, encouraged by most state agencies for rural development and agrarian reform, even though scientific research has demonstrated clearly the failure of this system in most tropical ecosystems.

When cattle-grazing systems are the main activity of resource-poor farmers with insufficient capital and minimal access to credit, returns are usually insufficient to support the minimal needs of the family. The consequence is that the land is sold, usually to the rich landholders, who, through economies of scale, can continue with the extensive grazing systems; and the resource-poor farmer turns once again to the forest and the destructive process continues.

To solve the problem of tropical forest destruction demands a strategy which is of necessity complex, if the remaining tropical forest areas with their ecological riches and biological diversity are to be preserved.

An intensive livestock production model, based on the concept of using highly efficient energy- and nitrogen-fixing plants, promises to offer an appropriate technological solution to the problem of providing an alternative to extensive cattle-grazing systems.

An appropriate strategy is the rational use of the natural resources of the tropics, namely:

- solar energy captured by highly efficient crops through the processes of photosynthesis; and
- the genetic diversity of the nitrogen-fixing plants present in the forest flora.

In recent years, several Latin American countries, have directed research and development activities towards validating the hypothesis that sugarcane can be the basis of intensive animal production systems, thus assuming the role played by the cereal grains in the temperate countries. In a complementary way, it is increasingly being recognized that nitrogen-fixing trees and shrubs (leguminous and non-leguminous) can provide much of the protein needed to balance the carbohydrates from the sugarcane.

The model has the additional benefit of providing a comparative advantage for the resource-poor farmer with limited land area. The model employs fractionation of both the sugarcane and the forage trees to provide suitable diets for monogastric and ruminant animals in an integrated operation, which is proving to be technically, economically and ecologically sustainable.

The model developed in Colombia employs complementary livestock species (pigs and sheep) managed in confinement. Productivity is a function of sugarcane yield which depends on soil fertility, water availability and variety. For the world average yield of 50 tonnes per ha per year, total liveweight production per year from pigs and sheep can be 1500 kg per year. With appropriate management, sugarcane can yield up to 180 tonnes per ha per year, which will give 8000 kg liveweight per hectare per year.

During the last three years, this model has been subjected to continuous testing and adaption to Colombian conditions with extremely promising results. The crops used in the model (sugarcane and forage trees) are perennial, thus soil erosion is contained.

Implementing these models on a massive scale will result in a substantial reduction of the area required to support a resource-poor farmer. At the same time, existing grazing areas can be transformed into more productive units with obvious advantages in terms of job creation and economic stimulus to rural development.

A weakness of the system is the lack of certainty as to the best way to provide the protein input. Recent developments in this area are encouraging. And even at the present stage of development, the results are much more superior, in economic, sociological and ecological terms, than traditional grazing systems.

1070 92 - 3/120

Integrated systems

Africa, Nigeria, humid tropics, study, snail utilization, traditional medicine, cultural values

AGBELUSI, E.A. and B.N. EJIDIKE

2. Utilization of the african giant land snail in the humid area of nigeria.

Trop. Agric. (Trinidad), 69, 1, 1992, pp. 88-92

This paper examined the utilization of the giant land snail among the people of Ondo State in Nigeria. The study was carried out in ten of the 17 local government areas in Ondo State of Nigeria.

A questionnaire was used to obtain data on the pattern of utilization of this animal.

The climate is tropical with two distinct seasons, the wet season and a dry season. The vegetation of Ondo State ranges from mangrove swamp at the coast to derived savanna towards the northern boundary.

The African giant land snail is the largest among the terrestrial Gastropoda living in Africa. This snail species is found mostly in the high forest zone. A mature adult weights approximately 750 g and the foot, which constitutes the edible part, is about 30% of the live weight.

Snail meat is highly relished and considered a delicacy for the peasant population living in the rural area of the forest zone of West Africa, especially in Nigeria and Ghana. Apart from its nutritive value, it is also used in traditional medicine.

The results indicate that snails are used primarily as meat by the rural and urban people. This may be due to a downward trend in the economy of the nation which places frozen fish and chicken out of reach of the common citizen, so that wild animals are the primary source of protein.

Although some groups of people have taboo, religious and other reasons for not eating snails, the numbers are quite insignificant when compared with those who relish snail meat and consider it to be a delicacy.

Alternative uses for giant land snails do exist. The land snails are very important in traditional medicine throughout the areas. Various parts of this animal are utilized in preparing medicine for curing numerous ailments. When mixed with other ingredients, the fluid from giant land snails cured headache and malaria. This fluid also improved blood clotting on a fresh wound. The shells of giant land snails when smoked/burnt to a colourless condition are ground and mixed with other ingredients in preparing a medicine for pregnant women during labour and as fertility drug for women experiencing difficulty with conception.

The importance of giant land snails is also reflected in cultural values. Snails are one of the ingredients used in making a sacrifice to Ogun (the god of iron).

Snail shells, which are regarded as the trophy of the animal, are used as decorative objects, especially when painted with different colours.

Some rural people also store traditional medicine in giant land snail shells and some make use of the shells as an abrasive for washing utensils and brushing teeth.

Snails also provide employment for some people in the rural area. Owing to a high demand for this animal, some of the rural dwellers are now full-time or part-time gatherers of snails.

These results revealed that the snails were important not only as a source of animal protein to the population but also an important ingredient in their traditional medicine.

1071 92 - 3/121

Integrated systems

Survey, developing countries, industrialized countries, livestock production, small-holders, development policies, environmental pollution, animals, extension, education

GUDAHL, D.

3. Important issues of small-holder livestock sector

worldwide.

Sustainable Agriculture, 3, 1, 1991, p. 5

Heifer Project International listed a comparison of important issues of the livestock world around the world.

Developing national and international policies which stress the importance that small scale farmer play in agriculture and environmental balance is important. Often, economies of scale are applied to agricultural situations leading to production efficiency at the expense of the environment, animal health and welfare of small farmers. Greater value must be placed on animals and crops raised by small scale producers to avoid monopolization of agriculture, increase agricultural diversity and keep rural populations viable.

The overriding issue listed was how are animals fed and cared for.

In non-industrialized countries, the concern for animals is more along the lines of how does one keep an animal fed during the lean months.

Farmer based technology such as agroforestry techniques, fodder banks, development of vegetative erosion control barriers, utilization of crop wastes, increased planting of leguminous trees and pasture crops are techniques that are readily adaptable. Farmers easily see how livestock and the land benefit from establishment of year-round reliable feed sources.

The most successful operations in non-industrialized countries are those that utilize livestock as waste converters. Ruminants, with their ability to digest cellulose, are especially suited to this task. Animals can be useful in using those things that are waste or inedible for humans and convert it into human food.

Finally a system that involves people, land, plants and animals is the paradigm for animal agricultural development for the 90s.

1072 92 - 3/122

Integrated systems

Review, book, developing countries, arid zone, semi-arid zone, tropics, small ruminant production, sheep, goats, breeding, nutrition, management, feeds, FAO

TIMON, V.M. and J.P. HANRAHAN

4. Small ruminant production in developing countries.

FAO Animal Production and Health Paper No. 58, FAO, Rome, ISBN 92-5-102343-3, 1985, price DM 33,-

FAO organized an Expert Consultation on Small Ruminant Production in Sofia, July 8/12, 1985. The papers published in these proceedings represent the technical contributions and discussions at the meeting.

Separate to these discussions the consultation addressed some of the broader issues of importance to the advancement of small ruminant production, particularly in the developing countries, and at the end of the meeting agreed a set of recommendations.

Twenty papers were presented and discussed in the consultation and are reproduced in these proceedings. Strategies in breeding and breed development, nutrition and management, the development and utilization of indigenous grasses, shrubs and forest feeds for the production of sheep and goats, in arid, semi-arid and tropical conditions.

Small ruminants such as sheep and goats have adaptive capacities to survive and produce in difficult environments be they arid, high altitude or extremely cold. Generally, small ruminants are efficient converters of forage feeds whether they are farmed in temperate, arid or semi-tropical conditions. Perhaps their greatest advantage relative to large ruminants is their low cost, small size, their suitability to small holdings and in many of the developing countries, their triple purpose use for meat, milk and fibre.

There is a steady increase in sheep and goat numbers; sheep numbers are in excess of one billion head and goat numbers globally are now approaching half a billion head.

Increasing numbers is not enough. The fundamental issues are increased efficiency of production, biological efficiency, structural/organizational efficiency or more effective use of basic feed resources.

The recommendations are set down under the following broad headings:

- Research and development in small ruminant production.

In view of the very significant contribution of small ruminants to the economy and livelihood of peoples in almost every country around the world, and particularly in the developing countries, the consultation strongly recommends that much greater priority and much larger investment should be made by national and international institutions in the promotion of small ruminant production.

- Coordination - linkages.

The consultation recommends that there is need for much more effective coordination and closer linkages between institutions involved in small ruminant production throughout the world and in particular involving research and development centres in the developing world.

- Support services/infrastructure.

The expert group considered the likely success of development in small ruminant production and recommends that an adequately planned infrastructure and support services must form an integral part of all development programmes in small ruminant production.

- Genetics and breed improvement.

Very serious consideration should be given to the choice of species (and/or mixture of species) and the choice of breed in the very first stages of planning the development of small ruminant production.

Adaptation of breed to local environment should be a key element in breed choice and breed development strategies. This means paying particular attention to indigenous breeds.

The consultation considered that many of the developments in the technologies of reproduction in small ruminants are not and will not be relevant to small ruminant production in the developing countries until levels of nutrition and management are substantially increased, and market prices dictate more cost effective results.

1073 92 - 3/123

Integrated systems

Review, book, microlivestock, animals, economics, future, microbreeds, poultry, rabbits, rodents, deer, antilope, lizards, bees

BOSTID

5. Microlivestock little-known small animals with a promising economic future.

Publ. of the Board on Science and Technology for International Development (BOSTID), Nat. Research Council; Nat. Academy Press, Washington, D.C., ISBN 0-309-04437-5; 1991, 370 p. + annexes

The purpose of this report is to raise awareness of the potential of small livestock species and to stimulate their introduction into animal research and economic development programs. It is geared particularly towards benefiting developing countries.

'Microlivestock' is a term suggested for species that are inherently small, such as rabbits and poultry, as well as for breeds of cattle, sheep, goats and pigs that are less than about half the size of the most common breeds. These miniature animals seem to have a promising future.

The book was prepared after an intensive survey of more than 300 animal scientists in 80 countries. They suggested more than 150 species for inclusion. The staff then drafted chapters on about 40 species and these drafts were reviewed by more than 400 researchers worldwide.

This study covers many species, but it by no means exhausts all the microlivestock possibilities.

As well as dwarf breeds of cattle, sheep and goats, the book covers more unusual species that can be farmed profitably including deer, the giant rat, coypu and guinea pig are dealt with.

Each potentially useful breed is analyzed and useful information set out under headings, including appearance, husbandry, behaviour and uses.

The muscovy duck, for example, is shown to have several advantages over the domestic duck, in that it is a good forager, is not so susceptible to disease and produces a lean carcass.

Not much space was allocated to the inclusion of aquatic food sources or edible insects, snails, worms, turtles, birds or bats, highly regarded food sources in some regions.

A warning was issued about the introduction of certain species, especially rodents, into regions where they do not exist. Such schemes can, obviously, have dramatic negative consequences.

This report is addressed to government administrators, technical-assistance personnel, and researchers in agriculture, nutrition, and related disciplines who are concerned with helping developing countries achieve a more efficient and balanced exploitation of their biological resources.

The book is easy to read, and with little technical language, the book will be particularly useful in those areas where good grazing is in short supply.

This is an extremely interesting book and is highly recommended for all those engaged in livestock production.

The Board on Science and Technology for International Development (BOSTID) of the Office of International Affairs addresses a range of issues arising from the ways in which science and technology in developing countries can stimulate and complement the complex processes of social and economic development. It oversees a broad program of bilateral workshops with scientific organizations in developing countries and conducts special studies.

This report was prepared by an ad hoc advisory panel of the Advisory Committee on Technology Innovation, Board on Science and Technology for International Development.

1074 92 - 3/124

Integrated systems

Review, book, Africa, subhumid zone, arid zone, Nigeria, Sudan, Kenya,

Botswana, livestock production, projects, multilateral agencies, NGO's, animal health, range management, livestock feed, restocking systems, ODI

OXBY, C.

6. Assisting African livestock keepers.

Overseas Development Institute (ODI), Regents College, Inner Circle Regent's Park, London NW1-4NS, UK; ISBN 085003-143-5, 1991, 61 pp., UK £5.95

‘Assisting African livestock keepers' is a collection of four papers which were originally published in the Overseas Development Institute

(ODI) Pastoral development network. They refer to a range of subjects within pastoral development; animal health, animal feed, range management, and post-drought recovery. All emphasize the need for the participation of livestock-keepers in project management. They describe projects in Nigeria, Sudan, Kenya and Botswana which cover both subhumid and semi-arid regions. The development institutions involved range from large multilateral agencies to a small Sudanese NGO.

The first paper, on animal health, describes an example of an increasingly popular approach to the delivery of veterinary services, namely the training of herder specialists. The project was a notable success in terms of the number of livestock vaccinated. The second paper is about range management and lists the conclusions to be drawn, and the problems that arose, during six years of work in Botswana on establishing fenced grazing areas radiating out from a central water point.

Improvement of livestock feed in the subhumid zone of Nigeria is the subject of the third paper. It describes the achievements and problems faced during the course of a research project set up to involve livestock keepers in fencing off a small plot of land near their homestead and in supplementing the natural pastures therein with a forage legume for use during the dry season. The fourth paper is an evaluation of four restocking projects set up in various parts of Kenya.

1075 92 - 3/125

Integrated systems

Review, book, Europe, deer farming, research, development, practical aspects, theory, nutrition, health, selection, breeding, farming systems, marketing, economy

REINKEN, G.

7. Deer farming.

Farming Press Books, Ipswich, UK, ISBN 0-85236-206-4; 1990; £15.95

In the quest for alternative forms of livestock production to sheep and cattle in northern Europe, deer farming has been strongly advocated. It is environmentally friendly with low inputs of fertilizers and pesticides and farmed venison is a lean and natural meat with a distinctive flavour desired by consumers. It has also an advantage over other proposed alternatives in that there is a strong body of scientific knowledge on the biology of deer and a resource of information on farming techniques which has been collected in the last 20 years.

This book draws on such research and development work carried out between 1970 and 1985 in Germany and elsewhere and decribes how to farm fallow deer in Germany, covering both theoretical and practical aspects in a comprehensive manner. Nutrition, health, selection and breeding, farming systems, marketing and economics are convincingly dealt with.

This translation from the German into English is generally of a good standard. While the book offers a valuable insight into the state of the deer farming industry and agriculture in West Germany in the mid-1980s, it could have had a broader appeal if some of the detail only relevant to German conditions had been omitted in the English edition.

The major strength of the book is its wealth of information on fallow deer and their farming which will be valuable to scientists, lecturers, advisers and consultants in many European countries. Although reference is made to the farming of other species, such as the red deer, where information on the fallow deer is lacking, there clearly exists a need for a companion volume on the farming of the red deer under European conditions. This book sets a high standard for future publications on deer farming which will no doubt appear as the potential of deer farming as an alternative livestock enterprise is realized.

Abstract by J.A. Milne

1076 92 - 3/126

Integrated systems

Study, developing countries, Africa, Asia, Latin America, sheep, goat, economic constraints, feed shortages, trade, policies, capital, flock size, risks, labour, FAO

GUTIERREZ-A., N.

8. Economic constraints on sheep and goat production in developing countries.

In: FAO Animal Production and Health Paper No. 58, FAO, Rome, Italy; 1985, pp. 138-147

This paper discusses some economic factors that have affected the efficiency of production, documents selected cases, and offers some solutions to the problems.

Sheep and goats are important livestock species in developing countries.

Fifty-three percent of the total small-ruminant population in the developing countries is found in Asia, particularly in India and Pakistan, 33% in Africa, and 14% in Latin America.

The total product from small ruminants increased in developing countries because their numbers increased.

Sheep and goats are important in development because of their ability to convert forages and crops and household residues into meat, fibre, skins and milk. The economic importance of each of the products varies between regions, especially in the developing countries.

Goats are hardy and well-adapted to harsh climates. Due to their grazing habits and physiological characteristics, they are able to browse on plants that would normally not be eaten by other livestock species. The presence of goats in mixed species grazing systems can lead to a more efficient use of the natural resource base and add flexibility to the management of livestock. This characteristic is especially desirable in fragile environments.

Sheep and goats contribute to a broad range of production systems.

The most common production system throughout the developing countries involves either the extensive system with large herds and/or flocks grazing on arid and semi-arid rangelands or the intensive system with smaller herds and/or flocks kept in confinement, mostly in the humid tropics. Both systems are characterized by low input use.

Most of the world's sheep and goats are produced on mixed-species farms rather than in species-specific units.

Technological development studies of small-ruminant production as it relates to other farming systems have been limited. Therefore, the target, in terms of research, has to be integrated production systems rather than isolated sheep and goat components. By using a multidisciplinary research approach, the problem can be addressed in a realistic and practical way.

The problems of sheep and goat production can neither be efficiently nor successfully solved until research concentrates on studying all of the related and interrelated components involved. For too long, research has focused on one discipline at a time, ignoring the developing country's culture, environment, educational level of its producers, and the availability and dependability of local technology transfer.

It is important to know that an increase in sheep and goat activity in an integrated system could increase the total productivity of a farm through more efficient labour and available resources and generate more income per unit of time.

If developing countries could increase herd productivity, they could increase production. To increase production in developing countries, existing constraints must be overcome.

1077 92 - 3/127

Integrated systems

Review, books, sheep, pigs, animal production, tropics, subtropics, CTA

GATENBY, R. and HOLNESS, D.H.

9. Sheep. Pigs.

The Tropical Agriculturist Series; Macmillan and CTA, Sheep 0-333-52310-5; Pigs 0-333-52308-3; 1991, available from CTA, Postbus 380, 6700 A.J., Wageningen, The Netherlands

Sheep is the second volume in this series to be produced in the field of animal production: it follows the volume on 'Poultry'. The importance of sheep in tropical countries is often overlooked. They are, in fact, very important: over 600 million of them are to be found in the developing world. Sheep will thrive under conditions where either crops or other forms of livestock would not because the climate is too arid or the soil too poor.

However, they can be integrated well with both crops and other forms of animal production and, because of their relatively small size, they can provide a more convenient source of meat than cattle and they are often kept by farmers as a kind of insurance for quick sale or slaughter for festivities.

The third book in the series, 'Pigs', considers some of their advantages. The world trend is towards the consumption of more white, rather than red meat. Pigs produce meat without contributing to the deterioration of natural grazing lands.

This is of paramount importance in relation to the current desertification, soil erosion and loss of productive land in tropical and subtropical parts of the world. However, there are problems, particularly those associated with feed supplies; and inadequate control of disease may make intensive pig production unprofitable or even untenable. Religious considerations may make pig-keeping unacceptable, and the possibility of transfer of disease and parasites to the human population may make extensive pig production unwise.

This book considers these problems to see which systems of pig production are most acceptable in various regions of the tropics and which should be avoided. It approaches the subject from the point of view of both the commercial producer and of the village pig-keeper. As with all the books in The Tropical Agriculturist series, these are readable, informative and practical guides.

Abstract from SPORE

1078 92 - 3/128

Integrated systems

Africa, Rwanda, Kenya, Sudan, Nigeria, Ethiopia, Mali, sheep production, traditional systems, farming systems development

WILSON, R.T.

