## III INTEGRATED SYSTEMS

557 90 - 3/60

Integrated systems
Review, crop-livestock interactions, tropics, smallholder, sustainable agriculture, farming systems, subsistence security, transfer of nutrients, vegetation, modification, herding, cropping, competition conflicts, agricultural development policy, IIED, SIDA

BAYER, W. and A. WATERS-BAYER

**Crop-livestock interactions for sustainable agriculture.**

Gatekeeper Series No. SA 13, Int. Institute for Environment and Development (IIED), Sustainable Agric. Programme, London, 1989, 16 pp.
This Gatekeeper Series is produced by the International Institute for Environment and Development to highlight key topics in the field of sustainable agriculture. Each paper reviews a selected issue of contemporary and draws preliminary conclusions of relevance to development activities. References are provided to important sources and background material.
Numerous links between crops and livestock have long existed in the tropics, but because they differ from those in temperate areas they tend to be overlooked. Crops and livestock are often linked by way of:
- arrangements between specialist herding and arable farming groups;
- arrangements between two enterprises within the same family, such as when a man is engaged mainly in cropping while his son or wife migrates with the livestock; or
- interactions within smallholdings, in which a few cattle, buffalo, small ruminants, pigs, poultry etc. are kept

Linkages between livestock-keeping and cropping found in many parts of the tropics include:
- Food linkage: almost all livestock-keepers, including nomads, consume cereals, and many farmers consume some meat and milk products;
- Investment linkage: income from crops is used to buy livestock, and animals are sold to finance cropping inputs;
- Manure linkage: animal manure is used to fertilise cultivated fields and home gardens;
- Forage linkage: crop residues and fallow fields are used as fodder and pasture;
- draught linkage: animal traction is used for cultivation and transportation, also of cropping inputs and outputs;
- Employment linkage: pastoralists sometimes keep animals for farmers, or members of farm families may be employed by pastoralists for herding or cultivation.

In smallholder farming systems, interactions between cropping and livestock-keeping serve the following functions:



- increasing subsistence security through diversification of the food-generating activities of farm families,
- transfer of nutrients and energy between animals and crops via manure and forage from cultivated areas and via use of draught animals, and
- modification of vegetation for the benefit of livestock and crop production and the farm families.

These crop-livestock interactions are essential for intensive use of local resources and for the social, economic and ecological sustainability of smallholder farming systems. It is therefore important that their functions be appreciated in the planning and implementation of agricultural development.
The aim is to increase awareness of the manifold implications of intervention in complex traditional patterns of crop-livestock interaction. For sustainable agricultural development, the ecological and economic merits of the existing low-external-input systems of crop and livestock production must be appreciated, maintained and strengthened. Existing crop-livestock linkages often become apparent to outsiders only after intervention. Therefore, close monitoring of the effects of project activities is essential so that the activities can be amended or supplemented to minimise the conflicts and maximise the complementarities between livestock and crop production.
Research and development of crop-livestock integration for sustainable agriculture should aim not at designing new techniques to replace traditional ones, but rather at understanding and strengthening existing crop-livestock links. For example, the effectiveness of traditional manuring practices should be evaluated so that the economic use of mineral fertilisers can be promoted to supplement them. Good management of organic matter in the soil is a prerequisite for effective use of mineral fertiliser and for sustainable land use.
The integration of crops and livestock for sustainable agriculture should thus be promoted by:
- promoting dual-purpose crops which bring not only higher grain yield for food but also more or better fodder;
- improving the efficiency of using crop residues as fodder;
- promoting the use of draught animals rather than tractors;
- maintaining farmers' tree-protecting practices on cropland and encouraging planting of additional trees and shrubs;
- gaining a better understanding of tropical agroecosystems, particularly the mechanisms and effects of nutrient transfer, the role of fire, and the implications of changes in vegetation composition and structure for crop and livestock production.

Author's abstract, shortened.

## III INTEGRATED SYSTEMS

557 90 - 3/60

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Author's abstract, shortened.

