Abstracts on Sustainable Agriculture

Compiled by Jürgen Carls

VOLUME 2

1989

Deutsches Zentrum für Entwicklungstechnologien – GATE

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PREFACE

This is the second GTZ publication to bear the title "Abstracts on Sustainable Agriculture".

These abstracts are more comprehensive than the usual type of annotated bibliography but they cannot substitute the original publication. For details we advise the reader to refer to the original.

We hope that the abstracts have a valuable role to play as part of the external input in the drafting of extension programmes. They make no claim however to offer tailor-made solutions. The responsibility for adapting the abstracts to suit local conditions rests with the reader.

Readers interested in the abstracts are asked to address their request to:

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Eschborn, June 1990

Jürgen Carls
Editor

Contents

GUIDE TO READERS

Selection of literature for the abstracts has been based on the following criteria:

- Ecological Aspects
  - . Sustainability
  - . Resource stability
  - . Soil fertility
  - . Diversity

- Socioeconomic Factors
  - . Promotion of smallholders
  - . Integrated systems (Animal-Man-Plant)
  - . Transfer of knowledge
  - . Low-external-input agriculture
  - . Sociocultural aspects

- Locational Factors
  - . Regional- and site-specific
  - . Practice-oriented
  - . Alternative uses

The abstracts are set up in the following way:

(1) Abstract number.

(2) Principal key-word: traditional land-use systems, cropping systems, agroecology, agroforestry, farming systems research and development etc.

(3) Key-words: if relevant, the geographical demarcation (continent, country) or the agroecological zone is given; the key words "review", "field trial", "field study" or "farm survey" indicate the nature of the paper; common names of field crops, soil fertility, pests, diseases, socioeconomic aspects etc. are used.

(4) Author's name.

(5) Title in the original language.

The subject index, based on the key-words, and the geographical indices are intended to help the reader to quickly find abstracts on specific aspects or areas of sustainable agriculture. The index of authors is intended to help the reader to find all publications by a particular author.

I. TRADITIONAL LAND-USE SYSTEMS

251 89 - 1/21

Traditional land-use systems
Review, traditional agriculture, sustainability, ecology, farming practices, appraisal
WOLF, E.C.
Mimicking nature.

Ceres No. 115, 20, 1, 1987, 20-24

Over the next 13 years, the world's population will increase from today's 5 billion to over 6 billion. Few analysts expect a significant increase in cultivated land by then. Merely maintaining current consumption levels will require a 26 per cent increase in the world's average grain yields. And by 2020, feeding the projected population of 7,8 billion will require grain yields 56 per cent higher than 1985 levels. Unlike past spectacular yield increases achieved under favourable cropping conditions, future improvements in average yields must come from raising the productivity of traditional farmers who cultivate unimproved crops under marginal conditions perhaps the most demanding challenge that national governments and the international development community have faced.
Subsistence farms around the world have certain common features. Farmers often mix different crops in the same fields to reduce the risk if a particular crop fails; they grow a variety of staple crops and vegetables to meet family food needs; and they rarely purchase artificial fertilizers or pesticides. It is not surprising that highyielding varieties of wheat and rice have been introduced to less than a third of the 423 million hectares planted to cereal grains in the Third World. For members of the 230 million rural households in Africa, Asia, and Latin America who use farming methods little different from those of their ancestors, green-revolution approaches will only be part of the answer.
Few researchers recognized the ecological and agronomic strenghts of traditional pratices that had allowed farmers over the centuries to maintain their land's fertility. In pursuit of higher productivity, many agricultural scientists overlooked the need for long-term sustainability.
Agricultural scientists have recently begun to recognize that many farming systems that have persisted for millennia exemplify careful management of soil, water, and nutrients, precisely the methods required to make high-input farming practices sustainable. This overdue reappraisal stems in part from the need to use inputs more efficiently, and in part from the growing interest in biological technologies. The complex challenge of Africa's food crisis in the early 1980s forced scientists to reexamine what peasant farmers were already doing. Many researchers today seek to improve existing farming systems rather than attempting to transform them in a major way.

Traditional farming systems face real agronomic limits and can rarely compete with high-input modern methods. It is important to recognize these limitations, in order to determine both how traditional practices can be modified and what such practices can contribute to the effort to raise agricultural productivity.
Traditional agriculture practised under biological and physical limitations often breaks down under growing population pressure. As rural populations grow, farmers try to squeeze more production from existing fields, often accelerating the loss of fertility. Or they may cultivate new, often marginal or sloping, land that is vulnerable to soil erosion and unsuited to farming.
None the less, traditional methods can make an important contribution to efforts to raise agricultural productivity. They use few external inputs, accumulate and cycle natural nutrients effectively, protect soils, and rely on genetic diversity.
The challenge for agricultural research is to improve agriculture in ways that retain the strenghts of traditional agriculture while meeting the needs of changing times.
Intercropping, agroforestry, shifting cultivation, and other traditional farming methods mimic natural ecological processes, and the sustainability of many traditional practices lies in the ecological models they follow. This use of natural analogies suggests principles for the design of agricultural systems to make the most of sunlight, soil nutrients, and rainfall.

252 89 - 1/22

Traditional land-use systems
Central America, Mexico, lowlands, traditional agriculture, ecology, subsistence farming, shifting cultivation, development
ALTIERI, M.A.
The modular systems in the Tabaşcan lowlands.

In: Agroecology - The Scientific Basis of Alternative Agriculture; Agroecology, 1050 San Pablo Ave., Albany, CA 94706, 1986, pp. 56-59

Various forms of subsistence farming are known to have been employed by the original Indian inhabitants of Tabasco, Mexico, and are thought to have achieved highly productive levels. Slash and burn agriculture was used for basic grain production (corn, beans), whereas extensive use of kitchen gardens (huertos familiares), composed primarily of tree crops and their associated understorey herbs, shrubs and vines, added great variety to the local diet. Cacao was produced as an understorey element in these kitchen garden systems and this crop has been expanded considerably using a plantation system which makes extensive use of legume shade trees.
In recent years the emphasis in agriculture in the Tabascan lowlands has been away from subsistence agriculture and towards commercial farming and stock-raising. Accompanying this shift towards commercial activities, a gradual abandonment of, traditional agricultural practices and varieties has taken place.

As part of a program to attempt once again to achieve the diversity and stability of productivity originally characteristic of the traditional agroecosystems of the region, production units were installed, referred to here as modular systems, whose primary focus centers around the application of ecological principles to agriculture with the incorporation of considerable empirical knowledge present in the region.
Each production unit consists of 5-15 ha controlled by several family units as part of their other agriculture activities. Depending on the social structure of the community, the families may actually live within each module or in a nearby community (ejido) and work in the module during the day. Thus production from each module would either be consumed directly by the families living there, or the products would be distributed to the members of the ejido. Any excess in production would be available for sale or exchange.
Each production unit has as part of its basic structural design an outermost band of vegetation consisting primarily of second growth species present naturally in the region. This band serves simultaneously as a windbreak, a source of natural predators and parasites for biological control, as well as a source of firewood and building materials. At the same time these shelter belts serve as biological reserves or germplasm banks for part of the great diversity of plants and animals normally present in tropical ecosystems. By selective species enrichment with forest and fruit tree species, it is possible to apply agro-silvicultural management practices, increasing the long term value of the shelter belt.
The interior part of each modular unit is constructed on the basis of the topographic diversity existent at each site. In cases where the lowest part of the module can be centrally located, large tanks are constructed which serve as catchments for all runoff from the production unit to collect dissolved nutrients and particles of soil and organic matter. Fish, ducks, and other aquatic animals are being produced in the tanks, with the aquatic plants and sediments being used as fertilizer in other parts of the module. Frequently small canals are built, radiating out from the central tank in order to further aid in the capture of excessive runoff. To avoid total inundation of the site, a principal canal can be built to eliminate excess water from the site, or in some cases, serve as a means of adding water in times of low rainfall.
Located around the central tank or along the edges of the water courses raised platforms (from 2,5 to 10 m wide and up to 100 m long) are constructed, often with the same material extracted from the catchment basins, forming a system of "tropical chinampas" for intensive vegetable production. The "chinampa" ist an ancient food production system extensively used by the Aztecs in the Valley of Mexico and by the Mayans in Southeast Mexico to exploit the swamplands bordering the local lakes. These systems still exist in many parts of Mexico. The Aztecs built chinampas up to a height of 0,5-0,7 m above water level and they reinforced the sides by posts interwoven with branches and by willow trees planted along the edges. The soil of the chinampas ist constantly enriched with

organic matter from the bottom of the reservoirs. Animals kept in small corrals, such as pigs, chickens, or ducks, are fed the excess or waste produce from the chinampas, as well as from other parts of the module, in order that manures can be incorporated back into the platforms for added productivity.
Around the areas of chinampas, the major part of the production of basic food crops traditional in the region is concentrated. According to the distribution of soil types, drainage, topography, and other physical characteristics of each site, a wide variety of annual and perennial crops are planted following the planting methods and combinations recommended by the peasants. This includes such systems as the local corn/bean/squash polyculture, cassava/corn/papaya, and fruit trees associated with various cover crops, shrubs, or vines.

253 89 - 1/23

Traditional land-use systems
South America, Chile, land-use, traditional farming systems, small scale systems, semi-commercial systems, crops, integrated systems
ALTIERI, M.A.
Traditional farming systems of Mediterranean Chile.

In: Agroecology - The Scientific Basis of Alternative Agriculture; Agroecology, 1050 San Pablo Ave., Albany, CA 94706, 1986,pp. 52-55

The farming systems of the small farmers (campesinos) of Mediterranean Chile are diversified systems. In these systems, the critical factor in the efficient use of scarce resources is diversity. Thus, campesinos assemble crops, animals and other farm resources to optimize production efficiency, nutrient cycling, crop protection, etc.
Although the manner in which campesinos assemble a particular set of farm resources varies from site to site, farming systems can be divided into two major groups: 1) small-scale intensive systems und 2) more extensive semi-commercial enterprises.
Small Scale Intensive Systems:
These systems rarely exceed 1 ha in size and the limited land area generally does not provide for all the food family requires. All items produced tend to be used for on-farm consumption. Missing resources have to be purchased with earnings from off-farm work. On these farms, campesinos typically produce a great variety of crops and animals, and it is not unusual to find as many as 10 tree crops, 10-15 annual crops and 3 to 4 animal species on a single farm.
The physical layout of these farms varies, but often they include, in addition to the tree and annual food crops, a sort of grapes ("parron") to provide shade, and fruit, herbs, medicinal plants and flowers. The typical animals of these farms are free ranging chickens and ducks, rabbits and occasionally a few pigs feeding on kitchen waste and crop residue. Intensified annual cropping usually involves the use of simple crop patterns (i.e., growing a set of annual crops only during the spring and summer), or more

typically crop sequencing (planting a second crop after the harvest of the first). In both crop patterns, campesinos may practice intercropping. Common intercropping systems include corn and beans, garlic and/or onion mixed with lettuce und cabbage, and corn-potatoes.
Extensive Semi-Commercial Systems:
The farms range between 5-20 ha in size. These systems are also diversified, but the crop and animal combinations are designed to increase production to yield a marketable surplus. With a larger area of land to work with, the campesino devotes much of it to more extensive activities such as pasture for livestock and grain cultivation. The additional land also affords more space for wood producing trees. In this way, nearly all of the household requirements are provided for on the farm.
Typically, the campesino grows crops preferred by the local community for commercial purposes. These crops, however, may entail relatively high risks. He hedges against this risk by growing several less valued and/or risky crops. Growing of beans, squash, potato or corn between rows of high value fruit trees (peaches, cherries, apples, etc.) is a good example.
The design of a 12 hectare farm about 10 km east of Temuco, in south Chile, is discussed where the campesino balanced his farm enterprises to provide for the needs of food, clothing, housing and capital. The farm consisted of an interplanted area of annual crops and fruit trees, a mixed orchard of fruit trees with rows of bee hives between the trees, approximately 5 ha of pasture, 2-3 ha of wheat and a stand of pine. From 26 bee hives he harvested 280 kg of honey/year, obtained 10-12 liters of milk per day from 3 cows, collected 10-11 eggs per day from his chickens, and from the wheat, supplied all of his flour for making bread. Pine trees were planted to provide for his wood requirements. The fast-burning wood was made into charcoal for cooking and heating and was also used in the construction of the house and barns. Guano from his animals and crop residues were collected in a compost pile for later use in crop fertilization.

254 89 - 1/24

Traditional land-use systems
Africa, review, traditional farming systems, Food plant
OKIGBO, B.N.
Broadening the food base in Africa: The potential of traditional food plants.

Food and Nutrition, 12, No.1, 1986, pp. 5-17

This paper reviews the potential for exploitation of African traditional food plants, in the context of traditional farming systems, the changes they have undergone, means to increase food production and appropriate measures to be taken, including international cooperation.
One important and widely accepted idea is that Africa developed two agricultural complexes: a seed agricultural complex,

characteristic of the savanna and involving the cultivation of grains and seed-bearing crops in open-field systems; and a "vegecultural" complex, peculiar to the forest regions and involving the growing of roots, tubers and cuttings in gardens rather than in fields.

Most tropical African livestock species were domesticated elsewhere or were introduced from North Africa and South-Eastern Asia. They include goats, sheep, chickens, pigs and ducks. Certain animals became adapted to specific ecological zones.

A simplistic model of traditional farms in tropical Africa consists of a pattern of fields at different distances and in different directions from the compound and/or homestead garden. Different methods of soil management and fertility maintenance are practised on each of the fields and in the homestead garden. The methods usually include fallows, clearance systems and production systems for varying numbers of crops and/or livestock according to prevailing practices, customs and the needs of the farmer. Each traditional farm is a complex of units or subsystems differentiated according to characteristic aspects of the production process.

The farm may be an enterprise and provide a livelihood for one or more individuals, but it usually supports a family unit in which some or all members may participate part or most of the time in farm work.

Farms are small: over 60 per cent range in size between 0.10 and 3.00 hectares. Farm size in savanna areas is usually larger than in the rainforest zone, perhaps as a result of high labour requirements in the latter for clearing, weeding and related tasks.

A diversity of farming systems exists, ranging from true shifting cultivation and nomadic herding to permanent settlement and intensive livestock production, such as modern poultry and dairy production.

In general, most of the traditional and transitional farming systems consist of shifting cultivation and related forest, secondary bush, woodland, thick and grassland fallows in respect of which varying periods of cultivation (two to five years) are followed by equally variable periods of fallow.

The second half of this paper discusses those changes which adversely affect food security and nutritional status in terms of increasing malnutrition in Sub-Saharan Africa. It also considers strategies for attaining meaningful levels of food self-sufficiency which should help to minimize that proportion of the food requirements that must be met through purchase with farm and/or non-farm incomes or through food aid.

Broadening the food base through greater utilization of indigenous food crops is one of the promising ways of increasing agricultural and food production in Africa within the strategies of increasing production per unit area and efficiency in the utilization of forest products and resources. Some indigenous food crops with developmental potential in the context of this paper are listed in a accompanying panel.

255 89 - 1/25

Traditional land-use systems
Central America, Mexico, sandy pits, study, traditional cultivation system
DEL AMO, R.S. et al.
The Tecallis: A traditional cultivation system.
In: Global Perspectives on Agroecology and Sustainable Agricultural Systems, Proc. of the 6th Int. Sc. Conf. of the Int. Fed. of Org. Agric. Movements, Univ of California, Santa Cruz, USA, 1988, pp. 433-443

As the sustainability of modern agriculture being increasingly questioned, studying and analyzing traditional cultivation systems has become more important. This paper describes a newly discovered cultivation system used along the banks of the middle Balsas River (Mezcala). Known as the Tecallis System (which means "holes" or Arenales (which means "sand culture"), this method is based upon efficient soil and water management, organic fertilizer, and intensive labour. The Tecallis System is an agriculture strategy developed for the dry season. The system is based on a high percentage of hand labour and represents a highly productive type of intensive agriculture.

In traditional Mesoamerican agriculture, two kinds of irrigation systems can be distinguished: those which require a hydraulic infrastructure and those which do not (the latter are termed "humidity cultivation" systems). In humidity cultivation, irrigation is accomplished through ditches and canal systems.

The basis of the agriculture system described in this study is the exploitation of the sandy soils that remain when the Balsas River level drops in the dry season (November to April). This system complements the other agricultural systems of these people in the following ways:

- During the rainy season, farmers cultivate maize and sesame seed fields on higher ground
- During the dry season communities carry out the arenales cultivation, which offers a subsistence base completely different from the maize-sesame seed system and includes vegetables, fruit, and flowers.
- Fruit tree orchards are tended in some sandy areas on the river bank.
- Tierra de sereno (night-dew culture), which uses moisture condensed during the night, is practiced during the months of September and October. This is developed on the lowlands of the river banks with maize sown for a second crop and watermelons grown between the maize plants.

The Tecallis System is ecologically sound because it efficiently uses water, natural fertilizers, space, and time; it does not rely on external inputs, and is based on diversity. The system facilitates intensive use of the environment through diversification in production and the profitable use of a seasonally specific and previously unexploited habitat. Diversity, soil protection, water conservation, and combination of species with different life cycles and from different habitats are

characteristics of the Tecallis System which integrate effectively into the natural ecosystem.
The Tecallis System has several socioeconomic advantages: farming occurs in the dry season when no other agricultural work is ongoing; certain crop species yield two or three harvests in one season; the system is highly appropriate for populations living in marginal river areas; while most food produced is consumed by the farmer's household, some surplus production is generated for barter or cash; and finally, this system provides food during the dry season, contributing to a stable year-round food supply in a region which is isolated from commercial large-scale food distribution.
Tecallis cultivation can be seen as a hydroponic system in that plants are cultivated in sand containing few nutrients to which natural fertilizers are applied. The rediscovery of techniques such as tecallis, a historical antecedent of hydroponics in ancient Mexico, is thus of great importance. Moreover, this system's advantage over modern and commercial hydroponics is that it does not entail any initial investment cost.

256 89 -1/26

Traditional land-use-systems
Africa, Nigeria, survey, agroforestry, homegarden, compound farm, germplasm conservation, tree improvement, land-use
OKAFOR, J.C. and E.C.M. FERNANDES
Compound farms of southeastern Nigeria: A predominant agroforestry homegarden system with crops and small livestock

Agroforestry Systems, 5, 1987, 153-168

This paper identifies the major components of compound farms and describes their uses, environmental variation, interactions and management practices. Prospects for and the implications of improvements to the system are examined.
Compound farms are a traditional land-use system that appear to have evolved with the shifting cultivation and bush fallow systems. Recent observations indicate the spontaneous establishment of compound farms by shifting cultivation seeking to establish land tenure alongside new roads.
Compound farms are found within the vicinity of homesteads and comprise numerous multipurpose woody species in intimate multistoried associations with annual crops and small livestock. The multistoried structure and species diversity allow almost complete coverage of the soil by plant canopies, thereby promoting soil conservation. Soil fertility is maintained by the use of household refuse, crop residues and animal manures.
The system has been recognized as a potentially sustainable form of land-use with possible applications for the entire humid tropics.
Several trees and shrubs are deliberately planted and managed on the compound farms for a variety of products or functions.

Goats, sheep and poultry are commonly kept for meat for sale or home consumption. Other animals occasionally kept include cattle and pigs. Livestock is fed with fodder from trees and shrubs, crop residues, grasses and herbaceous species growing in the compound farms or near fields. The animals are either confined in pens and stall-fed or tethered in fields. Trypanosomiasis is a major constraint to livestock rearing.
The number of crops decreases as the distance from the house increases. The highest diversity occurs on the compound farms and the lowest on the outlying fields. This minimizes the time spent visiting distant fields.
Vertically, several relatively distinct strata (canopy layers) can be distinguished in the compound farms. The lowest zone (0-1,5 m) comprises food crops like cocoyam, beans, cucurbits, okra and regeneration of overstorey trees and shrubs. The next zone (1,5-3 m) consists of cassava, maize, yams (on stakes) and castor. Next is the plantain/banana layer (3-6 m). Above this comes the fruit/vegetable tree layer (6-30 m +) comprising species for timber, fuelwood and cultural uses.
Due to different maturity periods, crop species are invariably planted and harvested at different times. Yams, for example, are planted before the onset of the rains, while maize and millet are planted a few months after the rainy season has begun. Cassava ist planted about four weeks after maize and harvested the following year. This diversified and continuous production of food is important not only nutritionally, but also because storage is difficult and post-harvest losses are high.
Numerous advantages are inherent in the multispecies, multistoried cropping systems like the compound farms. These include diversified production, risk minimization, enhanced labour efficiency, continuous production thereby minimizing post-harvest losses due to poor storage facilities, better nutrient cycling and nutrient use efficiency than in monocropping systems and good soil conservation due to continuous ground cover.
The biggest constraint of the compound farm or homegarden type of system is that it is perceived as a primitive form of subsistence land use. These view is common both on international and local levels of landuse policy and decision making and has resulted in little, if any, resources being devoted to the study and improvement of the system as a whole.
It is important that a well co-ordinated and systematic research programme is undertaken to obtain information relevant to enhancing the productivity and sustainability of the compound farms.

257 89 - 1/27

Traditional land-use systems
Africa, Rwanda, land-use, ecological farming, sustainability, gross margins, comparative study, economics
BENNETT, J. and R. PREISSLER
Traditioneller und Standortgerechter Landbau im Gebiet des Projet Agro-Pastoral Nyabisindu. Ein betriebswirtschaftlicher Vergleich der beiden Systeme.
(Traditional cropping and ecological farming in the area of the Agro-Pastoral Project of Nyabisindu. An economic comparison of the two systems.)

Projet Agro-Pastoral de Nyabisindu; Etudes et Experiences No. 10; GTZ Projet Agro-Pastoral de Nyabisindu, B.P. 70, Nyabisindu, Rwanda, 1987

The shortage of resources in many developing countries as well as the problems of a "high external input" agriculture, have led to an intensive search for ecologically sound land-use systems.
A model of land-use has been developed in the Agro-Pastoral Project of Nyabisindu, Rwanda which is more recognized not only within Rwanda but world-wide. In search for an alternative to the conventional European agriculture, methods of self-sustaining autochthon land-use systems have been combined with results of agricultural economy-research and adjusted to the local conditions of Rwanda.
Most important elements of methods are:
- Land contouring by integration of hedges, forage grasses and trees against erosion.
- Crop rotation with periodically returning green manuring,
- Manuring with compost, manure and mulch,
- Mixed cropping and
- Integrated livestock raising with fodder growing.

The activities have been tested on the experimental fields ("fermettes") of Nyabisindu and in model farms in the project area. First results and successes in the realization by the extension service give reason to believe that the way taken is the correct one.
The results of these tests accentuate the importance of a more intensive occupation with the economic aspects of ecological farming.
The present work tries to demonstrate the essential points for the economic evaluation of ecological farming by means of case studies received hitherto in Nyabisindu. The methodical main point of this work is to be seen in the expression and comparative interpretation of gross margins for traditional production methods as well as for those of ecological farming.
The data and calculating results used could serve as guide-lines for individual farm planning until the basis of research for ecological farming has been broadened.

258 89 - 1/28

Traditional land-use systems
Review, agriculture, sustainability, concept, traditional land-use, ecological farming, low-input systems, integrated pest management, alternative agriculture, environment, research needs
CARTER, H.O.
The agricultural sustainability issue: an overview and research assessment.

In: The Changing Dynamics of Global Agriculture; A seminar on Res. Policy Impl. for NARS; ISNAR/DSE/CTA, Feldafing, FRG, 1988, pp. 115-135

There is a growing and diverse literature based on agricultural sustainability - concerning its meaning, relevance as a concept in agriculture and development, and applicability for research planning and extension activities. Some confusion comes from the fact that the term has intellectual roots from different disciplines where it is used in a variety of contexts.
The term sustainable has long been used by resource managers with reference to the maximum harvesting of forests or fisheries consistent with the maintenance of a constantly renewable stock. Sustainability is the steady state when what is being used (harvested) is continually replaced.
Sustainability has been defined by some in terms of carrying capacity - the maximum population size that the environment can support on a continuing basis.
Other terms for agricultural sustainability include alternative, regenerative, low-input, ecological, environmentally sound, and organic agriculture. These terms are used by people interested primarily in alternative systems of farming that will feed expanding populations while minimizing potential negative effects, whatever they might be. Defining the negative effects essentially separates or categorizes the various proponents of sustainable agricultural systems. Some groups put primary emphasis on minimizing environmental damage and degradation. Sustainability becomes almost synonymous with stewardship of the earth.
Others want mainly to perpetuate a rural community system; community sustainability or maintaining viable rural communities becomes almost a goal in itself. Still others equate agricultural sustainability with food self-sufficiency while minimizing costs. Many advocate an energy-conservation agriculture - so much so that efficiency of the system is measured exclusively in terms of energy use. People require both safe food and water, which in turn, proponents argue, require an agricultural system that can operate ad infinitum with only meager dependence on external inputs. Thus, just as the term sustainability has differing dimensions in various contexts, the agricultural counterpart has social, ecological, economic, and emotional implications.
Summarizing, the paper discusses several meanings of agricultural sustainability, followed by a look at the current agricultural system and what the impetus is to change it. Then, the state of the art in research on low-input, sustainable farming systems is

discussed, what impediments there are for farmers to change from current agricultural production systems. Finally, change is more likely to be gradual than abrupt.

259 89 - 1/29

Traditional land-use systems
Africa, review, survey, semi-arid zones, natural resource management, forestry, range management, FAO
NIAMIR, M.
Traditional african range managment.

ILEIA, 5, 2, 1989, pp. 28-29

The pastoralist in Africa has developed principles and strategies for managing the natural resources in agreement with his variable physical environment and his social needs. Recently his situation had to face external pressures, such as crop expansion into high quality rangelands, nationalization of land by governments, population increase, indiscriminate water development, and a series of droughts, all of which have contributed to pasture shortages and land degradation.
In many areas the traditional system of management is no longer able to cope with the shortage of pasture, and instead is adding to the problem of land degradation. In addition, the traditional management knowledge is gradually being lost as more of the younger generation of pastoralists are attracted to urban areas. Yet the traditional system has developed an intimate knowledge of the environment and many successful techniques that could still be of use today.
A literature survey was commissioned by the Food and Agriculture Organization (FAO) of the United Nations, to collect details on traditional African natural resource management, and to evaluate the survival of traditional techniques and their potential for development in Africa. The study concentrates on four aspects: 1) the descriptive knwoledge of the physical environment (e.g. names of plants and soil types), 2) daily natural resource management techniques (e.g. which tree or pasture to use, when and why), 3) the social controls and organization of daily management (e.g. grazing controls), and 4) the socio-political structure of resource management (e.g. resource tenure issues). This article covers daily range and herd management techniques and the social controls on daily management.
Today many techniques are still in use, either in the original or a modified form, and can be incorporated into development projects. Development personnel in the field need to first consider whether the traditional techniques are still alive, for which they need the active assistance of the pastoralists in the planning, design and execution of the projects. In addition, these techniques cannot be revived without clarification of national land tenure laws, checks on crop expansion, official recognition of traditional socio-political organizations, greater incentives to young herders to stay on the range, greater sensitivity by

government officials and extension workers to the value of traditional knowledge, and a common, coherent national policy on the decentralization of natural resource management.