10. Strategies to increase sheep production in East Africa.

In: FAO Animal Production and Health Paper 58; FAO, Rome, Italy; pp. 118-123

Sheep in eastern Africa are managed in traditional systems. The end product is almost entirely meat, either for home consumption or to an internal or external market through sales. In parts of Sudan, sheep are also kept to provide milk.

In most traditional societies, first lambing occurs at 15-18 months when ewe weights are 80-85 per cent of mature size. Control of age at first breeding usually means delaying this and may result in first lambing not taking place until 2 years or older.

Total lifetime production of young can be increased by encouraging first lambing at early ages.

The growth rate is an important factor in livestock productivity. In traditional systems, because of overstocking, genetic potential is rarely expressed. Growth rates vary from as little as 40 g per day in Kenya Masai sheep to as much as 70 g per day in Sudan Desert type from western Sudan.

As an example of the potential for increased growth under improved conditions of nutrition and management, the "Mouton de Case" sheep in West Africa achieves a growth rate of 117 g per day to 40 weeks of age compared with only 60 g for its range-reared contemporaries.

Management practices in many traditional societies are such that the best adapted sheep or those with superior genetic potential are not used as breeding stock. This is because of the cultural or religious requirements for large fat sheep for slaughter at social and sacrificial occasions.

Pre-weaning mortality has been shown to be an extremely important constraint on productivity of sheep. Levels of up to 30 or even 40 per cent losses before weaning are not uncommon.

The standard approach to improving the supposedly unproductive indigenous African sheep types has been to import exotic breeds, usually of European origin.

There have rarely been successful transfer of these breeds to traditional systems. In East Africa, successes have almost entirely been confined to those cases where modern management practices can be assured and high levels of veterinary and nutritional inputs maintained.

Identifying these practices and abilities and extending them to other owners would lead to overall improvement. A plan for improvement of a traditional flock with the minimum of outside and costly interventions is shown in this paper.

1079 92 - 3/129

Integrated systems

Pacific, Solomon Islands, pig production, compound feeds, pig feeds

THORNE, P.J.

11. Alternatives to imported compound feeds for growing pigs in solomon islands.

Trop. Agric. (Trinidad), 69, 2, 1992, pp. 141-143

The developing island nations of the Pacific region are often at a disadvantage as locally available feed resources are limited and technical expertise to facilitate their use may be lacking. Importation of feeds into these countries greatly increases the pig farmer's cash outlay and, in many cases, can render intensive pig-keeping a rather marginal activity.

The small-scale pig farmer has markedly different requirements from those of the intensive pig producer. As an alternative to the use of compound feeds, it may be possible to supply locally-produced protein concentrates to pig farmers operating under village conditions. These can supplement the low nutrient-dense energy feeds (e.g. root crops, fresh coconuts) that are widely available and allow levels of production not greatly below those of intensive pig producers. Such systems, based on sweet potato and cassava as the principal energy source have been evaluated experimentally with encouraging results.

Therefore an experiment was carried out to consider the use of locally available raw materials in the diets of fast-growing pigs either as a complete compound feed or as a protein concentrate to supplement low nutrient-dense energy feeds.

Three dietary treatments were tested in the experiment. An imported pig-grower diet was compared with an equivalent compound diet of local origin and a semi-intensive system in which low nutrient-dense energy feeds (cassava and coconut) were supplemented with a 50% crude protein concentrate designed to be fed at approximately 20% of dry matter intake.

An imported compound pig grower diet resulted in slower growth (P=0.075) and poorer feed conversion ratio (P=0.001) than a similar diet compounded from locally available raw materials. The economic advantages of the local compound feed were marked (P<0.001) with cost per kg of liveweight gain being little over one third (SI$1.36 vs SI$3.11) of that observed with the imported feed. An alternative system employing a combination of a locally-produced protein concentrate and fresh cassava and coconut resulted in slightly poorer growth rates than the compound feeds but was still competitive in economic terms. The use of concentrate, cassava and coconut did, however, result in fatter carcasses in terms of back-fat measured at the mid-back (P=0.005) and the loin (P=0.007).

The true value of any livestock feed is only revealed when the economic advantages associated with its use are taken into account. A feed which results in fast and efficient growth but at excessive cost may be just as unsuitable as a cheaper feed which satisfies few of the animal's requirements and results in poor growth rates. The most suitable feed will invariably lie between these two extremes.

From these results it seems likely that pig production using imported feed might become uneconomic if high labour and service costs are incurred.

The locally-produced compound diet which combined fast, efficient growth with low cost therefore resulted in the highest returns.

The costings discussed above are based on pigs produced for commercial sale. The economics of pig sales in or between villages are likely to differ somewhat because of generally lower and more variable prices.

Under these conditions, the benefits of intensification by improved nutrition using purchased feedstuffs may not always materialize. Before recommending the use of purchased feeds to any farmer with a pig project, extension workers should consider what reliable markets are available for animal products.

Concluding, it can be said that raw materials are available in Solomon Islands which ought to allow local production of compound pig feeds with several potential advantages: feed costs are dramatically reduced when local ingredients are used; the quality of local feed ingredients is more easily assured than that of imported feeds as more local control is possible and import substitution is of general benefit to Solomon Islands' economic development.

1080 92 - 3/130

Integrated systems

Asia, India, on-farm research, dairy animal, sustainable development, economic analysis, crossbred-cows, green fodder, fodder production, technology transfer

SINGH, C.B.

12. Economic analysis of on-farm dairy animal research and its relevance to development.

In Proc. of on-farm animal research/extension and its economic analysis; Winrock Int. Inst. for Agric. Development, Los Baos, Laguna, Philippines; 1987, pp. 45-52

An economic analysis of on-farm research trials conducted in India on crossbred cows and fodder crops on rural farms was done.

Figures indicate a wide gap between availability of and need for milk in the country.

Low production and per capita availability of milk in the country are due to poor productivity of milk animals, which can be attributed to poor genetic potential, poor nutrition, widespread disease, and lack of organized marketing and credit facilities. The average annual milk yields of Indian cattle and buffalo are only 181 kg and 438 kg, respectively.

To improve animal productivity and increase milk production, concerted research and extension are needed.

Results showed the economic viability and superiority of crossbred cows over animals kept by the rural households. Three crossbred cows kept on an acre of irrigated land generated net and family labor incomes of Rs. 1,345 and Rs. 2,772 per cow per annum, respectively. A three plot system of fodder production on small farms gave an average yield of 61,803 kg green fodder which was sufficient to feed four adult crossbred cows in one year. This indicates that three crossbred cows can be maintained profitably on one acre if intensive fodder crop rotations are followed.

Highest average yields were obtained from a multi-cut mixture of fodder crops like sweet sudan, cowpea, teosinte, sorghum and pearl millet sown in summer (5,316 kg/ha) and berseem + mustard in winter (7,835 kg/ha).

The analysis revealed that on-farm trials can help small farmers in selecting fodder crops for economical milk production.

Dairy farming that uses high-yielding animals and scientific practices has great potential to increase income and employment levels; therefore, on-farm research trials are important for disseminating new innovations and technology to the farmers.

One can conclude that the technology demonstrated through on-farm research trials was technically feasible and economically remunerative and it can uplift the poor of India.

1081 92 - 3/131

Integrated systems

Review, book, UK, New Zealand, grazing management, grasslands, animal production, animal feed, low-input systems, herbage intake, grazing methods, sward monitoring, enterprise planning

HODGSON, J.

13. Grazing management: science into practice.

Publ. of Longman Group, UK; ISBN 0-582-45010-1; 1990; £11.95

This is the latest book in the series 'Longman Handbooks in Agriculture'. It is an opportune time for the book to be published as research has advanced knowledge of grazed grassland considerably in the past 15 years. The author has been at the forefront of these advances.

In particular, the understanding of sward dynamics and the animal behavioural factors influencing intake have been clarified by research.

This has enabled the limitations to animal production from grazed grassland to be implemented to increase output. Reductions in government financial support for agricultural food products in developed countries will accelerate the move to lower input systems of production, which for ruminant animals means a greater reliance on grazing.

There are 20 chapters liberally sprinkled with tables and figures. Ten chapters deal with the principles of grazing including the grazed sward, the grazing animal, factors affecting herbage intake, food conversion efficiency and output from grazing systems. The resources of plants, soils, fertilizers and supplements are covered in four chapters. The final six chapters are devoted to applications, including grazing methods, sward monitoring and control and enterprise planning.

The book is written to answer the question of how the science behind grazing can be used by management to increase output, rather than how grazing management can draw on science to assist it, that is, it is science-driven rather than management-driven. Great reliance is placed on research experience in the UK, although the penultimate chapter on

'Enterprise planning and feed budgeting' reflects the author's more recent New Zealand experience. Extensive grazing on hills or rangeland is not covered, nor are grazing and plant species diversity.

The book is stronger on the principles of grazing mainly with intensive grazing. Being strongly research-based, it is directed more at the enthusiastic learner than at the superficial reader. Nevertheless this is an up-to-date, comprehensive account of the principles of grazing management, written by a world expert, which should make an important contribution to teaching in agricultural and applied biology.

1082 92 - 3/132

Integrated systems

Review, research report, Africa, Sub-Sahara, case studies, fish farming

LAZARD, J. et al.

14. Fish-farming in sub-Saharan Africa: case studies in the francophone countries - proposals for future action.

AGRIDOC Inst. BDPA SCETAGRI, 27 Rue Louis Vicat 75738, Paris cedex 15, France; ISBN 2 11-086732-9; price 120 ff

Fish farming is a long-standing and traditional activity in Asia, but it is relatively new to Africa, arriving only in the last half century or so. Its potential has yet to be developed: the annual tonnage of fish, approximately 10,000 t, accounts for only 0.1% of world production. But the increasing demand for fish, especially in urban areas, means that there is likely to be a boom in aquaculture.

African fish-farming can be classified into several categories.

At the lowest end of the scale is "family" aquaculture: the peasant farmer will dig out a pond by hand, with the help of family members, to rear tilapia for his domestic consumption only. This practice is common in many francophone African countries and often receives considerable aid from international organizations or NGOs for the breeding of young fish, extension and training work, personnel, etc. However, the results are universally disappointing, the farmers are not motivated, yields are low and incomes poor.

The second category is small-scale commercial aquaculture, which is beginning to be a significant factor, especially close to cities. The difference between this and family fish-farming is that it is essentially business concern which necessitates buying in materials and marketing the produce. For this reason fish-farmers establish their businesses close to town in order to make use of the urban infrastructure and the marketing potential. FAO has developed a project of this type in C_te d'Ivoire, in the Bouak_ and Daloa regions. About 50 farmers have dug out their own ponds and now breed their own young stock and rear them with the help of the project staff. Research has shown that it is these small or medium-scale ventures which seem to have the best chance of succeeding.

The characteristic of the third category, 'network' aquaculture, is that its different stages (hatcheries, fish-feed processing, fish production) are separated.

This system is well-suited to some areas, for example where there are lakes, lagoons or water courses. The lagoons of Cte d'Ivoire have rearing projects in enclosures and cages, and Niger has set up cage culture schemes in the river. It particularly suits some sectors of the population - for example it can provide an alternative living for fishermen when their traditional sources of income are insufficient, and city businessmen are able to invest capital in the hope of significant returns. However, further research into the ideal environment for fisch-rearing and into improving feed is still necessary.

The final category - 'industrial', large-scale aquaculture - is carried out in sizeable production units. It depends on high productivity and, for example, raceways, tanks or cages, which demand considerable capital outlay. Burkina Faso set up the Banfora Aquaculture project of intensive-system fish production with cages and raceways, but hatchery and feed problems forced it to close down in 1986. An industrial fish farm in Brazzaville (Congo) forecast tilapia production of 500 tonnes per annum in concrete raceways using water pumped up from the nearby river. This enterprise was also bedevilled by numerous technical problems which slowed production, and financial results were well down on the forecasts. At present this type of fish culture is extremely problematic in that the cost of production is still considerably higher than the sale price.

All these categories of fish-farming are surveyed in this report, which has just been published by the French Ministry of Cooperation. It analyses the current state-of-the-art and suggests some future directions. Particularly useful are the many case studies used to support the theories put forward by the authors, and the analysis of socio-economic factors, especially the market study comparing farmed and wild fish. Also described in this book is 30 years' experience of experimental research done in the field. It addresses the problems of the training need to improve the technical and professional skills of African aquaculturalists.

1083 92 - 3/133

Integrated systems

Review, book, tropics, integrated crop-livestock-fish farming, concept, research framework, education, institutional framework, ICLARM, UNDP

EDWARDS, P. et al.

15. Research and education for the development of integrated crop-livestock-fish farming systems in the tropics.

Publ. by ICLARM, MC P.O.B. 1501, Makati, Manila, Philippines; ISBN 971-1022-46-x; 1988, 47 p. + annexes

In this publication, an attempt is made to create a framework for a truly interdisciplinary approach to research and education in integrated farming - a fusion of agricultural and aquaculture sciences.

Hunting/gathering/fishing preceded the development of agriculture but are still of importance in many third-world countries, particularly with regard to fish. Indeed, the capture of wild fish, as opposed to aquaculture, is still the major source of fish in most third-world countries.

The crop, livestock and fish subsystems may function independently in certain farming systems, and their products be only additive. An output from one subsystem in an integrated farming system, which otherwise may have been wasted, becomes an input to another subsystem resulting in a greater efficiency of output of desired products from the land/water area under a farmer's control. There is synergism in integrated farming since the working together of the subsystems has a greater total effect than the sum of their individual effects.

That means the word integrated is derived from the Latin verb "integrare", which means to make whole, to complete by addition of parts, or to combine parts into a whole.

The main biological feature of an integrated farming system is byproduct recycling; but improved space utilization, in which two subsystems occupy part or all of the space required for one subsystem, may be an important aspect of increased productivity. A major socioeconomic benefit of integrated farming is that inputs to the various subsystems that comprise the farming system tend to be intra-farm, with a diminished reliance on inter-farm or agro-industrial inputs. Integrated farming systems also spread the risks associated with farming because of the increased diversity of produce. They also lead to a more balanced diet for the farming family that chooses to eat some of its own produce.

A schema is presented in this study of the possible evolutionary development of integrated farming systems to set the research framework recommended here in an appropriate context.

Aquaculture science is a relatively new field of study.

The attention normaly remains narrowly focused on the fish and the aquatic environment rather than on the farmer and the whole farm.

The greatest scope for the development of integrated crop-livestock-fish farming systems is in the humid tropics. This is where the need is also greatest.

This climate allows tropical fish to grow year-round.

The integrated farming systems discussed in this study make use of tropical fish, particularly the omnivorous tilapia which has been hailed as the "aquatic chicken" of the future. Tilapias breed and grow year-round in the tropics.

Integration of aquaculture with agriculture is more developed in Asia than in any other region of the world. Integrated farming systems are presently used by only a very small minority of farmers in a few countries and have not progressed far in terms of productivity and efficiency from their traditional beginnings.

A vast potential still exists for many more of Asia's numerous and needy small-scale farmers to enjoy the benefits of integration of aquaculture into farming systems. To realize this potential requires a new research and education program, as is proposed in this publication.

For Africa, the potential for aquaculture and integrated farming development is far less certain.

For many African nations there are serious constraints to aquaculture and integrated farming development.

A holistic view of the farm is essential. Aquaculturists must learn to understand existing crop and crop-livestock farming systems and agricultural researchers the fish farming subsystem. The processes of research and education for the development of integrated farming systems are therefore closely interlinked. This calls for an innovative approach to bring aquaculture into the mainstream of agriculture.

A cautious approach to aquaculture development is needed; not a rush into development by transfer of foreign technologies. Such a cautious approach should best be undertaken in parallel with further research for the development of Asian integrated crop-fish and crop-livestock-fish systems for which reliable management guidelines are still lacking.

1084 92 - 3/134

Integrated systems

Asia, Philippines, study, goat/fish farming, culture periods, tilapia

LIBUANO, L.P.

16. Goats/fish integrated farming in the philippines.

AMBIO, 19, 8, 1990, pp. 408-410

This paper presents preliminary findings from the two 120-day fish-culture periods in a 240-day goat rearing cycle in the Philippines.

There is a government program for an effective approach to improving the quality of life of the people, not only in the urban communities but also in the rural areas through the livelihood project. The project is a centerpiece program and seeks to boost livelihood opportunities nationwide. Goat raising has become one of the priorities of the program. The small size of goats, their early maturation, inquisitive feeding habits and low capital investment must be exploited to spur development of intensive goat production including the utilization of the manure in fish culture.

The present project was initiated to determine the maximum rate of goat-manure loading and stocking density of Nile tilapia (Oreochromis niloticum) per unit area of fishpond and design a goat/fish integrated farming system that could give the highest economic return, with manure as the only added nutrient source.

This study was conducted in twelve 200 m2 fishponds. The goat houses had a floor area of 0.75 m x 1.5 m per goat and were built partially overhanging the surface of the pond.

An integrated farming system offers several potential advantages, i.e. increased productivity, greater income, improved cash flow, fuller employment, a better diet for the farmer and his family and the spread of both biological and economic risks, since two subsystems are involved as opposed to one in a single commodity farming system. This strategy, however, requires knowledge and management skills.

The major constraint for small-scale farmers involved in aquaculture is the shortage and high cost of pond fertilizer and commercial feeds for the fish.

In the Ilocos Region, Philippines, intensive goat raising is possible due to the high demand for chevron (goat meat) which is the main delicacy of the Ilocanos. Intensification is greatly limited by the problem of waste disposal. Many Ilocanos are engaged in small-scale aquaculture, but operations are hindered by the shortage and high cost of commercial feeds and fertilizer for their fish ponds. This goat/fish production trial described employ 0, 200, and 300 goats with fish-stocking densities of 10,000 and 20,000 of Nile tilapia

(Oreochromis niloticus) per ha. The highest individual fish weight (78.05 g), in a 120-day fish-culture period, was recorded for the combination of 300 goats and 10,000 O. niloticus per ha, whereas the lowest gain (45.95 g) was obtained at the stocking density of 20,000 O. niloticus per ha without goat manure. The highest total fish yield of 1170 kg x ha 1 was recorded for a combination of 20,000 O. niloticus and 300 goats per ha. Currently, the goat manure loading per ha is increasing to 400, 500, and 600 goats.

Concluding in the two trials conducted, the growth of tilapia increased with the rate of goat manure loading. This indicates that the fish feed produced in the ponds with goat manure is being efficiency utilized by the fish biomass. The analysis shows that the highest net return of Philippine dollars 129872 was obtained from the 300 to 20,000 combination followed by the 300 to 10,000 per hectare (PD 108952.50). If the present trend in some local markets prevails where large fish fetch significantly higher prices than small-size fish, the 300 goat to 10,000 fish per hectare combination would be more profitable.

Raising goats and developing a family-level fishpond for small-scale use could help to decrease protein malnutrition.

The integration of goat with tilapia production is a means of establishing a sustainable farming system aimed at maximizing productivity and minimizing operational costs. There is great potential for this production as the demand for milk and meat is high.

1085 92 - 3/135

Integrated systems

Africa, Rwanda, aquaculture, project, techniques, extension, organization, farm structure, USAID

MOLNAR, J.J.

17. The sustainability of aquaculture as a farm enterprise in Rwanda.

J. of Applied Aquaculture, 1, (2), 1991, pp. 37-62

The objective of this article is to identify correlates of self-sufficient practice of fish culture by Rwandan farmers. It focuses on the degree to which fish farmers have achieved autonomous confidence in growing tilapia and on their relative willingness to forego dependence on government services.

Data were obtained from a sample of active Rwandan fish farmers randomly selected from project rolls.

Fish culture is one of many diverse efforts to increase food production and food security by producing a much-needed protein crop.