558 90 - 3/61

Integrated systems
Review, book, Australia, sustainable agriculture, policy implications, national association, international cooperation

WYNEN, E. and S. FRITZ

**Sustainable agriculture: A viable alternative.**

National Ass. for Sustainable Agriculture, Australia, Ltd., Sydney south, P.O.B. A 366, Sydney 2000; Discussion Paper No. 1, ISBN 0-7316-0337-0, 1987, 130 pp.

Until the middle of last century, a successful agricultural management system was largely dependent upon the maintenance of an ecological balance. This was achieved through employing techniques such as rotation systems, mechanical cultivation, livestock and inorganic pesticides. Such management methods enabled agriculture to be sustained for many centuries.
The desire for increased productivity has led to the use of artificial fertilisers and synthetic pesticides.
The new inputs were aimed at intensifying agriculture by enabling a higher percentage of land to be cropped. In the western world this new technology was widely adopted by farmers.
Today there exists widespread concern that modern agriculture is not sustainable in the long term. This is attributed mainly to the effect of this kind of technology on phenomena such as pesticide resistance and soil degradation in the form of, for example, erosion, acidity, salinity and compaction.
In Australia the National Association for Sustainable Agriculture, Australia (NASAA), was started by and for people concerned about the effects of the current generally accepted way of farming. The organisation was inaugurated in March 1986.
This is the first in a series of discussion papers to be published by NASAA.
The purpose of the series is to stimulate the exchange of ideas and information regarding issues of importance in the field of sustainable agriculture.
It is intended that this paper provides a basis for discussion about issues leading to an increased awareness.
Here, sustainable agriculture refers to a form of agriculture in which no synthetic fertilisers and pesticides are used.
In NASAA's constitution sustainable agriculture is defined as:
"A system of agriculture able to balance productivity with low vulnerability to problems such as pest infestation and environmental degradation while maintaining the quality of land for future generations.
In practice this involves a system which avoids or largely excludes the use of synthetically compounded fertilisers, pesticides, growth regulators, livestock feed additives and other harmful or potentially harmful substances. It includes the use of technologies such as crop rotations, mechanical cultivation and biological pest control; and such materials as legumes, crop



residues, animal manures, green manures, other organic wastes and mineral bearing rocks."
In this first discussion paper a wide range of issues about sustainable agriculture is addressed. These include long-term soil productivity, pesticide resistance and health issues on the farm. Various other issues are also included, such as human health and environmental degradation.
Enquiries about sustainable agriculture in general, and about obtaining copies of this publication ($11.50 per copy, $9.50 per copy for 10 or more) should be addressed to:
The Secretary
National Association for Sustainable Agriculture, Australia (Ltd)
Sydney South P.O.Box A 366
Sydney 2000

559 90 - 3/62

Integrated systems
Africa, Kenya, case study, vegetation management, sustainable production, livestock, wild animals, statistics

OORO OLANG, M.

**Vegetation management for sustained production.**

In: Proc. of a Conference on Wildlife/Livestock Interfaces on Rangelands; Ed. S. MacMillan; Publ. by Inter-African Bureau for Animal Resources, P.O.B. 30 786, Nairobi, Kenya, 1985, pp. 153-158

The main objective in vegetation management is to achieve the highest level of production while at the same time maintaining or improving the vegetation's condition. Plants are grouped into two categories: woody and non-woody.
Vegetation management techniques include control of the animal stocking rate, reseeding, design of grazing systems, use of fire, water distribution and manipulation of plants to suit the groups of animals using the area.
A study of vegetation productivity was conducted in Narok District by the Kenya Rangeland Ecological Monitoring Unit (KREMU). The productivity data obtained were used to calculate animal stocking rates for the area and extrapolated for other areas in the country. The study area was divided into Siana, Loita Plain and Mara Plain and covered 6,400 km².
Two methods were used to sample vegetation and animals in the area. Animal census was conducted using Cessna 185 aircraft, while the Ocular Estimate Method was used to survey the vegetation.
About ten different wild animal species were observed, six of which were grazers. Of the grazers, wildebeest were numerically dominant by far.
It was shown that even resident wildebeest move out of their usual grazing areas into the bushy area.
Wild herbivores comprised 64 per cent and livestock 36 per cent. This worked out at 132 herbirvores/km2.
The months of January, February and March are usually the driest each year and the grass height and cover is usually at its lowest. Plant growth starts again following the onset of the long rainy season of April through June. Plant growth vigour depends on the amount of nutrients carried over into the rainy season.
Herbage height was twice as tall in the Mara and in the Siana as it was in the Loita Plains. In the Mara the height of Themenda triandra ranged from 0.7 to 1.0 m, while in the Loita the average height of T. triandra was 0.4 m. In the Mara bare ground ranged between 10 and 40 per cent, while in the Loita it ranged between 30 and 70 per cent.
Plant composition in the Loita Plains has changed over time. Themenda trianda has been replaced by creeping grasses such as Cynodon dactylon and Digitaria milanjiana.
The cover of these creeping grasses was observed to have dropped in 1984 and shrubby plants such as Sida cuneifolia, *Achyropsis*