260 89 - 1/30

Traditional land-use systems
Latin America, Mexico, traditional farming, highlands, agro-ecosystem, mixed cropping, low-input system, sustainability, modern practices, integrated systems
BOROWITZ, S.
Lessons from a traditional agroecosystem.
The Cultivar, 7, 1, 1989, pp. 1-4

Increasing population pressures led the people of Tlaxcala, Mexico to expand their agricultural fields to include hillsides.
The farmers developed a unique agricultural system - canals associated with the terraced fields. Using this system - which incorporates nutrient cycling, crop diversity, and careful soil management - Tlaxcalan farmers have maintained the agricultural productivity of much of their soil without chemical pesticides or fertilizers.
Despite the long-term success of their traditional practices many Tlaxcalan farmers are abandoning them in favour of modern inputs and techniques, including synthetic pesticides and fertilizers, heavy machinery, and monocropping. This transition from a low-input, regionally adapted system to practices which do not emphasize the maintenance of soil structure and fertility threatens to deplete the area's fragile resource base and diminish the long-term sustainability of the system.
Traditional Practices:
The Tlaxcala region, located in the volcanic highlands 200 kilometers east of Mexico City, features intermittent, heavy rainfall, and alternating layers of clay soils covered by a thin protective layer of topsoil. Stripped of the topsoil, the underlying becomes hard and unworkable.
To control the runoff from the heavy rains Tlaxcalan farmers have developed a carefully designed system of sloping terraced fields, and built canals divided into catchment tanks, or cajetes, at the base of the terraces.
The cajetes, with an average capacity of 168.5 cubic meters per hectare, can trap up to 16.85 mm (0.65 in) of rain. As much as 24 mm (0.95 in) can fall in less than half an hour in this region, but the fields can also absorb some of the moisture.
The cajetes act as compost pits, trapping soil and leaf litter washed from upslope. Each year, the farmers dig out the cajetes and return the captured soil and composted vegetation to the terraced fields. Combined with manure from livestock and humans, as well as rotations of legumes, the soil and compost from the cajetes have provided a good portion of the nutrients and organic matter necessary for the system to remain productive over three thousand years of cultivation.

The diversity of both crop and non-crop plants plays a major role in maintaining the system. To meet their dietary needs, Tlaxcalan farmers traditionally plant intercrops, emphasizing corn/bean/squash. This kind of mixed cropping has been shown to use both soil nutrients and solar energy more efficiently, as well as suppress weeds and discourage pests, leading to a greater total harvest. In addition, farmers plant several seed varieties of each crop to insure success of at least one of each type in the variable climate. Through this traditional practice of seed selection, seeds especially adapted to regional conditions have developed.
The typical practice of leaving the areas around cajetes as permanent border space, where agave, cactus, fruit trees, native shrubs, and a variety of annuals thrive, ensures that regional plant diversity is also maintained.
The border plants provide food, fuelwood, and fodder, and provide food and shelter for beneficial insects that prey on and parasitize harmful insects. Trees along the border also control wind erosion and circulate nutrients from the deeper soil strata; nutrients are transferred to leaves, which eventually decompose and make nutrients available to crop plants.

<u>The Impacts of Modern Practices:</u>

Although the terrace/cajete system has traditionally produced more than enough food for the community, farmers are beginning to abandon it, due in part to pressures from a variety of sources - including government, banks, agribusiness interests, and export organizations - which promote modern high-input methods. To raise national production levels, Mexican agricultural policy encourages standard input-intensive systems using tractors, hybrid seeds, and synthetic chemical fertilizers and pesticides.
The scenario on Tlaxcalan farms has begun to change. To receive government aid and bank loans, farmers must monocrop using seeds produced under "ideal" conditions. These seeds, developed on farms with precise irrigation and fertilizers, and protection from wind and pests, are not appropriate for highland conditions. Monocropping leaves the crops vulnerable. To compensate, farmers begin to rely on government-subsidized pesticides.
To provide fields for the growing population, the government also subsizides the construction of tractor-built terraces. Existing fields are combined into larger plots, and new terraces are created on land that may be inappropriate for long-term agricultural use. Since these new terraces lack cajetes, which would collect nutrients, farmers find they need synthetic fertilizers to maintain soil fertility.
Even though high-input methods are a faster and less labor-intensive way to raise production in the short term, they cost more money, require more energy from fossil fuels, and can degrade the ecosystem.

<u>Integrating Traditional and Modern Practices:</u>

Mexican agricultural policy could promote proven traditional agricultural practices, such as those of the Tlaxcalans', in addition to appropriate "Green Revolution" methods. That's where development projects should begin."

The Mexican government could developed seeds selected for local conditions, and could encourage diversity, rather than monocropping. New terraces could allow for tractor access yet still include cajetes. And instead of subsidizing fertilizers and chemical pesticides, the government could use the same money to buy animals to provide not only manure, but meat and milk.
The Tlaxcalan methods can apply to most slope agriculture where soil and water conservation is essential.
A combination of resource-conserving, traditional methods and current scientific knowledge may provide increased productivity while still protecting the natural resource base.

261 89 - 1/31

Traditional land-use systems
Africa, Sub-Sahara, review, traditional systems, rotations, shifting cultivation, cropping systems, farming systems, ecology, sustainbility
OKIGBO, B.N.
Cropping systems and rotations development for improving shifting cultivation and related intermittent production systems in tropical Africa.
In: Improved Product. Systems as an Alternative to Shifting Cultivation, FAO Soils Bulletin 53, ISBN 92-5-102 121-X, Rome, Italy, 1984, pp. 121-140

This paper considers criteria for selecting suitable farming systems for different ecological zones and suggests more efficient cropping systems and rotations by integrating traditional with new technologies. It also presents examples of improved cropping systems with recommendations for integrating them into planned rational land use supported by research.
Traditionally, Africa has not been a major food importer; the food self-sufficiency ratio was much higher in the 1960s (98%) than in 1981 (88%). Yields per hectare are lower in Sub-Saharan Africa than elsewhere and whereas yields elsewhere have increased during the last decade, in Africa they have generally either been decreasing or have remained constant. It is, therefore, not surprising that studies agree on the poor performance of agriculture and on a gloomy future for food production in Sub-Saharan Africa.
In efforts to solve this problem, traditional farming systems have become increasingly outmoded because of such modernization pressures as rapid population growth, high rates of urbanization, rising incomes, and a demand for convenience foods produced outside Africa.
To overcome these low production rates in tropical Africa the following recommendations are given:
- The highest priority should be given to cooperative international and regional efforts to help African countries develop their own research especially that seeking alternatives to shifting cultivation and related fallow systems.
- Land development and soil management benchmark and technology

transfer activities of the IARCS and other international institutional efforts should be strengthened financially and in their national and regional manpower development programmes.
- Although some improvement is being made in the design and development of management principles for cropping systems in drier areas, progress in solving similar problems in the humid and subhumid tropics has been very slow. Crops there include several species not yet affected by the Green Revolution; more serious effort should be devoted to designing cropping systems and developing management principles for the humid tropics.
- In countries of tropical Africa which are not producing enough food to meet current demand, high priority should be given to: (a) strategies to increase productivity through more efficient cropping systems and rotations, (b) ways to maximize irrigation benefits including watershed development, especially in the drier areas, and (c) significant increases in the use of valley bottoms and hydromorphic soils especially in rice production for which a possible two million hectares is potentially in tropical Africa.
- Most African countries faced with problems in food production are giving priority to achieving self-sufficiency and to producing food commodities that are currently being imported. In all these efforts, primary emphasis should be placed on those resources, crops, soils, etc. which will give maximum returns per unit input; those of medium potential should be developed secondarily and lastly those with low or marginal potential. In tropical Africa this is not the case, where much effort and many resources are being devoted to production in marginal areas.

262 89 - 1/32

Traditional land-use systems
Tropics, developing countries, review, traditional systems, small-scale farmers, diversity, ecology, sustainability, nutrient cycling, diseases, pests, weeds, productivity, agroforestry
ALTIERI, M.A.
The significance of diversity in the maintenance of the sustainability of traditional agroecosystems.

ILEIA, 3, 2, 1987, 3-7

The ethnobotanical knowledge of certain traditional farmers is so elaborate that the Tzeltals, P'urepechas and Yucatan's Mayans of Mexico can recognize more than 1200, 900 and 500 plant species respectively.
Hanunoo swidden cultivators in the Philippines can distinguish over 1600 plant species.
Therefore a striking feature of traditional farming systems is their degree of plant diversity in time and space in the form of polyculture and/or agroforestry patterns.
Peasants knowledge about soils, climates, vegetation, animals and ecosystems usually results in multidimensional productive strategies which generate, within certain ecological and technical

limits, the food self-sufficiency of farmers in a region. For agroecologists interested in the development of sustainable agricultural systems, there are several factors of traditional agriculture as well as aspects of traditional knowledge that are relevant. By understanding the features of traditional agriculture, such as the ability to bear risk, biological folk classifications, the production efficiencies of symbiotic crop mixtures, etc., it is possible to obtain important information which may be used for developing appropriate agricultural strategies more sensitive to the complexities of agroecological and socio-economic processes, tailored to the needs of specific peasant groups and regional agroecosystems. It is difficult to separate the study of traditional agricultural systems from the study of the cultures that feed them. For this reason researchers must deal with both the complexity of the production systems as well as with the sophistication of the knowledge of the people that manage them. Such complex studies require the participation of social scientists interacting with agronomists and other biologists.
In this paper the roles of diversity in agroecosystem function is discussed:
- diversity and nutrient cycling
- diversity and insect populations
- diversity and plant diseases
- diversity and weed populations
- diversity and productivity
- diversity and sustainability

In essence, the performance of the total system is dependent upon the level of interactions between the various farm components. Systemdriving interactions are those direct interactions where products or outputs of one component are used in the production of another component.
The subsidizing of a peasant agricultural system with external resources (pesticides, fertilizers, irrigation water) can bring high levels of productivity through dominance of the production system, but these systems are sustainable only at high external costs and depend on the uninterrupted availability of commercial inputs. An agricultural strategy based on a diversity of plants and cropping systems can bring moderate to high levels of productivity through manipulation and exploitation of the resources internal to the farm and can be sustainable at a much lower cost and for a longer period.

263 89 - 1/33

Traditional land-use systems
Latin America, Mexico, study, agroecosystems, traditional agriculture, productivity, crops, soil fertility, plant protection, sustainable agriculture, ecology, research needs
JIMÉNEZ-OSORNIO and SILVA DEL AMO R.
An intensiive mexican traditional agroecosystem: The Chinampa

In: Proc. of 6th Int. Conf. of IFOAM, California, USA, 1988, pp. 451-462

This paper describes a study of the chinampas in San Andrés Mixquic, Méxcico D.F. The objectives of the study were to: describe the current status of the chinampas; determine changes in the basic elements and practices of the peasants from 1971 (the date of the oldest records) to the present; recover and understand the ecological basis and interactions involved in the chinampa system in order to utilize them in the design of sustainable agroecosystems; and propose research areas necessary to understand the ecological mechanisms and interactions involved in the system.
Traditional agriculture in Mexico has led to the development of complex agroecosystems characterized by high levels of production. The chinampa agricultural system, represents the pinnacle of Pre-Hispanic - technology in Mesoamerica and still functions today. The word chinampa, meaning "net of branches," is derived from the Nahuatl language. Both the Nahua and the chinampas were once part of the Aztec empire.
A chinampa is essentially a long narrow strip of land surrounded on at least three sides by water. The basic elements of the chinampa agricultural system are water, soil fertility, energy cycling, seed beds, and use of noncrop plants. The ample supply of water which characterizes the chinampas is important. Canals are used for transport, and the abundant water enables peasants to cultivate their land all year, instead of only during the rainy season. Chinampa soils have traditionally been managed intensively. Soil fertility is continuously renewed with organic amendments such as canal muck, aquatic plants, crop and weed residues, and animal manure.
The chinampa agricultural system is self-sufficient due to continuous recycling of energy and materials. Human labour is intensive, cultural practices are well adapted to the environment of the chinampas, and external inputs of materials are minimal under ideal conditions. This system is an example of how natural resources can be successfully managed without long-term depletion or destruction.
An essential element in the chinampa system is the technique for preparing the starter seedbeds, which are called almacigos.
Habitat and plot microclimate are controlled with the use of noncrop plants. The willow tree (Salix bomplandiana H.B.K.) is an important element and is planted around the perimeter of the plot at 3- to 5-meter intervals. Tree roots stabilize plot edges and draw moisture directly from the water table, thus enhancing water management in the field. Rows of willow trees reduce wind and are

an excellent habitat for some beneficial organisms such as birds and entomophagous insects. The branches of the willow tree along with other noncrop plants such as grasses and aquatic plants protect seed beds from heavy rains, frosts, and excessive drying. Almost all weeds are used as forage and fertilizer.
Although government projects have been designed to protect the ecology of this area, they have failed to recognize two important factors in the survival of the chinampas: water and the chinamperos. Future government projects need to recognize that water is a major component of the chinampas and that any change to the water supply affects the entire chinampa agroecosystem.
Family and social organization have been important factors in the survival of the chinampas. The decline of the chinampas has affected the social structure and cultural characteristics of the people living on them. Cooperative work on the canals has declined, for instance, as has the tradition of families working together within a chinampa. Younger generations look to the city for employment rather than to farming. The decline of the chinampas signals not only the loss of a production system, but a cultural system as well. Projects aimed at protecting and encouraging the chinampas' production system should protect and utilize its sociocultural attributes.
Since the chinampas are still functioning, studying the ecological mechanisms and interactions involved in the extraordinary and seemingly perpetual productivity of this system could provide useful information in the development of a sustainable agriculture. Research questions should include:
- What are the ecological roles and benefits of the noncrop plants?
- Why is the silt of certain canals incorporated in seedbeds?
- Does the system have mechanisms of pest control built in? If so, what are they?
- What are the allelopathic interactions involved in the system and how important are they?
- Are there plant species in the system that can be managed and incorporated into other agricultural systems?
- What are the nutrient dynamics and how are they affected by fertilizer usage?

Although these questions are focused on ecological factors the chinampa agricultural system includes ecological, technological, and social factors. Multidisciplinary study is therefore required.

264 89 - 1/34

Traditional land-use systems
Africa, tropics, review, book, Terres et Vie, CTA, agriculture, sustainability, sociology, traditional systems, diversification, ecology, farmers, crops, water resources, land managment, agroforestry, trees, soil fertility, cultural practices, economics
DUPRIEZ, H. and P.DE LEENER
Agriculture tropicale en milieu paysan african (Agriculturel in African Rural Communities).

MacMillan Publ. Ltd, London and Terres et Vie, Nivelles, Belgium and CTA, Netherlands; ISBN 0-333-44595-3, 1988, pp. 292 + ix

Agriculture in African Rural Communities is a basic introduction to principles of crop physiology and practices of crop husbandry. The book recognises the realities of traditional subsistence farming but introduces improved methods. As well as details of plant requirements and the importance of soil and water, it describes environmental, climatic, cultural, social, managerial and economic factors.
This book is about tropical agriculture in general, although stockraising and the keeping of poultry and small animals are not covered. The book does not overemphasize how best the grower might improve his or her farming methods. The reader must draw his own conclusions about the practical steps to be taken. It is more important to understand and think over one's farming methods than to imitate. Therefore a careful examination of the illustrations is needed. They show ways of working the land. Whether these ways are appropriate for a particular farmer, only the farmer can decide.
Each of the forty-nine lessons in this book are each on a different subject, but they form an interrelated whole.
This book does not treat agriculture simply as a technical activity which needs only specialists trained in institutes of higher education.
The "Land and Life Series" is aimed at practitioners and students of agriculture and rural development and associated vocational and technical skills. The books in the series treat topics according to appropriate, smallscale and affordable technology taking into account traditional ways but adding relevant modern improvements. For training, they can be used in secondary schools and vocational training centres and colleges up to diploma and degree level, but they are chiefly meant to be used in the field, in practice. They are ideal for self-help, adult education and rural extension projects. They are written in a clear and highly illustrative style and thus can be used equally by those for whom English is a second language and by non-specialists. All the titles in the series are designed and produced as low-cost editions. Although based on African practice, the books are relevant to similar climatic regions in other continents.

265 89 - 1/35

Traditional land-use systems
Africa, Ghana, report, cocoa, traditional practices farming, cropping systems, intercropping
ANABAH, S.
Traditional cocoa farming in Ghana.

IFOAM, 3, 1988, pp. 11

Cocoa is produced in Ghana by traditional organic methods, dating from 1879. It is grown in the tropical rainforest in the southern parts of the country by smallholders using traditional techniques. The recent adoption of intensive farming practices and the establishment of commercial farms in some parts of Ghana has not displaced these smallholders. Their cultural practices have prevented devastation of forests, helped in the maintenance and build-up of humus rich top soils, and prevented landslides and soil erosion on the hill tops and slopes where cocoa is grown.
The establishment of a cocoa farm starts with the clearing of jungle followed by judicious and selective felling of forest trees by axe. Many trees are retained to provide permanent shade for the cocoa plants. Most farm operations are done manually, although some farmers now use chain saws and motorised spraying machines. The debris is burned to open up the area for planting, to sterilise the soil, provide potash and destroy weed seeds. Once established, there is no further burning.
Weeds are clearing by hand twice a year just before the commencement of each of the two rainy seasons. They are left on the soil to decompose and build up the humus.
Artificial fertilizers and herbicides are not applied on the cocoa plants or on the staple food crops (cocoyam, plantain and cassava) intercropping with the young cocoa seedlings. These crops provide shade for the young plants and also biodynamic organic food for the farmer's family. Intercropping ceases when the cocoa overshadows the food crops and starts bearing pods about three years after planting. A well-maintained cocoa farm is always naturally covered with litter of cocoa leaves, which perpetually mulch and preserve soil moisture. This also accelerates the decomposition process.
Cocoa trees infected with swollen shoot disease caused by mealy bugs are cut out to arrest the spread of infection. Black pod fungus is also treated by removing diseased pods; and judicious pruning and reduction of shade brings it under control. Capsid beetles are very often a menace when there are flushes of new growth, and a pyrethrum base insecticide is sprayed twice a year. Another troublesome common pest establishing itself all over Ghana is the grasshopper, which feeds on nearly all green vegetation. Fortunately it perishes with the heavy rains, so is not a major problem.
The golden pods of cocoa are harvested and usually broken open by the communal efforts of neighbouring farmers in order to get the beans ready in time to allow for successful fermentation. The fresh cocoa beans are piled up on banana and plantain leaves and

covered up for a few days to ferment without chemical additives. After this period, the beans are sun-dried and sold.
Traditional cocoa farmers' wives burn sun-dried cocoa husk into potash, and together with palm oil they manufacture organic soap. So the traditional cocoa farmers of Ghana wash with organic soap, eat organic food, cure diseases with medicinal herbs growing around them, and brush their teeth with chewing sticks and sponges gathered from the forest.

266 89 - 1/36

Traditional land-use systems
Latin America, Amazon Basin, humid tropics, traditional agriculture, appropriate technology, migratory agriculture, acid soils, ecology, ecosystem, cropping systems, soil fertility, farmer, economics, low-input system, pasture, agroforestry
NICHOLAIDES, J.J. et al.
From migratory to continuous agriculture in the Amazon Basin.

In: FAO Soils Bulletin No. 53, ISBN 92-5-102121-x, 1984, pp. 141-168

Appropriate technologies for changing migratory agriculture to continuous agriculture in some parts of the Amazon Basin have been developed. These agronomically sound, scale-neutral technologies are beginning to be used on some of the Amazon Basin's acid and infertile soils normally subjected to shifting cultivation.
Two types of farmers are involved in the clearing of the Amazon Basin. Shifting cultivators are responsible for most of the clearing in the western part of the Basin, while ranchers trying to develop pastures are the primary cause for the clearing of the seasonal semi-evergreen forest in most of the Brazilian or eastern portions of the Basin.
Acid and infertile soils (Oxisols and Ultisols) occupy almost 75% of the Amazon Basin. These red or yellow soils are deficient in most nutrients, usually welldrained, and have generally favourable physical properties.
Most shifting cultivators in the Basin use the slash and burn technique. In this system, the larger trees and shrubs are cut by axe, machete, or chain saws during periods of low rainfall, are allowed to dry for at least 10-14 days and are then burned either in place or in piles with smaller trees and shrubs. Other shifting cultivators, such as those in the very high rainfall areas of Ecuador's Amazon Basin, practise "slash and mulch" by broadcasting the crop seed in the forest, cutting the undergrowth and using that vegetation as mulch instead of burning. Still yet another variation of shifting cultivation is in the Xingu River Basin in the centre of Brazil's Amazon Basin by the Indians who plant their root crops in the cleared forest prior to burning. Then, with the burn, the root crops lose their green material, but not the vitality of the underground root system which absorbs nutrients leached from the ash when the rains begin.

The Basin's shifting cultivators most commonly plant some combination of rice, bean, maize, cassava, sweet potato, and plantain among the ashed debris using a stick to make the hole into which seed or vegetative portions of the crops are planted. Cassava and banana are often planted before rice in many areas of the Basin and it has been reported that cassava is planted to 90% of the Basin's cultivated fields.
After one or two crops, especially on the acid and infertile soils, yields decline so drastically due to soil fertility depletion and consequent greater weed competition that the land is then abandoned to a forest fallow. This fallow usually lasts for 14-21 years during which the fertility of the soil is regenerated by nutrient cycling of the forest growth and litter. The land is cleared once again, cropped and returned to fallow after one or two more crops.
With the opening of the Trans-Amazon highway and feeder roads, there is consequent increased population pressure, shortening of the forest fallow period and the soil fertility regeneration process, and a subsequent conversion of an ecologically sound cropping system into an unstable, unproductive one which creates ecological disaster. The effect of this shortened fallow is especially pronounced on the more infertile soils which make up three-quarters of the Basin.
In Yurimaguas, Peru, continuous cropping systems for the acid, infertile soils of the Amazon Basin and other similar agro-ecological areas have been developed. The results of these research efforts are felt to offer attractive alternatives for shifting cultivators in the Amazon Basin and in similar soil-crop climatic areas.
Important components of the continuous cropping included determining the most important crops, their nutritional needs, best sequences and changes in soil properties with time of cultivation.
Included in the Yurimaguas research are various rotations and combinations of rice, maize, soybean, groundnut, cassava, cowpea, sweet potato and plantain.
The improved Yurimaguas technologies offer an agronomically, economically and ecologically attractive alternative to that scene for certain areas of the Amazon Basin.

267 89 - 1/37

Traditional land-use systems
Reviev, Africa, Sahel, book, technical notes, land-use, traditional systems, ecological approach
UNESCO
The Sahel: ecological approaches to land-use.

MAB Technical Notes, UNESCO, 7 Place de Fontenoy, 75700 Paris, France, ISBN 92-3-101237-1, 1979, pp. 99

The official reports of MAB published to date in the "MAB Report Series" number some 30 issues. These reports contain the

proceedings of the different types of meetings which have marked the planning phase of the programme. While these reports are above all of a logistic nature, it is evident that they have been established on the basis of the present state of ecological knowledge, as described and summarized in documents prepared by specialists and presented to each meeting.
It has been decided to publish such documents (in English, French and if necessary, Spanish) in a new series, entiled "MAB Technical Notes". These technical notes will provide reviews of scientific knowledge relating to the ecological bases of, and new techniques for the management and exploitation of natural resources. Eventually, the series will contain reviews or the results of the operational phase of the programme.
The present volume is devoted to the Sahel.
After an introduction to the problem, the book contains the following articles:
- The Sahel: climate and soils, by L. Berry
- Remote sensing potentials for ecological research and training in the Sahel, by N.H. MacLeod
- Plant cover and pastures of the Sahel, by H. Gillet
- Pastures and livestock in the Sahel, by G. Boudet
- The improvement of pastoral economy in the Sahel: research trends, by G. Boudet and H. Gillet
- Animal production and health in the Sahelian zone, by H.S.H. Seifert
- Studies on pastoral nomadism in the Sahelian zone: bibliographic review, by E. Bernus
- Human geography in the Sahelian zone, by E. Bernus
- The status of pastoral nomadism in the Sahelian zone, by D.L. Johnson
- Improvement of pasture and livestock exploitation in the Sahel: proposals for management and land use, by G. Boudet

These basic information documents, enriched and amended by discussions, constitute a useful body of information for a larger public, for use in research, planning or teaching.

268 89 - 1/38

Traditional land-use systems
Latin America, Chile, subtropical zone, slopes, survey, interviews, small farmers, agroecology, cropping systems, cultural techniques, sustainability, socioeconomy, productivity, soil conservation, appropriate technology, rapid rural appraisal
RODRIGUEZ, J.A. et al.
Agroecological typification of traditional farming systems in Central Chile.

In: Proc. of the 6th Int. Sc. Conf. of IFOAM, Santa Cruz, California, 1988, pp. 463-468 + Annex

Under prevalent conditions of economic uncertainty in Chile, attempts to improve rural life and income must emerge from rural

development strategies that minimize dependence on purchased inputs and industrial technology, improve the efficiency of the use of local resources are used, emphasize self-sufficiency in production and consumption, and favour the organization of peasants to enhance their capacity for economic and social survival. The approach must be based on people's goals, indigenous knowledge, autochthonous technologies, local resources and social organization, so that it becomes a village-based effort with the active participation of all peasants.
A typical agroecosystem of the described area rarely exceeds 2.5 ha and is composed of the household, a kitchen garden, a chicken house, a mixed fruit orchard, a pasture with grazing animals, and the cropping systems which include tobacco, corn/bean polycultures, potatoes, vegetables and a fallow section. Most farmers devote about 25% of their land to tobacco. Crop growing seasons are concentrated between October and March, with virtually no cropping activities during late spring and winter months.
Tabacco and traditional crops compete during the growing season for the same land, scarce labour, and/or cash resources. At present farmers devote more effort to tobacco because it provides secure cash when grown under contract with the National Tobacco Company of Chile. Although yields of traditional crops exhibit a decreasing trend, farmers still plant them to secure subsistence food. Risk avoidance is expressed through crop diversification and/or early planting to provide an early source of food.
After evaluating the information derived from a survey it has been decided to concentrate the technical efforts in three main areas: reorganization of production space, soil conservation practices, and use of appropriate technologies.
Reorganization of Production Space:
A proposed design of a model farming system deviates from the traditional model in various ways:
- it includes raised beds for biointensive year-round vegetable production using organic residues and wastes; medicinal herbs are also emphasized in these units;
- includes a cow "corral" built close to the compost pile;
- bee hives are placed between the mixed orchard and the annual cropping system area;
- it includes a portable chicken house to distribute manure in otherwise unused spaces; and
- it includes a crop rotation system designed to preserve the soil and to assure constant diversified production by dividing the land into 6 small fields of fairly equal productive capacity. The rotation is designed to produce the minimum variety of a basic crops, including winter crops such as fava beans, lentils, barley, and wheat, taking advantage of the soil-restoring properties of the legumes.

Soil Conservation Practices:
This includes simple recommendations such as plowing in contour, minimal tillage techniques, use of terraces and hedgerows, and cereal/legume rotations as well as improved management of fallow periods. It also involves construction of fences for better grazing rotation and cattle management.

An important technique for marginal areas on the slopes is the design of agroforestry systems.
Use of Appropriate Technologies:
This takes advantage of several techniques and tools like solar drying, greenhouse construction, solar heaters and ovens, basic food cooking recipes, home building techniques, etc., which would enable farmers to conserve energy, food, and other materials.