Although first introduced by Belgian colonialists in the 1950's, in the past decade fish culture has experienced a renaissance in Rwanda.

Beginning in 1983, the Rwanda National Fish Culture Project has assisted farmers with the upgrading of their ponds and identified the Nile tilapia, Oreochromis niloticus, as a species suitable for the high-evaluation, cool-water environment. Average annual yield among project participants was raised from an initial annual of 300 kg/ha to 1,550 kg/ha.

The purpose of the USAID Rwanda Fish Culture Project was to assist the Ministry of Agriculture in the development of an Aquaculture Extension

Service to provide technical assistance to Rwandan farmers. In its seven years of operation, the project has established four fish stations, trained over 60 extension agents, and helped establish over 1,150 private ponds. Aquacultural extension representatives assist farmers with pond construction, fish production, and related activities.

A tilapia production system has been implemented by farmers, utilizing readily-available inputs to grow fingerlings to market-sized fish.

Nearly 20,000 farmers and family members are associated with the project.

Most respondents planned new ponds; most felt capable of doing without extension assistance; and very few reported conflicts with other enterprises. When extensionists visited more frequently, farmers attented to their ponds more frequently. Wealthier farmers were less happy with the technical assistance they received. Women gave the male extension representatives lower helpfulness ratings. The results showed the advanced degree to which farmers have grasped the technical aspects of fish culture and their relatively favorable perceptions of the extension assistance.

The survey responses suggest that farmers expect to continue growing fish. Many of the factors that affect the independent practice of fish farming depend on the government and are beyond farmer control.

Several contextual factors not measured in this study affect the prospects of aquaculture in Rwanda, regardless of its ecological, socioeconomic, or nutritional merits. The commitment of the Rwandan government may shift to other priorities, not the least of which is threats to national security. Donor priorities about environmental and natural resource issues may induce reallocations of scarce internal funds. The financial condition of the country may disrupt the payment of salaries of fail to provide sufficient resources to recruit and train additional staff or replacements. The extension administration may fail to allocate sufficient travel funds for the moniteurs. Farmers have little way of knowing or understanding the larger national questions about the direction of agricultural policy or the status of foreign exchange and the need to redirect spending to produce export crops.

Production schemes that fail to gain the confidence and enthusiasm of farmers will generate neither food nor revenue. As a consequence, a central aspect of sustainability of fish culture is the extent to which the farmers understand and use the technology in their normal pattern of farming.

One threat to the evolution of fish culture in Rwanda is that improperly constructed ponds will undermine the success achieved by project participants. Ponds that are too small, leaky, or have continual water flows that waste nutrients and chill pond waters create negative examples that undermine the reputation of the enterprise.

To summarize, the Rwandan farm data showed only limited connections between the sustainability indicators and the variable sets identified.

The results showed the advanced degree to which farmers have grasped the technical aspects of fish culture and their relatively favorable perceptions of extension assistance.

An important next step in the evolution of aquaculture in

Rwanda is to identify spontaneous emulators and provide the necessary corrective assistance to assure the proper realization of fish culture. It also will be important to understand why some farmers did not undertake aquaculture and others turned pond land to other uses.

1086 92 - 3/136

Integrated systems

Asia, Malaysia, aquaculture, prawns, crawfish, ponds, rice production, aquatic macrophytes, grass carp, water quality

GRANADOS, A.E. et al.

18. Double-cropping malaysian prawns, macrobrachium rosenbergii, and red swamp crawfish, procambarus clarkii.

J. of Applied Aquaculture, 1, (1), 1991, pp. 65-77

The objectives of this study were:

- to determine the effects of three crawfish stocking densities on survival, growth, and yield of prawns and crawfish cultured in a double-cropping scheme;

- to contrast survival, growth, and yield of prawns cultured with crawfish with those when prawns are cultured in a monoculture system; and

- to compare survival, growth, and yield of prawns fed a commercially formulated diet in the double-cropping system with those of prawns that are cultured in double-cropping systems that receive no formulated feed.

Prawns, Macrobrachium rosenbergii, and crawfish, Procambarus clarkii, were alternatively grown in ponds to determine if they were compatible and if total production could be increased. Brood crawfish were stocked into replicated ponds at rates of 0, 60, 120 or 180 kg/ha on 18 April.

Water was removed to encourage burrowing. Following this, rice was planted as forage. Post-larval prawns (0.02 g) were stocked 3 July in all ponds at 17,500/ha. Prawns in half the ponds were fed and those in the other ponds were not. Ponds were drained from 7 to 11 October. Prawn production ranged from 157 to 248 kg/ha; survival ranged from 69% to 88%, and average size ranged from 11 to 17 g. There was no significant difference ($P > 0.05$) between fed and non-fed treatments. The ponds were reflooded and crawfish were harvested by trapping from 15 January to 15

May. The average yield of crawfish ranged from 746 to 1,266 kg/ha.

Stocking rate had no effect on crawfisch yields (P > 0.25). Total yield, with prawns and crawfish combined, ranged from 1,037 to 1,237 kg/ha.

Overall, prawns and crawfish were compatible in rotation.

This study demonstrated that prawns and crawfish are compatible in pond production and that one crop of each can be produced annually in the same pond. To achieve this, pond management strategies had to be modified. For example, rice was planted as forage only in the shallow area of the pond, and a deep portion was left open for initial stocking of prawns. While the crawfish yield in ponds was acceptable (1,000 kg/ha), prawn yield was low due to small size at stocking (0,02 g), low stocking rate (17,500/ha), and short growout period (93 days).

The ongoing goal of most commercial prawn growers is to produce a large prawn (30 g+), but when prawns exceed approximately 17 g they begin to segregate into different size groups. Up to 17 g, there is virtually no size distinction, even between males and females. Successful marketing of such small individuals would produce additional revenue.

Crawfish are normally not available during summer and early fall, but prawns can be harvested during this period. The ideal size of prawns for molting troughs is about 17 g. Thus, prawns could possibly fill both a biological niche (rotation with crawfish in ponds) and a market niche (soft shell). Preliminary research indicates that prawns can be molted in the same shedding tanks as crawfish, and this could allow year-round production of a soft-shell product. The implementation of this would require new management strategies. Crawfish may have to be cultivated differently by introducing a formulated diet instead of allowing them to feed on rice forage. This management strategy could also produce a larger, more valuable crawfish (33 or less per kg), especially for the European market. Additionally, stocking systems will have to be developed to produce a 17-g prawn during those months when crawfish are normally not available. This study suggests that production of 17-g prawns is possible. Future research should concentrate on stocking dates, stocking sizes, stocking rates per hectare, and length of grow-out period.

1087 92 - 3/137

Integrated systems

Asia, Malaysia, study, rice, fish, farming systems, resource utilization

AHYAUDIN, B.A.

19. Rice/fish farming in Malaysia: a resource optimization

AMBIO, 19, 8, 1990, pp. 404-407

This paper summarizes and discusses the ecology as well as rice/fish farming system as practiced in North Kerian, Perak, Malaysia.

In Malaysia, where arable land is limited, integrated farming systems are widely practiced to optimize land use. Integrated rice/capture-fish farming is an example and is an important source of freshwater fish.

Capture-fish farming is practiced in North Kerian, Perak, Malaysia, where wild fish are retained and grown in the rice fields and later harvested at the end of the rice-growing season. Sump ponds, dug at the lowest part of the rice fields, provide refuges for fish during periods of low water availability or quality and facilitate fish harvest.

Before the early 1970s, when single cropping of rice was practiced, the system was the major supplier of freshwater fish, especially snakeskin gouramy (Trichogaster pectoralis), catfish (Clarias macrocephalus), and snakehead (Channa striata). But when double cropping of rice began in the 1970s followed by the widespread use of herbicides and pesticides, fish harvest began to decline.

The system described here requires no biological and little economic input, and native fish are found to be both biologically and economically suitable. The system can utilize different specific habitats, the fish are tolerant to extreme physiochemical changes, and command good market prices. The different feeding habits of the predatory snakehead (Channa striata), omnivorous catfish (Clarias macrocephalus), insectivorous climbing perch (Anabas testudineus), and plantivorous-omnivorous gouramies (Trichogaster pectoralis and T. trichopterus) indicate possible yield improvements through rice/fish polyculture. Aquatic productivity of the prevailing ecosystem is low despite repeated seasonal fertilization. Productivity is probably low due to shading and competition with aquatic weeds and rice plants.

Zooplankton is not readily available to the fish larvae and fingerlings because aquatic weeds provide easy refuge. This lack of food results in fish below marketable size. The short growing season resulting from double cropping, coupled with widespread use of herbicides and pesticides, also affects fish production.

The shorter growing due to double cropping of rice cannot be avoided since it is the policy of the government to increase rice yields.

Increasing the system's productivity is the only way to increase fish yields.

Integration of other farming activities into the rice/fish-capture farming system are being tried in order to fully optimize land use.

Extra income could be obtained by properly planting the large dikes surrounding sump ponds with valuable fruit trees such as coconuts (Cocos nucifera), bananas (Musa spp.) and mangoes (Mangifera spp.).

Farmers also planted the perimeter dikes with produce such as tapioca (Manihot spp.),squash (Cucurbita spp.), and sweet potato (Ipomea batatas) that can either be used at home or sold at the local market.

These and other activities are a recent addition to the traditional rice/fish-farming system and further investigations should be undertaken to determine their economic feasibility.

1088 92 - 3/138

Integrated systems

Review, fishfarms, farming, biotechnology, transgenic fish, aquacultural genetics, feed conversion, environmental impact

BIOTECHNOLOGY AND DEVELOPMENT MONITOR

20. Biotechnology in fishfarms: integrated farming or transgenic fish?

Biotechnology and Development Monitor No. 7, 1991, pp. 3-6

For many developing countries fish trade represents a significant source of hard currency. Although the developing countries' share in world fish exports remained stable at 45 per cent, net fish exports from developing countries doubled between 1985 and 1989 to US$ 10,5 billion.

Industrialized countries accounted for about 90 per cent of total fish imports in 1989. Aquaculture had already its share in the net export increase, and the application of biotechnology may boost fish exports even more.

Demand for fish is soaring worldwide. It appears unlikely that the increasing demand can be met through increased natural harvest.

Aquaculture could help to meet increasing demand, and biotechnology can make a contribution to improve aquaculture yields.

In Asia, where the bulk of aquacultural products is produced, aquaculture has a long-standing tradition as an extensive low input production system, practiced by resource-poor farmers. Recent interest in aquaculture biotechnology in industrialized countries could have a positive spin-off for these systems.

To be effectively applied to small-scale systems, aquacultural biotechnology methods should start from the more traditional technologies already in use. The efficiency and relevance of these technologies are impressive.

Organic agricultural wastes can be recycled as fish feed. Rice bran, for example, or the brown crust of rice which become available after rice polishing, possibly mixed with mustard or ground nut oil cake, is a very good feed for fish. Soybean cake and wine residues are also given as feed to carps, while grass carps are fed with chopped soft grass and vegetable tops. Wastes from livestock and poultry are recycled too, in some systems by dropping the manure directly into the ponds, thereby raising the production of algae, protozoa and zooplankton.

Mahua oil cake, a residue from oil extraction, is used in India to kill predators in the ponds before fingerlings are stocked.

Mahua cake works as poison at the initial stage, but loses all its toxicity after 15-20 days and is then valuable as fertilizer. In Malaysia teaseed cake is used to kill predators.

For cleaning the ponds, duck weed is used in India. To increase alkalinity, banana stem cuttings are allowed to rot in the water.

Planting of tamarind leaves and stems have the effect of decreasing alkalinity of pond waters. Lotus plants maintain oxygen balance in ponds.

Widely adopted in southeast Asia also, is polyculture. In this system, a compatible group of 3 to 6 non-predator fish species of different feeding habits are introduced together in the same pond so that all types of food produced either at column, bottom or surface, are effectively consumed by fishes.

In order to be helpful, biotechnology should be integrated with these traditional methods. Newly introduced techniques must be comprehensible to farmers, and should use materials locally available.

Much of the current biotechnology research, however, seems to be directed at high input aquaculture production that requires, e.g. a well trained staff, pumps, tubewells and formulated feeds. To justify these costs, farmers need to produce high value products which often go for export, since in developing countries only the relatively wealthy can afford to eat their products. In poor communities, even the costs involved in building a small pond might be beyond financial reach of the farmer.

The impact of aquaculture on the environment varies by rate of intensity of the production system. According to ICLARM, even the more extensive aquaculture systems (where little or no feed or fertilizer inputs are used) may lead to the destruction of eco-systems, and pose health risks to workers from water borne diseases. Especially in integrated agriculture-aquaculture systems, toxic substances in livestock feeds (e.g. heavy metals, pesticides, or antibiotics) may accumulate in pond sediments and fish.

Intensive aquaculture systems, mainly reliant on external feed and fertilizer inputs, will have additional abusive effects because of pollution by effluents. Escapes of exotic modified, or genetically modified organisms on ecosystems may have an unpredictable impact as well.

Increased aquaculture productivity may lead to oversupply and declining world prices in specific markets. Shrimp trade is the most significant example. Shrimp trade amounts to over 20 per cent of world fishery trade, with more and more supplies coming from culture ventures. Main exporters are China, Taiwan, Thailand, Indonesia, and Malaysia. Shrimp breeding has recently also been taken up in India, Bangladesh, Sri Lanka, Ecuador, and Mexico.

Prices are likely to remain weak in the future, as shrimp farming is expanding enormously throughout developing countries.

1089 92 - 3/139

Integrated systems

Review, book, semi-arid zones, case studies, agricultural engineering, crop production, tillage systms, dry farming, soil properties, soil erosion, management systems, tillage equipment, FAO

GODWIN, R.J.

21. Agricultural engineering in the development: tillage for crop production in areas of low rainfall.

FAO Agricultural Services Bulletin 83, FAO, Rome, Italy; ISBN 92-5-102542-8; 1990, 119 p. + annex

The objective of this publication is to provide perspectives and guidelines in the formulation of tillage strategies for the low rainfall areas, where dry-farming is practiced.

A better understanding is needed of the effects of tillage on the soil physical, chemical, and biological environments and how these environments are altered by various tillage practices.

Conservation tillage systems have been developed in a number of countries where dryland farming is practiced, but the scope of development considerably lags behind that for more humid regions.

There is little published material available concerning the efficiency of traditional dry farming systems that have been developed in Africa and Asia.

The primary objectives of tillage in any cropping system are to control weeds, enhance soil water storage and retention, reduce erosion, and to prepare a desirable seedbed.

The success of dry-farming depends heavily on the ability of the farmer to conserve water, and also to establish a suitable environment for seed germination, root growth, and control of soil erosion.

Dry-farming is practiced in the low rainfall or semiarid regions, where average annual precipitation is generally less than 500 mm.

Soils are often shallow, sandy, low in organic matter, and highly vulnerable to erosion when the surface is unprotected. During the wet season high intensity rains may result in severe runoff and erosion, and this is often followed by dry periods and severe wind erosion.

Tillage systems are generally referred to as reduced, minimum, or low tillage systems and zero till.

Conservation tillage is a term that is widely used to denote tillage systems that emphasize water conservation and erosion control.

The chapters carefully analyze:

- tillage effects on soil physical properties,
- organic matter dynamics,
- erosion,

- plant response,
- alternative tillage,
- planting equipment.

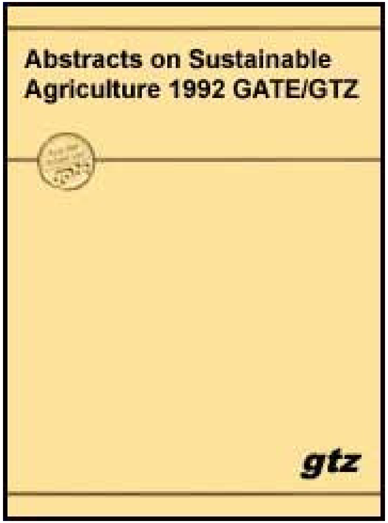
Conclusions and recommendations are drawn specifically to:

- tillage practice,
- water infiltration and conservation,
- erosion control,
- soil fertility,
- crop response,
- tillage implements,
- planting equipment.

An integrated approach is required to meet the tillage objectives for optimum seed preparation, weed control, erosion control, water conservation, and preservation of organic matter.

This is a reference book to assist scientists and extension workers in explaining alternative tillage practices.

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



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.).

20. Economic feasibility of green manure in rice-based cropping systems.

- 21. Effect of nitrogen on pigeonpea (cajanus cajan) and rice (oryza sativa) intercropping system.
- 22. Smallholder cotton cropping practices in Togo.
- 23. Effect of row arrangement on yield and yield advantages in sorghum/finger millet intercrops.
- 24. Yield, economics and nutrient balance in cropping systems based on rice (oriza sativa).
- 25. Mechanisms for overyielding in a sunflower/mustard intercrop.

31. Economic returns from yam/maize intercrops with various stake densities in a high-rainfall area.

32. Performance of three centrosema spp. And pueraria phaseoloides in grazed associations with andropogon gayanus in the eastern plains of Colombia.

33. Barley, lentil, and flax yield under different intercropping systems.

34. Biological potential and economic feasibility of intercropping oilseeds and pulses with safflower

(carthamus tinctorius) in drylands.

35. Screening of different tropical legumes in monoculture and in association with cassava for adaption to acid infertile and high al-content soil.

36. Intercropping studies in peanut (arachis hypogaea l.).

37. Intercropping of rainfed groundnut (arachis hypogaea) with annual oilseed crops under different planting patterns.

38. Resource use and plant interactions in a rice-mungbean intercrop.

39. Cassava/legume intercropping with contrasting

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

Abstracts on cropping system

Acknowledgements

1090 92 - 4/133

Cropping systems

Asia, review, lowland, green manure crops, rice, cropping systems, rainfed conditions, irrigation, food production, crop productivity, high-yielding varieties, fertilizer, nitrogen source, legumes

ABROL, I.P. and S.P. PALANIAPPAN

1. Green manure crops in irrigated and rainfed lowland rice-based cropping systems in south Asia.

In: Proc. of a Symposium on Sustainable Agriculture, IRRI, Philippines,

ISBN 97-104-189-8, 1988, pp. 72-82

Green manuring is the practice of incorporating in situ easily decomposable plant material either from crops grown specifically for organic fertilizer or plant materials brought from outside the field. In situ green manuring is done by turning under the entire plant, usually a leguminous crop. When brought from outside, the green matter may consist of leaves, twigs, and loppings from selected trees or bushes.

Increased food production must come primarily through increased crop productivity and increased cropping intensity. In India, food production has nearly doubled in the last two decades. This has been achieved through the adoption of high-yielding crop varieties, intensive cropping, and improved management practices, including improved fertilizer use.

Nearly one-third of the total N consumed in Indian farming is used for rice. Rice is grown over an area of about 40 million ha. A considerable fraction of the P and K fertilizer used is also for rice. Fertilizer production in India lags behind actual consumption, compelling large imports worth more than US$ 1 billion annually. The increase in fertilizer prices combined with the low purchasing power of farmers is imposing serious limitations on increased crop production and calls for increased efforts to mobilize cheaper and alternative sources of nutrients.

The advent of high-yielding crop varieties in recent years caused organic manure use to decline in favor of mineral fertilizers. There is renewed interest in organic manure, largely because increasing costs of fertilizers, greater incidence of multiple nutrient deficiencies, and deterioration in physical soil properties are resulting in reduced yields.

Farmyard manure, compost, and green manure are the organic materials commonly used. Because the availability of farmyard manure and compost is limited, green manure offers greater potential as a feasible and cheaper substitute for fertilizer N.

Green manuring techniques differ in rice-growing regions. The various techniques are described in this paper.