*grennwayii*, *Becium americanum* and *Justicia elliotti* had increased. Grasses in the Mara Plains were in good condition and Themenda triandra was still the dominant plant species.
The study area that was divided into three ecosystems had two different grazing systems. Loita area experienced continuous grazing because livestock no longer migrated into the Mau Hills during the dry season because the wheat plantations had cut off their migratory route.
The Loita Plains had an animal density of 111/km2 in 1979, showed a downward trend in vegetation cover and production.
The standing crop in the Loita Plains averaged 660 kg/ha/year.
The plant utilization in the Loita Plains was not sustained throughout the year and the animals in the area were possibly having a lower calving rate, low resistance to disease and took a longer time to mature. This is a destructive type of utilization.
The standing crop in the Mara area averaged 2,265 kg/ha/year.
In terms of percentage, 80 per cent of the available forage was removed by animals while 20 per cent was left. Although what was left and carried over into the next season was small, plants maintained their vigour and condition because of an annual rest during the growing season.

560 90 - 3/63

Integrated systems
Review, Africa, Sub-Sahara, livestock research, systems approach, on-farm trials, agropastoralism, animal traction, crop-livestock systems, ILCA

NEATE, P.J.J.

**A systems approach to livestock research in Sub-Saharan Africa.**

entwicklung + ländlicher raum, 3, 1988, pp. 16-18

ILCA's work is organised into six major research areas or thrusts: cattle milk and meat; small ruminant meat and milk, animal traction; animal feed resources; trypanotolerance; and livestock policy and resource use. Its aim is to develop improvements that are both ecologically sustainable and economically stable.
ILCA has used a systems approach to research since it was established. The objectives of this approach are to:
- diagnose constraints to increase animal production;
- develop prototype technologies under farm conditions;
- develop research methodologies;
- monitor technology adoption; and help develop the systems research capacities of national institutions.

On-farm trials with crops can, in many instances, be conducted in much the same way as on-station trials, with treatments, replications, randomisations etc. providing statistically analysable results. But with livestock, especially on smallholdings, the small number of animals precludes this approach, and on-farm trials are often aimed more at assessing the relevance and appropriateness to farmers of proposed interventions.
Animals are more complex to work with than crops, especially on-farm. Their mobility reduces the degree of control; inputs are made daily, rather than seasonally; the production cycle is long, and the products of an individual animal may be numerous and their relationships complex.
In this paper two of ILCA's experiences with livestock systems research, one in the Nigerian subhumid zone, the other in the Ethiopian highlands are outlined.
Concluding, the author states that livestock and crop-livestock systems are usually more complex than simple cropping systems and are thus more difficult to improve. Producers' needs and objectives vary and may change following adoption of an intervention. Unless they are closely involved in developing "improvements", as in the systems approach, adoption may be poor. As shown by the example of fodder banks, an intervention may have to return repeatedly to the design phase in response to producer-identified problems.
Although it can be a time-consuming process, the systems approach produces "improvements" that are more likely to have a sustainable impact on complex production systems.



561 90 - 3/64

Integrated systems
Africa, Kenya, field study, wildlife, resources, human needs, education, extension, rancher

ABOUD, A.A.