269 89 - 1/39

Traditional land-use systems
Pacific, Polynesia, Micronesia, review, book, traditional agriculture, subsistence agriculture, environment, ecology, sustainability, sociology, economics, vegetable, food plants, extension, education.
BARRAU, J.
Subsistence Agriculture in Polynesia and Micronesia.
Bernice P. Bishop Museum Bulletin, 223, Publ. Kraus Reprint Co., Millwood, New York, 1976, pp. 85

From a geological viewpoint, roughly three principal types of island are found in the south Pacific: (1) Coral islands, which are atolls or raised reefs. (2) Volcanic islands, whose rock formation may belong to one of two distinct mineralogical types.
(3) Continental islands consisting of plutonic and metamorphic rocks, particularly common in Melanesia but also found in Micronesia, as well as in the Fijian-Tongan group on the fringes of Polynesia.
The deterioration of the vegetation in a number of high islands in both Micronesia and Polynesia is due, at least partially, to the techniques of primitive agricultural systems. Often, such degradation is accompanied by the large-scale development of certain introduced weeds.
Traditionally, the Polynesian family was the owner of the land. The family, in the local and very wide interpretation of the term, included the whole group of descendants of a common ancestor under the authority of the most direct descendant, who was responsible for the administration of family land. Households and even some individuals of the group were entitled to a section of the family property, which was not transferable without the consent of the community and its chief. For instance, in the Samoas, where this traditional system has been retained, the head of the family, or matai, enjoys undeniable authority. It is not unusual for him to receive the wages earned by members of his family from their European employers, as well as the profits obtained from the sale of agricultural produce. The matai, in turn, is expected to provide each of the members of his family with sufficient means for subsistence. This system, intended for a strictly subsistence economy, has been the object of severe criticism in this modern era which began with European colonization. Nowadays, it is accused of paralyzing all personal initiative and retarding economic development.
In regions of the Pacific, the wooden digging stick was the most

frequently used agricultural implement, and it still has considerable use in some of the high islands of Polynesia where taro is grown in low-lying swamps. A variant of the digging stick is an enormous club, which is used for making a wide, regular, cylindrical hole in the mud, thus providing the tuber with a container in which it can develop freely. Nowadays, metal hand tools of European manufacture are increasingly common.
The time when Polynesia and Micronesia had a purely subsistence economy is past. Today, account must be taken of new economic factors resulting from the presence of Europeans, whose influence has varied in degree depending upon the area involved.
This social and economic classification permits the general observation that European influence, although varying in degree from one area to another, is considerable throughout Polynesia and Micronesia. All of the islands have been submitted to missionary activity; all are engaged today in cash-producing enterprises, and all have benefited, with European settlement, from the introduction of food plants. In short, few Polynesian or Micronesian islands have conserved their traditional subsistence economy intact.

270 89 - 1/40

Traditional land-use systems
Africa, Cameroon, survey, traditional farming, postharvest technology, root crop, tubers
NUMFOR, F.A. and S.N. LYONGA
Traditional postharvest technologies of root and tuber crops in Cameroon: Status and prospects for improvement.
In: Proced. of the 3rd Triennial Symp. of the Int. Soc. for Trop. Root Crops, Nigeria, 1986, pp. 135-139

Important tropical root and tuber crops in Cameroon include cassava (*Manihot Esculenta* Crantz), cocoyams (*Xanthosoma sagittifolium and Colocasia* esculenta), yams (*Dioscorea* spp.), and sweet potatoes (*Ipomoea batatas). The other* root and tuber crops either have been recently introduced or are of limited, local importance. This survey looks at root and tuber crops as staple foods; those of medicinal or pharmacological importance are excluded.
Postharvest losses of root crops in Cameroon involve losses in the quantity or quality of the produce caused by physical, physiological, and pathological factors. Losses occur at various postharvest stages: harvesting, gathering, transportation, storage, processing, culinary preparation, and consumption.
Traditional African societies have developed simple technologies for reducing postharvest losses. Because of rapid population growth and shortened handling and preparation times, however, these apparently ingenious methods are inadequate for current needs. Consequently, consumers prefer foreign-processed foods.
Available research results on postharvest technologies of root crops in Cameroon are crop specific and do not comprehensively assess traditional postharvest technologies. To fill this gap, the

existing traditional methods of processing and preservation were surveyed. The goal was to formulate future research priorities in the postharvest technology of root and tuber crops in Cameroon.
This survey indicates that postharvest technology research should focus on the following aspects. Simple storage techniques and structures must be developed. The production of root and tuber crops is indirectly constrained by the lack of effective storage techniques and structures. Most farmers are easily discouraged when, after a bumper harvest, most of the crop is lost during storage. With the growth of cities and the higher demand for food in the rural areas, any effective techniques and structures for the storage of root and tuber crops will promote increased production.
Improved handling and processing techniques must be developed with emphasis on nutrition, hygiene, and quality standards. There is a wide range of traditional skill for handling and processing root and tuber crops; however, these techniques need improvement. As people become aware of nutrition, hygiene, and quality standards, traditionally processed foods tend to be less desirable than imported foods. The emphasis, therefore, should be on developing existing local technologies.
Root crops could serve as raw materials for the development of industrial products. Cassava, for example, is a source of good-quality starch for the pharmaceutical, textile, and food industries, and the aroids contain chemicals that are important in medicine.
New, competitive, fast-food products should be developed. Most traditional products require a lot of time to prepare. Therefore, the general tendency is to buy imported foods that are easier to prepare. Root and tuber crops, show good base for the development of fast-food products.
Animal feeds must be developed. Root and tuber crops, particularly their shoots, offer useful material for animal feeds. Traditionally, the shoots of these plants have been used minimally, although they are rich in good-quality proteins and vitamins.
Basic data on root and tuber crops are required. Some information exists on the approximate composition of root crops. More information is needed, however, on the variability of these data with crop variety, environment, age, and storage and processing. Nutritional studies are also needed.

II FARMING SYSTEMS RESEARCH AND DEVELOPMENT

271 89 - 2/31

Farming systems research and development
Africa, Kenya, farming systems, strategies, subsistence, marginal area, beekeeping, livestock, crops
ABELLA, J.C. et al.
The farming system in Tharaka: Strategies for subsistence in a marginal area of Kenya.

ICRA, Bulletin 15, 1984, 55 p.

The study aims to identify and evaluate development options and research recommendations which are likely to meet the objectives of both the farmers and the Government in the Tharaka region.
The study area comprises 80% of the total 370,000 acres 150,000 ha of Tharaka Division, making up the arid and semi-arid parts of the Division.
The physical and natural resources of Tharaka present an unsuitable environment for arable farming, but the density of population makes mixed farming inevitable.
Population growth in Tharaka is around 3,3% per year (1969-1984). If this growth rate continues, it will result in a decrease of landholdings from 20 acres at the moment to 10 acres per household by the year 2005, far too small to support a household if the land is predominantly cultivated under a bush fallow system with fallow lenghts of mainly 2-5 years.
Labour is almost entirely provided by family members. Cash is required in certain periods to buy food and make up for a poor harvest. It is also needed for school fees, especially for secondary education. Small amounts of cash are also required for domestic needs. The economy in Tharaka is still largely run without cash. Sales match purchases in a way that is only a short step from a barter economy. Goats almost function as commodity money.
Cropping is undertaken in a situation of severe erosion and decreasing fertility of soils because the measures undertaken to prevent erosion are very poor. 83% of the cultivated area is devoted to food crops, mainly millet, sorghum, green gram and cowpeas. The remaining 17% is devoted to the cash crops, cotton and sunflower. Some farmers occasionally use ox ploughs but handtools are mainly used in cropping.
Livestock (sheep, goats and cattle) are owned by 85% of the farmers surveyed for a variety of socio-economic reasons. They are regarded as a source of wealth and prestige.
Beekeeping is the most promising way of earning money other than from sale of crops and/or livestock. More sales of honey or wax could provide a significant increase in income for a wide range of farmers. There is very little prospect of charcoal-burning, basket-making or other income-earning activities being able to make a significant impact in Tharaka.

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II FARMING SYSTEMS RESEARCH AND DEVELOPMENT

271 89 - 2/31

Farming systems research and development
Africa, Kenya, farming systems, strategies, subsistence, marginal area, beekeeping, livestock, crops
ABELLA, J.C. et al.
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Beekeeping is the most promising way of earning money other than from sale of crops and/or livestock. More sales of honey or wax could provide a significant increase in income for a wide range of farmers. There is very little prospect of charcoal-burning, basket-making or other income-earning activities being able to make a significant impact in Tharaka.

For arable agriculture the emphasis is on reducing risk. Proposals are directed to soil and water conservation measures in order to maximize the use of rainfall and minimize soil and water losses; to the introduction of more reliable cropping patterns; to more efficient use of labour; and to food insurance through specific measures to improve the marketing systems. Research recommendations concentrate on improving the reliability of crop yields.
The recommendations for livestock are directed less to research than to institutional and organizational developments. The most appropriate solution to the problem of over-grazing is seen as the establishment of small group ranches. The encouragement of cooperatives is proposed to act as a channel for improved health services and husbandry advice and to provide a more reliable external outlet for livestock sales. The only recommendation for additional research relating to livestock is to evaluate the browse and grazing in the area.
While marginal improvements can be made at the moment the basic problems of populations growth and the limiting agro-ecological circumstances remain.

272 89 - 2/32

Farming systems research and development
Africa, Nigeria, farming systems, yam, smallholder
DIEHL, L.
Smallholder farming systems with yam in the Southern Guinea Savannah of Nigeria.

Schriftenreihe, GTZ, 1982, 226 pp., ISBN 3-88085-135-2, 36,- DM

Yam is traditionally the most important food-crop in much of Africa. Yet, detailed knowledge about the large variation of production systems and their respective economics has been scarce. The present study examines smallholder farming systems with yam in Nigeria.
The study's hypothesis assumes that yam production is bound to decline due to unfavourable input/output relations and in particular low return to labour when compared with other crops.
This hypothesis is investigated on the basis of an intensive socio-economic survey including 68 yam producing farms in three locations of Nigeria's Middle Belt. During a period of 14 months all agricultural activities on the farm were enumerated in 2-3 interviews per week. Agricultural inputs and outputs were recorded, samples of local units being weighted and cultivated farm land being measured.
By means of statistical analysis on the farm as well as on the enterprise level similarities and differences among groups of farms in respect to resource endowment, factor allocation and income were investigated. The studied farms being subdivided into according to ethnological differences and varying distances between their farming locations and the village. Factor productivity on the enterprise level was analysed by budgeting,

enterprises being grouped into crop mixtures with and without yam and hydromorphic or well drained soil types.
The husbandry practices and cropping principles of the studied farms are described and explained in detail, emphasis being laid on the agronomy of yam. The interactions between yam and other crops have been analysed with particular respect to labour requirements over time.
Defining yam production enterprises it is important to differentiate between upland- and lowland-yam systems. The comparison of crop mixtures including yam with non-yam mixtures reveals the following characteristics of yam production:
- labour input to yam production is fairly stable and on an average amounts to 1300 man-hours per hectare in upland-yam systems and 2100 man-hours per hectare in lowland-yam systems,
- labour input to non-yam mixtures is extremely variable and on an average ranges from 660 to 1300 man-hours per hectare,
- yam production requires high capital inputs in the form of planting material due to extremely unfavourable physical input/output relations which range from ½ to ¼ in the survey area.

In spite of these unfavourable characteristics the analysis of factor productivity reveals that yam is by far the most profitable crop grown in the survey area as:
- the gross margins per hectare achieved in yam production are 4-6 times higher than those of non-yam mixtures,
- the gross margins per hectare of lowland-yam enterprises are 2060% higher than those of upland-yam enterprises,
- the returns per man-hour of labour input are between 2-6 times higher in yam production than in non-yam-mixtures. They are lower in lowland-yam systems than in upland-yam systems.

In spite of high requirements, labour was not a constraint to yam production due to the complementary distribution of labour requirements over time among yam and non-yam systems.
Yam production is, however, seriously constrained by:
- a physical shortage of planting material, and
- an increasing scarcity of suitable land.

The availability of yam sets is not only limited by the low rate of reproduction but also by the households' subsistence demands as yam makes significant and vital contributions to the food supplies and cash incomes of the farm households.
Symptoms of an acute shortage of fertile farm land were observed in four of the five distinguished strata in spite of the generally low population density in the survey area. The constraints on the availability of farm land are imposed by:
- the topographical limitations to arable land, and
- the clustering of farming in road-side locations due to social and economic advantages.

The observed scarcity of land has led to an intensification of farming. This process may well reflect the generally expected development of farming systems in the tropics, being characterised by:
- higher plant densities,
- increased diversity of land use,

- higher labour inputs, and
- higher inputs of cash for hired labour as well as fertilizer.

In this development of the farming systems yam production will gain rather than lose importance as it is tailored to the envisaged development of smallholder farming towards labour and capital intensive farming with high returns to land and labour.
The economic superiority of yam production is based on the present farmprice-relations. This situation is fairly stable unless major changes in these price relations occur. Such changes would imply marked alterations in the composition of production costs or the structure of demand for agricultural commodities. Both, however, are not to be expected in the near future.
The possible development of yam production technology and the implications of agricultural research show that yam may well maintain its position in the farming systems of the future. The yield potential of this crop as well as the possibilities of breeding and agronomic improvements are far from being exploited. Therefore more research is needed in respect to yam production. Any significant improvement of the input/output relation in particular is likely to have a drastic and lasting impact on the income of a large number of smallholder farms in much of West Africa.
Author's summary, amended

273 89 2/33

Farming systems research and development
Africa, Ghana, dry savannah, farming systems, compound farms, bush farm, livestock, crops, soil fertility, socio-economic analysis
PANIN, A.
Hoe and bullock farming systems in Northern Ghana.

Nyankpala Agric. Res. Report 1, 1988, 182 p. + Ann. ISBN 3-8236-1128-3, GTZ-Project Nyankpala, Ghana; Distributor: Triops, Raiffeisenstr. 24, D-6070 Langen, FR Germany

The use of bullock traction technology for crop cultivation in some areas in Northern Ghana has a long history which dates back to the early 1930's. Yet its overall impact on the farming systems in the area is not known. This study was therefore undertaken to assess the impact of the technology on the farming systems of the rural communities.
Following the main objective of this study, the analysis is based on the following hypotheses:
- Bullock farmers are more endowed with land, capital, and labour capacity than hoe farmers.
- The bullock traction technology is superior to handhoe technique in turning out increased food and cash crops per unit of land in the dryland farming systems. This is attributable to the increases in the productivity of labour and land that characterise the bullock traction technology.
- Bullock farmers realise higher net income and greater security of subsistence than their hoe counterparts.

- The rise in the factor productivity of bullock farmers is positively related to the experience in the use of the technology. These hypotheses are investigated on the basis of an intensive socio economic survey of 42 households selected from three villages in one part of Northern Ghana. During a period of one year from April 1982 to March 1983, data on various aspects of farm households activities were collected.

The selected households studied were stratified into two main groups:
- farmers who use the hoe as a major tool for cultivation and
- those using bullock traction as a method of cultivation.

The major findings of the analysis of the two farming systems (hoe and bullock) are summarily presented as follows:
Resource endowments: Bullock farmers are better equipped with land, labour capacity, and livestock than hoe farmers. But whether or not the higher resource endowment is partly the product of using bullock traction technology could not be established. The heads of bullock households were far older than their counterparts in the hoe households.
Land use:
- Effects on cultivated area: There was an increase of 4 percent in total area cultivated per active worker for bullock farmers compared to hoe farmers. But among the bullock households, the area cultivated per active worker was inversely related with years of bullock traction experience.
- Effects on cropping emphasis: The effects of bullock traction on the cropping systems were very small. The area allocated to the major food crops by hoe and bullock households accounted for 80 and 74 percent of their respective total cultivated areas. The overall shift to cash crop cultivation was therefore very slight, with bullock farmers growing slightly more cash crops than hoe farmers. However, there were remarkable changes in the cropping systems of the various bullock subsamples. These changes took the form of systematic shifts from the production of major food crops to cash crops as the years of traction experience increased.
- Effects on mixed cropping systems: Bullock traction technology led to increases in the number of different types of crops in the mixed cropping systems. Among the bullock subsamples however, these increases were negatively related to the years of bullock traction experience.
- Effects on crop yields: There were substantially higher yields per hectare from all the major cropping patterns for bullock farmers except one. Yield increases ranging from 16 to 35 percent were found among the bullock farmers. Total output of all crops per hectare was also considerably higher for bullock than hoe farming. According to the results of the production function analysis, bullock traction technology has a positive effect on total crop yield.

Effects on labour use:
- Labour use per hectare: The average labour input per hectare for all major farming operations together increased with the introduction of bullock traction technology. The increase in labour input per hectare was also positively related to the

years of bullock traction experience. As regards labour requirements per hectare for individual farming operations, the use of bullock traction technology increased those of clearing, weeding and harvesting, while those of ridging and planting were reduced. Moreover, in terms of labour use for the respective cropping patterns, bullock traction had different effects. Whereas it raised the labour intensity for some crop mixtures (e.g. groundnut-grains), it reduced it for others (e.g. cornmillet-beans).

- Seasonal variations in labour inputs: Survey data indicate that farming in the area is highly seasonal for both hoe and bullock households. The seasonal constraints are extreme, as agriculture is virtuallly impossible during the slack season in the year. Data indicated that the current use of the traction technology did not make any impact on the distribution of labour over the year.
- Labour input by household members: Survey data indicate a reduction in annual field labour use for small children of 6-9 years (both male and female), adult women, on heads of households in bullock households. But at the same time, annual labour input for field work contributed by boys, male adults, and both elderly women and men increased with the adoption of bullock traction technology. Further, there was an increase in labour input per man equivalent of household labour for bullock households.

Effects on income and production costs

- Net farm income: Based on either income per man equivalent of household labour or per active worker, the income effect of bullock traction technology was great. A substantial increase in net farm income of 32 and 40 percent per man equivalent of household labour and per active worker respectively was found for bullock farmers. The respective increase is attributable to increased crop production, on which the use of bullock traction has a positive significant impact.
- Annual cash income: The study indicates substantially higher disposable annual cash income among bullock households than hoe households. An increase of 151 percent in net annual cash income per household member was found for bullock households. The use of bullock traction contributed substantially to this increase through increased crop production and revenue from contract ridging.
- Farm investment analysis: The general performance of bullock traction technology (ridging) at the individual farm level as shown by the ten-year income projections is substantial. Over the ten-year investment period, bullock ridging produces an internal rate of return (IRR) of 65,5% which is quite appreciable. Further, it provides substantial increases of 17,5% and 16,8% of the net present worth (NPW) of the incremental net benefits respectively, before and after financing over the NPW of income from hoe farming.

Finally, the analysis shows that the performance potential of bullock ridging sets in quickly, and hence, the investment does not pose any severe problem on the cash flow positions of the adoptive farmer.

The findings of this analysis confirm the validity of the study hypotheses. For the analysis has shown that there were substantial increases in total crop production under the bullock farming systems. This was possible through the increase in factor productivity. Further, the net incomes of bullock farmers were high relative to those of hoe farmers, thus enabling the former to achieve greater security. Finally, the analysis revealed that bullock farmers were better endowed with resources than their hoe counterparts.

In conclusion, bullock traction technology offers a clear solution to the problem of low productivity which characterizes agriculture in the study area.

Although its use was limited to ridging only, the bullock household were able to realise higher crop production, higher income and a generally higher living standard compared to hoe households.

Therefore, if the use of the technology is expanded to cover all the major farming operations, the benefits to bullock households will increase even further. These benefits will then spread among the farming population, if the number of farmers using the technology increases.

Author's summary

274 89 - 2/34

Farming systems research and development
Africa, Botswana, study, farming systems research, crop production
JONES, R.B.
Crop production systems in Ngamiland West, Botswana.

Farming Systems Newsletter, CIMMYT, 1987, 17-31

The Republic of Botswana is a landlocked country in the centre of the Southern African Plateau.

An important aspect of the country is the harsh climatic environment, often described as semi-arid.

Precipitation occurs almost entirely in the summer months from November through to April and is unreliable, in that the annual total and seasonal distribution vary, and is of poor quality in that it usually falls in heavy showers of short duration leading to runoff and erosion. As a consequence of this, arable agriculture is a risky undertaking, the country being better suited for extensive grazing by ruminant livestock.

Although this paper focuses on crop production systems it is important to realize that livestock systems cannot be ignored because the two types of production are linked together. Livestock is essential for the provision of draft power and also play an important role in the cycling of nutrients.

It should be realized that production systems not only evolve in response to physical and environmental constraints but also in response to government policies.

Molapo Farming System:
Three major ecotypes have been distinguished in the Okavango Delta according to their lack or abundance of water.
A complex land tenure system has developed which takes into account the necessity to shift cultivation in response to the changing flood regime. With the drying up of the Thagoe River the areas available for molapo cultivation have become scarse with the result that the overall productivity from the area has declined. Molapo fields need several seasons of cultivation with the traditional ox-drawn mouldboard plough before weeds are controlled and smooth even seedbed is produced. Without this, germination is patchy reducing yields and making weed control almost impossible.
During the same period livestock numbers have increased drammatically due to campaigns carried out by the veterinary services, which provid free vaccinations against the major livestock diseases, and the control of tsetse fly. Conflicts between the two production systems have increased because both are competing for areas with more favourable conditions.
Dryland Farming System:
The Hambukushu grow millet, their staple food crop, together with sorghum, maize, mellons, groundnuts and a variety of beans on the soils which surround the Okavango Delta.
Farmers clear land burning the brusch but leaving stumps in the ground. Areas with dense vegetation are chosen with preference for clearing as they are considered to be more fertile. However after approximately 10 years the fields are abandoned and new lands cleared. At the beginning of the cropping season any remaining crop residues which have not been grazed by cattle in the field are collected an burnt. Land preparation and planting is done either by single furrow moulboard plough or by hand hoe. Plough teams are composed of only two oxen with donkeys being used very occasionally. Planting takes place by dropping seeds in every other furrow at carefully spaced intervals of 50-100 cm. Planting is done into both dry and moist soil although the latter is preferred. Often farmers will separate planting and ploughing preferring to plant into the ploughed seedbed when moisture conditions are optimal either using a hand hoe or the feet to knock over the ridge of the furrow thereby covering the seeds. If oxen are not being used land preparation is carried out by clearing an area of weeds using a hoe followed by planting at carefully spaced intervals.

275 89 2/35

Farming systems research and development
Africa, Liberia, tropical rainforest climate, survey, farming systems research, smallholders, labour, socio-economics, project, monitoring and evaluation
WESTPHAL, U. et al.
Baseline survey on smallholders in Nimba County to facilitate decision taking in project planning.

Schriftenreihe des FB Int. Agrarentwicklung (FIA) Nr. 109, SLE, 1987, 187 p.+ C1-C6, ISBN 3-924333-66-1, DM 19,-, Verlag J. Markgraf, Postf. 105, D-6992 Weikersheim, F.R.G.

The purpose of the study was to gain information about smallholders in Nimba County, placing emphasis on labour requirements and socio-economic data in order to facilitate further decision taking in project planning. It should also create a basis, in the form of indicators, for the monitoring and evaluation unit to measure the impact of project activities.
- The results of the baseline survey led to criteria in order to facilitate decision taking in project planning. The criteria cover the subjects of socio-economics, labour and ecology.

In order to demonstrate the use of criteria seven proposals for project activities have been developed. The proposals include programmes already practised but have been supplemented with components neglected so far. These proposals have been ranked according to more positive or negative aspects in regard to the criteria.
For the proposals which were rated feasible in comparison to the others M & E indicators have been developed.

276 89 2/36

Farming systems research and development
Africa, Ghana, study, dry savannah, farming systems, farm households, agronomic practices, cropping systems, yields, farm income, socioeconomic parameters
RUNGE-METZGER, A.
Variability in agronomic practices and allocative efficiency among farm households in Northern Ghana - a case study in on-farm research.

Nyankpala Agric. Res. Report, 2, 1988, p. 121, ISBN 3-8236-1134-8; CRI/GTZ Joint Project, Tamale, Ghana; Distributor: Verlag J. Markgraf, Postfach 105, D-6992 Weikersheim, F.R. Germany

Agricultural production in the Guinea Savannah in Northern Ghana is mainly done by small farmers. The high population growth of 3,6% p.a. in this region basically increases the pressure on arable land.
In the past, farmers of Wantugu, the study village which is located close to the regional capital, Tamale, tended to prefer

the first two solutions, so that ratio between cropping period and the length of the whole cultivation cycle decreased steadily. But recently farmers also extend their farms into virgin areas, which indicates that the soils located around the villages are exhausted. Farmers did not establish measures which could efficiently prevent soil mining.
Morever the destabilization of the fragile agroecosystems is accelerated by the increasing demand for firewood and the annual recurrence of burning the bush. In the long run soil fertility will further decrease so that self-sufficiency will become uncertain.
Consequently, the goal of the Nyankpala Agricultural Experiment Station is to develop sustainable cropping systems giving higher yields and improving soil fertility, so that also in future farm incomes will cover at least the basic needs of the family members.
This is followed up with two research strategies:
- On-station research for identifying the effects of improved agronomic practices and for identifying new varieties.
- On-farm research for testing the recommended practices and for developing new technologies in close cooperation with the farmers.

The disadvantage of both approaches is that they are very time consuming. Therefore a study which follows another approach was conducted in 1984.
The study was undertaken with the main aim to test a methodology for investigating the variability of agronomic practices and of factor allocation and their influence on yields and farm income. Therefore, farm sizes and other data were not selected to be representative for the whole region.
Furthermore the results of the agronomic analysis are strictly derived from on-farm observations. They are not an outcome of an on-station experiment where environment can normally be better controlled. Hence, the results have to be interpreted facing this empirical background.
In general, the results of the study show that the method of investigating the variability of the current farming system is a possible way to provide appropriate solutions for smallholder farm families to increase yields and incomes in a short period of time. Another advantage of this approach is that this method could easily be taken up by the extension services in order to generate extension messages in the field. This bottom-up approach promises to be more successful than the top-down oriented approach which is still widely practised in West Africa. The latter seems to fail in these countries where the research network is obviously too wide. This implies that agricultural research is not able to cover the whole range of ecological systems of a single country.
Therefore the bottom-up approach is recommended which comprises two steps. Firstly the actual socioeconomic situation of a household should be analyzed, while in a second step it should be looked for adequate technical innovations. Necessarily the extension agents have to be educated extensively in the techniques of data collection and microeconomic data analysis of small scale farm households.

277 89 - 2/37

Farming systems research and development
Developing countries, farming systems research, review
DOROGI, J. and R. RICHTER
Farming system research in developing countries.

Beiträge trop. Landw. Vetrinärmed. 26, 1, 1988, pp. 5-9

The role of the FSR is based on the recognition that farmers use farming systems which are researchable and can be improved at the farm, cropping, or crop system level. The FSR is essentially a multi-disciplinary activity, and it is envisaged that the programme will have both upstream and downstream roles. The upstream activities comprise the analysis of resources, the politico-socio-economic environment, and existing farming systems. This will improve the understanding of the natural resource base, farm producers' skill and production methods, and of reasons for the wide gap between the results demonstrated at the research stations and those obtained at the farms. Further, these investigations will enable users to identify major constraints in production, priority technical problems, and policy issues limiting the production and income. In a downstream context, the FSR programme will be an important complement to crop improvement and other discipline-oriented research programmes and would provide structures for fitting new findings into production systems and evaluating these under realistic farm conditions. The primary objective of FSR is to improve the well-being of individual farm families by increasing the overall productivity in the context of the entire range of private and social goals and given the potential and constraints imposed by the technical and human elements which determine the existing farming systems.
FSR can be divided into four stages:

the descriptive and diagnostic stage
The objective of this stage is to understand the farming systems practised in the target area. This enables the FSR team to determine the constraints that the decision-making households face and the flexibility that exists in the current farming system - timing, skill, slack resources etc.

the design stage
In this stage, improved technologies thought to be relevant to overcoming or avoiding the constraints identified in the fist stage are specified.

the testing stage
The objective of the testing stage is to evaluate a few of the more promising technologies arising from the design stage on farmers' fields.

the extension stage
In this stage, technologies found during the design and testing stages to best overcome the constraints outlined in the descriptive and diagnostic stage are widely extended to other farmers. Problems in the extension stage should be monitored - perhaps accompanied by a new round of descriptive

and diagnostic work. This process is dynamic and iterative because there is a frequent return to previous stages.
The distribution between the stages is not sharply defined as there is much overlap, and several stages are tackled simultaneously. The process is flexible and adaptable to many circumstances and different problems.
The essence of the FSR's methodology is that it analyses and assesses the original situation, the present level and results of production, and in this way learns in the constraints and elaborates alternatives of development. It is necessary to test these alternatives and chose the most suitable. After introducing the new system, or system components, it is necessary to test and compare the new system's level and results with the original one.
FSR can be the first step of an important development, but it must not be conceived in an isolated way. It should then be part of an agricultural policy which includes the necessary social and economic reforms. A farming system is not only a summary of crops and animals to which one can apply this or that input and expect immediate results. Rather, it is a complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs, and environmental influences. The farmer's understanding of his environment, both natural and socio-economic, affects his farm system.