Research shows almost universal beneficial effects of green manuring on rice yields. Green manure can substitute for up to 60-100 kg fertilizer

N/ha. Many studies have shown it can enhance the availability of native or applied P and of micronutrients. Green manuring hastens the reclamation of alkali soils, largely because increased CO2-production during decomposition of the green manure crop enhances the solubility of lime.

An alternative to growing a crop exclusively for green manure is to grow a short-duration pulse (e.g., mungbean Vigna radiata, cowpea V. sinensis) for a green pod harvest and straw incorporation.

Although the value of green manuring for increasing rice production by supplying nutrients and maintaining soil productivity is well established, the practice has not been widely adopted by rice farmers.

Farmers are unable to appreciate the benefits of green manuring, since the benefits sometimes are not as spectacular as those observed from direct application of inorganic fertilizers.

Green manuring has a large potential to augment nutrient supplies.

Improved experimentation is needed so that crop responses to green manuring can be quantified. The factors responsible for crop responses must be identified to develop sound scientific strategies for green manuring practices.

The patterns of nutrient release during green manure decomposition and the patterns of rice crop utilization need to be better understood. The long-term effects of green manuring on soil properties and crop responses need evaluation. Knowledge of the changes in soil physical properties would be particularly valuable. Organic matter decomposition sets up a chain of physiochemical events which alter the form and availability of several nutrient elements. Green manuring has a special place in problem soils of low fertility and those with alkali problems.

Identification of species or strains that accumulate high N or biomass is another research area of importance.

1091 92 - 4/134

Cropping systems

Africa, Nigeria, humid tropics, lowlands, study, field trials, intercropping systems, maize, melon, yam, soil water content, soil temperature, root length, crop performance

GHUMAN, B.S. and R. LAL

2. Comparative evaluation of some inter-cropping systems in the humid tropics of southern nigeria.

Journal of Sustainable Agriculture, 2, (2), 1991, pp. 59-73

The present study was conducted to investigate the effects of intercropping maize with a mixture of melon and yam on soil moisture, soil temperature, rooting characteristics, and productivity of intercrop on an Ultisol in the humid tropical region of southern Nigeria.

Although much attention has been given to intercropping over the last two decades, there has been little research done on the effects of intercropping on soil moisture and temperature, particularly so in mixtures with more than two component crops. Traditionally, farmers in southern Nigeria would grow five or more annual and perennial crops simultaneously.

Field experiments were conducted near Benin City, southern Nigeria.

Before the initiation of the present trial, field plots were under no tillage for 2 years and, therefore, the same system was followed for this investigation also. Three plots, each measuring 30 x 60 m, were marked for intercrop and nine plots, each measuring 8 x 30 m, for sole crops. The intercrop treatment comprised maize, melon and yam. Local cultivars of yam and melon, grown by farmers of the region, were grown for these experiments. Yam sets, weighing 200 to 250 g each, were planted at 1 x 1 m spacings. Melon was planted at 0.5 x 1 m spacings in the yam rows so that there were two melon plants between a pair of yam plants. Maize (cv. TZSR-W in

1987 and TZSR-Y in 1988) was planted between yam + melon rows at 0.3 x 1 m spacings. Planting of crops at a given spacing was carried out on the same day in the intercrop and monoculture plots. After planting, 400 kg ha-1 of 15:15:15 NPK mixture fertilizer was carefully spread on the maize rows alone. One month later, the second dose of N (60 kg ha-1) as calcium ammonium nitrate was side-dressed to maize after thinning to one plant per hill. About 2 months after germination, yam vines were supported with wooden stakes over 3 m long.

At 0.10 m depth, the soil was desiccated most under the intercrop compared with monocrops. The trend changed at 0.30 m depth where minimum soil water was under sole maize. At 0.01 depth, maximum soil temperature in the intercrop was lower by 1-2, 8-10 and 8-11 C in relation to monocultures of melon, yam and maize, respectively, depending on insolation load and soil moisture content. At

0.20 m depth, however, temperature differences between intercrop and monocrops were much smaller due to soil's damping effect. Intercropping decreased plant height and leaf area index of maize as compared to monocropping. Maize root length density in the 0-5 cm layer under the row was lower in the intercrop than sole crop, but in the 10-20 cm layer this was reversed.

The intercrop of maize, melon and yam produced 61 and 98% more food than monocrops in 1987 and 1988, respectively, as assessed by area x time equivalent ratio.

The intercrop was more productive in terms of food production per unit area than the monocultures as indicated by the values of LER. For example, intercropping produced 130 and 167% more food per unit land area than component monocultures in 1987 and 1988, respectively. LER does not take into account the growth periods of crops and is considered an inappropriate index for evaluating the potential productivity of a mixture consisting of crops of widely different maturity periods. The point is that if long duration crops (yams in the present study) had not been grown, two crops of shorter duration, e.g., maize or melon, could have been taken in a year. The ATER was 1.61 and 1.98 in 1987 and 1988, respectively. This index confirms the earlier conclusion drawn by LER that productivity of the intercrop was higher than monocultures per unit area but not as high as is indicated by LER.

1092 92 - 4/135

Cropping systems

Latin America, Colombia, study, intercropping, land-use efficiency, cassava, maize, yam, yield performance

CIAT

3. Intercropping improves land-use efficiency.

CIAT Report, Cali, Colombia, 1989, pp. 15-17

Associated cropping reduces the chances of the farmer losing everything to pests, drought, or diseases. If one crop fails, the other may survive and will compensate for the loss or provide at least some food or earnings. Another advantage of intercropping is that it often makes more efficient and intensive use of available labour. Most researchers agree that unless socioeconomic conditions change radically during the next few years, small farmers will continue to practice intercropping.

One of the most common association used by small farmers in the tropics are systems involving maize and cassava. The farmers have discovered by trial and error that if they lose their maize they can fall back on their cassava. Cassava is well known as a hardy crop that can withstand very stressful conditions.

CIAT Cassava Program in conjunction with Colombia's national program were conducting research designed to make this practice better.

For farmers in the northern coastal plains of Colombia the most common problem is lack of land, caused by a combination of rural population growth and the traditional pattern of land inheritance. Constant division of available land has left north coast farmers with an average of 5-6 ha, about 50% of which is maintained in natural pastures or left fallow to restore soil fertility. With natural or chemical nutrients difficult to obtain, they must make as efficient use of the land as possible.

It was interesting to find that the local maize varieties competed more aggressively with cassava than the improved varieties. Grown under farmers' conditions, cassava yielded an average of 16 t/ha of roots in sole cropping and 11 t/ha in association with the improved varieties of maize. Yet, when cassava was grown with traditional maize varieties, it only yielded 8.8 t/ha. Improved maize varieties, on the other hand, yielded 2.6 t/ha in sole cropping and 2.0 t/ha in association.

Traditional varieties yielded 1.5 t/ha in sole cropping and 1.3 t/ha in association. This indicates that the improved maize varieties not only yield higher in monocropping but also in intercropping, while cassava intercropped with these improved maize varieties also yielded more.

The intercrop produces a land-equivalent ratio of 1.4. That is, 40% more land would be necessary to obtain the same production as from sole cropping.

1093 92 - 4/136

Cropping systems

Africa, Nigeria, semi-humid region, savanna zone, maize variety, legumes, agroforestry

IITA

4. A new maize modernizes savanna farming.

In: IITA 1990; Publ. of the Int.Inst. of Trop. Agriculture, (IITA), Nigeria, 1990, pp. 5-8

A new maize has broken the mode of agriculture in northern Nigeria, enabling farmers to begin modernizing their age-old practices with intensified farming.

Agricultural procutivity has improved markedly in the most savanna zone of northern Nigeria. Recent surveys there by IITA and the Institute for Agricultural Research (IAR) have shown increases in use of improved maize, fertilizer, and improved management practices, such as animal traction and effective weeding, as fallow periods have become abbreviated.

IITA has developed a high-yielding maize variety, TZB, by building on two composite breeding lines of Nigeria's Federal Department of Agricultural Research. In experimental trials the new variety yielded consistently one-and-a-half to two times as much as local varieties.

Also, it was resistant to the fungal diseases of rust, blight, and ear rot, and highly adapted to growing conditions in the savanna.

The agricultural development projects introduced TZB to northern farmers and demonstrated how to obtain high yields.

Maize has become a major food crop in virtually all villages, and a major cash crop in more than two-thirds of them.

Sorghum, traditionally the favorite food crop, is still planted over a greater area than maize. However, since TZB outyields local varieties of sorghum and millet, the other staple cereals in the region, TZB can reduce the land requirement for feeding farmers' families. Many farmers have found that, by growing TZB for household consumption, they can free additional land for cash crops. With the surplus over food needs being marketed, farmers have increased their cash income which they can use to reinvest in cash crop production.

The characteristics which enabled TZB to make farming so commercially viable are its high yields and attractive appearance. Experiments on farmers' fields show that TZB, with moderate levels of fertilizer, yields 21-115% more than local maize. Its grain quality, with a white color and resistance to the ear rot, make it compatible with local food preferences.

The question of sustaining intensification, moreover, spotlights two distinct and critical issues: economic sustainability, in terms of the profitability of maize production; and environmental sustainability, in keeping up soil fertility and keeping down pests and diseases.

Environmental sustainability becomes a problem when cereals dominate the cropping regime, as sorghum and maize do in the savanna. Cereal dominance drains the soil of nutrients, because cereals demand a high level of soil fertility to be productive. And cereal dominance leads to a build-up of specific pests - insects, fungal diseases, nematodes, the parasitic weed striga, among others - because a similar pest and disease complex preys on all cereals. An ominous threat lies in the proximity of sorghum, historically striga's main host, with maize, also highly susceptible. The combination appears to be hastening the spread of the pest.

Several research institutes have joined to explore ways to help promote sustainability by expanding the role of nitrogen-fixing legumes in the cropping system. Legumes restore soil fertility with nitrogen from their residues or direct deposits.

1094 92 - 4/137

Cropping systems

Asia, Thailand, study, field trials, environmental effects, crop adaptation, genotype component, soybean varieties, yield evaluation

IVORY, D.A. et al.

5. Analysis of the environmental component of genotype x environment interaction in crop adaptation evaluation.

Field Crops Res., 28, 1991, pp. 71-84

In this paper, emphasis is given to the methodology of analysing and interpreting the environmental component of genotype (G) x environmental (E) interaction analysis using seed yield data from the on-farm evaluation of six soybean lines grown in 19 environments throughout the major soybean-growing areas in Thailand.

The relative performance of plant genotypes or lines is commonly found to vary in different environments, due to the interaction of genetic and non-genetic factors. This genotype by environment (G X E) interaction confounds comparisons of genotypes with the environments used for plant yield evaluation, and complicates the selection of lines for release as commercial varieties, recommendations of cultivars for particular environments or the definition of future breeding objectives. Effective plant improvement depends on an understanding of G X E interaction.

Various methods have been used for detecting and characterizing G X E interactions.

A basic objective of the regression approach is to identify systematic variation in performance in G X E matrices, but it is only informative where G X E interactions are linearly associated with an environmental index - often not the case in crop variety trials.

Another technique used for the investigation of systematic response or pattern in G X E matrices is cluster analysis, or numerical classification.

This method has been seen as useful in summarizing patterns of genotypic performance and environmental productivity.

There has been less attention given to the methodology used to improve or simplify the interpretation of the differential response of genotypes in different environments and the environmental factors which are causing differential genotype responses in different environments.

The use of genotype yield deviations from environmental mean yield as a measure of the G X E effect in pattern analysis, and their representation in bar graphs has proved very effective in separating differential soybean line responses in different environments in Thailand. The two methods enhanced the description of the way each of the line responses differed across the environments in which they were grown.

In the soybean farm trials, biotic factors had little influence on crop yield, due to the low incidence of diseases and insect pests, and the soybeans were irrigated in the dry season. In these circumstances, differences in environment mean seed yield should be mainly related to the fertility status of the location. The classification of environments based on mean seed yield showed no particular geographic distribution, which indicated that differences in mean yield were location-specific and probably due to differences in such things as soil fertility or the moisture environment.

It has been clearly demonstrated that recommendations can be made to farmers on the best line to grow in different regions, viz., CM60 in the north and northeast and 7608 in the lower north, west and central region. It is also apparent that the promising soybean line 7608 should be released as a new cultivar because of its widespread superiority to all other cultivars in the southern regions. In addition, regional recommendations can be made for a second "back-up" cultivar, where it is felt that there may be insufficient seed supplies of the premier cultivar available to farmers for planting.

1095 92 - 4/138

Cropping systems

Asia, India, review, semiarid tropics, ICRISAT, cropping systems, climatic analysis

VIRMANI, S.M.

6. Climatic analyses and cropping systems in the semiarid tropics.

In: Weather and Rice; Proc. of an Int. Workshop on the Impact of Weather Parameters on Growth and Yield of Rice; Publ. of IRRI, Los Baos, Philippines, 1987, pp. 215-220

Climate and agriculture are intimately related. Both long-term meteorological factors (climate) and short-term meteorological events (weather) affect crop growth, development, and production.

Studies of climate help understand crop production and other land use patterns that have evolved over a long period of time and assist in introducing new and more productive farming systems. At ICRISAT the relevance of climatic environment to the development of improved cropping systems for semiarid tropical areas are studied.

Semiarid tropical (SAT) areas are defined as those regions that have a mean annual temperature exceeding 18 C and mean monthly rainfall exceeding mean monthly potential evapotranspiration for 2-4.5 consecutive months in the dry SAT and 4.5-7 month in the wet/dry SAT.

Precipitation is characterized by annual and seasonal variability. the coefficient of variation for annual rainfall is 20-30%. Even within the rainy season, droughts of varying durations are common.

The major climatic constraint to crops in the tropics is lack of adequate water. Against a continuing evaporative demand, the supply is discontinuous and variable, particularly in the drylands.

To cope with the variable climate, farmers tend to grow a mixture of crops. They usually include long-duration crops in their cropping systems.

Traditionally, the SAT areas have had agropastoral, silvipastoral, and agroforestry production patterns. Cultivation had been mainly restricted to dryland crops, with a crop or two of rice in the lowlands or where irrigation water is available. With large population increases in recent years, most of the land is now sown to crops; the area under forests and grasslands is rapidly decreasing. Soil erosion has increased tremendously and surface waterstorage systems have lost much of their effective storage capacity. Crop production is much more variable in both drylands and irrigated areas. Average crop production from the drylands does not exceed 0.7 t/ha a year in most of the SAT.

Agroclimatic analysis helps define the recommendation domain for transferring technology from the research center to farmers' fields.

An efficient cropping system is determined largely by climatic, and management factors. A more complete quantification of the temporal and spatial distributions of natural resources is a key factor in assessing the agricultural production potential of a region. Mapping the agroclimate of an area in relation to its resources could give the recommendation parameters for improved cropping systems or farming systems technology.

A map of semiarid India showing the suitability of areas for the adoption of improved technology has been prepared.

1096 92 - 4/139

Cropping systems

Africa, tropics, review, book, field crops production, agronomic practices, climatic factors, soil fertility, irrigation, drainage, cereals, roots, tubers, grain legumes, oilseed crops, fibre crops, beverages, CTA

ONWUEME, I.C. and T.D. SINHA

7. Field crop production in tropical Africa.

Publ. of the Centre Technique de Cooperation Agricole et Rurale (CTA), Postbus 380, 6700 A.J. Wageningen, Netherlands; ISBN 92-9081-086-6; 1991; available from CTA, Netherlands

A new CTA publication 'Field crop production in tropical Africa' by I.C.

Onwueme and T.D. Sinha brings progress in scientific research and practice in crop production within the easy reach of students of agriculture. It provides a comprehensive text for an introductory course in field crop production and combines detailed treatment of agronomic principles with a crop-by-crop treatment of the major field crops of tropical Africa.

The authors explain that the most important phase in the history of the dispersal of crops from their centres of origin to other parts of the world followed the enormous expansion of world trade during the sixteenth and seventeenth centuries. During the sixteenth century New World crops (i.e. crops indigenous to the Americas) such as maize, groundnuts, sweet potatoes, potatoes, tomatoes and cassava were introduced to other parts of the tropics. The most recent developments in the dispersal of crops have been associated with the expansion of international agricultural research. Although there are relatively few indigenous plants of outstanding economic value in Africa, there are now many introduced crops which have been accepted and are grown on a large scale.

Part I of the book looks at agronomic practices generally and particularly at climatic factors, soil fertility and conservation, irrigation and drainage. Part II covers each crop in detail within categories such as cereals, roots and tubers, grain legumes, oilseed crops, and fibre crops. Sugarcane, tobacco, tea, coffee, cocoa and para rubber are also covered. Botanical descriptions of each crop are followed by details of cultivation and crop protection methods. The book is illustrated with line drawings and black-and-white photographs.

Although the book is written mainly for undergraduate students, it may also be useful to postgraduate students of agronomy, research workers, agricultural extension officers and progressive farmers.

1097 92 - 4/140

Cropping systems

Review, book, tropics, subtropics, crops, plants, cultivation, economic value, utilization, IAT, CTA

REHM, S. and G. ESPIG

8. The cultivated plants of the tropics and subtropics.

Verlag Josef Markgraf, Weikersheim in cooperation with CTA, Wageningen; ISBN 3-8236-1169-0, 1991, 552 p.

This book is the translation of the well known original German edition: "Die Kulturpflanzen der Tropen und Subtropen".

The original German edition of this book was based on the lectures of the senior author (S.R.) at Gttingen University and on the documentation on tropical crops collected by G.E.

The number of plants which are cultivated in the tropics and subtropics is very large. About 2,500 species have been named, excluding ornamental and forest plants; this number includes the cultivated plants of the temperate zone, and some close relatives of the species cultivated.

The wealth of plants is far from being fully exploited and harbours genetic resources on a much larger scale than today used. More than 1,000 plants are discussed in this pocket manual.

World trade, the drive for exports, and the transition to rational production procedures are nowadays the causes of rapidly progressing changes in plant cultivation in the tropics and subtropics.

The main concerns of the authors in this book are to comprehend these changes, to exclude obsolete plants, to indicate new developments, and to consider the economic importance of each plant.

With regard to the scientific nomenclature of plants, the authors endeavoured to use the names which are valid according to the International Code. Where plants are still frequently cited in the literature under a name which is no longer valid, the most synonym has been given and if necessary, two synonyms.

It seemed desirable to give the common names of plants also in several of the world's most important languages, because the scientific names of the plants are not always given in the foreign literatures.

Botanical particulars (morphology, anatomy, physiology) have been limited to the features which are important for the agronomist. It has been impossible to present the multitude of agricultural methods and possibilities. The book is limited to emphasizing the most basically important and generally valid aspects.

Detailed advice about fertilizers has been omitted because of the extraordinary differences in soil types found in the tropics and subtropics.

Diseases and pests have been reviewed in as much as they cause severe damage and are of more than regional importance.

The book is organized in the following way:

Each chapter begins with an introduction to the particular properties of the plant group, giving an overview on the economics, production trends, nutritional aspects, chemistry, and technological features. The major crops are treated in detail. With regard to these, the authors sought to cover all essential points: production, botany, breeding, ecophysiology, cultivation practices, diseases and pests, processing and utilization.

The numerous minor or only locally important crops were collected in the tables; these give the valid botanical name of each plant, a selection of its vernacular names, and indicate its distribution, economic importance and uses. The drawings help to identify the plants and depict important morphological peculiarities. The diagrams illustrating the production during the last ten years are intended to offer visual information on the relative importance of a crop and on current trends.

As a key to available information, a large number of references to all the species included has been given. In selecting the quotations the authors aimed at covering all aspects of production and utilization, and all regions of the tropics and subtropics. All information on the plants dealt with in this book is available off-line from a continuously updated data bank for cultivated plants and relevant literature.