**Integrating wildlife resources with human needs.**

In: Proc. of a Conference on Wildlife/Lifestock Interfaces on Rangelands, Kenya, 1985, pp. 129-135

The broad spectrum of Kenya's wildlife resources can be viewed in the context of tourism, hunting, game cropping, game ranching and aesthetic, scientific, cultural and economic values.
The group that has the most influence on the well-being of Kenya's wildlife resources receives little attention and regard. This group comprises the ranchers and herdsmen who live with the wildlife near the national parks and reserves and on whose ranches and grazing lands the wildlife lives in some seasons.
This study attempts to name those conflicts and ranchers' ideas about how to solve the conflicts and suggests ways to make ranchers appreciate and benefit from wildlife resources.
An exploratory field study was undertaken in Narok District in March 1985 to determine the traditional, economic and other uses made of wildlife by the Masai group ranchers; to expose wildlife/human conflicts; and to solicit suggestions for solutions from group ranchers themselves.
A questionnaire was given to 57 group ranchers.
The ranchers considered game a threat to their survival while at the same time the ranchers are blamed for the wildlife/human conflicts. It is recommended that as a prerequisite for creating a long-term remedy to the conflicts, the following three measures be taken:
- integration and coordination of wildlife matters at the top governmental level,
- the management and use of wildlife as a range resource,
- provision of a strong education and extension programme,
- use of traditional range management systems as well as modern technology to create more acceptable and efficient wildlife conservation methods,
- consideration of ranchers' values and needs in the wildlife industry,
- involvement of ranchers in decision-making in wildlife projects that affect them, so that, with ranchers' suggested solutions implemented, ranchers' interests and incentives to protect, conserve and benefit from wildlife will help integrate wildlife and human needs.

562 90 - 3/65

Integrated systems
Africa, Sudan, case study, workshop, crop-animal production system, sustainable agriculture, model project, natural resources, socio-economy, agricultural activities, constraints, potentials, DSE

YUSOF, M.M. et al.

**An integrated crop-animal production system for Halfaya Village, Sudan.**

In: Proc. Int. Training Course on Sustainable Agriculture (Ecofarming) and On-Farm Experimentation, SEARCA, Los Baños, Laguna, The Philippines, 1988, pp. 283-294

The purpose of the workshop was to design a model of a sustainable agricultural project applicable to Halfaya Village in the northern part of Sudan.
A brief attempt was made to gather maximum possible information on the study area. These include the natural resources, the socioeconomic environment, and the current agricultural activities. Problems and constraints were analyzed and potentials for agricultural development were exhaustively discussed. A practical model of a sustainable agricultural project based on crop-animal integration was proposed.
The assessment of the physical environment summarizes the available natural resources of the study area. This assessment was felt important to fully understand the natural ecosystem, which is relevant in addressing the sustainability of the present and future agricultural endeavors in the northern region as a whole.
The severest constraint lies in the tendency of the farmers to use increasing amounts of chemicals in their efforts to increase crop yields.
The key toward achieving sustainability in agricultural production in Halfaya is to improve the two existing subsystems - the crop subsystem and the animal subsystem. The two subsystems must ideally be linked or integrated into a tight and close holistic system. This system approach was thought to be more realistic and meaningful in addressing the problems and issues of sustainable agriculture, particularly for the study area.
As the intensity of each subsystem is improved, together with the diversity of farm produce, farm productivity can eventually be expected. Recycling of nutrients from the two subsystems will further reduce costs of production and thereby increase the profit margin as a whole.
The crop subsystem may be improved through the careful planning and implementation of multiple cropping concept. A crop-production strategy must be incorporated on a whole farm basis.
The animal production system is proposed to exploit the resources related to it. The fodder crops and other palatable plant products from the crop subsystem form the basic need formulation to achieve maximum gain in body weight. Manure from these animals will be



used as source of nutrients required by the crop subsystem and for soil amelioration.
A model for a sustainable integrated crop-animal production project for the village of Halfaya is summarized.
The model emphasizes profitability, stability, and sustainability in production. Although the yield may initially be lower through the use of less chemicals and inorganic fertilizers, profitability may still be achieved through the lower costs of production and utilization of the farm wastes or by-products. As soil fertility and balance pest population are achieved, productivity will be increased.
The success of this model farm will inevitably spark further adoption by neighboring farmers. Other factors, however, need to be addressed such as policy, roles of research and support services, marketing, and organizational set-ups. The most relevant is formulating a national or regional sustainable agriculture program with a more systematic approach. Through these concerted efforts, the impact will be felt in all concerned areas.