278 89 - 2/38

Farming systems research and development
Review, book, developing countries, food security, poverty, policy study
THE WORLD BANK
Poverty and hunger: Issues and options for food security in developing countries.

The World Bank, 1986, pp. 69 + xi, USD 7.50 (softcover)

A publication as important as this by the World Bank has to be viewed in the context of the Bank's shift over the last six years to a much more conservative outlook. A lot has been heard from the Bank about "getting prices right", allowing market forces to have a free hand and so on, and much less of the talk heard during the 1970s about direct measures to eradicate poverty. Given the political climate in the Bank, this is an exceptional document; given what needs to be done about reducing poverty and hunger by improved food security.
Such chapter headings as "National measures to reduce chronic food insecurity" and "International support for food security" create the impression that insufficient attention has been given to household and community level factors and how those should be taken into consideration in designing food security policy. The document is one which can form the basis for promoting the argument that issues of national economic growth and equity can and do overlap in improving food security.

The policy study is essentially split into three parts. After a definition of terms and an overview, there is a discussion of whether food security is a problem of supply or purchasing power. That is reviewed by reference to two aspects - chronic and transitory food insecurity. The former is defined as continously inadequate diet caused by the inability to acquire food; the latter is a temporary decline in a household's access to enough food, resulting from instability in food prices, food production or household incomes. Inadequate production, household purchasing power and unstable world and domestic prices are all reviewed as causative factors.
The second part discusses national measures to reduce both chronic and transitory food insecurity. The former includes increasing the food supply (by trade interventions, production subsidies), subsidizing food prices (by targeted subsidies, marketwide subsidies) and augmenting incomes. The national measures to reduce transitory food insecurity are given as stabilizing domestic food supply (production, buffer stocks, trade), stabilizing domestic demand and protecting vulnerable population groups. The third section concentrates on international measures: external finance including food aid and international trade.
They should be tried to take household characteristics and priorities and see how those can be built up into national programmes that are technically, and politically, feasible. Many projects and policy studies have failed because inadequate attention was paid to the target group itself.

279 89 - 2/39

Farming systems research and development
Asia, Philippines, study, technology transfer, farmers, rice, language differences, IRRI,
CABANILLA, V.L. and T.R. HARGROVE
The Effectiveness Among Farmers of a Farmer's Primer on Growing Rice in two Philippine Dialects.

IRPS No. 127, 1987, pp. 11

Language differences inhibit the flow of agriculture information not only among scientists but even more so from research institutions to farmers, the ultimate users of technology. To alleviate the language barrier in technology transfer, the International Rice Research Institute (IRRI) has developed its copublication program - cooperative ventures with national agencies and private publishers in which the cooperator translates IRRI books and handles most distribution. IRRI designs certain publications to make them easy and inexpensive for cooperators to copublish.
The Tagalog and Hiligaynon editions of "A farmers's primer on growing rice", which is published in 30 languages, were evaluated for their effectiveness in transferring rice technology information to 84 farmers in Cavite and Negros Occidental, two provinces in the Philippines. Relationship among farmers'

sociodemographic characteristics, communication variables, and the Primer's effectiveness in terms of knowledge gain were also tested.
A 73-item test was used to measure initial knowledge level. The farmers were then given copies of the Primer in Tagalog (Cavite farmers) or Hiligaynon (Negros farmers). A post-test was given 45 days later to measure knowledge gain.
On both tests, farmers who answered less than 50% of the test questions correctly were defined as having "low"levels of knowledge, and those with 50% or more correct answers as having "high"knowledge. Only 4% of the farmers had high knowledge in the pretest, but 46% had high scores after reading the book. The t-test also showed that, although farmers who finished the book and those who did not were not significantly different in initial rice knowledge, the difference in post-test scores was highly significant. The farmers' knowledge gain concerning fertilizer was highest. In the pretest, only 15% knew the meaning of "24-12-12" on a fertilizer sack, but half knew after the treatment. Of 14 independent variables tested, only 4 were significantly related to knowledge gain: previous participation in rice training courses, land tenure, number of years in rice farming, and exposure to newspapers. The Cavite and Negros farmers generally matched well in most variables.
Farmers evaluated the Primer's design, packaging, and message content favorably but suggested improvement to increase its effectiveness, such as the deletion or substitution of abstractions and symbols that they found confusing or hard to understand.
IRRI is using the findings of this study to make forthcoming publications, designed on the Primer concept, more effective.

280 89 - 2/40

Farming systems research and developing
Latin America, Mexico, livestock, crops, smallholders
ALUJA, A. et al.
Decision making by livestock/crop smallholders in the state of Veracruz, Mexico
Cornell international agriculture mimeograph, 105, 1984, pp. 44

Prior to proposed agricultural development program in the Mexico State of Veracruz, 13 farms were surveyed in an effort to identify and quantify factors in farmer's decisionmaking. Data were collected in physical resources, (land, facilities and equipment, cropping), livestock, pasture management (grazing systems, pastures, quality of forages, supplementary feeding), milk output, livestock reproductive performance, animal health, selected indicators of livestock performance, marketing, labor, and economic factors. It was found that the farmers'decisionmaking in regard to both crop and livestock systems was rational. Farmers appreciated that to increase animal and milk production from modest to high levels would not be supportable under present marketing conditions. It is concluded that the government should

recognize that farms in Veracruz State are supplying local needs through low inputs and contribute to state and regional food supplies than is generally recognized. A 3-page bibliography (1955-84) is appended.
Abstract from FSR

281 89 - 2/41

Farming systems research and development
Africa, Zambia, adaptive research, farmers, scientists, farming systems research
KEAN, S.A.
Developing a partnership between farmers and scientists: The example of Zambia's Adaptive Research Planning Team.

Expl. Agric., 24, 1988, pp. 289-299

This paper is based on the experiences of the Adaptive Research Planning Team in Luapula Province (ARPT-LP), which is one of the nine provincial ARPT teams conducting farming systems research (FSR) in Zambia. The ARPTs form a section within the Research Branch of the Ministry of Agriculture and Water Development. The Research Branch also includes 16 Commodity and Specialist Research Teams (CSRTs), who conduct research mainly at the provincial research stations. This paper shows how a government-operated national agricultural research system has attempted to involve farmers in the process of research and technology generation.
When ARPT was established in 1980 one of its primary function was to involve farmers, especially small scale farmers, more fully in the technology generation process. However, only a few evaluations of ARPT and the Research Branch have seriously considered what progress has been made in involving farmers as partners in research. This paper makes such an assessment.
ARPT started working in Luapula Province in 1982 and since then has become increasingly concerned to involve the farmers in both planning and implementing the team's research programme. The team has used several formal and informal opportunities to interact with farmers and involve them in decision making. These opportunities and several key factors affecting the evolution of this interaction are examined here.
The information was collected as part of a larger study, covering the work of ARPT in Zambia as a whole, and is being published in a nine country comparative study of organization and management of on-farm client oriented research by the International Service for National Agricultural Research.
Even though ARPT has a mandate to work with farmers, the experience of ARPT-LP indicates that it is easy to underestimate the amount of time and effort needed to explain the purpose of the team's work and its specific activities, and to build an effective partnership with farmers. It is very easy for scientists conducting farming systems research to regard farmers simply as recipients of new technologies rather than as partners and initiators in the research process.

Research priorities should be set taking great care to use information derived from surveys and discussions with farmers. Farmers' ability to suggest topics for research can be enhanced over the long term if scientists explain clearly the range of technological options available to meet a particular need. They should therefore have some basic training in communication skills. Informal opportunities for discussion between scientists and farmers have been as important as formal occasions. However, care has had to be taken to ensure that comments made by farmers have been properly recorded.
Various factors likely to enhance the level of farmer participation include involvement of local leaders, use of extension workers or scientist with experience of extension work, selection of farmers in close proximity to one another, and emphasis on greater farmer participation by senior research managers.
Monitoring the level of farmer involvement in decision making in a national research system is difficult because there can be many informal, as well as formal occasions when information and opinions can be passed from farmers to scientists. It is also difficult because it is usually possible for scientists to justify decisions they have made by referring to survey results or comments made by farmers on some occasion. But if research organizations or sections have been given specific mandates to involve farmers in the research process, it is important that such mandates are included in the monitoring and evaluation of the research system.

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89 - 2/42

Farming systems research and development
Discussion, workshop paper, farming sytems research, socioeconomic models, ICRISAT, small farmers
ANDERSON, J.R. et al.
Socio-economic modelling of farming systems.

FSR Workshop, Richmond, New South Wales, 1985, 30 pp.

The types and role of socioeconomic models in FSR are discussed in this non-technical workshop paper. In basic type, models are either descriptive or optimizing; the latter are defined as those which incorporate an algorithm which directly generates a solution for a specified function in the model. Among the variants of these two types, budgeting and mathematical programming stand out respectively; the latter's relative advantage in eliminating bias is exemplified during an excursus on the experiences of one of the authors in an FSR program conducted by ICRISAT. Socioeconomic modeling permits detailed evaluation of the performance of a given farming system and identification of its strong and weak points and helps assess the viability of a proposed technology. Problems involved in the use of socioeconomic models include the difficulty of striking a suitable balance between data gathering, model building, and model exploitation, the physical and/or cultural

remoteness of modelers from farmers (or, by contrast, an excessively anthropological approach), and various sins of omission, of which the most serious is failure to recognize the crucial role of female farmers. A concluding section stresses the need for greater sensitivity to the ideas and needs of small farmers. A 4-page bibliography (1970-86) is appended.
Abstract from FSR

283

89 - 2/43

Farming systems research and development
Asia, Pakistan, sustainability, development, agroecosystem zoning, farming systems survey,rapid rural appraisal
CONWAY, G.R. et al.
Rapid rural appraisal for sustainable development: experiences from the northern areas of Pakistan.

Presentation to the IIED's Conf. on Sustainable Development, London, Earthscan, 1987, 30 pp.

The challenge for the designers and managers of development projects is to find ways of analysing situations that are rapid and cheap and that ensure their recommendations will lead to sustainable development. This paper describes several methods that go some way to meeting the challenge and how they are being applied in development project in the Northern Areas of Pakistan.
Rapid rural appraisal (RRA) aims to provide enough structure to the observation and analysis to ensure a relatively high degree of accuracy, without incurring lengthy or costly studies. RRA is also a response to dissatisfaction with many conventional socio-economic and agricultural surveys. Experience suggests that in addition to being time consuming and expensive they often do not ask the key questions or obtain the critical data. RRA recognises that the context of the data may be as important as the data themselves, and that variations may be more revealing than the averages that are often the sole output of conventional surveys. Above all, RRA is intended as a highly iterative process. Learning takes place in the field as part of a dialogue with the farmers and the other members of the RRA team. Accuracy is achived by triangulation, i.e. by repeated cross-checking of information from several different directions using different techniques. It follows that RRA is primarily a process of generating and refining hypotheses about rural development.
There is no single, standardised methodology for RRA. In each situation this depends on the objectives, local conditions, skills and resources. However there is a suite of techniques in existence which can be used in various combinations to produce appropriate RRA methods. The suite includes:

- Secondary data review
- Direct observation
- Conceptual tools
- Semi-structured interviews
- Analytical workshops.

Secondary data consist of reports, maps, aerial photographs etc. that already exist and are relevant to the project. The review process involves searching for relevant data and summarising these in diagrammatic models, simple tables and brief abstracts.
The aim is to be sceptical and critical and to look out for what has been missed, but not to spend time here that could be better spent in the field. **Direct observation** includes measurement and recording of objects, events, and processes in the field, either because they are important in their own right or because they are surrogates for other variables that are important. **Conceptual tools** consist of a wide variety of simple techniques for summarising information. An important set of such tools are diagrammatic models, including maps, transects, seasonal calendars, flow diagrams, bar diagrams, decision trees and venn diagrams.
One of the most important of RRA techniques is **semi-structured interviewing**, which is a form of guided interviewing where only some of the questions are predetermined and new questions or lines of questioning arise during the conduct of the interview, in response to answers from those interviewed. The information is thus derived from the interaction between the knowledge and experience of the interviewer and the interviewee(s). The latter may be groups, for example of village leaders, or key informants, such as school teachers or local government officals, or the farmers themselves, selected on one or more criteria.
The final RRA technique is the **analytical workshop**. This takes place very soon after field visits, is semi-structured and provides an opportunity for intensive multidisciplinary analysis of the information acquired in the field.
Over the past two years these various RRA techniques have been explored as means of determining priorities for the next phase of development in the Northern Areas of Pakistan. The outcome has been a series of RRA methods under the headings of agroecosystem zoning, agroecosystem analysis, topical rapid rural appraisal and farming systems survey. In practice they have been developed and refined and it is only recently that their logical relationship to one another, as presented in this paper, has become apparent.
Underlying the use of these appraisal methods are a number of basic concepts that provide a framework for analysis. The first is that agricultural land use in the Northern Areas of Pakistan can be represented as a set of more or less distinct agroecosystems, typically arranged in a hierarchic fashion. An agroecosystem can be defined as an ecological system partly modified by humans for the purpose of food or fibre production. The wheat field is an example of such a system.
Each agroecosystem has a characteristic behaviour that may be summarised by four interconnected properties:
Productivity, which is the output of valued product per unit of resource input (e.g. land, labour, energy or capital) and is commonly measured as annual yield or net income per hectare or per agroecosystem, or per man hour or unit of investment.
Stability, which is the constancy of productivity about its long term trend in the face of small disturbing forces arising from the normal fluctuations and cycles in the surrounding environment, for

example in the climate, or in the economic conditions of the market. Such forces affect the variability of production but leave the long term trend unchanged. Stability is most conveniently measured by the coefficient of variation in productivity.
Sustainability, which can be defined as the ability of an agroecosystem to maintain its productivity when subject to stress or shock. A stress is here defined as a frequent, sometimes continuous, relatively small and predictable disturbing force which has a large cumulative effect, for example salinity, toxicity, indebtedness or declining market demand. A shock, by contrast, is an irregular, infrequent, relatively large and unpredictable disturbing force, such as a rare drought or flood or a new pest or the sudden rise of an input price. Stresses and shocks have the potential of causing lower, or declining trends in production or even collapse.
Equitability, which is a measure of how evenly the productivity of the agroecosystem is distributed among its human beneficiaries. The more equitable the system the more evenly are the products, the food or the income, shared among the population of the farm, village, region or nation. It can be represented by a statistical distribution or by a measure such as the Gini coefficient.
These four properties are essentially descriptive in nature, summarising the status of the agroecosystem. But they can also be used in a normative fashion, as indicators of performance, both in the design of agricultural innovation and in its subsequent evaluation. Experience shows that in agricultural development there is almost inevitably some degree of trade-off between these different properties and the challenge for rapid rural appraisal is to accurately foresee these trade-offs and ensure they are taken into account in project planning and management.

89 - 2/44

284

Farming systems research and development
Review, tropics, developing countries, technology transfer, farmers, modelling system, decision support system, appropriate technology, data requirement, future outlook
UEHARA, G.
Technology transfer in the tropics.

Outlook on Agriculture, 18, 1, 1989, pp. 38-42

The purpose of this paper is to examine factors that govern technology transfer and describe how these factors can be incorporated into new efforts to accelerate agricultural technology transfer in the tropics.
There is a growing sense that a technology is appropriate only in the eye of the beholder. The certainty that only farmers can recognize appropriate technology has generated strong opposition to researcher-designed technology packages and has given rise to arguments that agricultural research should be conducted with farmers, for farmers' fields.

Most researchers concede that the user must participate in the selection, design, and testing of a new technology, but in practice few farmers are involved in technology assessment. The problem with the well-intentioned aim of involving farmers in technology development is that it is too slow, too expensive, and unreliable.
It is not so easy to propose a better method. But it is abundantly clear that the current methods must be supplemented with a fresh approach.
An international group of agricultural and systems scientists met to design a decision support system for agrotechnology transfer (DSSAT). The participants were asked to focus on systems analysis and crop simulation models as the primary means to match crop requirements to land characteristics. The aim was to develop a solid foundation for dealing with the soil-plant-atmosphere continuum so that strong links between the biophysical and socioeconomic processes could be later forged. The scope of work was limited to ten food crops including four cereals (maize, rice, sorghum, and wheat); the grain legumes (dry beans, groundnut, and soybean); and three root crops (aroid, cassava, and potato). The first approximation of the minimum data set needed to stimulate crop performance was prepared. This report has since undergone two revisions and continues to serve as a guide to design field experiments for model validation and refinement.
The DSSAT is microcomputer software designed to provide users with easy access to soil, weather, crop, and experimental data as well as simulation models and expert systems to simulate outcomes of alternative management strategies. The system now includes a weather generator which provides the model with daily weather data to stimulate crop performance for 10 to 50 years. The weather generator uses historical weather data to compute coefficients with which to reproduce statistically similar weather data.
This paper is based on the experiences of an international team of agricultural and systems scientists which has been involved in the development and validation of a DSSAT. More information about the software and users' guide can be obtained from:
IBSNAT Project, Department of Agronomy & Soil Science, 2500 Dole Street, Krauss Hall 22, University of Hawaii, Honolulu, Hawaii 96822, USA.

285 89 - 2/45

Farming systems research and development
Review, humid tropics, IITA, farming systems development, models, ecosystems, conservation, utilization, food needs, sustainable farming systems
JUO, A.S.R.
New farming systems development in the wetter tropics.

Expl. Agric., 25, 1989, pp. 145-163

This paper highlights some of the unique features of the tropical forest environment and assesses some promising technologies that

may lead to the development of new farming systems in the wetter tropics.
Except for some densely populated urban areas in the coastal regions of south Asia and west Africa, the supply of basic foods has not been a real problem in the wetter tropics. Rice, cassava, sweet potato, cocoyams, small ruminants and a wide range of forest products have provided nearly all the basic needs of the indigenous population.
In tropical forest regions, most soils, for example, are inherently less fertile; the climate is continuously hot and humid; and the average farm worker is less well educated and less skilled.
Farming systems may be devided into three simplified models: the irrigated paddy-rice multistorey homestead garden complex of Asia, the tree and cash crop plantations of Latin America, and the mixed root-bush fallow systems of Africa.
Farming systems in the wetter tropics may be illustrated by simplified models, the main features of which reflect their natural resource base, their cultural and social characteristics and, above all, the path of agricultural development taken during past centuries.
An overriding factor guiding future agricultural development in the wetter tropics is probably the fragility of its upland ecosystems, particularly in areas where acid and kaolinitic or lateritic soils predominate. Agricultural development in the region should, therefore, be based on long-term environmental stability rather than short-term economic returns. Thus, high priority should be given to developing ecologically sustainable mixed systems involving annual food crops, trees and perennials on small family farms. Achieving household security for food and nutritions would remain the most important goal in such systems; family income would be derived mainly from cash crops and off-farm activities.
However, new farming system development does not explicitly imply inventing new systems or component technologies. To prevent further destruction of the earth's remaining tropical forests, there is an urgent need to develop or introduce new farming systems that are more in harmony with natural ecosystems and better suited to be cultural heritage of the indigenous societies in the wetter tropics:
- Multistorey homestead gardens
- Alley cropping
- Rotation with cover crops
- Food crop improvement
- Tree and perennial crop plantations
- Livestock range farming
- Farm units along a toposequence

Because of the fragility of the natural resource base, sustainable farming systems in the wetter tropics rest on a delicate balance between conservation and utilization. Much more research is needed to understand the dynamics of tropical forest ecosystems better and to assess their biological potential for future agricultural development. The current knowledge clearly indicates that predominantly acid and nutrient-depleted soils in the low altitude

wet tropics are unsuited to energy-intensive and market-oriented food crop agriculture. However, to meet the food and nutritional needs of the indigenous population, there is enormous potential for the development of more productive and stable multistorey homestead gardens and mixed systems including tree, perennial and annual crops.
The principle and practice of "alley cropping" provide an ecologically sound basis for future farming systems research and development in the wet tropics.

286 89 - 2/46

Farming systems research and development
Review, tropics, developing countries, farming systems, on-farm research, requirements, framework, design, execution
CAMEOENS, J.K.
Farming systems and their on-farm research requirements.

In: Proc. of on-farm animal research/extension and its economic analysis, Los Baños, Laguna, Philippines, 1987, pp. 19-24 + app., Distr.: Winrock Int. Inst. for Agric. Development, Petit Jean Mountain, Route 3, Morrilton, AR 72110, USA

A historical perspective tracing the development and application of on-farm research is presented.
The historical setting permits the classification of on-farm research needs into five broad categories: human, technical/technological, production economics, marketing linkages.
For purposes of identifying on-farm research needs, ten types of agricultural systems can be described:
- swidden agriculture
- shifting cultivation
- nomadic herding
- transhumant farming
- rainfed agriculture
- irrigated agriculture
- plantation farming
- contract farming
- commercial livestock production
- nontraditional livestock farming

Major characteristics of these systems are presented in this paper.
On-farm research should be planned, designed, executed, and analyzed within the framework of some important operational principles:
- Principle one: (Ask-the Farmer). Find out what the farmers are doing and design research to help them do it a little better.
- Principle two: Assemble on-farm resource data; determine their quantities; analyze on-farm resources' allocative efficiency; program on-farm research to optimize resource allocation and test the results for repeatability.
- Principle three: Determine the value of the research to the farmer and to the national economy.

- Principle four: Do not implement the change until the success of the research can be demonstrated as being repeatable.
  Principle five : On-farm research could awake the slumbering tiger. Beware of the consequences!

On-farm research is expensive and is becoming more difficult to fund because so much previous research was unsuccessful, and because it employs highly qualified scientists. Over 75% of research budgets are for personal payments. It is a luxury for developing countries; hence, it must be practiced with utmost care and economy, it must demonstrate a favorable benefit cost ratio, and its results must have effects in the shortest possible time. No scientist must yield to the temptation of doing research for its own sake, for the sake of a publication, or to add another decimal point to a statistic. On-farm research must have the farmer at its aim. Its objectives are to find out what the farmer is doing, help him do it a little better, and enhance the farm and national economies.

287 89 - 2/47

Farming systems research and development
Review, on-farm research, IITA, farming systems research, research procedures, farmer, productivity
MUTSAERS, H.J.W. and D.S.C. SPENCER
On-farm research - a necessary tool in the development of innovations.

entwicklung + ländlicher raum, 22,3, 1988, pp. 10-12

This article reviews some of IITA's recent experiences with on-farm research (OFR) as well as its current thrust in this area.
OFR is rightly considered as primarily a function of national research institutes. International institutes should develop prototype technologies to be adapted and tested for local conditions by national institutes.
Prototype innovations cannot be effectively developed without direct exposure to farmers conditions, particularly in Africa where national research institutes are weaker than in Asia or Latin America. Scientists in the International Agricultural Research Centers (IARC's) need direct contact with the farmers to test how realistic their ideas really are. Furthermore, there is a strong demand from national institutes for training in OFR. It is inconceivable for IARC's to respond to such training demands unless they have first-hand experience in OFR.
One important element of OFR in which it differs from conventional extension demonstration methods is its adoption of a stepwise approach. Farmers have often been found to resist the adoption of multielement packages as they are commonly offered by extension agencies. New crop varieties for example, are often introduced with a set of recommended practices attached such as sole cropping, row planting, recommended fertilizer, timely weeding etc. This requires a large number of changes in farmers' habits all at the same time, which they are unlikely to make.

The OFR - approach would break down the package into its constituents and test them one or two at a time while leaving everything else unchanged. This not only allows the researchers to observe their technologies under more realistic conditions but it also enables them to study the farmers' current practices and how they affect their yields. This is almost impossible when complete packages are tested: farmers will quickly leave everything to the researchers and even loose interest when the innovations are too different from their usual practices. The "one-farm trials" then degenerate into replicas of station trials.
In order to illustrate these points the paper briefly reviews some of the experiences with the introduction of a new maize variety and a moderate dose of fertilizer in farmers' conventional maize + cassava intercrop system and with alley cropping.
The paper concludes that IITA is becoming increasingly involved in OFR, both in its outreach projects and from its Ibadan main station. It enables to expose the technologies to realistic conditions which is a necessary step in the development of prototype technologies. It also provides with an opportunity to observe farmers' constraints and problems at first hand. Finally, it provides a field laboratory for the further development of appropriate OFR methods.

288 89 - 2/48

Farming systems research and development
Review, tropics, Asia, farming systems research, economics, measurement methods
BARLOW, C. and S.K. JAYASURIYA
Improving the economic impact of farming systems research.

Agricultural Systems, 22, 1986, pp. 109-125

Improvements in the economic impact of farming systems research are considered in this paper in two main and related senses. One sense concerns measurement of the extent to which a new technology affects in the incomes and resource use of farmers, and thus has wider economics and social significance at regional and higher levels. The other sense involves adjustment of farming systems research per se.
The focus of this paper is on what are judged to be key practical issues in each of these senses of impact analysis. Wider aspects of such analysis are already well covered in other literature, to which due reference is made. The concentration is on farming systems research in its commonest application on national sites, where the aim is to secure new technologies directly improving the economic viability of local agriculture. This is often termed "downstream" research, in contrast to the less direct "upstream" work undertaken by some international and regional centres. The prime concern is with the Southeast Asian area where are today several hundred crop and livestock sites. The rapid spread of such sites, with their usually fragile resources, emphasizes the need

to recognize limits on research possibilities, and, within these, to pinpoint ways of maximizing the value of what is done.
Some practical issues in the measurement of impact at the three stages of farming systems research are discussed. While most issues are seemingly obvious, the fact that they persist as serious deficiencies in so many research contexts indicates that they deserve important consideration.
With the ex ante stage the needs of securing representativeness of the target area and of benchmarking the wider initial situation, including economic, social and agroclimatic features, are emphasized. With the ongoing stage, the importance of using suitable partial budgeting techniques is stressed. With the ex post stage, an assessment of wider technological and economic effects is called for, together with the identification of enabling factors and constraints in technological progress.
The adjustment of the farming systems research process itself is finally considered, and the desirability of simplifying the process, further training junior field-level researchers and securing better interaction between workers at the various research levels, is highlighted.
The theme in this paper is that the effectiveness of such research could be substantially improved through a revised analysis of the impact of designed and actual new technologies, supported by certain adjustments to the farming systems research arrangements per se. The essential argument is for a broader analysis of technology effects, where the "total" environment, theoretically recognized as pertinent to farming systems studies, is better taken into account at successive stages. Achieving this goal is difficult under the poorly endowed conditions of most research sites, and will demand substantial revision of the current approaches of junior economic staff, accompanied by improved training and much better interaction with senior researchers.
The goal of this paper is to pinpoint deficiencies in current analysis, in the hope that an already valuable study technique may be thereby enhanced.

289 89 - 2/49

Farming systems research and development
Review, sustainable development, institution building, farmer organization, organizational structures, investments, agricultural development, project, socio-cultural compatibility, development strategies, social action, methodologies
CERNA, M.M.
Farmer organizations and institution building for sustainable development.