The book will be of use to undergraduates, graduates and practioners involved in plant sciences or other looking to extend their general awareness of this exciting area.

Clearly written in a precise form and well illustrated, with an extensive bibliography, this book is an excellent source of information.

The book is therefore highly recommended to all interested in tropical agriculture.

1098 92 - 4/141

Cropping systems

Review, software system, package, starter data-files, handbook, plant growth, growth prediction, plant species, soils, climates, lesser-known crops, trees

CSIRO

9. Software system for plant growth prediction.

CSIRO Publications, 314 Albert Street, East Melbourne, Victoria 3002, Australia; 1992

Farmers have predicted plant growth according to their experience for thousands of years. Now a new software system, PLANTGRO, combines this experience with modern scientific techniques to provide new ways of predicting the growth of hundreds of plant species, including some lesser-known plants.

The PLANTGRO package, which was designed by the Division of Tropical Crops and Pastures of the Commonwealth Scientific and Industrial Research Organization of Australia (CSIRO), comes with a handbook which uses a simple skill-rating system.

It encourages users to go at their own pace. In this way, people who have a strong feeling for plants but have little contact with computers or formal plant science, quickly realise that their expertise is valuable and can be recorded. The package provides starter data-files for 60 plants, 30 soils and 40 climates.

PLANTGRO can be used in numerous contexts. For farmers, foresters and rural advisers, it provides an on-the-spot means of thinking about new land-use options. For planners at higher levels who use computerized resource information systems, it represents an add-on package which can give life to soil and climate data held in store. And for those struggling to integrate scraps of information about lesser-known plants, it provides procedures for almost every situation.

Crops covered include banana, cashew, cassava, cocoa, coconut, coffee, cowpea, kenaf, lentil, maize, oil palm, pineapple, potato, rubber, soybean, sugarcane, sweet potato, taro, wheat and yam. Trees include

Acacia spp. and tropical hardwoods.

Software programme language is GWBASIC (not supplied), System: MS DOS 3.2 or higher. Total access is given to software. Editing and upgrading of data-files can be performed by using a simple word processing package.

The price is $A65 for the handbook only and $A40 for disks only.

1099 92 - 4/142

Cropping systems

USA, Florida, study, wetlands, flood-tolerant crops, low-input agriculture, soil conservation strategies, alemangrass, sugarcane, rice, taro, crop management, water management, economics

PORTER, P.S. et al.

10. Flood-tolerant crops for low-input sustainable agriculture in the everglades agricultural area.

J. of Sust. Agriculture, 2, (1), 1991, pp. 77-99

The objective of this paper is to describe potential crops for production in reflooded wetlands and present yield and resource use data (water, nitrogen, and phosphorus). The crops in the study include a tuber (taro, Colocasia esculenta), three grasses (alemangrass,

Echinochloa polystachia, flood tolerant sugarcane, Saccharum sp., and rice, Oryza sativa).

Wetlands have traditionally been viewed as wastelands; now vast areas of such lands have been converted to agricultural production worldwide.

This has often been done in the past without regard for potential environmental consequences or long term sustainability of agricultural production. Recently, wetlands have become appreciated for, among other things, their role in environmental quality and stability. This greater appreciation for wetlands, combined with extensive wetlands loss, has recently led to concerted efforts to protect these areas and, in some cases, has led to confrontations with agricultural interests.

Wetlands are often highly fertile when initially drained. This is the result of rapid oxidation of a soil which had accumulated in a flooded environment. During this oxidation process, nutrients which had accumulated in the soil organic matter over an extended period of time are released to the soil solution at a high rate. Eventually, the stocks of nutrients and soil organic matter are depleted, leading to poor native soil fertility, low agricultural production, and in some cases, abandonment of the now depleted wetland.

Studies of wetland cropping systems have been conducted at the Everglades Research and Education Center (EREC).

The crops in this study vary widely in yield and nutrient uptake. Rice, for example, thrives in water with very low phosphorus contents.

Alemangrass is a tremendous phosphorus sink, but may require supplemental phosphorus fertilization. Crops which thrive in oligotrophic conditions, as well as those which require large amounts of nutrients, are useful in water quality management. For example, alemangrass could be effective in reducing the phosphorus content of drainage from fields previously cultivated with crops which leave behind a large amount of fertilizer phosphorus, as do some vegetables. Rice can further reduce phosphorus contents to levels found under natural conditions. In addition, operating costs in a flood-tolerant cropping system may be lower for flooded crops because periodic flooding aids in the control of some pests and weeds.

Results from this study pertaining to crop management, water and nutrient budgets are encouraging. More information is neded about soil formation and nutrient dynamics in a flood-tolerant system. For example, the balance between soil formation and soil loss for the crops in this study is not well understood. A desirable feature of flood-tolerant crops may be a reduction in nitrogen and phosphorus fertilization over that required by upland crops, however, nutrient mineralization rates and availability to crops when fields are flooded for long periods of time are not well understood in the EAA either.

Economic viability is a complex topic as well.

Currently, upland crops are profitable to the extent that it is not economically sensible to make meaningful investments in soil conservation.

Successful expansion of wetland agriculture in the EAA imlies reversal of soil loss, reduction of nutrient levels in drainage, compatibility with natural hydrologic cycles, and economic viability. Long term sustainability has been experienced in similar systems in other parts of the world. For example, it has been reported that aquatic crops have been grown for more than 400 years in the same organic soil without fertilization in Malaysia.

The development in the Everglades Agricultural Area (EAA) of sustainable agriculture in a former wetland can serve as a model for the many countries which have undertaken or contemplated wetland conversion.

Indonesia, for example, is draining parts of 27 million ha of organic soils, much of it along coastal areas.

1100 92 - 4/143

Cropping systems

Review, book, tropics, crop production, environmental factors, plant population density, crop productivity, physiological process, CAB, ODA

SQUIRE, G.R.

11. The physiology of tropical production.

CAB INTERNATIONAL, UK.; ISBN 0-85198-677-3; 1990, paperback, £13.95

This is an excellent book that examines the way the physiological processes of tropical crops are influenced by environmental factors, namely solar radiation, temperature, photoperiod, saturation deficit, soil water and nutrients.

The effects of plant population density are also considered.

The work is based largely on the research funded by the UK Overseas Development Administration which examined the physiological control of yield of pearl millet, grain sorghum and groundnut by temperature and drought.

The subject matter in this book is extended to cover more physiological processes and environmental factors (e.g. nutrients) and more tropical crops (including maize, sugarcane, pigeon pea, cassava, tea and oil palm). To keep the book to a workable size, the research presented is selective, with examples largely from developing countries in the tropics. This does not detract from the value of the book, and it is a valuable contribution to tropical crop physiology.

The physiology of yield is examined in terms of four types of process - development, expansion, productivity (both in terms of solar radiation intercepted and water transpired) and partitioning of dry matter.

Throughout the text, the effects of solar radiation, temperature, water and nutrients on these processes are examined in terms of a duration and a mean rate. For example, leaf canopy development is examined in terms of an expansion rate governed largely by temperature and a duration governed largely by temperature and photoperiod. Then, restrictions to the rate and duration of leaf canopy development due to solar radiation, saturation deficit, water and nutrient supply are considered.

The first five chapters of the book consider the key physiological processes. The chapter titles are: 1. Control of Development; 2. The Leaf Canopy and Root System; 3. Dry Matter Production by Interception and Conversion of Solar Radiation; 4. Transpiration and Dry Matter Production; and 5. Partition of Assimilate. The final chapter (6. Environmental and Physiological Control of Yield) attempts to draw together the responses of crops to environment and cultivation. Yield is analysed in terms of supply-limitation (water-limited) and demand-limitation (radiation-limited). Then, the physiological responses to nutrients, plant population density and mixed cropping are considered, and finally, species are compared in terms of their main physiological attributes.

Perhaps one disappointment with the book is its lack of application of the physiological understanding to the solution of agricultural problems. The main value of the physiological understanding, described so well in the book, is in the development of crop growth simulation models. Given that most crops in the tropics are grown under variable and relatively unpredictable environmental conditions, it is impossible to sample sufficient growing seasons to obtain the mean response and assess the climatic risk to production, using conventional field experimentation. Consequently crop physiologists should view crop simulation as an adjunct to field experimentation. It would have rounded the book off nicely if a final chapter had been devoted to the application of this physiological knowledge.

Abstract by R.C. MUCHOW, shortened

1101 92 - 4/144

Cropping systems

Asia, Indonesia, study, cropping systems, labour requirements, mulch rotation system, sustainable systems, deforestation

LORENZ, C. and A. ERRINGTON

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

Trop. Agric. (Trinidad), 68, 3, 1991, pp. 249-254

The present paper demonstrates that the Mulch Rotation System has another major advantage over more traditional systems since its labour requirements more closely match labour availability on the settlement units. It thus demonstrates the importance of including a systematic assessment of labour requirements and labour availability in the field trials of any new farming system.

In order to overcome the considerable problems of replacing rainforest with sustainable agricultural systems, IITA has developed a 'Living Mulch' system. The results have shown that in contrast to a conventional till system, in which yields decline rapidly after six seasons, sustainable yields of food crops can be achieved under a live mulch which tends to take over most of the functions of the natural vegetation.

A somewhat different approach described as a 'Mulch Rotation" System has attracted considerable interest in Indonesia.

The system starts with a one-year fallow when a legume cover crop - Pueraria javanica Benth. - is grown on the land cleared of rain forest.

After one year the cover crop is cut by hand and food crops are sown into the decomposing mulch. This continues for three seasons (one year) and the cover crop is again planted (as cuttings) into the last food crop - upland rice - after which the land is left under the legume cover crop fallow for a further year.

In addition to plant nutrients, however, the sustainability of a farming system depends on the availability of a whole range of other inputs.

Labour is a major constraint. However, both the Living Mulch and the Mulch Rotation Systems use no-till methods; and because the mulch, whether living or dead, tends to suppress weed growth, two of the most labour-intensive operations, soil tillage and weeding, are markedly reduced.

This paper shows how labour profile techniques can be used to evaluate this aspect of the Mulch Rotation System.

The introduction of the Mulch Rotation System can reduce the labour peaks dramatically. All the data for this system show a profile with less severe peaks and some extended troughs giving time for social activities and leisure. It should be noted that the Mulch Rotation System does include a one-year fallow. This implies the need for some additional land though the actual amount required depends on the yield improvement of food crops grown after a legume cover crop. Trials' work to date suggests that this yield improvement may be substantial but further work needs to be done to establish whether the introduction of the Mulch Rotation System would in fact need to be accompanied by a change in the standard size of settlement farm (from 2 to,say 2.5 ha).

Labour requirement data of the type used in this study must be validated under different climatic and soil conditions and further data gathered on other food crops. On the labour supply side, more reliable information is needed on the relative contribution of different family members in order to include appropriate weighting factors in the analysis.

1102 92 - 4/145

Cropping systems

Asia, Philippines, IRRI, green manure, legumes, biomass, nitrogen accumulation, nitrogen substitution, rice yield, residual effects

MEELU, O.P. et al.

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

Trop. Agric. (Trinidad), 69, 2, 1992, pp. 133-136

This study was undertaken to compare eight green manure legume species for biomass production, N accumulation and as substitutes for fertilizer

N in rice.

Crop residues and organic manures are common sources of humus and soil N. During the past few decades, organic manures were abandoned in favour of inorganic fertilizers that came with modern varieties of rice, maize (Zea mays L.) and wheat (Triticum aestivum L.), but owing to fertilizer input cost and concern for sustainable agriculture, interest in organic manures has been renewed. Farmyard manure, compost and green manure are commonly used organic manures, but farmyard manure and compost are limited in supply and generally low in nutrient content. Hence, re-examination of legume crops as a source of organic matter and N for rice is justified.

The treatments were arranged in strip plots with strips of green manures in one direction and N levels in the other. Eight green manure species were grown: dhaincha (Sesbania cannabina (Retz) Poir.); sunhemp (Crotolaria juncea L.); soybean (Glycine max (L.) Merrill); lablab (Lablab purpureus (L.) Sweet); indigo (Indigofera tinctoria L.); pigeonpea (Cajanus cajan (L.) Millsp.); cowpea (Vigna unguiculata (L.) Walp.); and mungbean (Vigna radiata (L.) Wilczek).

No fertilizer was applied to the green manures.

The green manures were incorporated in situ 60 DE by a tractor-mounted rototiller and by a power tiller-drawn mouldboard plough in 1985.

The above-ground biomass of Sesbania cannabina accumulated mean maximum N (84-199 kg ha-1) and indigo accumulated the least N (8-84 kg ha-1) in 30-60 days. Mungbean and cowpea, which produced grain and crop residue, are potential dual-purpose grain and green manure species. Regardless of species, mean rice grain yield from green manures was 4.0 t ha-1 in 1984 and 4.6 t ha-1 in 1985, comparable with 4.1 t ha-1 from 50 kg fertilizer N in 1984 and 4.7 t ha-1 from 105 kg fertilizer N ha-1 in 1985. In both years, 50-day Sesbania and Crotolaria acumulated N in excess of the rice crop requirement. Residual effects from green manures on dry season (DS) rice were not significant in 1984 but were significant from Sesbania green manure in 1985. Soil organic C and total N were also significantly higher after Sesbania and Crotolaria than after other green manures or fertilizer N treatments.

1103 92 - 4/146

Cropping systems

Asia, Philippines, study, field trials, intercropping, maize, mungbean,nitrogen,utilization efficiency, inoculation, land equivalent ratio

CHOWDHURY, M.K. and E.L. ROSARIO

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

Field Crop Research, 30, 1992, pp. 41-51

This study was undertaken to examine the effects of rhizobial inoculation and applied nitrogen on growth and performance of

intercropped maize (Zea mays L.) and mungbean [(Vigna radiata(L.)
Wilczek] and to relate nitrogen utilization efficiency of the component crops to the yield advantage.

The experiment was conducted to determine the effects of rhizobial inoculation and nitrogen applied at 0, 30, 60 and 90 kg ha-1 on growth and performance of intercropped maize and mungbean.

Inoculation decreased both dry matter and grain yield of intercropped maize and mungbean. Applied N at levels above 30 kg ha-1 increased the dry matter and the grain yield of maize but reduced that of the associated mungbean. Intercropping drastically reduced the dry matter yield of mungbean but maize showed negligible reductions;the reductions were evident when the crops flowered. Inoculation increased the land equivalent ratio (LER) by increasing the partial LER of maize. Applied N at high levels also increased the partial LER of maize but this failed to increase LER due to corresponding reductions in partial LER of mungbean. Nitrogen at 30 kg ha-1 produced the highest LER (1.40).

Applied N increased N uptake of maize but decreased that of mungbean.

Inoculation increased the N uptake of both mungbean and maize at 48 days and onward. Large reduction in N uptake of intercropped mungbean was observed when it flowered at 33 days but maize was affected 2 weeks later at the tasseling stage. Thus, the competition for N was acute when the crops were at the reproductive stage.

The LER analysis in terms of N utilization efficiency showed that N absorption efficiency of both maize and mungbean was reduced due to intercropping, and mungbean was more affected than maize.

Intercropping severely depressed N uptake in mungbean compared to maize but mungbean utilized the absorbed N relatively more efficiently than maize producing a higher quantity of grains per unit of absorbed N compared to sole mungbean.

1104 92 - 4/147

Cropping systems

Africa, Ethiopia, study, greenhouse trials, underseed cropping, legumes, wheat, soil erosion

P_LSCHEN, L.

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.

J. Agronomy & Crop Science, 168, 1992, pp. 249-254

The objective of the study was to record quantitative effects of two underseed species - Medicago polymorpha L. and Scorpiurus muricatus L. - on the shoot and grain dry matter of main crop (competitive effects) and succesive crop (residual effects). Both species are abundant annual leguminous weeds in the Ethiopian highlands.

Depending on the site factors, agronomic and technical measures at hand, mixed cropping systems may serve widely differing purposes: In vast areas of the Ethiopian highlands (>1500 mm NN) which are mainly characterized by semipermanent cropping systems they could especially contribute to erosion control and to restoration or stabilization of soil fertility.

The highlands are exposed to a considerable population density and its continuous increase leads to declining proportions of pasture fallows and to the cultivation of steep slopes which in turn drastically increases the risk of soil erosion.

Apart from a lowering of soil erosion risks and a preservation of the soil's N- and C-pool leguminous underseed species are suggested to increase water permeability due to an improved soil structure.

Two successive greenhouse trials have been carried out in two factorial designs with three replications.

The leguminous weed species which are widely distributed in annual crops of the Ethiopian highlands have been studied with varying coverage with regard to their suitability as underseeds and with wheat (Triticum turgidum [L.] Thell. var. durum [Desf.] MacKey) as a main crop. The competitive effects of Scorpiurus muricatus L. on the grain yield of wheat were smaller than those of Medicago polymorpha L. (-14.1% and -23.6% respectively, compared with the underseed free control) which is mainly ascribed to differences in their speed of development and shoot height. The residual effects of the underseed's root masses on the grain yield of the successive teff crop (Eragrostis tef [Zucc.] Trotter) were significantly higher with Scorpiurus muricatus (+99.3%) than with

Medicago polymorpha (+63.6%).

Leguminous underseed species adapted to the above described environments should be able to perform in waterlogged sites. This could possibly also have some ameliorative effects, if the combination of main crop with underseed species leads to an increased evapotranspiration rate compared with single crop cultivation and if it improves soil aeration through increased soil organic matter content.

Per se S. muricatus fits better as an underseed partner than M. polymorpha, due to its lower competitive power and due to its even stronger positive residual effects on the successive teff crop.

Moreover it was found out by inquiries of Ethiopian farmers that both species serve as a feed for livestock and that S. muricatus is preferably grazed on harvested fields.

1105 92 - 4/148

Cropping systems

Latin America, survey, Honduras, intercropping, beans, sorghum, maize, environment, management practices, on-farm research, rainfall, temperature, soils, planting, cultivars, CATIE

DIAZ, D.R.E.

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.)

Tesis Mag. Sc. Turrialba, Universidad de Costa Rica; Centro Agronomico Tropical de Invest. y Enseanza; 1982, 130 p.

Using a modification of the area characterization methodology developed in farming systems research, cropping systems involving beans and sorghum associated with maize (M + B, M + S, M + B + S) were studied in Honduras. By means of a survey of 378 farmers, selected at random from different areas of the country, data was collected of the farm, the soil, the predominant cropping systems and their management. This data was used with secondary information of climate and soils to characterize the three cropping systems and analyze their relationship with different environments. Seventy-five percent of the farms studied were less than six ha in size, and 63 percent less than four ha. The area planted to the cropping systems was even smaller; 75 percent, 50 percent and 61 percent of the M + B, M + S and M + B + S plots respectively were less than 1.4 ha. The majority of the farmers were owner-occupiers, although share-cropping (where the farmer gives part of the harvest and the sorghum straw as payment to the landowner) was evident in the M + S and M + B + S systems. Seventy percent of the farmers utilized all their produce on-farm and only 5 percent sold more than 50 percent of their produce. The use of bought inputs was minimal: only 19 percent used fertilizers and practically none used herbicides, insecticides or fungicides. It was found that the physical environment influenced both the localization of the cropping systems and also their management. As an example of this influence it was showned that the three cropping systems were concentrated at different altitudinal ranges: M + S at less than 750 m; M + S + B at 500 - 1250 m; and M + B between 500 and 2000 m.