563 90 - 3/66

Integrated systems
Review, manual, guidelines, planning, small scale projects, environment, sustainable agriculture, soil management, water management, soil nutrient management, pest management, agroforestry systems, glossary, VITA, CODEL

VUKASIN, H.L.

**Environmentally sound small-scale agricultural projects - Guidelines for planning.**

CODEL, Inc., Environment and Development Program, 475 Riverside Drive, New York 10115, U.S.A., ISBN 0-86619-283-2, 1988, 157 pp., available from: VITA Publ. Services, P.O.B. 12028, Arlington, Virginia 11109, U.S.A.

This book is aimed at those who plan and implement small-scale agricultural projects. By promoting awareness of environmental concerns, the manual can increase the development worker's ability to design projects that are both environmentally sound and potentially more sustainable.
Environmental planning requires more than finding the right technology and a source of funds. Planning involves consideration of the social, cultural, economic, and natural environments in which the project occurs. The challenge is to develop sustainable food systems that have reasonable production but do not degrade the resource-base and upset the ecological balance.
The manual has two objectives:
- To promote well-planned and environmentally sound small-scale agricultural projects.
- To introduce environmental concepts into technology development and alternative management techniques, and encourage the transfer into training programs.

The idea is that development workers are in a position to pass on awareness of environmental concerns to community groups, government planners, village residents, farmers, and students.
By providing guidelines to planning, this manual can assist development workers to view projects as part of larger environmental systems.
The manual covers the following subjects:
- Introduction to important ecological concepts relevant to the development of agricultural projects.
- Technical information related to environmental issues.
- Some suggestions for planning small-scale agricultural projects.
- Guidelines for using knowledge of environmental effects to determine positive (benefits) and negative (costs) factors in a given small-scale agricultural effort.

Consideration of these factors can lead to well-informed decisions on alternative project designs. This background information can be used as the basis for planning environmentally sound projects in



the areas of water supply and management, nutrient management, soil conservation, pest management, and related subjects.
Many issues of importance to small-scale agricultural projects that need to be considered are beyond the scope of this manual. These are land use patterns, inability of small landless farmers to take risks, lack of credit and money, and access to technical personnel and appropriate agricultural expertise. This manual cannot address all of the environmental conditions or implications associated with individual project sites. The use of the general concepts and principles outlined here should enable development workers to recognize environmental issues and to consider them in the planning process.
Coordination in Development (CODEL) is a private, non-profit consortium of forty Christian-related development agencies working in developing countries. CODEL funds community development activities that are locally initiated and implemented. These activities include agriculture, water, forestry, health, appropriate technology, and training projects.
The Environment and Development Program of CODEL serves the private and voluntary development community by providing workshops, information, and materials designed to document the urgency, feasibility, and potential of an approach to small-scale development that stresses the interdependence with human and natural resources. For more information, contact CODEL, Environment and Development Program at 475 Riverside Drive, Room 1842, New York, N. Y. 10115 USA.
Volunteers in Technical Assistance (VITA) is a private non-profit international development organization. It makes available to individuals and groups in developing countries a variety of information and technical resources aimed at fostering self-sufficiency: needs assessment and program development support; by-mail and on-site consulting services; information systems training; and management of field projects. VITA promotes the use of appropriate small-scale technologies, especially in the area of renewable energy. VITA's extensive documentation center and worldwide roster of volunteer technical experts enable it to respond to thousands of technical inquiries each year. It also publishes a quarterly magazine and a variety of technical manuals and bulletins. For more information, contact VITA at 1815 N. Lynn Street, Suite 200, Arlington, Virginia 22209 USA.