In: Sustainability Issues in Agricultural Development - Proc. of the Seventh Agric. Sector Symp., The World Bank, Washington, D.C., Eds. T.I. Davis and I.A. Schirmer, ISBN 0-8213-0909-9

This paper reports and discusses the findings of a recent systematic analysis of the correlation between the sustainability

of development projects and several factors assumed to affect it, including institutional and organizational factors. The analysis covered 25 largescale development projects financed by the World Bank. It sheds light on the premises of sustainability and, conversely, on the causes of non-sustainable development interventions.
The sections of the paper (i) present the empirical findings produced by the study, (ii) discusse implications of these findings, and (iii) define some issues and lessons relevant for designing strategies for sustainable development, particularly in agriculture. The issues refer to specific organization building and engineering approaches required in development programs and to the social science research and applied work needed for their realization.
The experience of many unsuccessful, or marginally effective, development projects has shown that the long-term sustainability or non-sustainability of such projects cannot be attributed only to factors of an economic and/or technological nature, but is related to institutional and organizational factors as well. The research devoted to this topic has been chronically insufficient.
The concept of sustainability of development interventions, while not new, is recently acquiring high visibility. Sustainability should be a sine-qua-non of every financially induced development program. Without the building bricks of sustainability, much financing is condemned to inducing only short-lived "development spurts".
The concern for sustainability is being powerfully reinforced now by the international debt crisis, which has thrown light on a profound paradox of both nationally and internationally financed development programs. Such programs are undertaken with the expectation that their benefits will not only allow recovering the investments and repaying the loans that made them possible, but will also generate a net surplus. However, if such projects do not foster sustainable development, then instead of surplus benefits the borrowing party ends up increasing its accumulated debts. In part, the international debt crisis is a product of repeated investments in non-sustainable development programs.
The definition of sustainability used was essentially an economic definition. Project sustainability over time was defined as the maintenance of an acceptable net flow of benefits from the project's investment after its completition, i.e. after the project ceased to receive Bank financial and technical support. The actual economic rate of return (ERR) was recalculated at the time of the in-depth impact evaluation studies (IES). The standard for determining economic sustainability has been to assess whether the ERR was equal to, or greater than the opportunity cost of capital.
The analysis concluded that 12 out of the 25 projects appeared to have successfully achieved long-term sustainability, while 13 did not. In 5 of the 12 successful projects, the flow of benefits at impact evaluation time was even significantly higher than the level of returns at completion time, while in the other 7 projects the level stayed constant. By area, the highest success durability rate was in East Asia (6 projects) and Latin America (4 projects);

the lowest rate was in East Africa and West Africa, with only 2 out of 15 projects able to sustain their initial good results.
The remaining 13 projects failed to sustain the minimum flow of benefits to qualify for an assessment of continued, lasting success. At the time of project completion, the rate of return projections for these 13 projects had been satisfactory and ranged between 15 percent and 30 percent. However, at impact evaluation they had all declined to less than 10 percent and in two projects the ERR had turned negative. The average rate of return assessed for these 13 projects at impact evaluation time was as low as 2.7 percent; this rate reflects the inability to sustain project activities in the post-completion period.
These are serious findings, even if they cannot be extrapolated, to the Bank's overall agricultural experience. Such a high number of unsustainable projects was certainly not expected.
Five main factors or sets of factors were found to have a decisive bearing on the sustainability of the 25 projects analyzed. These elements were derived by contrasting the experiences of the projects which performed significantly above expectations at audit against those which performed worst:
- institutional build-up and participation of beneficiaries;
- technological improvements;
- socio-economic compatibility;
- favourable policy environment;
- recurrent cost financing/recovery.

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Farming systems research and development
Review, book, study, project maintaining, evaluation, agriculture, IFAD, FAO, WORLD BANK
CASLEY, D.J. and K. KUMAR
Project monitoring and evaluation in agriculture.

The Johns Hopkins University Press, Baltimore, Maryland 21211, USA; published for The World Bank, Washington, D.C., a joint study of the World Bank, IFAD and FAO; ISBN 0-8018-3615-8, 1987, 157 pp.

The accumulating experience and the growing consensus regarding concepts and definitions led the World Bank and IFAD in collaboration with the FAO to agree to produce a set of technical publications on the monitoring and evaluation of agriculture investment projects which would provide the basis for training programs at the regional and national levels.
This book provides a conceptual framework. A companion volume provides specific methodological guidance.
This book is based on the Task Force Guiding Principles and provides monitoring and evaluation concepts and definitions in the particular context of agriculture investment projects.

The book contains the following chapters:
1 Monitoring and Evaluation: A Management Perspective
2 Monitoring and the Management Information System
3 Monitoring of Physical and Financial Progress
4 Beneficiary Contact Monitoring
5 Follow-up Diagnostic Studies for Monitoring
6 Communicating Information
7 Evaluation: Substantive Focus and Types
8 Measurement of Production Increases: Methods and Limitations
9 Special Topics in Impact Evaluation
Suggested Readings
Index

Examples of actual monitoring and evaluation problems are interspersed in the text to illustrate significant points. These narratives have been edited and in some cases sharpened to dramatize the point being made. A full reference is given if the source document is available. In many cases, however, the source document is restricted and only the agency name is given.
It is necessary to stress what this book and its companion are not. This book does not deal with monitoring and evaluation of national programs and policies.
The framework proposed is put forward solely in the context of the monitoring and evaluation of agriculture and rural development investment projects, which are defined as interrelated and coordinated activities formulated and financed to achieve specific sets of objectives within a limited span of time and operated by an identifiable and formally responsible management team.
The primary intended audience comprises those in the developing world responsible for the design and implementation of monitoring and evaluation systems. Project managers may also benefit from this volume. It is hoped that this publication will be useful to those who provide training courses in this subject and to all who are interested in the issue of judging the success of the development effort in rural economies.

291 89 2/51

Farming systems research and development
Asia, Pakistan, study, rapid agroecosystem zoning, project, development strategies
PRETTY, J.N.
Rapid agroecosystem zoning of Alpuri sub-division, Swat District, North West Frontier Province, Pakistan.

Report of Malakand Fruit and Vegetable Development Project, MFVDP, Mingora, Pakistan and International Institute for Environment and Development, London, 1988, 67 pp.

At the request of Intercooperation (Switzerland) and the Pakistan-Swiss Malakand Fruit and Vegetable Development Project, an exercise in Rapid Agroecosystem Zoning and Rapid Rural Appraisal was conducted in Alpuri Sub-Division, Swat District, in July 1988.

The objectives were twofold: firstly to test the applicability of rapid zoning techniques to the work of the MFVDP and to identify different zones within Alpuri; secondly to produce a series of strategies for fruit and vegetable development and key questions for investigation in the identified zones of Alpuri Sub-Division.
This report has been written by the workshop participants and compiled and edited by Jules N. Pretty.
The dynamics of agroecosystems can also be described in terms of four interconnected properties - productivity, stability, sustainability and equitability.
These terms are defined as follows:
Productivity is the output of valued product of the zone per unit of resource input.
Stability is the constancy of production of the zone in the face of small disturbing forces arising from the normal fluctuations and cycles in the surrounding environment.
Sustainability is the ability of the zone to maintain production when subject to stress or shock. Stresses and shocks have the potential of causing declining trends in production of even collapse.
Equitability is the evenness of distribution of the production of the zone amongst the people.
These four properties are essentially descriptive in nature, but they can also be used as indicators of performance both in the design and evaluation of innovations. Experience has shown that in agricultural development there is almost inevitably some degree of trade-off between these different properties. The challenge for Agroecosystem Zoning is to foresee acurately these trade-offs and ensure they are taken into account during planning and subsequent management.
Methodology of Rapid Agroecosystem Zoning (RAZ):
The methodology makes use of a number of important techniques falling within the rubric of Rapid Rural Appraisal (RRA).
The key features of an RRA are as follows:
- it is iterative and involves "learning-as-you-go", enabling processes and decisions to be changed in the light of new generated information of analyses.
- it uses the farmers' perspectives to help define differences in field conditions.
- it is partly structured, flexible and adaptable,
- it reduces complexity to a few key problems and opportunities,
- it uses small teams of mixed disciplines and a system perspective to make communication easy,
- it is quick and relatively cheap,
- it emphasises not only productivity, but also other agroecosystem properties and the critical trade-offs between them.

This zoning of Alpuri used a number of important techniques of RRA, namely secondary data review, direct observation in the field, semi-structured interviews, drawing of diagrams, analytical games, portraits and stories and analytical workshops.
Secondary data and information are published or unpublished data, acquired by other people at an earlier time, that are relevant to the topic or target of the RRA. Time spent on quickly reviewing

and summarising secondary data can help avoid time wasted in repeating studies and, by revealing gaps or biases in the existing data, it can also stimulate ideas and suggest paths of investigation. Nonetheless it is important not to spend time on what could be better spent in the field.
Direct observation is relatively straightforward and encompasses any direct observation of field objects, events, processes, relationships or people that is recorded by the team in note or diagrammatic form. Innovative forms of direct observation rely on carefully chosen indicators. These are events, processes or relationships which are easily observed or measured but can be used as an indicator of some other variable that is more difficult or impossible to observe.
Semi-structured interviewing or semi-structured learning is probably the most powerful of RRA techniques. It takes place in informal,guided interview sessions.
Diagrams are simple, schematic devices which present information in a readily understandable visual form.
Analytical games are such techniques as ranking which are used as a quick means of finding out an individual's or group's list of priorities and preferences.
Portraits and stories are short, colourful descriptions situations encountered by the team in the field or stories recounted by people met there.
Analytical Workshops are means of bringing people together to participate actively in reviewing, analysing and evaluating the information gathered.
Throughout the RRA, whilst in the field or in the workshop, the team focussed on understanding the problems and opportunities particular to fruit and vegetables in each village or area under study. During field visits the team learnt from farmers of the important factors which characterised different zones.
The RAZ took a total of 11 days, alternating betwen analytical workshop sessions and visits to the field.
The Alpuri Sub-Division has been divided into 16 zones. These can be regarded, for planning purposes, as the basis for General Recommendation Domains. Each domain is characterised as having biophysical and socio-economic features sufficiently in common that a menu of diverse innovations and interventions can be appropriately recommended throughout the domain.
The zones were drawn up after considering a wide range of biophysical and socio-economic factors, both in the field and in an analytical workshop. Rapid agroecosystem zoning is, however, an iterative excercise, and boundaries for zones are expected to change in future as more information and knowledge on Alpuri is gathered.

292 89 - 2/52

Farming systems research and development
Study, Philippines, Peru, Mali, GTZ, ODI, participatory technology development, ecologically-oriented agriculture, sustainability, techniques, methods working models, institutions
WATERS-BAYER, A.
Participatory technology development in ecologically-oriented agriculture: Some approaches and tools.

Network Paper 7 of the Overseas Development Institute, Agric. Administr. Unit, Regent's College, Inner Circle, Regent's Park, London NW1 4NS, England, ISSN 0951-1873, 1989, pp. 62 + ii

This paper is an abridged version of a manuscript which was commissioned by the German Agency for Technical Cooperation (GTZ) and which is under review for publication as a "GTZ Working Paper for Rural Development".
Ecologically-oriented agriculture, organic farming, sustainable agriculture, alternative agriculture - the terms vary, but they all have some basic aims in common:
- developing land-use systems appropriate to site-specific physical, biological and socioeconomic conditions;
- making optimal use of locally available resources, and thus minimising dependence on external inputs;
- achieving productive, long-term sustainability. For the sake of brevity, this type of agriculture will be referred to here as "ecofarming".

The concern here is with the efforts of smallholders in the tropics to maintain and develop their farming systems and with the efforts of outsiders - agricultural researchers, extensionists, development project staff (nationals and expatriates) - to help them do so. As these outsiders have been trained in methods of formal agricultural science and are regarded by practical farmers as representatives of this science, they will all be referred to here as "scientists". The term "smallholders" refers to resource-poor farmers, i.e. persons who derive their livelihood mainly from agriculture and have very limited access to land and capital. They will usually be referred to here simply as "farmers". The central concept of this paper is "participatory technology development (PTD)": specifically, how farmers and scientists are collaborating to generate new ecofarming techniques and knowledge in Asia, Africa and Latin America.
The primary target group of this paper comprises planners and advisers in aid agencies or non-governmental organisations (NGOs) who are trying to help farmers improve their systems of land use and agricultural production. The aim is to increase awareness of how cooperation between scientists and farmers can lead to the development of farming techniques which are ecologically sustainable, economically feasible and socioculturally acceptable.
Specific aims are:
- to explain the concept of PTD and encourage incorporation of participatory methods into agricultural research and development (R & D);

- to indicate the place of PTD in the overall R & D process;
- to give concrete examples of PTD;
- to introduce tools which can be used to increase farmers' contribution to technology development in R & D programmes;
- to provide sources of further information so that those who recognise the potential of scientist-farmer collaboration in R & D can gain ideas and encouragement.

The focus is on the development of agricultural production technology. Although innovations in socioeconomic organisation on the village and regional levels are vital for "embedding" the new technology, i.e. for ensuring that smallholders can continue to apply and adapt it in response to changing conditions, the promotion of organisational innovation is not considered in detail here.

Emphasis is on the evolution of existing farming systems in areas of long-established land use by man. Here, resource-poor farmers are likely to regard completely new integrated ecofarming systems as too risky to adopt wholesale. They are more likely to try out small changes or new components which fit into and improve their existing farming systems, just as they have done in the past to evolve their present systems.

This paper is primarily concerned with actions which have been taken or are presently underway. The sources of information are the authors' own experience in a multidisciplinary research team which worked together with livestock-keepers in central Nigeria, reports on PTD given in two recent workshops on this theme, and personal contacts with scientists who attended these workshops and are/were directly involved in participatory R &D programmes.

The paper reviews the origins of participatory technology development, seeking ways in which conventional and participatory R & D can complement each other. Case studies are drawn from the Philippines, Peru and Mali. The bulk of the paper is allocated to a discussion of techniques for initial orientation (including village brainstorming, investigating indigenous innovations, studying farmers' informal trials, diagramming, crop histories, board games and preference ranking) for technology development (including participation in trial design, experimentation with working models, innovative workshops and group scoring) and dissemination (including farmer-to-farmer workshops, community video and farmers'field days). The final sections contain useful lists of institutions and individuals working in participatory technology development.

Author's Abstract, extended

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Farming systems research and development
Asia, Philippines, systems-problem research, participatory method, marginal uplands, rehabilitation
LIGHTFOOT, C. et al.
A participatory method for systems-problem research: Rehabilitating marginal uplands in the Philippines.

Expl. Agric., 24, 1988, pp. 301-309

To improve the adoption of research findings by resource-poor farmers, "farming systems research" and its variants "farmer-first-and last" and "farmer-back-to-farmer" provide an alternative approach.

Rapid diagnostic methods have been developed but do not use systems tools to link biological and socio-economic relationships. Systems tools are especially important to FSR because farmers' problems are systems problems. They usually involve many components of the whole farm system.

Methodological questions remain on how exactly one goes about identifying farmer systems-problems, how these systems problems can be analysed and how this understanding leads to experiments.

The experiments developed first identified farmer systems-problems, second, analysed a key problem, and third, elaborated experimental hypotheses. Farmers participated throughout.

Initially, farmers were self-selected but later on random selection was used. While the methods are presented as three stages, in practice they flowed uninterrupted.

The research was carried out in three villages in the Philippines. These villages, whose combined population does not exceed 150 households, are located among rolling hills of infertile Alfisols. These brown acid soils are very poor in organic matter (3.0%) and phosphorus (29 ppm). Although the annual rainfall reaches 3000 mm an irregular dry season occurs between January and June. Between valleys of bunded rice, small plots of upland rice, corn, cassava, sweet-potato, coconut and banana break up the hills that are otherwise dominated by *Imperata cyclindrica,* locally known as cogon.

An informal random sample survey, guided by topics of inquiry and biological measurements that employed systems analytical tools, was used to obtain a farmers' perception of "systems-problems". Systems diagrams also provided a framework for searching and screening solutions. A sequence of vining legumes was tested in rehabiliting the marginal uplands. For this experiment farmers elaborated hypotheses on control of Imperata, recovery of soil fertility, and reduced labour costs in re-cultivation. Extensive research activity among the farmers indicates the value of this participatory method.

The method used encourages farmer participation. It also encourages the use of systems logic in identifying systems-problems, analysing systems, and elaborating experiments. Consequently, these experiments are very different from typical

cropping pattern trials which place priority on maximizing crop grain yield per hectare with high cash inputs.
The priority lies in the long term rehabilitation of cogonal land and in saving labour.
A more holistic systems logic also leads to differences compared to conventional cropping pattern trials.
A wider view of upland farming systems reveals that upland farmers not only cultivate many agroecological zones, but they do so on a crop-fallow rotation. Thus farmers are interested in the management of cogonal fallow land and not just the cropped areas.
More participation and a wider systems view than in conventional cropping pattern research undoubtedly produced important differences in both research topic and orientation of intervention.
Participatory methods that use farmer knowledge and systems logic are now solving problems that conventional cropping pattern research was incapable of addressing.

294 89 - 2/54

Farming systems research and development
Review, book, ILO, rural women, developing countries, development, status, domestic role, policy
FETHEROLF LOUTFI, M.
Rural women unequal partners in development.

Publ. of the Int. Labour Organization (ILO), CH-1211 Geneva 22, Switzerland, ISBN 92-2-102389-3, 1987, pp. 75 + ix

Rural women are the most silent participants in the economic life of developing countries. Women in the lowest classes and castes are deprived by their poverty, illiteracy and ill health of the means to escape from a short life of drudgery and fatigue. A majority of the poor is female.
To achieve substantial growth in production depends partly on women, and progress toward more just societies must include greater equality for women. Any acceptable definition of development should include both material improvement and greater equity.
What it is aimed to highlight in this study is the nature of forces and of interventions that can facilitate an upward progression of women in their roles as workers and managers wherever the location in the spectrum of socio-economic-political change and development.
Yet, in general, women still posses less education and training than men, and what they do have is less suited to the labour market. Average earnings still tend to be lower: occupations with a high proportion of women offer lower average earnings. This creates inequities not only between men and women as individuals, but also between female-headed and other households. In virtually all societies women work longer hours than men for smaller rewards, and a great many women accept and even defend the systems that ensure their dependence and even exploitation. But Third

World rural women in the lower classes and castes are the most disadvantaged in that their work is the hardest and yet the least rewarded. Some of the factors which sustain this, and those which could sustain an improved reality, are the subject of this study.
The first step is to examine the nature of rural women's work in developing countries. Perceptions of status are then reviewed and discussed with a view toward their interrelationship with and impact on rural women's work. The importance for benefiting women of looking beyond the household to the individuals inside is explained. Then the effects of official policies on rural women are highlighted. Where governments intend to attack rural poverty, the neglected necessity of taking particular account of the strains on female-headed households is observed. Possible constructive policies in various sectors are mentioned, as is the role of food-for-work. The urgency of providing opportunities for increased cash earnings along with reducing work burdens is stressed. And the dependence of effective policies on the participation of rural women is explained. Finally, a more abstract view of some general realities applicable to all countries with respect to the dynamics sustaining unequal wage and occupational structures and those that could sustain equality is taken.
This monograph draws together the principal themes arising with respect to rural women's work, while also discussing some general realities concerning women in all societies. It aims to place official policies in perspective as well as indicate constructive directions. The emphasis on the participation and organisation of poor rural women is characteristic of the programme on rural employment in general.

295 89 - 2/55

Farming systems research and development
Latin America, Brazil, Asia, Indonesia, Thailand, CEBEMO, RTI, study, review, self-help promotion, objectives, methodology, promotion instruments, economics, holistic development approach
VERHAGEN, K.
Self-help promotion.

Royal Trop. Institute, Amsterdam/Cebemo, Oegstgeest, ISBN 90 6832019 X, 1987, pp. 152, Distributer: Foris Publications, P.O.B. 509, 3000 AM Dordrecht, The Netherlands

This publication is an integrated report of a study conducted by three nongovernmental organizations in Brazil, Indonesia and Thailand, coordinated by CEBEMO, on the promotion of economic activities in rural areas.
Cebemo is a Dutch organization for development co-operation, which, on behalf of the Dutch Catholic Community, acts as a channel of the joint financing programme of the Dutch Government. Cebemo finances initiatives of a developmental nature at grassroot level.

The basis of the activities of the Royal Tropical Institute is the collection and dissemination of knowledge in tropical countries, concentrated in three main programmes: rural development, tropical hygiene and transfer of knowledge. The relevant development projects in these fields are carried out preferably in combination with scientific research, education and training.
The study was carried by local NGO's partner-organizations of Cebemo, which in the present study have been termed Self-Help Promotion Institutions (SHPIs).
Promotion refers to the development task these SHPIs have set themselves, namely to facilitate the emergence and foster the functioning of cooperative-type organizations at grassroots level, known as Self-Help Organizations (SHOs).
Since the rural poor have become too numerous to be helped from outside, "self-help" has emerged as a new paradigm for combating rural poverty, and "self-help promotion" as the main orientation for local NGOs in developing countries.
Two key elements in this approach are fundamental:
- building upon what the rural poor have, rather than what they lack;
- Facilitating and promoting their organization.

The study is divided in two parts and 10 chapters:

This book is the result of a lot of research, reflection and discussion. It should therefore be studied by all those interested in rural development in general and self-help promotion in special.

296 89 - 2/56

Farming systems research and development
Africa, Rwanda, farming systems improvement project, problem analysis, trials, field day, information transfer, cover crops, organic farming systems, soil fertility, leguminous shrubs
YAMOAH, C.F. and R. GROSZ
Linking on-station research with on-farm testing: The case of agroforestry and organic matter-based cropping systems for the Rwanda farming systems improvement project.

Agroforestry Systems, 6, 1988, pp. 271-281

The Rwanda Farming Systems Improvement Project (FSIP) is located in the Ruhengeri Province in the northwestern highlands of the country. This area is noted for its high potential in agricultural production. It is one of the most densely inhabited areas in the country, with about 372 people per square kilometer.
Hillside farming with its attendant erosion and decline in soil fertility is commonplace in the area served by the Farming Systems Improvement Project. The project is designing landuse systems that check erosion, increase soil organic matter and restore soil fertility.
Agroforestry and organic matter-based cropping systems, using leguminous plants, are some of the promising interventions recommended to deal with accelerated soil degradation problems on sloping lands.
This paper reports the approach used by the Rwanda FSIP to involve farmers in the entire research process.
Problems were identified through review of secondary data, exploratory surveys with farm families, consultations with scientists who have Rwanda experience and direct communication with local administrators and key informants.
The interventions suggested were:
- tillage (zero and minimum)
- mulch systems (live and in-situ)
- manures and composts
- agroforestry systems
- inorganic fertilizers

Farmers were exposed for the first time to technologies such as alley cropping, green manure and mulch systems using various cover crops.
This event was also an opportunity to show communal extension agents how to use a field day as an effective communication tool to integrate farmers into their activities. It was, thus, a learning experience and a linking event for all three partners in the FSR/E approach, researchers, farmers and extension agents.
The use of leguminous shrubs and cover crops as nutrient sources are options that land-use experts think might solve the problem. There is a dearth of knowledge about the biological feasibility of these interventions in the project area.

297 89 - 2/57

Farming systems research and development
Latin America, national programs, cassava, on-farm research, intercropping, evaluation, production constraints, small-scale farmers
CIAT
El programma de yuca amplia la investigación en fincas. (Cassava program expands on-farm research).

In: Informe CIAT 1988, Centro Internaciónal de Agricultura Tropical, Aportado Aéro 6713, Cali, Colombia, ISSN 01120-3169, pp. 35-38

Cassava in terms of calories is the fourth most important crop grown in the tropics after rice, sugarcane, and maize. Social and technological changes and the developments in recent decades make it desirable and possible for cassava to be used in nontraditional ways. CIAT's Cassava Program, in response to these changes, aims to exploit the staple's potential by developing ways to increase its production and to refine its processing and marketing.
In Latin America cassava is a small-farmer crop and is produced under a wide range of cropping systems of varying complexity. Understanding production constraints and what factors influence the adoption of new cassava technology, requires appraisal of the entire production system.
The Cassava Program has intensified its collaboration with national programs in onfarm research in selected areas in Latin America. The research is conducted in the areas where production, use, and marketing pilot projects are operating.
For example CIAT and the Colombian Agricultural Institute (CCA) are working with farmers to simultaneously evaluate new varieties of both cassava and maize. They are looking at how they perform when they are intercropped, as well as testing ways to improve the selection, treatment, and storage of the cassava planting stakes. Promising cassava varieties are routinely evaluated with farmers within their production systems. The farmers' participation helps scientists identify factors that influence the adoption of new technology.
Three years on on-farm testing have shown that cassava yields are greater when intercropped with the new ICA maize varieties than when grown with traditional maize types. Maize yields, too, are higher when intercropped with new cassava varieties than with old.
In Panama, CIAT is conducting with IDIAP's (Instituto de Investigaciónes Agropecúarias de Panamá) on-farm research. A cassava production package was developed which, in addition to adapted varieties, had recommendations on weed control, soil management, and fertilization. Because the crop has proved to be economically successful, the Banco de Desarrollo Agropecúario de Panama is using this package as the basis for loans to cassava growers in specific areas.
In an ecological study made with CIAT, Paraguay's SEAG (Secretaria de Estado de Agricultura y Ganadería) identified the main cassava production systems at Paraguari and Caaguazu. Analysis of the

production constraints showed that onfarm research should focus on soil management at Paraguari and on intercropping with maize at Caaguazu.
These examples show that in on-farm studies the evaluation of intercropping systems and the understanding of production constraints are inseparable if new technology is to be successfully adopted by small-scale farmers. CIAT and national programs see the need to conduct further research if efficiency of currently practiced intercropping systems is to be improved.

298 89 - 2/58

Farming systems research and development
Review, handbook, extension, theory, practice, methods, developing countries, GTZ, BMZ, CTA
Manuel de vulgarisation agricole - bases théoriques et méthodes (Handbook for agricultural extension - Vol. 1 - Theoretical bases and methods).

BMZ/GTZ/CTA-Publication, 1989; available at CTA, Postbus 380, 6700 A.J. Wageningen, Netherlands

The handbook is aimed at all professionals who try to improve agricultural advisory services through appropriate developing measures. "Manuels de développement rural" is a series published by the German Ministery of Cooperation (BMZ) and the German Agency of Technical Cooperation (GTZ).
"The handbook of agricultural advisory instructions" appeared in French with the help of CTA. It is the first of a serial collection which attempts to give short and precise informations about practical technical help. Based on acquired experiences, Vol. 1 gives theoretical informations about agricultural extension, how to plan and realize it.
Far from being a "book of recipes", this manual doesn't give instructions, but informs about ways leading to solutions. It aims in a practical way at filling a gap, i.e. the lack of information and advisory publications for smallholders.
Vol. 2 which consists in working documents is not yet available in French.
Abstract from SPORE

299 89 - 2/59

Farming systems research and development
Africa, Ethopia, farming systems research, on-station research, extension, appropriate technologies, small farmers, methodology, socio-economic condition
GEDENO, G.
Farming systems research linkages with on-station research and with extension at Bako, Western Ethiopia.

Farming Systems Newsletter, 33, 1988, pp. 10-25

Farming systems research and extension (FSR/E) is used to develop and adapt appropriate agricultural technologies for small farmers in order to increase their productivity.
The major reason for ineffectiveness of conventional, station based agricultural research is its reliance on a top-down approach which neglects the socio-economic conditions of small farmers.
Farmers in Ethiopia are often found to be reluctant to accept most of the technologies offered. The body of knowledge available from on-station research is useful for FSR/E. Some of the findings can be used with only slight modifications.
This paper describes the integration of OFR/E with on-station research and with extension, as they relate to Bako, Western Ethiopia.
The FSR/E programme's surveys and on-farm experiments have produced useful feed back for the on-station research programme and the on-station researchers are responding to the problems identified. From the on-farm experimentation there is a new recommendation available on fertilizer rate for maize and a tentative recommendation on intercropping forage crops with maize and sorghum varieties for producers' cooperatives. These recommendations were only possible due to on-station research results. Without a strong on-station research programme effective on-farm experimentation is not possible.
The collaboration and understanding between FSR/E and on-station researchers is progressively improving. For further improvement, the suggestions made to improve the integration of FSR/E with the on-centre research and extension should be given due attention. In contrast the progress made in FSR/E and extension linkage is limited.
The staff of the two organizations are physically separated and have their own programmes to follow. The organizations should develop a common interest and reconsider the importance of a strong institutional linkage to work out the problems.