Using principal component analysis it was shown that the most variable management practices of M + B were those relating to spatial arrangement of the crops and choice of variety (especially grain color in maize and growth habit in beans). By means of contigency tables and multiple regression it was demonstrated that these management factors were influenced principally by altitude (temperature) and rainfall (quantity and distribution). As the present study only utilized a part of the data collected, it is recommended that further analysis be undertaken to improve our understanding of these cropping systems which are of such influence both in Honduras and Central America.

1106 92 - 4/149

Cropping systems

Asia, India, field trials, on-farm research, rainfed condition, sandy loam soil, flooding occurrence, intercropping, pigeonpea, pearl millet land equivalent ratio

SINGH, R.A. et al.

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

In: Pigeonpea Newsletter (IPN), 14, 1991, pp. 14-17

Most of the agricultural land of Diara regions are small and marginal units, and farmers adopt mixed cropping of pigeonpea and pearl millet during monsoon with poor yields.

Farmers of the area mix seeds of pigeonpea and pearl millet in about equal proportion of the required seeds of both the crops and broadcast them in the field along with a small amount of fertilizers (about 9 kg N and 10 kg P ha-1).

Two experiments were conducted. The experiments were laid out in a randomized-block-design with four replications having five treatments of pigeonpea.

Sole crop treatments of both the crops were grown at their optimal plant population.

Intercropping of one row of pearl millet in between two rows of pigeonpea was done and plant populations of pearl millet were maintained by reducing within-row spacing.

Intercropping of pigeonpea (100% plant population) with various plant populations of pearl millet in additive combinations was more productive than growing them as sole crops, as total land-equivalent ratio (LER) values were greater than 1.0 for these treatments.

With the increasing plant population of the intercrop pearl millet, the pigeonpea yield decreased, probably because of increasing competition from pearl millet. In the pigeonpea pearl millet intercropping system, partial LERs for pigeonpea were less than those for pigeonpea grown alone. This indicates suppression of pigeonpea growth by pearl millet.

The total partial LERs of pearl millet, however, were greater than pearl millet alone up to 100% plant population, but it decreased at 150% plant population of pearl millet. Thus, the overall efficiency of pigeonpea/pearl millet intercropping system was optimal with a pigeonpea plant pupulation of 100% and pearl millet plant population of 50%. It seems that pearl millet better utilized space and resources between two rows of long-duration pigeonpea up to 100% plant population.

At 150% plant population of pearl millet between two rows of initially slow-growing, long-duration pigeonpea, both the crops were put under stress for space, light, and other resources resulting in reduced yields of both crops.

1107 92 - 4/150

Cropping systems

Asia, Bangladesh, field trial, rainfed conditions, silty loam, mixed cropping, lentil, barley, sole cropping, land equivalent ratio, monetary returns

ISLAM, M.N. et al.

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

LENS (Newsletter), 1991, pp. 24-26

The experiment explained in this paper was conducted to determine a suitable seeding ratio for lentil and barley sown in a random mixture.

In a mixed cropping experiment, three combinations of lentil (Lens culinaris Medik.) and barley (Hordeum vulgare L.) were compared to corresponding sole crops.

The experiment was conducted under rainfed conditions.

The treatments consisted of three combinations of lentil and barley (100:10, 100:30, and 100:50) plus the monocultures of the two crops as checks. The design was randomized complete block with five replications.

The results of this study revealed that yield and yield parameters of lentil were lower in mixture with 50% barley than in monoculture. Grain yield, plant populations/m2, number of pods/plant, number of seeds/pod, and 1000-seed weight of lentil in mixed cropping were statistically identical to sole lentil (1.05 t/ha) up to addition of 30% barley seeds.

Due to higher competition of nutrients, moisture, space, and light, the number of pods/plants, number of seeds/pod, and seed size, i.e., yield/plant of lentil were reduced.

Grain yield and number of spike/m2 of barley differed significantly mainly due to different amount of seeds used in the combinations. Sole barley produced highest grain yield (2.58 t/ha) and the highest number of spikes m2. In mixed cropping, the yield/plant of barley was significantly higher over sole barley, as were the yield components, i.e., number of spikes/plant, number of grains/spike, and 1000-grain weight. The increase in yield/plant might be for beneficial effect of lentil on barley.

Relative yields of barley showed that barley yields were higher than the expected yields (on the basis of seeding percentage) in the mixtures.

That is 10%, 30%, and 50% barley seeds produced 11%, 36%, and 51% yield of monoculture, respectively.

From the above results, it may be concluded that 30% barley seed did not reduce lentil yield significantly, producing highest LER of 1.29.

Highest monetary return was also obtained from the same combination.

Summarizing, it may be stated that 30% barley seeds can be mixed in normal lentil without substantial yield loss and with high monetary return in the region.

1108 92 - 4/151

Cropping systems

Europe, Italy, study, intercropping, wheat, pea, yield performance

PAOLINI, R. et al.

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

Publ.of the Inst. of Agronomy, Univ. of Tuscia, 01100 Viterbo, Italy, 1991

Intercropping of cereals and grain legumes often gives higher resource use efficiency compared to homologous sole crop systems. Complementarity between bread wheat and grain pea can derive from their different growth habits, earliness, and ability to use different sources of N and/or, presumably, other nutrients owing to root stratification in the mixture.

As to plant morphology and growth habits, consistent variation also occurs among pea cultivars. Results are reported of a study carried out during two cycles (1989/90 and 1990/91) at Viterbo (central Italy) where four pea varieties (the early "leafy" cv. 'Stehgolt' and the early "semileafless" cv. 'Consort'; the medium early "leafy" cv. 'Frijaune' and the medium early "semileafless" cv. 'Countess') were intercropped with the medium early bread wheat cv. 'Pandas' under two different inorganic N conditions (9.0 g/m2 and 16.1 g/m2). Both wheat and pea intercrops were compared with their respective sole crops under the same conditions. Complementarity clearly occurred in both years in two cases out of four (mixture of wheat with the early cvs. Consort and Stehgolt), only under the lower N availability conditions. LER values were about 1.20 for both Pandas/Consort and Panda/Stehgolt mixture; partial LERs showed a great yield advantage of wheat and a moderate yield disadvantage for pea. In the most balanced mixture (Pandas/Consort), grain yields of wheat and pea intercrops compared to sole crops were 7180 vs 4380 kg ha-1 and 3340 vs 4380 kg ha-1, respectively. Both medium-early cultivars (cv. Countess and cv. Frijaune did not show complementarity with wheat, and components did not give yield advantages. Under high N availability conditions (16.1 gm/m2), complementarity between wheat and pea never occurred. Wheat was more competitive than the early cultivars of pea (cv. Stehgolt and cv. Consort), but equally competitive against the medium-early ones (cv. Frijaune and cv. Countess). Intercropping of wheat with early, standing pea cultivars represents a promising solution to obtain yield advantages under low to moderate N input conditions.

1109 92 - 4/152

Cropping systems

Asia, Philippines, study, rice, green manure, economic feasibility, azolla fertilizer

ROSEGRANT, M.W. and J.A. ROUMASSET

20. Economic feasibility of green manure in rice-based cropping systems.

In: Proc. of a Symp. on Sustainable Agriculture - Green Manure in Rice Farming; IRRI, Philippines, 1988, pp. 11-16

In this paper the authors discuss the key concepts, issues, and methods of determining the economic feasibility of green manure; employ these concepts in a case study of the economics of azolla as a green manure in

Philippine rice production; and draw a number of general conclusions regarding the economic feasibility of green manuring in rice-based farming systems.

Increased use of fertilizer, with development and dissemination of improved varieties and expanded and improved irrigation, has been a key factor in the growth of rice production in Asia and elsewhere.

The increase in fertilizer use has been remarkable by any standard.

Between the first and second halves of the 1970s, average fertilizer consumption grew by 50% in South Asia, 39% in Southeast Asia, and 53% in

East Asia.

The rapid growth in fertilizer use has been due almost entirely to increased use of chemical fertilizers. Organic fertilizers (green manure crops, animal manure, and compost), traditionally important sources of nutrients, declined in relative importance with the rapid increase in use of chemical fertilizers.

Although data on use of organic fertilizers is scarce, there is at least some evidence that their use has declined in absolute, as well as in relative terms.

Despite (or because of) these trends, interest in the potential for expanded use of green manure has been renewed.

Concern also has been rising over possible long-term adverse effects of heavy use of chemical fertilizer on soil structure, crop productivity, and off-farm pollution. Green manure and other organic fertilizers can maintain and improve soil structure.

Increased use of chemical fertilizers may also incur long-term environmental costs. In areas where chemical fertilizers are heavily used, drainage runoff contributes to eutrophication of rivers and lakes.

Green manure and other organic fertilizers have a number of apparent agronomic and environmental advantages.

The case study results suggest that azolla usually is not a cost-effective substitute for urea fertilizer. Green manuring is uneconomic,largely because of the opportunity cost of land used to grow azolla. Use of land for azolla incurs a substantial cost of alternative cropping opportunities forgone. Compared to using N from urea, using azolla as an intercrop is profitable only with good irrigation.

High labour costs, high opportunity costs of land, and poor water control are major constraints to the economic feasibility of green manure. Given the current stage of azolla technology and its relatively poor economic feasibility, policy support for widespread investment in technology dissemination is not appropriate. Instead, strong support should be given to a research program designed to overcome the constraints to economic feasibility. Improvements in azolla technology that increase nitrogen yield and pest resistance or reduce the opportunity costs of labour and land could make azolla economically feasible in a greater number of environments.

1110 92 - 4/153

Cropping systems

Asia, India, study, field trial, intercropping system, pigeonpea, rice, nitrogen economics

MAHAPATRA, P.K. et al.

21. Effect of nitrogen on pigeonpea (cajanus cajan) and rice (oryza sativa) intercropping system.

Indian J. of Agric. Sc., 60, 1990, pp. 519-522

An experiment was conducted under rainfed situation to assess the legume advantage under varying levels of N in a pigeonpea [Cajanus cajan (L.) Millsp.] - rice (Oryza sativa L.) intercropping system.

The experiment was conducted during the rainy seasons in a randomized block design with 4 replications in the rainfed upland. The soil was lateritic with a sandy -loam texture.

N was applied through urea 30, 45, 60 and 75 kg/ha. Of the total N applied, 10 kg/ha was given in lines uniform to all the treatments at sowing along with 18 kg P/ha and 17 kg K/ha. The remaining amount of N for each treatment was top-dressed to rice in 2 equal splits, at 20 and 40 days after sowing. The sole pigeonpea received a fertilizer dose of 28, 18, 17 kg N, P, K/ha at the time of sowing.

The land-equivalent ratio was calculated for each fertilizer N level by adding the proportion of rice yield in the intercrop to that in the sole crop with the proportion of pigeonpea yield in the intercrop to yield of sole pigeonpea. The energy input and energy output were also calculated.

The transfer of N during the rice-growing period from pigeonpea to rice was negligible. Application of 30kg N/ha to rice in the intercrop gave the optimum economic return. This could recover 59 and 90% of the grain yields of sole rice and pigeonpea with an yield advantage of 49%, net profit of Rs 4432, energy output of 129400 MJ/ha, and energy output-input ratio of 16.59. Sole rice was an inefficient user of energy input.

It can be concluded that pigeonpea can adjust well with rice in the rainfed upland in an intercropping system at different levels of N.

Optimum economic returns with high energy-use efficiency were observed when only 30 kg N/ha was applied to rice in the intercropping system.

1111 92 - 4/154

Cropping systems

Africa, Togo, cropping practices, cotton, yield, smallholder, production systems, extension, research topics

COUSINI+, P. and K. DJAGNI

22. Smallholder cotton cropping practices in Togo.

Coton Fibres Trop., 46, 1991, pp. 285-290

The work described here was undertaken over the period 1980-1990 in five villages in Togo and provided an understanding of the ways cotton growing has developed: smallholder responses to recommendations and the main obstacles to increase cotton yields. The analysis of production systems was completed by experiments in the smallholder sector, destined to test innovations developed by research or to expand on the agricultural survey.

The cotton development operation in Togo was one of the most spectacular in West Africa in the 1980s.

Many smallholders in Togo have only recently started to grow cotton, and are small-scale producers, with an average area of 0.5 ha of plantings each.

The low cotton productivity levels observed are partly explained by the use of lower quantities of inputs than recommended.

Despite the low productivity observed, cotton is still an attractive crop, by virtue of the income it provides and the fact that it can be used to fund inputs for food crops.

By linking the behaviour of cotton smallholders with the various constraints mentioned above, it is possible to characterize various smallholder strategies. Four main types of situation are described in this paper.

The main causes of these low yield levels are essentially linked to the logic behind smallholder cropping practices, which consists in deliberately growing cotton extensively so as to reduce the risk of failure.

Concluding, it can be said that extension activities should be based on priority topics, taking acount of technical constraints encountered in the field. It would be beneficial if detailed technical responses could be drawn up depending on the region and the existing production system, to ensure more effective valorization of the inputs purchased by the smallholder. A considerable effort should be made to pass on messages to farmers, since the main obstacle to intensification is not so much developing new techniques as encouraging smallholders to adopt existing ones.

For its part, agricultural research should take account of the difficulties encountered by smallholders in applying recommended techniques. Hence agronomists should be able to propose techniques more adapted to conditions in the rural environment, and it is essential to redefine research topics with a view to minimizing the technical constraints facing smallholders in Togo.

The final aim is to eventually produce specific recommendations, where the supervisor would move from his current role to that of advisor. It has to be said that the current state of cotton growing in Togo (numerous small-scale producers and low yields) makes this a difficult target.

In addition, cotton development cannot be dissociated from other agricultural or livestock activities. It would be no good concentrating on cotton in view of the fact that food crops are often the smallholder's priority and govern his behaviour with respect to cotton.

Cotton intensification should therefore be looked at in overall terms, i.e.in terms of integrated development, taking account of all the constraints encountered by smallholders in Togo.

1112 92 - 4/155

Cropping systems

Africa, Uganda, study, highlands, field trials, intercropping, sorghum, finger millet, row arrangements, yield advantage

SSEKABEMBE, C.K.

23. Effect of row arrangement on yield and yield advantages in sorghum/finger millet intercrops.

Trop. Agric. (Trinidad), 68, 1991, pp. 19-22

A study was conducted to determine the effect of row arrangement on the yield and yield advantages in a sorghum-finger millet mixture grown at four different plant population densities.

The study was carried out at an altitude of approximately 1200 m. Most of the soils are oxisols and highly weathered, but are deep, firmly heavy and well drained. The mean daily maximum and minimum temperatures of the area are approximately 27 and 17 C. The annual rainfall averages 1300 mm and is bimodal in distribution.

The results indicated that the yield of each species increased with increase in planting density. The sorghum yield and the total yield of the mixture were reduced when a proportion of sorghum was replaced by an increasing number of millet rows. However, the total yield of the mixture was increased when pure-stand finger millet was replaced by an increasing number of sorghum rows. Calculation of Land Equivalent Ratios

(LER) revealed that the differences among the various row arrangements in terms of yield advantage were not significant, although the 1:2 sorghum + millet row arrangement gave an exceptionally higher overall yield advantage at all planting densities tested.

Concluding, the present experiment has shown that total yield of each species was highest when grown in pure stand, and this decreased when a proportion of it was replaced by the other species.

On the basis of the results, it is advisable for a farmer interested in maximum yield, irrespective of which species, to grow pure stand sorghum. This is usually the case for farmers who grow sorghum primarily for making a kind of local beer from bananas; the sorghum flour is used as a starter in brewing the beer. However, farmers interested in some yield from both species should grow them in a 1:2 sorghum:millet row arrangement. This is suitable for farmers who use a mixture of sorghum and millet in preparing 'atapa' (thick porridge), a kind of food. In making atapa a little sorghum is mixed with a larger quantity of finger millet flour, in a proportion of about 1:4 (sorghum:millet), depending on how much millet flour is available. On this basis, even the 1:4 sorghum:millet row arrangement may be worthwhile since it yields more millet (than the 1:2 arrangement) and a still substantial amount of sorghum.

1113 92 - 4/156

Cropping systems

Asia, India, field trial, rice, wheat, sugarcane, mustard, greengram, economics, employment

YADAV, D.S. et al.

24. Yield, economics and nutrient balance in cropping systems based on rice (oriza sativa).

Indian J. of Agricult. Sciences, 61, (12),1991, pp. 872-876

An experiment was conducted to find out the production potential, economical feasibility and nutrient removal of different rice-based cropping systems, including sugarcane as the component crop.

The six cropping systems tested were viz.-wheat-fallow; S2, rice-maize (Zea mays L.)-maize + cowpea [Vigna unguiculata (L.) Walp.] fodder (1:1); S3, rice-toria [Brassica rapa (L.) Thell. emend. Metzger var napus L.; syn B. napus L. var napus L. sensu stricto; B. campestris L. var toria Duth. & Full.]-wheat-dhaincha [Sesbania cannabina (Retz.)

Pers.] green-manure; S4 rice-potato + Indian mustard

[Brassica juncea(L.) Czernj. & Cosson] 3:1 - blackgram (Phaseolus mungo L.); S5, rice-wheat + Indian mustard (9:1)-greengram; S6, rice-wheat + sugarcane 4:1-ratoon-wheat (3-year rotation). Randomized block design was followed with 4 replications.

Rice (Oryza sativa L.) - potato (Solanum tuberosum L.) - wheat (Triticum aestivum L. emend. Fiori & Paol.)-greengram (Phaseolus radiatus L.) system is the most remunerative among the tested sequences in eastern Uttar Pradesh. Sugarcane (Saccharum officinarum L.) is taken as a popular cash crop owing to its economical and ecological security.

Rice-wheat (Triticum aestivum L. emend. Fiori & Paol.) + Indian mustard [Brassica juncea (L.) Czernj. & Cosson]-greengram (Phaseolus radiatus L.) proved the most remunerative system with a net profit of Rs 12 178/ha/year and 1.07 cost : benefit ratio, whereas rice-wheat-fallow sequence showed the highest cost: benefit ratio. The highest cost of cultivation (Rs 17 337/ha/year) was incurred in rice-potato (Solanum tuberosum L.) + Indian mustard-blackgram (Phaseolus mungo L.) cropping system. This system also gave the highest employment opportunity and the highest rice-grain equivalent. The maximum removal of N, P and K was found in rice-maize (Zea mays L.)-maize + cowpea fodder [Vigna unguiculata (L.) Walp.] sequence. Positive apparent balance of N and P, and negative apparent balance of K was noticed in all the cropping systems except rice-maize-maize + cowpea (fodder), in which negative balance of N was found.

It was concluded that rice-wheat + Indian mustard-greengram cropping system gave high production and net returns, without much loss of fertility. An other alternative system, more productive and remunerative than the traditional rice-wheat system, is rice-potato + Indian mustard-blackgram. The sequence involving maize and rice both should be avoided in less-fertile soils.

114 92 - 4/157

Cropping systems

USA, field trials, intercropping, sunflower, mustard, yield performance, nitrogen, land equivalent ratio, water use

PUTNAM, O.H. and D.L. ALLAN

25. Mechanisms for overyielding in a sunflower/mustard intercrop.

Agronomy J., 84, 1992, pp. 188-194

The objectives of this study were to verify the occurence of overyielding and to examine patterns of N and water use as possible mechanisms for over-yielding in sunflower/mustard intercrops. Secondary objectives were to examine the effect of N fertilizers and intercrop structure (planting pattern) on intercrop resource use and yield advantage. It is hypothesized that the lack of competition between species for a significant resource (the competitive production principle) was a cause of previously observed advantages in this intercrop system.

Two intercrop patterns and sole crops of mustard (Brassica hirta Moench) and sunflower (Helianthus annuus L.) were planted in 1988 and 1989 on a silt loam soil to examine mechanisms for overyielding in this intercrop system.