300 89 - 2/60

Farming systems research and development
Report, farming systems research, extension, implementation, monitoring, women's contribution, subsistence farming, agricultural productivity
STRING, A.
Trials and errors: using farming systems research to reach farmers who are often neglected.

In: Farming Systems Reseach, Vol. III, No. 079, 1986, pp. 21

Although a large percentage of subsistence farming is conducted by women, agricultural extension and training programs have traditionally neglected them. This report suggests that because FSR is farmer-based, it may help researchers to recognize and nurture women's contributions to overall agricultural productivity.

In-depth analysis is made of soybean demonstrations and farmer trials in Malawi, where 50-70 of all smallholder farm operations are conducted by women, to determine whether the acceptance of new technologies is gender-related. Farmers were instructed in soybean cultivation techniques, and the level of acceptance and effects of the new technology were assessed. Constraints such as poorly adapted seeds and ineffective inoculants were not gender-related and affected all farmers equally; however, women had poorer crop yields than male farmers due, it is argued, to the lack of agronomic training given to women. The soybean project demonstrated: (1) that women are agriculturalists and interested in new technologies; (2) the importance of interaction between research and extension, farmer-oriented technical information, and an instruction methodology involving demonstrations and corrections; and (3) that further work is needed to include female farmers in agricultural development and training programs and to improve working relationships between female farmers and extension agents.

III INTEGRATED SYSTEMS

301 89 - 3/30
Integrated systems
Asia, Indonesia, review, home gardens, agro-ecosystem, plants, animals, agro-ecosystem
SOEMARWOTO, O. et al.
The Javanese home-garden as an integrated agro-ecosystem.

Sep. Print of the Int. Congr. of Scientists on the Human Environment, Japan, 1985, pp. 10

In the countryside of Java, the existence of a village is indicated by a goup of dense vegetation amidst rice fields. The houses are almost completely concealed by this dense vegetation.
This is particularly true in Central-Java. In West-Java many times the houses are clustered together with hardly any open space in between, while the gardens surround this cluster of houses. The village may also be fenced by a hedge of bamboo or other plant species.
The structure of the home-garden varies from place to place as influenced by ecological factors, like climatic, edaphic and social-cultural factors.
A salient facture of the home-garden is that it is planted with many kinds of plant species. For example, in the two adjacent subdistricts Cinangka and Padarincang in Banten, West-Java, 179 cultivated plant species were found in the home-gardens which included annuals and perennials of different hights varying from those creeping on the ground to trees of about 25 m. But not all species were found in every garden.
In addition, 62 weed species are found. But the term "weed" should be used with extreme care, since the people were using many weed species for one or other purpose. From a preliminary survey it was known that of these 62 species, 18 species were used for herbal medicine, one specie for roofing and fodder, four species for vegetable and almost all grass species for fedder. It is expected that more in-depth studies were likely to reveal that more weed species were actually used by the people in different ways.
Animals are raised by the villagers in home-gardens. The poor family may have a few chickens only and the rich one a few water buffaloes or cows, while goats and sheep are owned by people at the intermediate level. Other animals commonly found are horses, ducks, rabbits, guinea pigs, besides of course, pet animals, such as dogs, cats and birds.
In West-Java, particularly in the Priangan Region, fish ponds are a common part of the home-garden system. Kitchen waste form part of the fish food. The fish ponds are also fertilized by animal and human wastes, for which purpose the home stable and the bathroom-toilet are built above the fish pond.
From the description given above, it is clear that a village with its home-gardens is not merely a dwelling place, but also an important agro-ecosystem. It is an integrated unit in which the solar energy is channeled through the plants to animals and man,

and matter is cycled and recycled. This cycling and recycling process, together with the storied plant cover, effectively protects the soil of the home-garden from exhaustion, leaching and soil erosion.
Home-garden plants are also an important source of building materials and fire wood, supplemented by wood from forests.
Since home-gardens are still undeveloped, the potentials for increasing their production and economic value are still great. But their development should be carried out with care and with a full appreciation of ecological principles underlying their existence, including the social-economic aspects. Many of the plants and animals can still be improved by selection from the local varieties, followed later on by a hybridization program. In this respect the high diversity of the home-garden provides a rich genetic resource.
Since the villagers are poor und the unemployment rate is high, the need is for simple labour-intensive technologies. But even these technologies could displace people and disrupt the social structure of income distribution. The introduction of economic plants, which theoretically would give high economic returns, could become disastrous, if it would increase the need for capital investments, such as for the purchase of expensive seedlings, fertilizers and pesticides, and the daily income and food supply would be disturbed, since it might drive the people into the hands of money-lenders. Economic plants would also have the disadvantage of being sensitive to fluctuation of market demands and prices. Therefore, in the development process, it is essential that the introduction of economic plants in the home-gardens, should not eliminate plants and animals, which are essential to support the subsistence of the people. This means that the diversity of the home-garden will have to be high which is also important for its stability, thus reducing the need for energy subsidies. Consequently the technologies needed to improve the living standards of the people should be geared to an ecosystem of high diversity and not to that of a monoculture. It is also essential to develop an effectiv credit system in order to prevent the villagers from becoming victim of money-lenders.

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Integrated systems
Asia, Thailand, rice, fish, sustainability, stability, ecosystem, research, pests, diseases, yields, economics, productivity, equitability, smallholdings
MACKAY, K.T. et al.
Rice-Fish culture in Northeast Thailand: Stability and Sustainability.

In: Proc. of the 6th Int. Sc. Conf. IFOAM, UC, Santa Cruz, California, USA, 1988, pp. 355-369

The small-scale farmers of northeast Thailand are the poorest in the country. One crop of rice is grown during the rainy season.

Upland crops (e.g., peanuts and corn) are often grown in rain-fed areas during the dry season, while either an upland crop or a second crop of rice is grown during the dry season in irrigated areas. Traditional and locally improved varieties are used. Soils are poor, fertilizer levels are low, and some pesticides are used. Fish have recently been introduced to rice paddies and it is hypothesized that this increase in diversity will increase income, decrease fertilizer and pesticide use; and increase system stability and sustainability. This paper describes both the farming systems methodology used to test these hypotheses and the preliminary results.
Fish are nutritionally and economically important to many small farmers in Asia. The fish harvested from rice paddies are often the farmers' main protein source. Fish in rice paddies are also important economically, and benefits are often greater to tenant farmers than to owners. However, fish production in paddy fields has declined sharply in the past 20 years. Indications from Indonesia and Malaysia are that the introduction of double and triple rice cropping along with increased fertilizer and pesticide use have been the contributing causes. Similar decreases have also occurred in China and Thailand.
Recent research in rice-fish culture has concentrated on developing techniques to integrate fish back into rice production. These management techniques involve minimizing the harmful effects of fertilizer and pesticides on fish.
In northeast Thailand, rice-fish production is now increasing. Reports from various rural development workers indicate a rapid expansion of the fish production in rice paddies. What is unique about this development is that it is occurring spontaneously among farmers. Mixed rice-fish culture is not being pushed by any development programm but is being aided by a number of government and nongovernment development organizations. The causes of the expansion are not completely known although some are discussed in this paper.
Since 1984, the Farming Systems Research Institute, Department of Agriculture, Thailand, and CUSO Fisheries cooperative have been conducting on-farm research with rice-fish farmers in northeast Thailand. This research is designed to test the hypothesis that introducing fish into farming systems of this region will increase diversity, resulting in greater stability and sustainability, both ecologically and economically.
This paper reports selected results from larger studies of rice-fish culture. These studies are part of programs to increase farmers' income through improved and diversified agricultural production. These studies have focused on current farmers' practices, research in association with farmers, and extension to other farmers.
Due to the short timeframe of the study, it is not possible to measure changes in stability and sustainability. Indicators of stability are, however, examined: farm productivity, farm income, incidence of pests and diseases, requirements for chemical inputs, and farmers' perceptions of the system.
While the data from these on-farm experiments are incomplete and problematic with regard to statistical analysis, it suggests that

increased agroecosystem diversity increases productivity. The addition of fish to rice paddies appears to increase both rice yields and fish production, thus increasing total yields and economic returns.
The introduction of fish into the rice system offers additional food and income sources, decreases pest incidences, may reduce fertilizer requirements (i.e., increases linkages in ecological terms), and should increase ecosystem stability.
It is not possible to quantify sustainability of the rice-fish system. There are, however, certain features of this farming system which suggest sustainability: (1) chemical and other external inputs are reduced, (2) it is adapted to the social environment, and (3) there are reinforcing synergistic effects on other aspects of the farming system.

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Integrated systems
Review, workshops, sustainability, agriculture, diversification, economics, agricultural policy, research needs
WINKELMANN, D.L.
Diversification, sustainability and economics.

In: Proc. of the Seventh Agric. Sector Symposium - Sustainability Issues in Agricultural Development -. Ed. T.J. Davis and I.A. Schirmer, The World Bank, Washington D.C., ISBN 0-8213-0909-9, 1987, pp. 295-304

The theme of the workshop was sustainability in agriculture. The author of this article referres to diversification and sustainability.
This article is concerning sustaining productivity in agriculture, with little attention to issues related to other domains and even without going much into spillover effects beyond agriculture per se., e.g., ground water and down-stream pollution. Then this article focuses on the land, the water, and the germplasm employed in agriculture.
In detail the article starts with sustainability, technology, then relates diversification to sustainability, agricultural policy, and mentiones some research issues.
History gives examples of the fates suffered by civilizations whose agricultural production could no longer be maintained. For the most part, however, the more dramatic cases seem to be related to changes in climates.
The concern is less with long-term trends in climate, but more with maintaining production in the face of the acts of man. Some particularly telling examples are in the overgrazed areas of the Sahel and in the heavily eroded areas of central Mexico. But whether man or climate, the consequences of declining productivity can be staggering.
Much more research is needed which relates current output to the question of sustainability. Doing so will imply a much longer research horizon than most currently apply. Given the way much

research in the tropics and subtropics is financed and implemented. It is especially important that development assistance agencies lengthen their own horizons, at least with respect to topics related to sustainability. And, of course, before initiating such efforts the research of the past should be carefully reviewed.
Research should incorporate "natural farming" as one of its elements. This research, too, will require long horizons.
Such research must include not only biology but other circumstances of farmers as well.
The connections among diversification, sustainable agriculture, and practice run through biology, economics, and institutions. Much is known about selected facets of those interactions, far too little about most. Much research needs to be reviewed, much research remains to be done and a good portion of this research must have long horizons. Development assistance agencies concerned with sustainability should hasten to encourage, foster, and promote such research.

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Integrated systems
Review, agricultural development, integrated approach, integrated plant production, organic farming methods, agricultural policy, IFOAM, EC
SCHÜLER, C.
"Integration" - the future for agricultural development?!

IFOAM, 5, 1988, pp. 3-5

Three possible paths of agricutural development are discussed:
- "High-Tech-Farming" with widespread use of gene-technology
- further pursuit of the presently prevailing "Modern Agriculture"
- environmentally sound forms of agriculture such as "Integrated Plant Production" (Integrierter Pflanzenbau) or organic farming, the latter point being strongly favoured by the majority of representatives of organic farming in such discussions.

If we, the representatives of organic farming methods, intend to rise up and met the laid out standards, which in this dispute are taken more and more seriously, then the following questions have to be answered:
- Does "Integrated Plant Production" allow a development towards environmentally sound agriculture or is it merely an ecological touch to continuing conventional farming practices?
- Do organic farming methods provide a sound alternative to conventional farming which can be integrated into agricultural policy and hence cover the entire farming community in West-Germany or even the EC?

Both concepts of integrated plant production and organic farming including the historical development and the present-day state are briefly sketched and followed by an evaluation of their future potential in consideration of the questions raised above.

305 89 - 3/34

Integrated systems
Asia, Thailand, study, integrated farming, subsystems, vegetables, pigs, duck, fish, economic analysis, farming systems, scenarios
EDWARDS, P. et al.
Pilot small-scale crop/livestock/fish integrated farm.

Asian Institute of Technology Report No. 184, P.O.B. 2754, Bangkok 10501, Thailand, 1986, pp. 88 +vii

The pilot small-scale integrated farm operated by a farmer and his family was set up to gain quantitative biological and economic data to assess its relevance for improving the lot of the small-scale farmer. The 4,000 m² farm comprised vegetable, pig, duck and fish subsystems. Vegetables were raised continuously, four batches of pigs were fattened, one batch of egg laying ducks was reared, and two crops of fish were harvested in the 2 year project. The vegetable, pig and duck subsystems functioned independently to a large extent using off-farm inputs but the fish subsystem depended totally on wastes or by-products from the other three subsystems, mainly pig manure, but also duck manure and waste vegetables. The disposable income for the 2 year operation of the farm was only about 50% of the minimum wage for the area, mainly due to overcapitalization of the pig sty and to a poor yield of marketable sized fish in the first fish crop. A series of hypothetical modifications were made related to both technical and economic data derived from the actual operation of the farm. In Scenario 1 with the basic modifications, the monthly disposable income was 56% higher than the minimum wage, with only 69% of the farmer's time devoted to farming activities. The project demonstrate the feasibility of a small-scale integrated farm of only 0.4 ha to maintain a rural farming family. The vegetable subsystem was the only labour intensive activity on the farm and could be expanded to more fully utilize the working day and generate more disposable income as indicated in Scenario 2. Since the operating costs for the pig subsystem were 59% of the total, the farmer should attempt to substitute labour for relatively expensive feed which would lead to substantial improvements in labour income. Labour should also be directed to increase the nutritional inputs to the fish pond to optimize its use since it is a fixed asset of relatively high capital cost.
Sequencing of labour requirements would need to be considered if the small-scale integrated farm were developed on a traditional rice farm, the most likely way for a widespread development of integrated farming to occur. Since considerable skill is required to manage an integrated farm, it would have to be developed in a step by step way. Marketing may provide a greater constraint to the widespread dissemination of integrated farming systems than the need to adopt a variety of technological innovations.
Author's summary

306 89 - 3/35

Integrated systems
Asia, Malaysia, study, integrated agriculture, fish farming
TAN, E.S.P. and K.H. KHOO
The integration of fish farming with agriculture in Malaysia.

In: Proc. of the ICLARM-SEARCA Conf. on Integrated Agriculture Farming Systems, Manila, Philippines, 1979, Eds. R.S.V. Pullin and Z.H. Shehadeh, Rep. 1986, ISSN 0115-4389, pp. 175-187

The objectives of this paper are to outline the status of freshwater aquaculture in Malaysia, the forms of integration of such practices, other farming activities and to describe the results of specific case studies of integrated farming systems involving fish culture.
In Malaysia, agricultural activities dominate the life of the rural population. If aquaculture is to be introduced to the rural areas, it follows that some form of integration of aquaculture with agriculture is essential, at least during the early phases of development, so that the potential value of aquaculture, not only as a reliable source of food protein but also regular income, is gradually realized by the rural population. Such a strategy would enable financial assistance to be channelled to the rural poor directly. As these communities are located away from the sea, freshwater aquaculture using both fish and crustaceans is appropriate.
The status of freshwater aquaculture in Malaysia is reviewed with special reference to integrated farming. Case studies of pig-fruit-vegetable-fish, pig-fish and pig-poultry-fish farms are described in detail and the kampung style integrated farms (smallholding involving rice, fruit, vegetable, livestock and fish production) are discussed.
Integrated farming systems aim to optimize food production from limited land and water space. In practice, they maximize utilization of the farmer's time, with or without the efficient recycling of wastes. The recycling of animal wastes in fish production, as observed in pig-fish farms, is important in providing additional income for the farm.
The utilization of disused mining pools for fish farming in Malaysia requires minimal capital costs. As a commercial enterprise, it is very profitable provided that adequate fertilizers, both inorganic and organic, are used. This provision can be met by channelling animal wastes, especially pig manure, into the pools. There is, however, little control of the quantity of wastes being drained into these pools and excessive quantities can cause mass mortality of fish by entrophication and oxygen depletion. Further studies are required to determine the appropriate amount of various animal wastes required for a defined water space and the recommended stocking densities of fish so as to maximize production.
Fish yields in ponds in Malaysia are low and could be improved by better management techniques. Intensive fish farming techniques have yet to be practiced commercially in Malaysia, though their

potential should be investigated in view of the increasing competition for the utilization of land.
Unlike the commercially-operated integrated farms which are profit-oriented, fish culture in small ponds operated by smallholders at the kampung level is relatively recent. As an additional activity for small subsistence integrated farms, it involves minimal operating costs yet provides a valuable source of animal protein. It also provides practical experience in fish culture which offsets the rather poor initial yields and offers a way of directly assisting the rural inhabitants. With proper training, farmers should be able to increase the yields which would generate further interest in aquaculture at the kampung level. Ultimately, improved methods for fish culture must be formulated to make it more commercially viable.

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Integrated systems
Asia, case studies, workshop, on-farm research, animals, extension, economic analysis, farming systems
AMIR. P. and H. KNIPSCHEER
On-farm animal research/extension and its economic analysis.

Proc. of a Workshop - On-farm animal research/extension and its economic analysis, Los Baños, Laguna, Philippines, sponsored by Winrock Int. Institute for Agric. Development, USA, 1987, pp. 113

During the last decade increasing attention has been called to developing strategies for increasing the productivity of small farm animals. While rapid increases from the green revolution have been a mixed blessing for some groups, countries facing stiff competition in the commodity export market are anxious to diversify agriculture. Improving animal productivity appears to be one viable alternative.
While discipinary scientists are good at designing broad-spectrum technology, these improvements seldom reach the doorstep of the average farmer. Acceptance is now growing for the idea that researchers should participate in all stages of technology generation: problem description, diagnosis, design and testing, and evaluation. This approach requires an interdisciplinary focus.
This book contains 14 papers presented at a workshop in the Philippines: Devendra's paper discusses the need for on-farm animal research in Asia, outlining areas of concern and future directions. Camoens'paper looks at on-farm research from the perspectives of 10 farming systems.
Five papers document country experiences with on-farm animal research: Dickey's paper discusses the potential for using bioeconomic models to diagnose problems, using Bangladesh as a case study. Singh presents development strategy followed by the National Dairy Research Institute in India, giving special attention to economic analysis of different sized dairy units maintained on small farm. Hanjra's paper looks at dairy-improvement strategies in Pakistan, with special emphasis on the

cost of milk production. Papers by Calub and Ranjhan deal with the methodological and institutional problems in designing and conducting on-farm research. Calub's paper uses the Santa Barbara cattle fattening project as a case study, while Ranjhan's paper documents buffalo development in the Philippines and India.
Arboleda's paper stresses the need to design on-farm research with some consideration to statistical rigor.
Dawson's paper addresses the soil-pasture-animal ecosystem by looking at the use of animal manure and its long-term residual effects. Saadullah's paper describes present efforts in Bangladesh to develop better strategies for dealing with animal problems - he stresses the need to make graduate curricula more relevant to farmers' needs and to involve students in on-farm experimentation.
Papers by Lai and Prucsasri illustrate economic analyses of on-farm animal research in Malaysia and Thailand. Amir's paper provides a comparative micro study of the performance of large ruminants in Pakistan and India, giving special attention to the influences of policy and farmer preferences on the productivity of farm animals. Rañola's paper highlights marketing and policy factors that must be kept in mind when making widespread technology recommendations.
The workshop ended with some general recommendations for improving the training material. The consensus was that opportunities for disseminating information pertaining to on-farm animal research should be identified. National programs showed keen interest in participating in and hosting such workshops and courses. The group suggested holding a similar workshop in 3 to 4 years to review the progress of on-farm research in selected national programs. Specific proposals for networking between national programs were also discussed. In summary, this workshop proved beneficial in updating participants about future directions of on-farm research in Asia and strengthening linkages among country programs.
Eds. Abstract, shortened

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Integrated systems
Asia, review, animal production, farming systems, animal resources, non-continental feeds, strategies
DEVENDRA, C.
Non-conventional feeds: Potential value for animals in the Asian region.

Outlook on Agriculture, 18, No. 2, 1989, pp. 58-63

The availability of feeds and efficiency in their utilization represents the principal constraint to animal production in the Asian region. The constraint is serious in that imcomplete use of the available feed resources is associated with inefficient feeding systems, resulting in continuious low productivity from animals. Between ruminants and non-ruminants, the contribution of the former is especially low, due to inadequate exploitation of their attributes and wider use of the indigenous breeds available.

This has in turn raised questions about the efficiency of existing ruminant production systems, and more particularly about potential possibilities of increasing the current level of output from the animal resources.
Animal feeds, including crop residues, agro-industrial by-products, and non-conventional feeds provide a link between crops and animals. In most parts of Asia, mixed cropping is the main pattern in agriculture, so that the relevance of ensuring efficiency in feed utilization is not only imperative but also contributes to the stability of farming systems.
Among the nutrients, dietary protein is the main limiting factor, but variations in the supply of energy, minerals, and vitamins are also implicated. The problem of inadequate feed supplies is particularly acute in all countries in South Asia (Pakistan, Nepal, Bhutan, India, Bangladesh, and Sri Lanka). Additionally, there is also competition between animal species for the utilization of the feed resources, and also with humans for cereals and cereal by-products. These aspects are further exacerbated by limitations in the availability of land and inadequate production of feeds to meet the annual requirements of animals.
Elsewhere in the more humid parts of South East Asia, such as Malaysia and the Philippines, feed availability is relatively greater and the major limitation is inadequate and inefficient utilization of the quantities potentially available. Theoretical calculations suggest that the feed availability in these countries is often in excess of current animal requirements, emphasizing that considerable opportunities exist for further increasing numbers and improving animal production.
Development strategies that can alleviate prevailing circumstances, overcome current limitations and ensure more complete utilization of the available feeds, are therefore especially important. These constitute a means to increase the overall contribution from animals. In this context, the potential value of non-conventional feeds deserves increased attention, together with more intensive use of other crop residues and agro-industrial by-products. The approach is to take advantage of these feeds and identify clearly utilization with the objectives of production through the development of innovative feeding that can support all-year-round management systems.
This article considers how far traditional feeds can be effectively supplemented by non-conventional ones such as crop residues and agro-industrial by-products.

309 89 - 3/38

Integrated systems
Review, book, Africa, tropics, beekeeping
VILLIÈRES, B.
L'apiculture en Afrique tropicale (Beekeeping in tropical Africa).

Gret-Le point Sur, n.11, 1987, 250 p., available at GRET, 213 Rue Lafayette, 75010 Paris, France

In spite of its extensive character as well as the lack of professionals specialised in this activity, beekeeping is of some interest for Africa. On the one hand, honey is an appreciated product and its price is high. An important potential market thus exists, which is far from being saturated through national production. On the other hand, being an activity of dry season, beekeeping does not get into concurrence with field work; furthermore, it can contribute to a complementary source of income at quite an opportune moment of the year, filling so a gap in farmers' activities.
The African bee is productive. Concerning the traditional beekeeping practices, they are most efficient considering the fact that the costs are practically non existent. Therefore, improvements should prevail over changes in African beekeeping.
Characteristics of the African bees, apiarian practices, how to valorize beekeeping, a list of materials'suppliers and places where to find informations, as well as an exhaustive bibliography, make this book the reference work (in French) of African apiculture.
Abstract from Agricultures actualité

310 89 - 3/39

Integrated systems
Asia, Nepal, study, integrated farming systems, agriculture, animal husbandry economics
RAJBANSHI, K.G. and M.B. SHRESTHA
A case study on the economics of integrated farming systems: Agriculture, aquaculture and animal husbandry in Nepal.

In: Proc. of the ICLARM-SEARCA Conf. on Integrated Agriculture - Aquaculture Farming Systems, Manila, Philippines, Repr. 1986, ISSN 0115-4389, pp. 195-208

Although multicrop and integrated production systems have a long history in Nepal, there is a lack of scientific information on their methodology, management and economic viability. The objectives of this case study were to develop reliable, quantitative management guidelines and economically viable production methods for integrated farming systems combining agriculture, aquaculture and animal husbandry, with modifications appropriate to local conditions.
A two-year economic case study is presented of a small Nepali farm 14 km east of Kathmandu. In the first year the farmer concentrated on cereal crops while in the second year he added a piggery, combined duck raising with fish culture and used improved varieties of cereals.
The case study shows some of the important factors which have helped the farmer to increase his production of various crops with the limited resources of land, labour and other inputs. The increased production of various crops using an integrated farming system has increased his income too.

The direct benefits of an integrated farming system of agriculture, aquaculture and animal husbandry compared to agriculture alone can be summarized as follows:
- The labour requirement for intensification of agriculture decreased by 39% while the production of agricultural crops alone increased by 56%. Also, the move to integrated farming system which requires the addition of a 5% increase in labour compared to agriculture alone has given a 19% increase in income.
- The use of waste materials from one operation has reduced expenditure on inputs and helped to raise production for other operations.
- The move to integrated farming yields fish, ducks and pig meat which are considered as cash crops by the farmer. These are much more valuable than cereals alone and help raise the economy of the rural farmer above the subsistence or near subsistence level.
- The production of animal protein in the form of fish, ducks and pig meat improves the diet of the farmer.

The input:output ratio for aquaculture and animal husbandry is low compared to crop farming which reflects the farmer's limited resources for such capital intensive operations and his lack of technical knowledge which must be remedied by technical assistance.
This study was carried out with a single farmer. Environmental, social and other factors may vary from place to place but the authors feel that the study indicates the attractions of integrated farming systems to assist the rural farmers according to their requirements and conditions. In this study, pigs were included in the integration of livestock, but in certain parts of the country farmers may hesitate or refuse to accept these on social and religious grounds. Therefore, there is a need to study integrated farming using dairy or beefcattle or buffalo as well as pigs so that integration of livestock with agriculture and aquaculture can easily be tailored to the choke of the rural farmer.
With the possible combinations of cattle or pig and even poultry, there is also room for domestic biogas production in integrated systems when processing the available manure for field use. Biogas operation would give the rural farmers who are deprived of hydroelectric power the benefits of gas lighting and gas fuel for domestic use. It would also help to reduce public health hazards in the villages, protect the farmers from the effects of unprocessed wastes, and help to reduce the expense of waste disposal.
In addition to all these recommended developments, a detailed resource study has to be carried out to determine availability of land for the various crop combinations to optimize production and maximize the income of the rural farmer.

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Integrated systems
Africa, Nigeria, study, crop/livestock production systems, germplasm, soil fertility, ILCA, fodder, alley farming
ATTA-KRAH, A.N. and J.E. SUMBERG
Studies with *Gliricidia sepium* for crop/livestock production systems in West Africa.

Agroforestry Systems, 6, 1988, pp. 97-118

Forage research at ILCA concentrates very heavily on the identification, selection and improvement of fodder trees and their development and integration into farming systems of the zone. The emphysis on fodder trees is a result of the general potential of trees, and their common occurrence in farms, fallow lands and compounds in the tropics. Their relative ease of establishment and management (compared to that of herbaceous legumes) and potential of their integration into local farming systems makes fodder trees, rather than forage legumes and grasses, the base for developing integrated fodder production systems for small farmers in the zone.
This paper gives a broad discussion of the potential of *Gliricidia* and describes research conducted, in the development of fodder tree-based production systems for the improvement and integration of crop and livestock production in humid and sub-humid West Africa. Relevant research on the species by some other workers in the zone are also cited.
It examines the biological characteristics of the species, with respect to growth, flowering and seed production, and analyses its potential for improving crop production (through soil fertility maintenance) and livestock production (through production of improved fodder). Integration of *Gliricidia* into cropping systems is necessary for optimum realisation of its crop improvement quality. The alley farming system is presented in the paper as one means of achieving sustainability in crop production through integration of trees, such as *Gliricidia*, into cropping systems. The use of *Gliricidia* in Intensive Feed Gardens, for production of leguminous fodder is also described as an alternative production system. The paper finally reports on experiences with local farmers in on-farm research and development for the integration of *Gliricidia* and *Leucaena* into local farming systems. It ends with a suggestion for more research, targetted specifically at improvement of the species and its utilisation.
The various studies and observations discussed in this paper, show very clearly that *Gliricidia* does not just grow 'tall for nothing'. The species is useful both for maintenance of soil fertility in cropping fields and for improving livestock production through the use of its high-protein foliage, as feed. Its fast growth and nitrogen-fixing qualities are two characteristics that make it comparable to *Leucaena leucocephala* in cropping systems. Like *Leucaena* it offers a way of integrating crop and livestock production, and has a potential for improving

the overall productivity of farmers in the humid and sub-humid zones of West Africa.
There is a need to improve the awareness of local farmers on the potential uses of the species, as well as encouraging and promoting more research targetted specifically at its improvement (through breeding), its management in various farming systems and its utilisation for improved crop and livestock production.

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Integrated systems
Review, bibliography, catalogue, tropics, agriculture
RTI/CTA
Tropical agriculture - selected handbooks -.

Royal Trop. Institute and Technical Centre for Agric. and Rural Cooperation (CTA), Netherlands, ISBN 90-6832-627-9, 1988, pp. 114 + XI

This catalogue is a guide to English-language books on agriculture and rural development (farming, animal husbandry, fisheries, post-harvest operations and related activities) in the tropics and subtropics, with emphasis on Africa, the Caribbean and the Pacific.
It is a compilation of 405 standard reference works which are still in print and available from publishers. As such, it is a practical buying guide for students, educational staff, researchers, extension officers, librarians and others.
Many outstanding handbooks on various aspects of rural development are out of print and, therefore, not included in this catalogue. Some of these titles can be found in the bibliographies and lists of references mentioned in the catalogue. Copies of out-of-print books are still available in many libraries.
The principal aims of this bibliograpy are:
- to provide a guide to reference works on tropical agriculture for research workers, extension staff, planners and decision makers;
- to create an awareness of the rich sources of information on tropical agriculture in the English language;
- to assist agricultural librarians in creating well balanced collections of textbooks, reference works and manuals in this field.

The catalogue is divided into categories and sub-categories. Within these groups the entries are arranged by subject. Entries with a broad scope are categorized by their main subject. There is one abstract for each book.
The catalogue is supplemented by an author index, with codes referring to the entry number. Bibliographic data provided in the descriptions of the books include: title, author(s); place of publication; publisher; year of publication; number of pages; figures, drawing and maps ('figs'); tables; number of references ('ref'); bibliography (for books which contain more than 100

references); name of series and volume number (in parentheses); ISBN; the price of the book (in Dutch guilders) and the abstract. Book selection, abstracting, editing and production were carried out by the Information and Documentation Department (Evert C. van't Sant and Wiebe de Boer) and the Publications Bureau (Keith Addison) of the Royal Tropical Institute.

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Integrated systems
Review, booklet, tropics, rabbit farming, small-scale, practical approach, animals, reproduction, raising, housing, feed, diseases, administration
AGROMISA
Backyard rabbit farming in the tropics.

Agrodok 20, Agromisa, P.O.B. 41, 6700 aa Wageningen, The Netherlands, 1989, pp. 68, price DM 15,--

The popularity of the rabbit in the tropics is on the increase. A national rabbit compaign in Ghana receives much attention; the Indonesian Government is also importing rabbits and stimulating interest in rabbit raising. Certainly other countries have similar programs, or private organizations like churches, schools and youthclubs all over the world have their rabbit projects.
People keep rabbits for many different reasons. The main aim of this booklet is to give some reasons for small farmers, low income families or children, and to discuss management, breeding, nutrition, veterinary, and other problems for this type of backyard farming.
The booklet contains the following chapters:

1. GENERAL INTRODUCTION
   - Some reasons for keeping rabbits
   - Some disadvantages of keeping rabbits
   - General husbandry, an introduction to the following chapters
2. TYPES OF ANIMALS (BREEDS)
   - Fancy and fur breeds
   - Meat breeds
3. SELECTING YOUR ANIMALS (BREEDING STOCK)
   - Health
   - Sex
   - Risks
4. MATING AND KINDLING (REPRODUCTION)
   - The male
   - The female
   - Mating of ram and doe
   - Pregnancy control
   - Kindling and mothercare
   - When to mate the doe again
5. RAISING THE KITTENS

6. HOUSING
   - Introduction
   - General advice before you start building
   - The stable
   - The individual hutches
   - The maternity hutch and the nest box
7. WHAT FEED TO GIVE
   - Introduction
   - Water requirements
   - Feedstuffs to feed
   - Growth rates of rabbits
   - Some practical remarks
8. THE SICK ANIMALS
   - Introduction
   - Prevention of rabbit-diseases
   - The main diseases
     Intestinal problems
     Problems of the respirational tract
     Parasites
     Other diseases and health problems
9. PROPER ADMINISTRATION
   - Introduction
   - Identification methods
   - The record-book
   - The calendar
10. PRODUCTS OF RABBIT BREEDING
11. GLOSSARY
12. RECOMMENDED LITERATURE
13. QUESTIONNAIRE

APPENDIX 1 Nutrient requirements of rabbits fed ad libitum
APPENDIX 2 List of common diseases of rabbits, their symptoms, causes, treatments and control
APPENDIX 3 The process of tanning

This book ist not meant to be comprehensive and on purpose it is kept very simple. The basics for "tropical backyard rabbit farming" are included. Only those things which can be understood by common sense and which require no specialised knowledge, laboratory work etc. are discussed.
The literature list gives some details of the most important publications which are easily available. In the text no reference has been made to specific literature sources. In the appendix interesting information is given which could not easily be fitted into the other chapters of this booklet.
This booklet is very useful for all those keeping rabbits or have the idea to do so.

314

89 - 3/43

Integrated systems
Discussion, integrated approach, tropics, temperate zones, livestock, earthworms, soil fertility, biotechnology, management, slurry, organic waste
HARTENSTEIN, R. and M.S. BISESI
Use of earthworm biotechnology for the management of effluents from intensively housed livestock.

Outlook on Agriculture, 18, 2, 1989, pp. 72-76

This article discusses how organic waste can be effectively disposed of on a large scale, by systematically managing the destructive and productive activities of earthworms.
The objective of this article, accordingly, is to describe a procedure by which animal wastes can be (i) managed at minimal cost: (ii) on minimal land; (iii) with minimum damage to the environment; and (iv) with the production of a coomodity from the waste material. Several species of earthworms are required if these goals are to be achieved. The species recommended are normally found mainly in the temperate zones of the world. The procedure called for, however, will lend itself to their use in the tropics as well.
With a rapidly expanding world population, growing use of intensive animal husbandry, and increasingly stringent waste disposal legislation, the problem of disposing of livestock effluent is already severe.
In relation to livestock that can be intensively housed, 0.30 cattle were available per person in 1975, 0.26 in 1984; 1,56 poultry per person in 1975; 1.52 in 1984; and 0.17 pigs per person throughout 1975-84.
The success of intensive management of effluents from intensively housed livestock hinges on a continuous peturbation of the soil in which the animal wastes are to become humified. Earthworms will pertub the system through tunnelling; through mixing various microbial species during digestion; through the creation of internal soil surface beneath the external soil surface; by establishing conditions through which nematodes, potworms, oribatid mites, springtail insects, terrestrial isopods, snails, slugs, millipedes, and predators of these animals - including mesostigmatid mites and centipedes - are brought into the system. Additional activity results from exposing an enormous surface to rain which carries acids, hydrogen peroxide, and various other oxidants such as the perhydroxyl radical, hydroxyl radicals, and superoxide anions into the soil.
It can be concluded by saying that the system outlined can also be applied to the management of slurry from intensively housed humans. By 2024, regardless of how many humans are on Earth, probably more than 90 per cent will be urbanized. In the event that doubling of the human population from 1984 could occur, in accord with the present inherent rate of population increase, more than one million dry tons of body wastes will be in need of management daily.

315

89 - 3/44

Integrated systems
Asia, Thailand, integrated approach, agriculture, aquaculture, farming systems, chicken-fish farming
KACHORNSAK WETCHAGARUN
Integrated agriculture-aquaculture farming studies in Thailand with a case study on chicken-fish farming.

In: Proc. of the ICLARM-SEARCA Conf. on Integrated Agriculture - Aquaculture Farming Systems, Manila, Philippines, 1979; ISSN 0115-4389, Repr. 1986, pp. 243-249

There are many possible approaches to increasing agricultural production and income, including diversification and integrated farming. The idea of integrated farming is not new. It has been in existence in Thailand for centuries and can be seen in most farm households in the rural areas which combine animal and fowl husbandry with crop raising. These activities are mainly for home consumption and gifts within the community, but not for sale as an additional source of income. They could, however, become an additional source of income if given adequate attention. Integrated agriculture-aquaculture operations can include combinations of fish farming with animal and fowl husbandry or with crop raising.
There was, however, no follow up study until 1968-1969 when the Agroeconomic Unit, Central Office, Chainat Province, carried out a systematic study on income and expenditure in farms of various sizes in the Chaophyra Irrigation Project. The main study involved the selection of representative farms and the injection of slightly improved management techniques and some basicnew technology which the average farmer could absorb and follow. This revealed that farms of the sizes studied could yield annual profits of 8,522; 18,679, and 26,212 baht, respectively, profit being defined in this paper as net return over variable costs. Moreover, a farm of 6 rai with all activities reorganized as an integrated farm (e.g., crops, vegetables, rice, fish ponds, livestock, etc.) would yield an annual profit of up to 24,770 baht compared with only 6,500 baht from rice cultivation alone. Thus, compared to the slight improvements mentioned which give a profit of 31% higher than normal, a reorganized integrated farm shows a 3-fold increase. This study shows clearly that increases in farm income are possible without corresponding increases in the amount of agricultural land. To achieve this, however, farm management techniques and modern technology must combine to fully utilize limited natural resources.
Most of the current integrated farms in Thailand are operated in the traditional way - without proper planning, modern technology or modern farm management techniques - and rely on personal experience. Marketing is therefore a recurrent problem except in very good years. Fish diseases constitute a further major problem which the farmers cannot solve by themselves since they have

inadequate experience and knowledge, and such knowledge is not as readily accessible as with other farm animals where feed manufactures or veterinary supply companies offer services to assist farmers in many cases. A further problem for farmers is the shortage of credit and working capital, which forces them to contract their produce sales to middlemen, usually at unfavorable prices.
Although integrated farming has proved to be highly profitable, its practice remains very limited in scale. This is because the relevant scientific and technological information on diversification of methods is unavailable to farmers. To remedy this, there must be a bridge between in information sources and the farmers, perhaps through extension services. A multidisciplinary approach is needed, including technological, economic, social and political aspects which are interrelated. Any approach must, however, be relevant to national economic, social and environmental conditions and to the farmers' needs. A systematic study on a pilot farm is recommended, including all the aspects mentioned above.
A case study shows that integrated chicken-fish farming can yield a very high profit. A comparison of the variable costs of production of an egg (0.63 baht), its farm-gate sales price (0.86 baht), and its retail market price (1.25 baht) shows that the farmer's profit per egg is 36.0%, whereas that of the middleman is 45%. This is considered to be an equitable arrangement.
The turnover and total profit are both very high for such a small farm, and should enable the farmer to make adequate savings for his working capital, considering his cost and standard of living. An interview with the farmers revealed, however, a continuing shortage of working capital and the consequential unfavourable credit arrangements with feed suppliers.

316 89 - 3/45

Integrated systems
Africa, Burkina Faso, project, agrosylvo-pastoralism, soil fertility, reforestation, mixed cropping, livestock, integrated approach
GIRARD, H.
Zoramba nataaba: projet du centre agro-écologique de Guie. (Zoramba nataaba: project of the agro-ecologic centre of Guie).

Centre Agro-écologique, 1988, 70 p., available at the author's address, 76 route de Guise, F-59550 Landrecies, France

This abstract describes a project situated in Burkina Faso. It is based on agrosylvo-pastoralism and comprises 3 sections:
- Section "Improvement of arable soils" with the aim of rehabilitation the soil fertility through the composting method of Jean Pain on one hand (very simple method requiring brushwood and water); on the other hand, by building up lots of tiny anti-erosive walls in the fields.

- Section "Reforestation": creation of nurseries, of anti-erosive quickset hedges with thorny species (preventing damages through animals), mixed cropping with trees (*Acacia albida* for example) promoting soil fertility.
- Section "Control of cattle dissemination": efforts are being made to reduce ovine livestock, keeping donkeys, bovine livestock, pigs and poultry. Bee keeping is also considered. An eyperiment has been made with beehive (on the soil), allowing better honey harvest and less hive loss.

To reduce the exodus of young people to the Ivory Coast, the Centre will open a class for practical and theoretical formation of the youth. Short-term training courses will be organised for adults. Furthermore, in the villages around the Centre, rural activities will take place, to sensibilize already existing groups to the problems of deforestation (villagers, women, chief authorities).
Abstract from Agricultures actualité

317 89 - 3/46

Integrated systems
Review, manual, FAO, mushroom cultivation, indoor cultivation, field cultivation
RAMBELLI, A.
Manual on mushroom cultivation.

FAO Plant Production and Protection Paper No. 43, 1985, pp. 65

This manual is an attempt to present all that is currently known on the cultivation of mushrooms, at both small-scale level and industrial level. The techniques described involve the use of laboratories specializing in production of the most important species concerned. Laboratories, however, are insufficient in developing countries which stand to benefit most from this new source of income, nutrition, and investment. It is hoped that the development of laboratories will become a priority so that cultivation of mushrooms can be encouraged and undertaken. In the meantime, the possibility of successfully producing mushrooms exists both in developing countries and elsewhere, using the techniques described in the first part of this manual, and adapting them to suit prevailing local conditions.
A beneficial and convenient use of fungi in agronomy is the cultivation of mushrooms for nutrition. New growing techniques, in addition to the old traditional method of mushrooms beds, guarantee an increased and selected production. Mushrooms have always been appreciated more as a delicacy than for their nutritional and therapeutic properties.
As well as the industrial production of mushrooms, the small-scale farmer can make a profitable sideline from their cultivation. Unused stalls, sheds, greenhouses, cellars, etc. can be economically transformed without an excessive outlay of capital, and mushrooms can be grown and sold either fresh or preserved. The income to be earned from the specialization in selection and

preservation of mushrooms compares very favourably with the production and sale of similar farm produce.
As well as indoor cultivation, farmers on both small-scale and family-run farms can round out their agricultural earnings with the outdoor cultivation of mushrooms.
Although a great deal of research on many aspects of mushrooms cultivation remains to be carried out, the actual state of scientific knowledge at present available, combined with the practical experience and observations gained over the years by the small farmer and cultivator, provides an excellent and interesting approach to this type of investment.
Tropical forests undoubtedly offer great possibilities for the development of mushroom production, but so far very little is known of these regions, either from a mycological point of view or as a source of species for possible artificial cultivation. Many plants from tropical forests could probably be incorporated in agriculture to supply an income together with eventual mycorrhizal-fungi production, used for nutrition. A great amount of research must be performed in this field, which seems very promising.

318 89 - 3/47

Integrated systems
Central America, Honduras, case study, integrated approach, development program
BUNCH, R.
Guinope - an integrated development program in Honduras -.

Publ. of World Neighbors, 5116 North Portland Avenue, Oklahoma City, Oklahoma 73112, USA, 1989, 17 pp.

The Guinope Integrated Development Program was initiated in January, 1981, as a tripartite effort between World Neighbors, the Honduran Ministry of Natural Resources and the Association for the Coordination of Development Resources (ACORDR).
By and large, the Ministry has provided legal papers, tax-free status and occasional logistics; ACORDR has offered a series of ecologically sound agricultural technologies, plus administrative support, and World Neighbors has supplied the program personnel, financial support and general orientation as to development strategies and philosphy.
The obvious root problem in the area was severe soil deterioration caused by erosion and the continual monocropping of corn. Much of the area's topsoil was gone, with the results that average yields were extremely low; many farmers were walking for hours or taking buses to other parts of the country to find arable land, while others had left permanently for the slums in Tegucigalpa, the nation's capital, and malnutrition among those who stayed was increasing noticeably. Empty houses scattered throughout the town were mute testimony to Guinope's declining economic fortunes.
The key factors in the program's success, which as experience has shown can be applied to programs in most of the Third World, are:

- All forms of paternalism should be avoided, including giving things away or subsidizing farmer activities. All work should be accomplished for the sole reason that villagers want to achieve it for themselves.
- Programs should start small and slowly, so that local people can participate from the beginning.
- The program must use a limited technology, so that villagers can learn and teach it as soon as possible and so that a maximum number of villagers will be reached. In this way, great socioeconomic differences are not created among the population, and efforts can be concentrated on a few ideas in order to assure success.
- The technology should be appropriate to the local area, and the first lesson taught should deal with traditional food crops. Technologies should be simple to learn and inexpensive. They should use locally-available resources and provide rapid successes.
- Farmers should not have to risk too much to learn. Therefore, the technology should be taught through a system of small-scale experimentation. The teachers should be village farmers who already have had success with the same technology in their own fields. Training should be done in one or two day sessions in the farmers' villages, with at least 70 percent of the class time in the fields.
- A multiplier effect must be an important component of any agricultural extension program, so that successful villager farmers become the trainers in the program, eventually taking it over completely.
- Programs do best by gradually responding to other fields of the community's farm family, including health, family planning, participation in the political system, environmental improvement.

One additional factor of success has been that of using small farmer adapted green manure cover crops as a major method of retaining soil fertility. Green manure cover crops can be grown with virtually no expense, with very little labour and without using any land on which other crops could be planted. They can be planted in association with basic grains, during the dry season, on land already abandoned because of depleted fertility, under fruit trees or along soil conservation infrastructures.
The per-hectare grain production of the 1,200 families in the program has tripled, assuring them ample basic grain supplies for the ensuing year. This has been achieved at an average cost of $212 per family (based on the $254,000 cost above). Absolutely all the costs of agricultural production are carried by the farmer. Thus, except for a small revolving fund used to buy and sell necessary equipment (hand sprayers and pitch forks, for instance), the program makes no expenditures for labour, equipment or raw materials, Since technologies are kept simple and locally replicable, there are no import requirements, nor is there any need for replacement parts or maintenance that is not locally available and easily afforded by local farmers.

Probably the major problem in the Guinope Program has been that of marketing cash crops. The area around Guinope has no traditional vegetable marketing structure. Thus, before the farmers could produce any major amount of vegetables, a marketing structure had to be built.
Farmers became more experienced as to what quality would be accepted. The program's nutrition classes helped to stimulate the growth of a local market, and farmers competed to deliver the best quality so as to receive repeat orders. All of this helped ameliorate the problem of quality control, although there will probably always be complaints.
The last problem is how to phase out the program's involvement in the store, which finally became profitable, but nevertheless is extremely complex.
Prices fluctuate rapidly, and setting prices that are competitive, yet fair to the farmer, is a constant challenge. A tremendous amount of information must be learned in order to meet customer preferences regarding appearance of produce layout of the store, conditions of the washroom, etc.
The break-even point for this store is approximately $15,000 total sales per month, an astronomical sum for villagers to handle. All sorts of cheating is possible in a system where market-bought products are never sold with receipts, and vegetables rot or lose weight over time.
The best possibility would be that other middlemen and retailers should begin to buy vegetables from the Guinope area. Thus, the store could be phased out altogether. A second, more difficult alternative is that the store be sold to Guinope's farmers or to an entrepreneur.
The goal of this program is not so much to sustain itself indefinitely, but rather to "work itself out of a job". By using small-scale experimentation, keeping simple accounts of their experiments and sharing results with each other, large numbers of small farmers can continue to develop their own agriculture long after the program has closed its doors.
The program has no plans for institutional sustainability of the agricultural extension program. What will be sustained is a loose-knit federation of village-level agricultural clubs, which will coordinate experiments each year and share results. The vegetable producers' association eventually will run the vegetable store in the event that alternative marketing channels do not grow around Guinope's now proven record of high-quality vegetable production.

89 - 3/48

319

Integrated systems
Africa, Zimbabwe, integrated approach, study, livestock development, mixed farming systems, smallholder
STEINFELD, H.
Livestock development in mixed farming systems: A study of smallholder livestock production systems in Zimbabwe.

Farming Systems and Resource Economics in the Tropics, 3, Wissenschaftsverlag Vauk, Kiel KG, Postf. 4403, 2300 Kiel 1, FRG, ISBN 3-8175-0030-0, 1988, 239 pp

In this series farming systems approach is understood to mean the analysis and planning of the farm and the household as a complex system. This includes an holistic concept, an interdisciplinary approach and the dynamics of systems. Cropping or livestock systems are, therefore, subsystems within the farming systems complex. The international and external relationships of this system are of special interest in the fields of physical, technical, economic, social, socio-cultural, administrative and institutional impacts. In resource economics special emphasis is given to resource availability, use and long-term stabilization from a micro, regional and macro-economic point of view. It is here where the relations between farms, regions/projects and national sectors are of greatest economic relevance.
The aim of this study has been to determine the type and extent of livestock contributions within mixed farming systems and to indicate if and how livestock development can be instrumental in agricultural development. This has been done by analysing smallholder livestock production systems in Zimbabwe, employing a farming system perspective. Analysis and elaboration of development implications are carried out with regard to the resource base, the management practices applied, livestock output and the functions that livestock fulfil. On the basis of a comparative analysis and on both normative and positive grounds, development approaches are identified and assessed and future trends outlined.
The prevailing farming system in the Communal Areas is based on smallholder mixed farming using animal draught power and a minimum of purchased inputs. Livestock are essential for cropping in that they provide work and manure, and their outputs such as milk and meat contribute to household consumption and income. At the same time, livestock constitute the only significant asset in terms of security and wealth.
This study on "Livestock Development in Mixed Farming Systems" concentrates on the integration of the livestock component in agricultural farms. The type and extent of livestock contributions within mixed farming systems in smallholdings in Zimbabwe is analysed by employing the farming systems perspective. Based on this, the results show how livestock development can be instrumental in agricultural development. Special attention is given to the resource base, the management practices, livestock output and the functions that livestock fulfils.

It is the aim of the study to contribute to a better understanding of the role and development possibilities of livestock in mixed farming systems. Livestock, particularly cattle, are at the base of the farming system both as a means of production and as products. They are the capital investment and they provide consumables and inputs to the farming system. The role of livestock is characterised by a multiplicity of linkages connecting both the resource and the product level of the livestock production system to the other sub-units of the farming system and the outside economy. The approach applied in this study in analysing and planning the development of the livestock production system follows a farming system methodology in which a three-phase procedure, viz. resources, livestock management and production, and livestock functions, is adopted. At the same time, these phases constitute the tactical and strategic points of intervention and levels at which change can be monitored. This enhances the validity of the chosen approach for livestock development. Priority in development planning must be given to flow products in order to strengthen livestock functions that concur directly with the farmer's rational needs and that induce agricultural development through their direct and indirect effects. This major conclusion is applicable to a wide range of mixed farming systems in similar environments. The validity of the "flow product approach" is given

- where communal grazing land and individually held livestock coincide with (at least occasional) cash surpluses from crops, livestock, remittances or off-farm employment and lack of financial facilities; and
- where a high degree of farm integration (both within the farming and the livestock production system) interacts with high human population pressure.

It is expected, that many of the findings and conclusions drawn from the analysis and planning considerations apply to a whole range of mixed farming systems in Africa. This becomes evident because the focus of this study has been on trends and on comparisons between species, different sizes of holdings and different agro-ecological zones, which are the major determining factors of both livestock production potential and constraints. It is in this context that the main development implications found for smallholder mixed farming systems in Zimbabwe have a wider applicability since they are based on strata comparison as well as on general dynamics of change and development paths.

Author's summary

320 89 - 3/49

Integrated systems
Review, book, tropics, water buffalo, animals, integrated approach, meat, milk, work, environmental tolerance, nutrition, reproduction, management, research needs
BOSTID
The water buffalo: new prospects for an underutilized animal.

National Academy Press, Washington, D.C., Library of Congress Cat. No. 81-83416 - Repr. 1984, 115 pp.

The water buffalo is an animal resource whose potential seems to have been barely recognized or examined outside of Asia. Throughout the world there are proponents and enthusiasts for the various breeds of cattle; the water buffalo, however, is not a cow and it has been neglected. Nevertheless, this symbol of Asian life and endurance has performed notably well in recent trials in such diverse places as the United States, Australia, Papua New Guinea, Trinidad, Costa Rica, Venezuela, and Brazil. In Italy and Egypt as well as Bulgaria and other Balkan states the water buffalo has been an important part of animal husbandry for centuries. In each of these places certain herds of water buffalo appear to have equaled or surpassed the local cattle in growth, environmental tolerance, health, and the production of meat and calves.
Although these are empirical observations lacking painstaking, detailed experimentation, they do seem to indicate that the water buffalo could become an important resource in tropical, subtropical, and warm temperate zones in developing and developed countries.
If this is the case, then it is clear that many countries should begin water buffalo research. Serious attention by scientists could help dispel the misperceptions and uncertainties surrounding the animal and encourage its true qualities to emerge.
This report describes the water buffalo's attributes as perceived by several animal scientists. It is designed to present the apparent strengths of buffaloes compared with those of cattle, to introduce researchers and administrators to the animal's potential, and to identify priorities for buffalo research and testing.
The present report is an introduction to the water buffalo and its potential. It is written particularly for decision makers, as well as scholars or students, in the hope that it will stimulate their interest in the animal and thereby increase the appreciation of, and funding for, buffalo research. The report includes much empirical observation, largely from the panel members. Some of these observations may, in the long rund, prove not to be universally applicable. Much benchmark information needs to be obtained.

321 89 -3/50

Integrated systems
Africa, humid zones, subhumid zones, tree crops, plantation, livestock integration, integrated approach, sociology, ecology, economics, viability
FAO
Integrating crops and livestock in West Africa.

In: FAO Animal Production and Health Paper No. 41, ISBN 92-5-101443-4, Repr. 1985, pp. 69-74

This publication attempts to bring together existing information relating to prospects for developing closer integration of crop and livestock production in West Africa and to present this in a format useful to senior professionals and technical administrators concerned with improving efficiency of land use in those parts of the subregion where increasing population density makes this necessary. Its focus is mainly on the subhumid and humid zones since these offer greatest scope for intensification and integration of crop and animal production.
Technical Feasibility:
The factors included are soil and climate, the size of the plantation, the number of animals it can support, the availability of fodder, its quantity and quality and whether these can meet the nutritional requirements of the stock for economic growth and performance, the effect of livestock on the performance of the plantation crop, nutrient (especially minerals) deprivation due to forage growth and consumption by the livestock, and direct damage to the crop by livestock.
The acquisition of land for the establishment of plantations and the right to use the land during the economic life of the plantation, which could be as long as 40-50 years for oil palms and 60 for coconuts, may be difficult to negotiate. Plantations established in grazing land can evoke tenurial problems.
If not correctly managed forage may compete with the plantation trees for nutrients and make the harvest of the crops difficult, e.g. creeping grasses and legumes like Giant Star Grass (*Cynodon plectostachyus)* and *Centrosema* growing up young trees or crowding out other useful grasses and legumes; on the other hand the grazing may be killed by shade if the canopy closes.
Lack of forage due to failure of rains or closed canopies will severely affect the supporting capacity under tree crops.
Damage to tree crops can be a limiting factor to crop/livestock integration. Apart from young trees being trampled and broken, livestock debark the trunks and expose roots of citrus, cashew, rubber, cocoa and mahogany. Cattle damage leaf tips of palm and eat ripe fruit bunches of oil palms when the trees are small and young; sheep pick and eat young cocoa pods and on heavy soils livestock can cause compaction. In high rainfall areas grazing and confinement at night cause puddling of the soil and adversely affect the root system of oil palms.