A strip intercrop pattern where 2.28-m strips of sunflower (76-cm rows) alternated with 2.28-m strips of mustard (15-cm rows) was compared with a more intimate row intercrop pattern of 76-cm sunflower rows interplanted with four 15-cm rows of mustard. Nitrogen was applied at planting at 0 or 112 kg N ha-1 to whole plots, with planting patterns allocated to subplots in a split-plot design. Soil water content, nitrate N, and total N were measured at different locations and depths in the intercrop and sole crop patterns during the growing season.

Mustard rows adjacent to sunflower in the strip intercrop yielded an average of 61% more than sole crop rows. Sunflower rows adjacent to mustard in the strip intercrop yielded an average of 40% more than sole crop rows. Yields of both sunflower and mustard were lower in the row intercrop compared with respective sole crops. Land equivalent ratios ranged from 0.96 to 1.43 in the strip intercrop and were generally below 1.0 in the row intercrop. Application of N did not consistently affect

LER. Soil depletion patterns indicated that border rows of mustard obtained both soil water and N from the strips planted to sunflower at a time when demand for these reources by sunflower was low. Sunflower border rows obtained water and N from mustard strips later in the season.

Concluding, intercropping, although an inexpensive technology, is an intensification of management. In the sunflower-producing areas of the northern Midwest of USA, extensive management practices are more common.

Although previous studies confirm that strip intercropping of the two species potentially could increase yield, few producers are currently using this technique. This may be due partly to the minor crop status of both crops in this region, but other Cruciferae, such as canola (Brassica napus L. or Brassica campestris L.), are also candidates for this type of strip intercrop system with sunflower.

The strip intercrop used in this study was narrower than would be practical for equipment used currently in the sunflower-producing regions of the USA.

Other management practices, such as tillage, weed control, diseases, insects, harvesting, and timing of agronomic practices, must also be considered. Mustard is a crop that requires a fine seedbed, and sunflower, though less exacting, is compatible with mustard in this respect. Both crops are planted early, although sunflower could be planted later in a strip arrangement.

There is no evidence in the field trials that disease or insect infestation differed in the intercrops compared with the monocultures.

In summary, there are potential yield and land-use advantages for the practice of strip intercropping but not row intercropping of sunflower and mustard. Complementary use of water and N over time are implicated as causes of overyielding exhibited by both species in this pattern. The creation of border areas between species through strip intercropping resulted in areas of excess soil N and water (compared with sole crops) that could be used by border rows of the companion crop during critical times of development, producing a border row yield advantage. This overyielding could be applied to mechanized systems if cropping intensification is wanted.

1115 92 - 4/158

Cropping systems

Australia, field trial, intercropping, cassava, pigeonpea, agronomic practices, land equivalent ratio, crop productivity

CENPUKDEE, U. and S. FUKAI

26. Agronomic modification of competition between

cassava and pigeonpea in intercropping.

Field Crops Res., 30, 1992, pp. 131-146

The objective of the study was to gain better understanding of how competitiveness of component species in cassava intercropping is determined and modified by agronomic practice when a long-season crop (pigeonpea) is used in association. Two cassava cultivars of contrasting canopy size were used, in addition to the variation in time of sowing and plant density of pigeonpea, to vary further the competitive ability of cassava.

In all intercropping treatments, radiation interception by the combined canopy increased rapidly, and full ground was maintained up to pigeonpea harvest (ca. 100 days). When pigeonpea was planted simultaneously with cassava, it became taller than cassava and its canopy occupied most of the cassava interrow space. When it was sown 35 days later than cassava, then cassava cultivar MCol 1468, which was tall and had a large canopy, dominated pigeonpea almost completely, whereas the smaller cultivar M 19 occupied up to only about half the total interrow area. Pigeonpea at high plant density (based on four rows between cassava rows) had similar height to that at low density (based on two rows), but its canopy occupied more interrow space and enhanced its competitiveness. The canopy width during the time of the complete ground cover was directly related to total dry-matter production and partial land equivalent ratio (LER) for economic yield of each component crop. However, cassava LER was more sensitive to reduced cassava canopy width than was pigeonpea LER, and higher total LER was obtained when a large cassava canopy width was maintained.

The results suggest that when cassava is intercropped with a crop of high competitiveness, agronomic management should be adopted so that the cassava canopy is taller than or about the same height as the associated crop and it occupies most interrow space.

The results also suggest that for high total LER of economic yield, the cassava/pigeonpea intercrop should be managed so that a wide cassava canopy is maintained when the ground is fully covered. This is because cassava LER is more sensitive to reduction in its canopy width than is pigeonpea LER. It appears that when pigeonpea dominates and cassava canopy widths is reduced, tuber growth is reduced.

It is therefore concluded that a vigorous cassava cultivar and late sowing of pigeonpea at a low density can sustain the desirable canopy width and competitiveness for high productivity of cassava/pigeonpea intercropping.

1116 92 - 4/159

Cropping systems

Africa, Nigeria, savanna, study, white Guinea yam, minisetts, production systems, economic evaluation

KALU, B.A. and P.O. ERHABOR

27. Production and economic evaluation of white guinea yam (dioscorea rotundata) minisetts under ridge and bed production systems in a tropical guinea savanna location, Nigeria.

Trop. Agric. (Trinidad), 69, 1, 1992, pp. 78-82

The objective of this study was to assess quantitatively the production and economic efficiency of D. rotundata (cv. Dan Onitcha) minisetts under two production systems - planting on ridges and on raised (flattened top) beds - with the view to evolving an additional technological package that would enable yam growers to produce both marketable ware yams and seed yams simultaneously from minisetts in quantity.

Studies in Nigeria have shown a high potential and suitability of use as minisetts in rapid seed yam multiplication.

Though the minisett technique has been developed for the rapid production of seed yams, farmers preferred its use for the simultaneous production of seed and ware yams.

The productive and economic attributes of a local variety, Dan Onitcha, of white Guinea yam (Dioscorea rotundata Poir.) minisetts were assessed under two production systems - planting on ridges and on beds at the same plant population density of 40 000 stands ha-1 during the 1987 to 1989 production seasons. The bed system improved emergence percentage (E% by 11, stand establishment by 18% and gave 28% increase in total tuber production over the ridge system.

An average of 67% of total harvested tubers were classified as ware yams (401-3000 g) under the bed system, and 77% as seed yams (less than 400 g) under the ridge system.

Based on gross margin analysis, the economic returns from the bed system was 275% more than returns from the ridge system, due in part to the high proportion of the more valuable ware yams realized from the bed system.

The results from this study suggest on technical grounds that farmers could use the ridge system if the priority is to produce only seed yams and to use the bed system if the decision is to produce only ware yams.

Overall, the bed system was superior to the ridge in producing both seed and ware yams.

Gross margin analysis of the two production systems indicate a high level of profitability of both. The analysis further showed clearly that the bed system was more economically efficient than the ridge system.

On both technical and economic grounds, the bed system was superior to the ridge system.

1117 92 - 4/160

Cropping systems

Latin America, Brazil, field trials, intercropping, cassava, maize, beans, evaluation, smallholder, farming systems, land equivalent ratio, fertilization

ZAFFARONI, E. et al.

28. Evaluation of intercropping cassava/corn/beans (phaseolus vulgaris l.) In northeast Brazil.

J. Agronomy & Crop Science, 167, 1991, pp. 207-212

The objective of the study was to test different sole and intercropping systems with cassava, corn, and beans (Phaseolus vulgaris) at two technological levels: traditional and one considered improved with use of fertilizer (N, P, K).

The treatments were repeated four times in a randomized block design in a factorial arrangement, with and without application of fertilizer (at rates of 50 N, 20 P205 and 30 K20 kg/ha at planting).

The soil was prepared by tractor in ridges 1 m apart.

Yield and yield components were taken in all crops.

All the data were analyzed statistically. The crops were adequately protected from insect pests, diseases and weed infestation.

The Northeast Region of Brazil grows 51% of the country's cassava, the greatest amount being produced in the region with an average annual rainfall of 650-1000 mm.

Intercropping is a major farming system in Northeast Brazil. Cassava is grown in two or three associations, probably to reduce the risk of harvest loss by a prolonged absence of rain and to improve the intensive use of a small area and family labor force. It is usually intercropped with beans and corn, and sometimes with cotton, rice, tobacco, coco palm, rubber trees, and Opuntia sp. (forage cactus). In the typical multiple cropping association in this area, advanced agricultural practices such as selected cultivars, pest and disease control, and the use of fertilizer, are not used.

Yields of beans were not affected by either intercropping systems or fertilization. Yields of corn and cassava were affected by intercropping systems, fertilizer, and cropping systems x fertilizer interaction. LER values were significantly different among cropping systems.

Growing three crops together was considered more attractive to the small farmers. Besides the greater advantage regarding the land use, this cropping system would have greater income and give different kind of nutrients to the farmers.

The use of fertilizer did not significantly enhance the advantage of intercropping when analyzed through LER. This indicates that the advantage of intercropping is not improved by the addition of nutrients.

1118 92 - 4/161

Cropping systems

Asia, Taiwan, study, field trial, sweet potato, legumes, varieties, planting dates

AVRDC

29. Intercropping of sweet potato and legumes.

In: AVRDC Progress Report 1990, pp. 240-243; ISSN 0258-3089; AVRDC,

P.O.B. 205, Taipei 10099

This study evaluated different leguminous crops and examined their planting time relative to that of sweet potato to increase the productivity of sweet potato-based intercropping systems.

Two soybean varieties (AGS 66 and AGS 129) one vegetable soybean (AGS 292), one mungbean (VC 3890 A) were intercropped with sweet potato (TN 67) on two relative planting dates.

This trial was carried out in late spring to compare with results from previous trials in different planting seasons and to determine the relationship between environment and agronomic management of these intercrops.

The climatic conditions during this trial was from a dry cool toward a hot-humid season.

Results of light interception clearly indicated that the mungbean canopy developed slowly compared to other crops. Thus, sweet potato growth, in terms of light interception after the legumes' harvest was less affected by mungbean than soybean. Vegetable soybean sown nine days after sweet potato reduced light interception of sweet potato less than that sown on the same days as grain soybean sown at either date.

The results show that there were significant effects of genotypes, and relative planting dates of legumes on sweet potato yield and the combined yield. Planting of legumes nine days after sweet potato transplanting substantially reduced the competition between legumes and sweet potato. Among legumes, mungbean was dominated by sweet potato because of its slow initial growth. Mungbean was more suited for intercropping with sweet potato than other legumes. Results of the combined yield indicated that late planting in spring is not suitable for sweet potato-legume intercropping compared to that in other planting seasons in previous trials.

It can be concluded that sweet potato-legume intercrop performed better in cool dry than in hot wet season. If it is adopted across dry and wet seasons, planting should begin in wet season with maturity in the dry season. To maximize the yield advantage of intercrops, suitable genotypes and appropriate relative planting time should be identified.

Component crops when intercropped usually compete with each other for growth resources such as light, nutrients and water. To minimize this competition and increase production, appropriate cultural practices such as choice of genotypes, plant populations and spatial arrangements and relative planting time should be adopted.

1119 92 - 4/162

Cropping systems

Review, book, Africa, shifting cultivation, cassava, technology development, ecological system analysis, systems framework, socio-economic aspects

FRESCO, L.O.

30. Cassava in shifting cultivation. - a system approach to agricultural technology development in Africa.-

Publ. of Royal Tropical Institute, Amsterdam, Netherlands;

ISBN 90-6832-013-0; 1986, 240 p; price 39.00 Dfl, Available: Publ. Departm., Royal Trop. Institute, Mauritskade 63, 1092 AD Amsterdam, Netherlands

Cassava is the most important staple food crop in Zaire, where both tubers and leaves are used, the former being the major source of energy and the latter a major source of protein, vitamins and minerals. Cassava plays an important role in the agricultural systems in Zaire.

Through a case study of cassava production in the Kwango-Kwilu region of central Zaire, this book provides a systems approach to agricultural technology development in Africa. In the region studied, cassava production has increased considerably over the last thirty years, keeping pace with or even surpassing population growth.

The author reviews the evolution of cassava production in the region, and its agronomic effects. Cassava, cultivated as a key component of a shifting cultivation system, allows great flexibility in cultural practices. The expansion of cassava onto marginal soils, the increased presence of cassava in crop rotations and associations, and the reliance on female labour explain much of the production growth. At the same time, however, cassava yields have declined and the shifting cultivation system is rapidly breaking down. Past and present research efforts on cassava are discussed with a view to determining strategies for agricultural technology development.

The relevance of this study lies in its detailed analysis of changes in shifting cultivation as well as in its method of analysis. It draws upon ecological system analysis and, to a lesser extent, on farming systems research, and presents a systems framework that allows the integration of technical and socio-economic aspects of crop production which has wide application.

There is certainly a need for greater research in areas such as postharvest handling and processing of cassava in order to find better ways of utilizing the crop at village and farm levels. This is an area that IITA will concentrate on in future as part of a strengthened commitment to cassava research in the humid tropics.

1120 92 - 4/163

Cropping systems

Africa, Nigeria, humid zone, field trials, intercropping, yam, maize, stake densities, production costs, economic returns

NDEGWE, N.A.

31. Economic returns from yam/maize intercrops with

various stake densities in a high-rainfall area.

Trop. Agric. (Trinidad), 69, 1992, pp. 171-175

The main objective of the study was to assess the effects of producing yam and maize under intercropping with a reduced stake population ha-1 without materially affecting their yields, and to determine the stake population ha-1 that gave the highest net economic return.

The profitability of producing yam (Dioscorea rotundata Poir.) with 0-5000 stakes ha-1 when intercropped with maize in a high-rainfall area in Nigeria was examined. Yam and maize populations used were 10,000 and 20,000 plants ha-1, respectively.

The high cost of producing yam in the forest zone of West Africa discourages farmers from increasing areas cropped with yam. The high production cost arises mainly from the cost of planting material (seed yam), the cost of stakes and a high labour requirement.

In this study tuber yield and weight tuber-1 decreased with lesser numbers of stakes ha-1. No changes occurred in maize grain and stover yields or in height and girth plant-1. Production cost was highest with 5000 stakes ha-1 and lowest in unstaked yams. Cost of staking decreased with fewer stakes ha-1, being 27, 17, an 13% of total production cost with 5000, 2500 and 1666 stakes ha-1, respectively. Trailing six stands stake-1, gave the best net return (48%) in sole yam but two stands stake-1 gave the best (22.4%) in intercropped yam, making the best net cash return in sole-cropped yam twice as profitable as a yam/maize mixture.

It is concluded that stake population density is an important factor affecting yield and net cash return in a yam/maize mixture, in addition to other factors.

If yam is to be cultivated with maize, as is practised by most farmers in this area, then not more than two stands should be tied to a stake.

When yam is intercropped with maize, the expected best net return will be only about 50% of that of sole yam trailed six stands stake-1, demonstrating that it is more profitable to grow yam as a sole crop in the environment than in mixture with maize.

Intercropping unstaked yam with maize did not affect the yield of yam.

The yam vines were expected to climb the maize stems and eventually tap more light to give a higher yield than sole, unstaked yam. Most yam vines in unstaked yam plots with maize did not climb the maize stalks.

This shows the need for the common practice of trailing yam vines to stakes to be adopted.

An appropriate stake population ha-1 or an intercropping system must therefore be used to produce yam tubers of desirable commercial size.

Medium-sized tubers are now generally preferred to big tubers by buyers because big tubers are often more prone to spoilage in storage from injuries sustained at harvest in this high-rainfall area and also because big tubers cost more than an average buyer can afford.

This study further demonstrates the high cost of producing yam, mainly from the high cost of planting material, stakes and labour.

Stake population ha-1 can be reduced in sole or intercropped yam without adversely affecting yield; such reduction is therefore a good area for reducing production cost and hence increasing profitability in yam cultivation.

1121 92 - 4/164

Cropping systems

Latin America, Colombia, savannas, associations, legume, grazing effect,

CIAT

GROF, B.

32. Performance of three centrosema spp. And pueraria phaseoloides in grazed associations with andropogon gayanus in the eastern plains of Colombia.

Trop. Agric. (Trinidad), 68, 4, 1991, pp. 363-365

The most important factor limiting animal production in the vast savannas (Llanos and Cerrados) of tropical America is the poor nutritive value of native grasslands and monospecific sown grass pastures. A fundamental approach in correcting these nutrient deficiencies is to establish improved pastures that are based on tropical legume and grass mixtures.

Over a three-year period, Centrosema acutifolium CIAT 5277, C. arenarium

CIAT 5236, C. macrocarpum CIAT 5065 and Pueraria phaseoloides CIAT 9900 were evaluated under grazing. Each legume was associated with Andropogon gayanus cv. Carimagua 1.

The experiment was conducted in Eastern Plains of Colombia.

The experiment was sown on a prepared seedbed in June 1982. There were two replicates of the four pasture treatments in a randomized complete block design.

The two replications were grazed separately by five criollo x zebu cross-bred heifers which was equivalent to two animal units ha-1 for seven consecutive days. The plots were then rested for 42 days during the dry season and a rotation was employed during the wet season.

The persistence of C. acutifolium was attributed to its stoloniferous growth habit. This legume exhibited tolerance of grazing and drought and has resistance to pests and diseases. The four legumes evaluated under grazing failed to produce soil seed reserves for recruitment of new plants and this contributed to the general decline in legume contents.

Pueraria phaseoloides (Roxb.) Benth. showed poor tolerance of drought and C. macrocarpum Benth. was adversely affected by grazing and low soil fertility. C.arenarium Benth., the least palatable species in the experiment, has proved to be unsuitable for grazing utilization.

It can be concluded that under the management treatments superimposed on the experiment, regeneration of legume from soil seed reserves has not occured in any of the grass-legume associations, and this contributed to the general decline in legume contents.

Of the legumes evaluated, only C. acuticolium has a stoloniferous growth habit, and its persistence and tolerance of grazing was attributed to this trait. This legume has tolerance of drought and has excellent resistance to pests and diseases.

1122 92 - 4/165

Cropping systems

Asia, India, field trial, intercropping systems, mulch, barley, lentil, flax, yield, irrigation

MANDAL, B.K. and S.K. MAHAPATRA

33. Barley, lentil, and flax yield under different intercropping systems.

Agronomy J., 82, 1990, pp. 1066-1068

This study was conducted to determine the productivity of intercrops, barley + lentil and barley + flax as compared to monocrops of barley, lentil and flax as influenced by the level of irrigation and mulch.

Six-rowed barley (Hordeum vulgare L.) was intercropped with lentil (Lens culinaris Medik) and flax (Linum usitatissimum L.)

with two levels of irrigations [(i) zero and (ii) one irrigation applied 35 d after planting] and two levels of mulch [(i) no mulch and (ii) rice straw mulch at the rate of approximately 7 Mg/ha-1]. Monocrop of each species were also grown.

Information on intercropping of barley with lentil and flax is very limited. Barley, lentil and flax are grown under rainfed conditions with limited water supply. Productivity per unit area could be increased through the use of suitable crops with higher yield stability and appropriate intercropping. In the winter dry season the amount of irrigation water available is very limited and in some areas only a single irrigation may be available. Limited irrigation of crops like barley, lentil, flax and conservation of water with mulches may make the difference between an uneconomical and an economical crop yield.

In this study the seed yield of the monocrops were higher than their intercrop yields. Intercropped barley yielded 73 to 81%

of the yield to monoculture. Intercropped lentil yielded 30 to 34% of the yield of monoculture, whereas intercropped seed yield of flax ranged from 27 to 31% of monoculutre. Yield increased from one application of irrigation ranged from 12 to 21% of zero irrigation. The increase in yield due to straw mulch was 11 to 17% higher over no mulch. The barley-lentil intercrop recorded higher values of land equivalent ratio (LER) and monetary advantage (MA), and had higher intercropping advantage of area time equivalent ratio (ATER) than the barley-flax intercrop.