Economic Viability:
Inputs like fertilizer for crops and forage, drugs for animals, tranportation for movement of staff, produce and livestock need to be available.
Operations like land clearing, plantation and cover crop establishment, purchase of livestock, drugs and fertilizer will require credit. Most small plantations are established by an individual helped by relatives, usually without the help of outside labour.
There are a large variety of food and cash crops such as cowpeas, cassava, plantains, maize, sunflower, peanuts, banana, etc., that are interplanted with tree crops to provide income while the major crop is becoming established. Decision has to be made on whether to interplant crops or to undersow plantations with forage for livestock.
Due to the remoteness of some plantations, regular cattle markets may not be available and stock owners may be forced to sell animals for low prices. This factor should be taken into account when assessing the economic alternatives of interplanting crops or integrating livestock.
Social Feasibility:
Attempts at settling pastoralists in the wetter areas of Nigeria and Ivory coast have run into problems because of the inability of pastoralists ot obtain land to cultivate food crops. It is possible, however, that pastoralists would like to establish plantations which could provide forage for their livestock, or that they could graze their animals under plantations for a fee.
The fact that the content is derived heavily from Nigerian experience is attributable to the location of two highly relevant internationally sponsored research programmes in that country. Nigeria encompasses all of the West African ecological zones from mangrove swamp to Sahel, and its national development plan supports small farmer development, pastoralist sedentarization and development of parastatal and private farming enterprises.
It is expected therefore that the Nigerian experience will have increasing relevance and value for other West African countries over the next few decades.

322 89 - 3/51

Integrated systems
Review, tropics, integrated approach, aquatic macrophyte, problems, productivity, composition, research needs, food potential
EDWARDS,. P.
Food potential of aquatic macrophytes.

ICLARM Studies and Reviews 5 ISSN 0115-4389, ICLARM, P.O.B. 1501, Makati, Metro Manila, Philipines, Repr. 1984, 51 pp.

The present paper reviews critically the various aspects in which aquatic macrophytes may be used in food production. The term "weed", to refer to aquatic macrophytes, has been purposefully

avoided as far as possible, since, as pointed out by certain authors, involving them in the food production process may be a far more effective control method than their mere destruction. Furthermore, several species have considerable potential in their own right and warrent detailed study. Indeed, considerable benefit would accrue in the field of aquaculture in general, if botanical aspects of the subject were given due attention.

The prolific growth of several species of aquatic macrophytes in certain water bodies leads to a multitude of problems. Because of the adverse effects of such dense vegetation, there is a voluminous literature on the control of aquatic macrophytes, with emphasis on their destruction. There is also the paradox of food shortages coexisting with large expanses of aquatic vegetation in many developing countries, where the utilization of these plants as food would convert a weed problem into a valuable crop.

An attempt is made in this review to identify ways in which aquatic macrophytes may be used in the food production process. A schema is presented which outlines strategies in which aquatic macrophytes are presently involved, or could become involved, in food production. Those strategies which may have the greatest value or potential are identified.

Because a certain strategy is recommended as worthy of attention, it does not necessarily mean that it should be implemented in a given locality, but rather that it should be considered against all other alternative uses of the aquatic macrophyte and/or utilization of the available space and energy inputs available. The final choice is likely to be influenced by a variety of factors including the physical environment, the climate, the degree of development of the area, marketing facilities, and local customs.

Aquatic macrophytes may be involved in the food production process, directly as human food, as livestock fodder, as fertilizer (mulch and manure, ash, green manure, compost, biogas slurry), and as food for aquatic herbivores, such as fish, turtles, rodents and manatees. An attempt is made to identify the strategies which may have the greatest potential at present. The following research areas are suggested as worthy of attention: protein content and yield of *Ipomoea aquatica* and *Neptunia oleracea*, two vegetables which grow year round in the tropics and can be propagated from cuttings; protein content and yield of various types of duckweed in the tropics as a function of different concentrations of various organic wastes; *Azolla* and filamentous blue green algae as biofertilizers; composting aquatic macrophytes and the use of the compost as an organic fertilizer in fish ponds; aquatic macrophytes in biogas production and the use of the slurry as an organic fertilizer in fish ponds, and the feasibility of stocking herbivorous fish in irrigation systems with large aquatic macrophyte populations.

The intention of this paper is to indicate the role of aquatic macrophytes in food production, and the author hopes that the research recommendations may be of use in focusing future studies on these underexploited plants.

89 - 3/52

323

Integrated systems
Africa, Nigeria, socioeconomic study, case studies, subhumid zone, ILCA, farming systems, integrated approach, research, pastoralism, dairy production, development, household, women, economics, smallholder
WATERS-BAYER, A.
Dairying by settled Fulani agropastoralists in Central Nigeria - The role of women and implications for dairy development -.

Farming Systems and Resource Economics in the Tropics Vol. 4; Wissenschaftsverlag Vauk, Kiel, Postf. 4403, 2300 Kiel 1, ISBN 3-8175-0033-5, 1988, 317 pp.

Over 95% of milk produced within Nigeria is derived from the traditional livestock sector. The dairy herds are kept primarily by pastoral Fulani families, which process the milk before selling. Milk production, processing and marketing are thus combined within numerous small independent dairy enterprises. This study is an attempt to describe and analyse the present situation of dairying by Fulani who have settled in an area of Nigeria thought by development consultants and planners to have a high potential for animal production, particularly dairying - the subhumid Middle Belt. The study is limited to the household level of dairy production and marketing. The marketing structure is depicted from the smale-scale producers' point of view. Where sales which do not go directly to consumers but rather via intermediaries, the description goes no further than the point when the milk products leavesthe hands of the Fulani producers and sellers.

The study formed part of a wider programme of Livestock Systems Research (LSR) conducted in central Nigeria by the International Livestock Centre for Africa (ILCA). The aim of this programme is to gain sufficient understanding of the existing livestock production systems to be able to develop appropriate, improved technologies to increase productivity. The case study approach and combination of qualitative and quantitative methods used are described and assessed so as to illuminate possibilities of development-oriented socioeconomic research within an interdisciplinary LSR team.

The thesis is divided into three parts: Part one (pp. 1-75) describes the methods on investigation, research objectives, the local setting of the study and the wider national context of dairy development and livestock industry in Nigeria. System approach has been used in order to 'study the existing livestock production systems as a whole, identifying and testing possible innovations and defining priority areas for more intensive research'. Part two (pp. 75-208) is devoted to the presentation of the material collected by the author, and the research findings. It represents the core of the study with detailed and rich first-hand field work material and results. Part three (207-328) refers to the planning implications of the study for milk-collection schemes, small holder milk production, dairy extension and training, small-scale

dairy processing groups and the relevance of all of that to rural and urban nutrition, on the one hand, and for Fulani women, on the other.

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Integrated systems
Africa, Mali, livestock production, economics, productivity indices, agro-pastoral system, ILCA, production traits, traditional system, cattle
WILSON, R.T.
Livestock production in central Mali: economic characters and productivity indices for Sudanese Fulani cattle in the agro-pastoral system.

Trop. Agric. (Trinidad), Vol. 66, No. 1, 1989, pp. 49-53

Most data relating to the productivity of African indigenous cattle come from modern production systems. Relatively few literature reports relate to productivity of native cattle under traditional African ownership.
It is probable that more than 90% of all cattle output in inter-tropical Africa comes from traditional systems. The constraints met in them and the actual productivity from their cattle should be understood before attempts to improve them are made. The results presented in this paper are a part of a study on one such traditional system carried out by the International Livestock Centre for Africa in central Mali.
Data relating to traditionally managed cattle for 1978-1984 were analyzed.
Calving interval (725 days) was not significantly affected by any variable. Cow postpartum weight (219 kg) was significantly affected by the management unit, the season and year of calving and by parity ($P<0.001$). 365-day calf weight (78,3 kg) was significantly influenced by the management unit ($P<0.01$) and by year of birth ($P<0.05$). Mortality to 365 days (17.4%) was significantly affected by system ($P<0.05$) and by year ($P<0.01$). The index, weight of young produced cow $^{-1}$, year $^{-1}$ (36.0 kg) was affected significantly ($P<0.01$) by parity but the values of the other indices (167 g kg $^{-1}$ and 718 g kg $^{-0.73}$) were not significantly affected by any of the variables. Significant correlations between calving interval, 365-day weight and mortality and all three indices indicated that some progress might be achieved in improving the indices. Lack of significant effects of the different variables on the indices themselves precluded easy construction of appropriate improvement paths such as have been proposed for goats and sheep in this environment.
Results of productivity studies on the same type of cattle under the controlled conditions of a livestock station in the same area in which the current research was carried out indicate that Sudanese Fulani cattle are capable of achieving outputs similar to those of other African indigenous breeds. Improvement of cattle productivity could perhaps best be attempted through improving the

feed supply by planting of forages or by intercropping them with staple cereals, by increasing the effectiveness of the veterinary services, by training in management skills of owners and herders, and perhaps by tackling the sensitive issue of total livestock numbers. The introduction of exotic breeds with high response capability to improved levels of inputs - a "solution" which is often proposed by politicians and developers - should not be attempted until the adaptive features of indigenous zebu cattle have been identified and exploited to the full.

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Integrated systems
Review, report, developing countries, tropical highlands, Latin America, Colombia, Africa, Rwanda, Tanzania, low-external-input, sustainability, ecology, development projects, multiple cropping, fruit trees, green manure, shrub legume fallow, agroforestry, fodder, erosion control, GTZ, EC, BMZ
KOTSCHI, J. et al.
Methods of ecologically oriented agriculture under low-external-input conditions in agricultural development projects.

Synthesis Report of a Res. Programme, No. TSD-A-070, The Commission of the European Communities (CEC), Brussels, Belgium and GTZ, Eschborn, F.R.G., 1988, 71 pp.

Smallholders in Third World countries constitute at least two thirds of the rural population. Most of them face problems of land scarcity, low fertility status of the soil, and limited availability of external inputs (e.g. mineral fertilizers).
The objective of the present research programme is to develop methods of ecologically sound agriculture which make use of few external inputs and are suitable for the conditions of smallholders. The most important measures to achieve this aim are:
- agroforestry or multistorey farming
- multiple cropping (sequential cropping and intercropping)
- intensive gardening and vegetable growing
- green manuring
- biological nitrogen fixation (cultivation of legumes, blue algae, azolla, etc.)
- manure and compost application
- mulching
- integration of livestock and crops within the farming system (e.g. by forage cropping, stall-keeping, using fodder trees and shrubs, and combining pastures with tree crops)
- pond aquaculture.

These measures are considered of primary importance because all of them either contribute to a higher production of biomass and/or an increase in organic matter content in the soil. Both the production of biomass and organic matter are most important parameters in a system designed to sustain soil fertility and to make more efficient use of basic resources like nutrients, water and light.

The approach taken to meet this objective has been to initiate several small-scale programmes of applied research in existing development projects supported by the GTZ (German Agency for Technical Cooperation). Close cooperation is sought with extension workers and farm families. Accordingly, less emphasis is laid on conducting agronomic trials on research stations and greater emphasis on trials in village demonstration plots and farmers' fields. In this way, a high degree of applicability of research results can be achieved.
Six GTZ projects initially applied for research support. Only four subprogrammes eventually came into being:
- intercropping and agroforestry research in the Caja Popular Project in Tunja, Colombia
- green manuring research in the Agro-Pastoral Project in Nyabisindu, Rwanda
- research on agroforestry and livestock-crop integration within a farming system, in the Soil Erosion Control and Agroforestry Project in Lushoto, Tanzania
- research on livestock-crop integration within a farming system, in the TAD project in Samarinda, East Kalimantan, Indonesia.

These four subprogrammes were jointly financed by the European Community (EC), the German Federal Ministry of Economic Cooperation (BMZ) and the German Agency for Technical Cooperation (GTZ). The different subprogrammes commenced work between January 1985 and February 1986, and not all of them have yet been completed. The work in Indonesia had to be discontinued and the preliminary results are not reported here.
This "Synthesis Report" presents the initial results of the research subprogrammes in Colombia, Rwanda and Tanzania. A description of each research location is followed by a brief problem analysis and - based upon this - an outline of the main aims of the research and the methods applied. The discussion of results is limited to the main findings, which already indicate the perspectives for future research. Deeper analyses of the data are still underway and final results will be presented in more detailed publications.
Abstract from author's introduction, amended

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Integrated systems
Africa, Nigeria, review, subhumid zone, ILCA, wet season, dry season, pastoralism, integrated approach, crops production, livestock production, agropastoralism, pastoral settlement, cattle, land-use, national policy, animal diseases, tenure, inputs, credit, research needs
FAO
The progression from pastoralism to integrated crop and livestock production.

In: Integrating Crops and Livestock in West Africa, FAO Animal Production and Health Paper No 41, Rome, Italy, Repr. 1985, pp. 13-32

It has been pointed out that the settlement of arable farmers and pastoralists are spatially, economically and socially related. Although West African arable farmers are disinclined to herd cattle, even if they own them, they appreciate cattle food products and the manure, draught and transport benefits which cattle provide; pastoralists also appreciate the benefits of convenient markets for livestock products and access to crop residues. Many pastoralists are becoming agropastoralists by including subsistence crops in their farming systems. Thus, apart from seeking the same social amenities like schools and health facilities as the arable farmers, many now have the same ecological and market needs which result in their settlement within, or on the periphery of, arable farming communities.
Pastoral women sell sour milk and butter along with prepared millet or sorghum which is mixed with the sour milk at the time of sale. This can bring about a partnership between the pastoral and the arable communities to trade their different products to the same consumers.
In the arid zones crop/livestock integration is limited by climate. As average annual rainfall rises above 400 mm, crop production becomes more important and is increasing in area in response to growth in human population; in the southern pastoral zone of Niger the influx of farmers into areas that were dry-season grazing reserves for semi-nomadic pastoralists started in 1948. This expansion was not interrupted by the drought of 1968 during which Hausa merchants continued to plant grain but depended on trade profits for the purchase of food. The provision of permanent water has permitted the establishment of large resident cattle populations. The combination of permanent farmers, resident cattle and dry years has so damaged land resources that migrating Tuareg farmers are being forced to settle. This sequence is common in many of the drier areas in West Africa.
The proximity of farming and pastoral communities is indicative of historical interdependence between the two groups. Deferred grazing of the pastoralists' own crop residues and the coralling of cattle on their fields as instances of deliberate integration of the two production systems are cited. The advantages of settlement are analyzed and concluded that settled pastoralists having crop residues were more likely to be able to supply their herds' nutritional requirements than nomads.
In this paper the following topics are discussed in detail :
- Pastoral settlement and the adoption of agropastoralism
- Agropastoral livestock production
- Agropastoral crop production
- Reduction in trypanosomiasis risk
- Cattle distribution within the subhumid zone
- Livestock national policies
- Impediments to integration
- Related research

The paper concludes that there is very little information that extension services can offer traditional agropastoralists who are adopting integrated crop/livestock systems.

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Integrated systems
Latin America, Ecuador, farming systems, cassava, shrimp farming, tide, pond, feed, subsistence crop, farmer
CIAT
Rising tide in Ecuador for cassava shrimp farming.

CIAT International, 7, No. 2, October 1988, pp. 3-6

Shrimp farming is a booming business in Ecuador's coastal Manabi Province. In the last decade, this industry has gone from a near novelty to a major contributor to the economy of this Andean country. Ecuador has become the world's largest exporter of pond-raised shrimp with pond area approaching 100.000 hectares. Fresh and frozen shrimp exports bring the country more than US$ 300 million a year and the demand is growing.
One of the components which is contributing to the development of the industry is cassava: new ways to process the root are providing an essential agglutinant for shrimp feed. This technology is making what had been principally a subsistence crop a key component of an international food marketing business.
Cassava is being used in shrimp feed because of its high content of elongated starch granules that give it its sticking properties. Used as an agglutinant to hold the feed pellets together, it is replacing imported, reportedly toxic, agglutinants. Shrimp growers cannot get enough cassava to fill production needs.
The system worked well and in just a few months the associations produced 50 tons of dried cassava in an initial test of the technology. Success was contagious as more farmer associations sprang up. By 1986, the amount of cassava dried doubled to 100 tons a year. The next year it was up to 500 tons, and in 1988, the year's output will be more than 1000 tons. There are presently 20 farmer associations with around 400 members.
This amount, though impressive for the initial phase of a project, meets only a fraction of the demand. Animal feed manufactures are eager to substitute even more cassava for maize and sorghum, particularly since grain prices are escalating and some grain is imported. With the discovery that dried cassava can be used as shrimp feed, the need for the crop has taken a dramatic upswing.
The feed, compressed in the form of pellets, contains high amounts of protein from fish meal or soybean meal to which vitamins and minerals are added. The pellets need to be sufficiently durable to remain undissolved in water for up to six hours, yet not so hard that the prawns cannot eat them. The crustaceans used their front claws to hold the pellet pieces while they eat them.
Most Ecuadorian manufacturers of feed concentrate for shrimp have used European-made, expensive, chemical glues based on formaldehyde that give the pellet its consistency. These chemical binders are no longer available. Cassava starch, on the other hand, can be used to produce a natural glue effect that is both inexpensive and non-toxic. An additional advantage of using

cassava for this purpose is that it can be produced locally and it generates jobs.
The demand of the burgeoning shrimp industry is not the only area of the market that is growing. Consumers in Guayaquil and surrounding areas are buying fresh cassava conveniently packaged. It is being sold by the farmer associations using CIAT-developed technology to conserve the root. Freshly harvested cassava is put into plastic bags, sprayed with thiabendazole (a chemical with fungicidal properties), and sealed. This retards deterioration and keeps it fresh for up to two weeks. Without such treatment, physiological changes begin within 24-48 hours after harvest and microbial deterioration often starts within 5-7 days.
Some big changes are taking place in the lives of several hundred farm families in Ecuador. Many farmers, who on the average have less than five hectares of land, are making a subsistence crop the basis for a profitable business. This was undreamed of only three years ago.
Agricultural officials, scientists, farmers, and industrialists are clearly optimistic about the future of cassava growing in Ecuador and have taken positive steps toward the integration of research, extension, farmer organization, and marketing.

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Integrated systems
Latin America, Peru, project, report, study, aquaculture, wastewater, natural resources, World Bank, GTZ, water supply, urban development, fish, prawns, sustainability
COINTREAU, S.J.
Aquaculture with treated wastewater: A status report on studies conducted in Lima, Peru.

Technical Note No. 3 of the Integrated Resource Recovery Project; The World Bank - Water Supply and Urban Development Department, Washington D.C., 1987, 54 pp.

In 1981, a global research, development, and demonstration project on integrated resource recovery was undertaken by the World Bank as executing agency for the United Nations Development Programme. The goals of the project are to achieve economic and environmental benefits through sustainable and replicable resource recovery and recycling of liquid and solid wastes from municipal and commercial sources.
A major goal of the project is to develop and encourage resource recovery as a means of offsetting some of the costs of community sanitation, which may account for more than 50% of total expenditures. Aquaculture in higher-level wastewater treatment (polishing) laggons offers one method of partially or totally offsetting these costs. This would not only make it possible to achieve high quality standards for effluent discharge for environmental improvement but would also enhance the opportunities for effluent reuse.

This note documents research, development, and demonstration studies on fish and prawn culture was conducted at the San Juan Laggons in Lima, Peru. Potential public health risks of fish consumption were examined through microbiological analyses of both raw and processed fish. Financial support was provided by the United Nations Development Programme, Global and Interregional Projects Division. Additional financial support came from the German Agency for Technical Cooperation (GTZ).

This study has shown that significant quantities of protein for either human consumption or livestock feed could be produced from wastewater-based aquaculture, which could be integrated with sewage stabilization lagoon systems. Reuse of treated sewage to fertilize the microbial food chain for aquaculture presents one of the most economic resource recovery options for cities in developing countries.

Fish and prawns were cultured in wastewater stabilization lagoons operating as polishing lagoons in series with primary and secondary ponds. Some of the fish ponds were operated as batch-type (receiving make-up water only) rather than flow-through ponds. The fish fed on the natural food chain fertilized by the nutrients in the treated wastewater; no supplemental feed was added.

The hypothesis being tested was that fish and prawns would grow in wastewater-based ponds and be acceptable for human consumption either directly or indirectly (for example, fish may be used as a protein source for livestock or a second generation of fish ponds). It was found that the environmental conditions in the ponds were satisfactory for the survival and growth of tilapia and carps, particularly in the cycle-end polishing ponds. Although the prawns grew satisfactorily, they did not survive unanticipated large fluctuations in water quality due to shock loadings, which may be common under uncontrolled conditions. The experience in Lima indicates that ammonia is a key water quality constraint for fish growth and production, and that total ammonia should not exceed 2.0 mg-N/l.

Raw fish examined in this study had no parasites on the gills or skin, or in the muscle. Furthermore, the bacteria load of the muscle portion of raw fish was acceptable for human consumption. However, higher bacteria levels within the digestive tract and peritoneal fluid could lead to contamination of food preparation areas during fish cleaning. Experiments in processing the fish through salting and smoking promise as a means of minimizing public health risks to consumers. Indirect consumption through crushing the fish and disbursing them to other fish ponds or for use as livestock feed has not been tested.

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Integrated systems
Review, book, tropics, goat, sheep, breeds, reproduction, feeds, diseases, parasites, management, productivity, processing, marketing
PAYNE, W.J.A. et al.
Goat and sheep production in the tropics.

Intermediate Tropical Agriculture Series; Longman Scientific and Technical, Longman Group UK Ltd., Essex CM 20 2JE, England; ISBN 0-582-60935-6, Repr. 1987, 264 pp.

Goats and sheep are important domestic animals in tropical livestock production systems. In the subsistence sector pastoralists and agriculturists often depend on them for much of their livelihood.

Both goats and sheep are widely distributed, from arid semi-desert to humid rainforest regions, and represent 20·2 and 28·9 per cent, respectively, of the total populations of ruminant livestock in the tropics and sub-tropics. Although the total number of sheep is greater than that of goats, sheep in the tropics represent a lower proportion of the total world population. The largest concentration of goats are in Africa and in the Indian sub-continent. India, with 71 million, is the country with the largest goat population. Africa also has a large sheep population as does Western Asia and South America.

Data on changes in the goat and sheep populations between 1970 and 1979 show that goats and sheep increased at the rates of 2·2 and 0·4 per cent, respectively. These rates are well below the rate of increase of the human population in the same area. In the Indian sub-continent and in South America the rate of increase of the goat population was greater than that of the sheep population whilst in Africa and Western Asia the reverse was the case.

This book describes goat and sheep husbandry in the tropics and suggests ways in which these domestic species can be exploited for the benefit of tropical peoples. There are regions in Africa and Western Asia that are located outside the geographical tropics, but where problems of goat and sheep husbandry, and even the breeds, are similar to those encountered in the tropics. There will, therefore, be some mention of breeds and husbandry systems that are not, by the strictest definition, tropical.

The book presents knowledge in a compact and easily available form and suggests ways of overcoming the limitations of goat and sheep production by the application of developments in technology.

Parts 1 and 2 discuss in some detail various aspects of goat and sheep production. Part 3 considers the important topic of potential production and aims to stimulate further interest in both species. Various possibilities for the achievement of maximum productivity, both technical and non-technical, are discussed. Terms which may be unfamiliar to readers are defined in the glossary.

The practical approach to husbandry gives a comprehensive and reliable knowledge of how to rear and maintain healthy, productive goats and sheep in a tropical environment.
Students of agriculture at schools and colleges will find the book of use, as well as teachers, farmers, agricultural extension workers, planners and administrators.

330 89 - 3/59

Integrated systems
Africa, Tanzania, Kenya, Botswana, tropics, developing countries, apiculture, agroforestry, farmers, sustainability, beekeeping, ICRAF

PAWLICK, T.
The underexploited bee.

Agroforestry Today, Vol. 1, No. 2, 1989, pp. 8-10

Apiculture, as an ancient craft using traditional hives, has been present in rural African life from time immemorial. So have a whole series of handicaps that make life difficult for those who harvest honey - obstacles which agroforestry could play a significant role in overcoming.
Typical African beekeeping problems include 'random occupation of hives; swarming, migration and absconding, and defensive (aggressive) behavior'.
The potential rewards of beekeeping are as great as the challenges Africa poses for it. Not only is there a market for honey - whose current average world retail price hovers around $10 per litre. Beeswax is also in demand, along with a whole host of honey or wax-based secondary products, from processed sweets and condiments to cosmetics. Perhaps equally important, particularly in an agroforestry context, is the effect bees have on both tree and field crops.
The potential has barely begun to be tapped in Africa. In Tanzania, for instance, it has been estimated that beeswax exports could be increased tenhold, if the country's forests and woodlands were properly exploited. For Africa as a whole, whose exports of beeswax are measured in hundreds of tonnes, the export figure could potentially rise above 3,000 tonnes if resources were fully utilized (of course, this assumes honey harvesting has been well established, so the removal of wax from hives does not cause too great percentage of bees to leave off honey-making in order to make up the wax deficit). A 1985 study noted Tanzania's crop of export quality honey totalled only 467 tonnes, while the potential yield could be as high as 184,000 tonnes per year.
Agroforestry, offers some solutions, based on the symbiotic relationships between bees, field crops and trees. Woody perennials are important sources of nectar and/or pollen for honeybees, and bees are important as pollinators. A system that combines apiculture and agroforestry - apiforestry, in other words - is therefore likely to improve the quality of life and the

revenue of many small farmers who would harvest hive products and would also probably have better yields from their trees as a result of better pollination.
By growing appropriate trees, the period when nectar and pollen are available can be extended. Woody plants are generally preferred to herbaceous species for this purpose because they are less affected by moderate climatic variations. This is especially important in arid of semiarid zones.
Best results are achieved by planting trees which are actually somewhat ill-suited to their environment. Those which are not at their ecological optimum, which are slightly marginal to local conditions, will often produce their flowers at a different moment than their neighbors. Some trees under these conditions even react by producing more flowers than normal.
For example, *Eucalyptus gomphocephala* gives better results in some places in North Africa than on its native sandy plains of southwestern Australia. There are tens of thousands of flowers on an adult eucalyptus, and each one of them provides work for several bees over several months. Even one tree thus represents a considerable source of nourishment for a bee colony. The popular agroforestry species *Grevillea robusta* is also known as a prolific producer of honey-yielding-flowers.
A tree of a great potential for dryland beekeepers is the so-called Apple-Ring Acacia, *Faidherbia albida*, also called *Acacia albida*.
Planting melliferous (honey-yielding) species could do much to alleviate some of Africa's chronic apicultural handicaps. Providing a water supply is present, extending the period when flowers are available as bee forage could significantly reduce colony migrations, as well as the need for bees to consume their own honey during periods of food scarcity. At the same time, it would boost the total honey output of the colonies affected.
Realizing the potential involved, the International Bee Research Association (IBRA) has made a survey of world honey sources, and has published a Directory of Important World Honey Sources. The directory includes hundreds of plants, many of them multipurpose trees capable of yielding timber, animal fodder, fruit or other products.
The IBRA's directory, which is stored on a computerized database, lists many such species. Programmed searches can be made for them on the basis of such economic uses as fuel, timer, hedges, afforestation, amenity planting, soil benefit, erosion control and soil enrichment.
For further information contact: Information Officer for Tropical Apiculture, International Bee Research Association (IBRA), Hill House, Gerrards Cross, Bucks, SL9 ONR, U.K..