This study indicated that in areas having no irrigation, straw mulch could be utilized for conservation of soil moisture which can increase yields of crops like barley, lentil and flax. One irrigation along with straw mulch was found to be the best for all these crops. Barley + lentil intercropping was preferable to barley + flax intercropping in the study area.

1123 92 - 4/166

Cropping systems

Asia, India, field trials, dryland, intercropping, oilseed, pulses, safflower, biological potential, economics

RAFEY, A. and N.K. PRASAD

34. Biological potential and economic feasibility of intercropping oilseeds and pulses with safflower (carthamus tinctorius) in drylands.

Indian J. of Agric. Sciences, 61, (12), 1991, pp. 893-897

An experiment was conducted to explore the feasibility of growing 3 other oilseeds as well as a pulse crop in association with safflower at different row spacings.

The experiment was conducted during the winter seasons of 1985-88. The soil was clay-loam with 25.5% clay, having low water-holding capacity.

The treatment of 3 row spacings (40, 50 and 60 cm) of sole 'A 300' safflower and 4 pure crops.

These were intercropped with safflower at 40, 50 and 60 cm row spacings, comprising 19 treatments. These were put in randomized block design, replicated thrice.

The low water-holding capacity and soil fertility along with low irrigation potential have compelled selection of a crop that could be suitable for growing under adverse situations in drylands. Safflower (Carthamus tinctorius L.) and some other oilseed and pulse crops, which are more drought resistant and have the capacity to grow well even under low soil-fertility conditions can be the ideal ones for a sustainable cropping system under dryland conditions. For increasing the production of oilseeds and pulses, intercropping of these crops may be a viable agronomic practice to take greater production from a unit of land during a cropping period.

In this study it was shown that although significant differences were noticed in yields under all the systems, sole chickpea gave the maximum grain yield (960 kg/ha), which was statistically equal to that of chickpea sown between 60 cm (900 kg/ha) and 50 cm (890 kg/ha) row spacings of safflower. The intercropping of linseed between 40 cm (860 kg/ha) and 50 cm (790 kg/ha) row spacings was also found statistically similar. It shows that narrow spacing of safflower is better for linseed and wide spacing for chickpea.

The individual yields of safflower were not significantly affected under the 2 narrow spacings (40 and 50 cm) with linseed and under all the spacings with chickpea, which were further evident from the partial land-equivalent ratio of safflower (0.66-0.81) obtained under these combinations.

The partial land equivalent ratio of intercrops, particularly of rapeseed (0.64-0.75), indicated their superiority in different associations with safflower. The overall land-equivalent ratio was the highest (1.34) under the association of linseed intercropped with 40 cm row spacing of safflower.

The relative crowding coefficient of safflower in associations with linseed and chickpea (KSi > 1) also indicated an advantage derived from safflower under these associations.

The sole crop of chickpea gave significantly higher net return than the other cropping systems. Intercropping of safflower with almost all the intercrops gave significantly better net return than sole safflower.

Intercropping of linseed between 40 and 50 cm row spacings and that of chickpea between 50 and 60 cm row spacings gave statistically equal net returns. The net return derived from investment per unit input further revealed the superiority of sole chickpea to the rest of the systems, which gave maximum net return/Reinvestment.

Pure chickpea gave very high net return (30.8%) compared with pure safflower. The net returns from intercroppings were negative compared with sole crops of linseed, rapeseed and chickpea.

The maximum monetary advantage was recorded in association of linseed sown between 50 cm and chickpea sown between 60 cm row spacing of safflower.

It was concluded that safflower may be intercropped with linseed at a narrow spacing (40 cm) and chickpea may also be intercropped with safflower at wider spacing (50 or 60 cm) to get greater advantage than sole safflower but not compared with sole chickpea and linseed.

1124 92 - 4/167

Cropping systems

Latin America, Colombia, CIAT, legumes, sole cropping, intercropping, cassava, marginal soils

HEGEWALD, H.B.

35. Screening of different tropical legumes in monoculture and in association with cassava for adaption to acid infertile and high al-content soil.

Beitr_ge trop. Landw. Vet. med., 28, 3, 1990, pp. 283-289

In this study 9 tropical grain legumes with 165 cultivars were screened or adaption to a low pH (3.9-4.1) and a high Al content in mococulture and in association with cassava.

In the monoculture experiment, the following grain legumes were tested: mung beans (Vigna radiata), cowpeas (Vigna unguiculata), pigeonpeas (Cajanus cajan), jackbeans (Canavalia ensiformis) as non-climbing, and winged beans (Psophocarpus tetragonolobus) and sword bean (Canavalia gladiata) as climbing species. The plot consisted of a double row 3.75 m in length, with a distance between rows of 0.6 m, and within rows 0.19 m.

In the mixed cropping experiments, the climbers winged bean and velvet bean were not tested, while soybeans (Glycine max) and non-climbing lima beans (Phaseolus lunatus) were added. The grain legume collection was planted in association with cassava (cv.CMC 84). 9 cassava plants were planted with one row of legumes on both sides. The fertility level of the plots was extremely low, only 500 kg/ha of lime was applied. The pH of the soil was even lower than in the monoculture screening experiment.

Good results have been obtained in multiple range cropping of cassava and common beans (Phaseolus vulgaris), but other tropical legumes, especially cowpea (Vigna unguiculata), are needed in cassava intercropping systems for climatic and soil conditions, under which beans do not grow well. This is the case on soils with low pH, low fertility, and high Al and/or Mn content, which are widely distributed in the tropics. An example of these conditions is the soil of the CIAT experimental station Quilichao in Colombia.

On this soil, common beans only grow when high levels of lime and fertilizer are supplied. Other legumes with tolerance of high levels of Al and Mn and low fertility show vigorous growth and high yield even at a very low level of purchased input. Although lower in nutritive value than common beans, their protein contents make them valuable complements to the high calorie producer cassava.

In this study with little or no fertilization the yields were low. The only acceptable yield was obtained from cowpea (Vigna unguiculata), averaging 1.1 t/ha in monoculture and 0,45t/ha in association with cassava. In the latter case, the cassava yield decreased by 26%. The other legumes - except for the velvet bean (Stizilobium derringianum) - were low yielding or without any yield, but some of them increased the tuber and starch yield of cassava.

It may be concluded that in selecting grain legumes for association with cassava, it is relatively safe to do this selection in legume-monoculture screening trials as a first step to eliminate materials with a low potential. Particularly on acid, infertile soils, the overriding factor will be that of adaption to adverse soil conditions; growth will be somewhat reduced and growth habits and therefore competition with cassava will not be serious. Nevertheless, legumes with intense early flowering (and maturity) appear to be most suitable, since early flowering reduces excessive vegetative development unfavourable for cassava yield formation, and early pod filling enables the legume to escape serious shading by cassava.

1125 92 - 4/168

Cropping systems

Asia, India, study, field trial, intercropping, peanut, pigeonpea, sunflower, finger millet, irrigation, planting geometrics, yield

SANKARAN, V.M. and G. KUPPUSWAMY

36. Intercropping studies in peanut (arachis hypogaea l.).

J. Agronomy & Crop Science, 168, 1992, pp. 34-36

With a view to study the effect of intercropping and plant geometrics in peanut cv. VRI-1, a field experiment was conducted at Area Agronomic

Centre, Tamil Nadu, India, during winter season 1989.

Three intercrops viz., pigeonpea, sunflower and finger millet were tested at two plant geometrics viz., paired rows of 40/20 cm and 45/15 cm.

Peanut is a major oilseed crop in India with an annual production ranging from 5 to 7.5 mt. over the last decade. With the increase in the cost of inputs like seeds, fertilizers and labour, there tends to exist a declining trend in monetary return from rising a pure crop.

Significant difference in pod yield of peanut among various treatments was observed. Intercropping with pigeonpea did not affect the pod yield of peanut significantly. Sunflower or finger millet as intercrop drastically reduced the pod yield of peanut. Plant geometrics, though influencing the growth characters, such as, plant height, LAI, failed to alter the pod yield. Larger competition free period of peanut and pigeonpea, and the potentiality of pigeonpea, by virtue of deep root system, to forage nutrients in deeper layers were attributable to less competitive effect of this intercrop on the base crop. In peanut intercropped with sunflower and finger millet, the growth, yield attributes and yield of the base crop, peanut, were greatly affected, obviously due to the competitive effect of these intercrops for light and nutrients.

When peanut kernel equivalent for different intercropping situations was considered, peanut intercropped with pigeonpea at 45/15 cm paired row registered higher equivalent yield of 2221 kg ha-1. Same treatment also recorded the highest net profit (Rs 13901 ha-1) followed by peanut intercropped with pigeonpea at 40/20 cm paired row (Rs 12633 ha-1).

Raising sunflower or finger millet as intercrops drastically reduced the net income over pure crop. Return per rupee invested was high (2.17) in peanut + pigeonpea at 45/15 cm paired row. Peanut intercropped with sunflower or finger millet recorded less return per rupee invested when compared to pure peanut.

1126 92 - 4/169

Cropping systems

Asia, India, field trial, intercropping, groundnut, rainfed conditions, oilseed crops, planting patterns

DAYAL, D. and P.S. REDDY

37. Intercropping of rainfed groundnut (arachis hypogaea) with annual oilseed crops under different planting patterns.

India J. of Agricultural Sciences, 61, (5), 1991, pp. 299-302

An experiment was conducted to evaluate the intercropping systems with oilseed crops, viz. sunflower (Helianthus annuus L.), sesame (Sesamum indicum L.) and castor (Ricinus communis L.) with groundnut by changing the crop geometry without reducing its plant population.

The experiment was conducted during the rainy seasons of 1986 and 1988.

The soil was clay loam, having organic carbon 0.96%, low available P (5.6 kg/ha) and medium available K (165.2 kg/ha). The experiment was laid out in randomized block design with 3 replications.

Groundnut (Arachis hypogaea L.) is grown mostly under rainfed conditions during rainy season. The wider spacing recommended for cultivation of groundnut made it possible to grow an intercrop with many other annual oilseed crops. Intercropping with groundnut increases production and monetary returns compared with sole cropping. Selection of proper plant geometry and compatible crops in an intercropping system is highly beneficial. With the availability of new high-yielding, short-duration varieties of oilseed crops having different types of canopy structure, it is possible to design the suitable intercropping system with groundnut.

In this experiment the intercropping system increased the oil yield (30.5%) and monetary returns (15.3%) compared with the sole crop of groundnut. By growing castor in the intercropping system, the maximum loss in yield was of groundnut pods (22.3%), followed by sunflower (14.8%) and sesame (9.4%). Irrespective of the cropping system and season, the paired-row planting consistently gave higher yield (23.4%) of groundnut than the normal planting.

Pooled data on monetary returns showed significant differences in both the years. Groundnut (paired-row) + sunflower recorded 18.8 and 34.3% higher returns than the sole groundnut planted under paired-row and normal planting respectively. Thus the study revealed that intercropping of groundnut (paired-row) with sunflower could be recommended for getting higher oil yield and monetary returns in the Saurashtra region of Gujarat.

1127 92 - 4/170

Cropping systems

Asia, Philippines, IRRI, field trials, intercropping, rice, mungbean, plant interactions

AGGARWAL, P.K. et al.

38. Resource use and plant interactions in a rice-mungbean intercrop.

Agronomy J., 84, 1992, pp. 71-78

The objective of this study was to compare above-and below-ground interactions between intercropped upland rice and mungbean, and to examine their effect on N uptake and crop productivity.

The yield advantage of any intercrop is attributed to below- and above-ground plant interactions. These interactions may be competitive, neutral, or complementary. The relative importance of below- and above-ground intercrop interactions is likely to vary depending upon the temporal and spatial differences in resource use by component crops.

In this study the authors used above- and underground partitions, residue removal, and plant removal to investigate the interactions between upland rice (120-d crop duration) and mungbean [Vigna radiata (L.) Wilczek, 65-d crop duration].

Nitrogen uptake by intercropped rice (33,4 and 41,1 kg N ha-1) approximated that of sole rice (35,4 and 38,1 kg N h 1). Intercropped rice yielded 73 to 87% of sole rice and intercropped mungbeans yielded 59 to 99% of sole mungbean. Root barriers did not affect rice N uptake or dry matter accumulation prior to the maturity of the mungbean, but reduced N uptake, dry matter, and grain yields substantially by the time of rice harvest. Sole rice with every third row removed at mungbean harvest had N, grain, and dry matter yields similar to the intercropped rice with every third row occupied by the legume. Sole rice with every third row vacant during the entire growing season yielded similarly (2.6 Mg h-1) to sole rice (2.3 Mg h-1) and intercropped rice (2.0 Mg h-1).

There was no evidence that N transfer from the legume to the rice increased N availability to rice above that expected with a sole rice crop with the same planting scheme. Rice yield compensation in the intercrop was apparently due to the increased soil volume for N extraction and increased aerial space available after mungbean harvest.

It can be concluded that above-ground interactions between the crop species were not important determinants of relative crop performance at row spacings used in this study. Below-ground crop interactions were found to be the dominant factors. When the root systems of the two crops were confined by root barriers, no effect was observed on mungbean yields, but rice N uptake and yield were reduced substantially.

The intercropping of a 120-d rice with a 60-d duration legume offers potential to better utilize space and nutritional resources in low input cropping systems.

1128 92 - 4/171

Cropping systems

Australia, field trial, intercropping, cassava, legume, component crops

CENPUKDEE, U. and S. FUKAI

39. Cassava/legume intercropping with contrasting

cassava cultivars. Part I

1. Competition between component crops under three intercropping conditions.

Field Crops Research, 29, 1992, pp. 113-133

In this paper, cassava/pigeonpea intercropping was examined under two growing conditions in which the competitive ability of pigeonpea was different. Cassava/soybean intercropping was examined in only one situation.

In the work reported in this series of two papers, various cassava cultivars were intercropped with either of two legume species to identify physiological and morphological characteristics of cassava which are suitable for different types of intercropping.

Seven contrasting cassava cultivars were grown in sole-cropping and in intercropping with soybean and with pigeonpea. In cassava/pigeonpea intercropping, time of pigeonpea sowing and plant density were altered in two experiments. In Experiment 1, four rows of pigeonpea were sown between cassava rows at cassava planting. In Experiment 2, two rows of pigeonpea or soybean were sown at 35 days after cassava planting.

In Experiment 1, cassava emerged later than pigeonpea.Canopy width of cassava did not increase once the cassava interrow was occupied by pigeonpea. Total dry-matter production of all cassava cultivars was severely affected in intercropping by the time of pigeonpea harvest.

Subsequent recovery was slow and final tuber yield in all cultivars was less than 25% of the corresponding yield in sole-crop.

When the competitive ability of pigeonpea was reduced in Experiment 2, only a short cassava cultivar was affected severely by pigeonpea, and its recovery was poor after pigeonpea harvest. Tall cultivars gradually became much taller than pigeonpea, and in most cultivars tuber yields were reduced by only up to 30%. The pigeonpea was almost completely suppressed by these cassava cultivars, and its seed yield was very poor.

It was concluded that the two species competed with each other for too long, and there was yield loss of cassava/pigeonpea intercropping over sole-cropping with any cassava cultivars, except one (MCol 1468) which was strongly competitive and produced a full cassava yield in intercropping.

This study has highlighted the need to develop intercropping systems that enhance productivity through the efficient sharing of resources (in this case, radiation). Excessive competition between component crops for the same resource can lead to unproductive systems.

1129 92 - 4/172

Cropping systems

Australia, field trial, intercropping, cassava, genotypes, soybean, pigeonpea, selection criteria

CENPUKDEE, U. and S. FUKAI

40. Cassava/legume intercropping with contrasting cassava cultivars. Part II

2.selection criteria for cassava genotypes in intercropping with two contrasting legume crops.

Field Crops Research, 29, 1992, pp. 135-149

In the work reported here, 18 diverse cultivars were used in sole-cropping, and in intercropping with soybean and pigeonpea. The objectives of this work were to determine if selection criteria could be developed using characteristics obtained in sole-cropping, and if these were different for different associated species.

An experiment was conducted to determine selection criteria for cassava genotypes for intercropping with legumes using 18 cassava cultivars which are contrasting in canopy size. Two legume crops were used; one a short-statured, quick-maturing soybean, and the other, a tall, late-maturing pigeonpea. They were sown at 37 days after cassava planting in double rows between cassava rows.

Intercropped soybean had little adverse effect on crop growth and tuber yield of cassava, and in some cases it enhanced tuber yield of cassava cultivars with small compact canopies.

The effect of cassava on soybean yield was least with short-statured, small cassava cultivars as solar radiation available to the soybean was highest. As the canopy development of cassava was hardly affected by soybean in any cultivars, the selection of cassava genotypes can be made in sole cropping with selection criteria of high tuber yield and narrow canopy width measured at about 90 days after cassava planting.

Intercropped pigeonpea had an adverse effect on canopy development and tuber yield of cassava, particularly of short-statured cultivars. Whilst tall cultivars with spreading canopy were least affected by pigeonpea,they reduced seed yield of pigeonpea to a very low level. It was therefore difficult to determine cassava types suitable for this intercropping.

The results of this experiment suggest that for cassava/pigeonpea intercropping, selection can be made in sole-cropping for high tuber yield and also for height which should be at least similar to that of the anticipated associated crop. Because of prolonged competition between the two species, the balance of competitiveness of the component crops can be easily altered by cultural modification. It is therefore important to identify competitiveness of component species using a few cassava cultivars under typical growing conditions for the intercropping before a large-scale selection programme is carried out.

1130 92 - 4/173

Cropping systems

Latin America, Costa Rica, CIAT, beans, varieties, resistence breeding, green revolution, traditional production systems

PACHICO, D. and A. VAN SCHOONHOVEN

41. A post-green revolution strategy for the

improvement of small farmer-grown common beans.

Trop. Pest Management, 35, (3), 1989, pp. 243-247

This paper outlines the post-Green Revolution strategy of the CIAT Bean

Program, then presents a case study from Costa Rica illustrating how it has worked in practice.

The Green Revolution's fertilizer responsive rice and wheat varieties had a major impact on production, but they created great controversy due to concerns about their adoption by resource poor farmers.

The short stature, highly tillering new rice varieties contributed to outbreaks of the brown planthopper in some Asian countries. The new varieties were selected for performance in favored conditions of high fertility and timely irrigation, situations that often failed to correspond to the reality faced by small farmers.

The CIAT Bean Program has focused on disease resistance breeding, with selection for performance under low input conditions and adaptation to farmers' current production systems. This strategy was chosen to make new bean technology more accessible to resource poor farmers in low income countries than had been the products of the Green Revolution approach of selecting for maximum yield under optimum high input conditions. A case study of adoption of new disease resistant bean varieties among small farmers in Costa Rica shows that the disease resistance strategy has resulted in varieties that improve productivity even in farmers' traditional shifting cultivation system. Many small farmers are finding it advantageous to intensify management in order to raise the gains from the new varieties. Such success in a disease resistance, small farm-oriented crop improvement program, depends critically on strong national agricultural research capacity, and a continuing commitment to deploy new resistance sources in locally adapted materials.

Gains made through the resistance strategy will necessarily remain vulnerable to being overcome by pathogenic variability or to newly emerging problems, but due both to the broad genetic variability upon which bean production is based, and also to the decentralized breeding strategy which targets specific genetic material to each particular production problem, production environment and grain type, such vulnerability will express itself only locally, and therefore ensure stable total production. A major part of the impact of CIAT's program may be the avoidance of substantial production reductions rather than the enjoyment of spectacular production increases.