564 90 - 3/67

Integrated systems
Review, tropics, livestock systems, feed resources, resource utilization, technology transfer, energy, food, socio-economics, education, research, development, dual purpose, restricted suckling, sugar cane, legume trees, urea-molasses, scientific communication, CTA

PRESTON, T.R.

**Matching livestock systems with available feed resources in tropical countries.**

Techn. Centre for Agricultural and Rural Cooperation (CTA), Postbus 380, 6700 AJ Wageningen, Netherlands, 1986, 25 pp.

There have not been the expected improvements in livestock production in developing countries largely because of oversimplified goals stressing productivity rather than the role of livestock in the overall farming system. The socio-economic constraints that influence acceptance of innovations were also not adequately recognised.
Technological transfer has been emphasised over research into local resources; and too often the introduced schemes have created "dependence" on imports, in order to achieve technical targets. Often the innovations are not crafted towards the system in which they are expected to fit; or the wrong system has been promoted.
Fuel from renewable resources is becoming as important as food in some communities; but this should be seen in the light of new options and opportunities that this creates for increased production of biomass, especially for tropical regions.
Education and research are essential tools in the development process. However, there are inherent dangers of training imparted in the environment of an industrialized (usually temperate) country, employing technologies and techniques which cannot usually be applied and may be completely inappropriate in the student's home country.
New livestock strategies are needed which stress needs and identify the resources which are locally, or potentially, available. The livestock system must then be matched with those needs and resources.
Examples are given of suitable technologies, which are often refinements of practices already understood and applied by indigenous farmers; and/or which take known crops/plants and develop other more effective uses for them. Dual purpose milk/beef production, calf-rearing by suckling, combined fuel/feed production from highly productive plants, integrated mixed farming systems and the use of urea supplements are considered to be technologies appropriate for widespread development as part of the above strategy.
A major constraint to the adoption of appropriate livestock strategies is the inadequate communication between scientists,



planners and decision makers within, and among, developing countries.
The key concepts are that the system should match the resource; that it is the economic optimum which should be pursued not the biological maximum; and that the priority targets are the workers and dwellers in rural areas.
It is becomingly increasingly accepted that livestock play a fundamental, often catalytic role in development processes. In most developing countries, the main source of cash income of most subsistence farmers and all pastoral groups arises from the sale of livestock and livestock products. Livestock are also a source of credit; they provide draughtpower for crop production and contribute milk, meat and hides. Within the existing farming systems framework there is considerable scope for increasing animal productivity and reducing costs.
The key concepts for bringing about these improvements centre on:
- the optimal use of available resources, rather than maximizing individual animal productivity;
- improving scientific communication among developing countries and;
- targeting the strategy so that the principal beneficiaries are the rural poor.

Author's summary, extended

565 90 - 3/68

Integrated systems
Africa, Zambia, case study, project, sustainable development, wildlife, community participation, game management, IIED, SIDA

DALAL-CLAYTON, B.

**Wildlife working for sustainable development.**

Gatekeeper Series No. SA 9, IIED-Sustainable Agriculture Programme, 3 Endsleigh Street, London WC1H ODD, UK; 1988, 15 pp.

The actual and potential contribution of wildlife to economic and social development can be substantial, but has long been overlooked.
The revenues from well-managed wildlife utilisation can be considerable and, if integrated into rural development programmes, can benefit local communities.
The wildlife of Zambia's Luangwa Valley, is potentially amongst the most important and economically valuable in Africa because it is dominated by large and valuable heavy game animals such as elephants and buffalos.
Studies in Zimbabwe within the Zambezi Valley have indicated that potential annual revenues from wildlife utilisation can be US$ 14/hectare. A Game Management Area (GMA) in Zambia is a buffer zone around a national park in which licensed safari and subsistence hunting is permitted.
The Luangwa Valley is rich in natural resources. Apart from wildlife, its abundant forests contain hardwoods, building materials and fuelwoods. It also contains areas of fertile arable soils.
Yet in spite of these rich natural resources, large parts of the Luangwa Valley are sparsely inhabited.
In the past most of the revenues deriving from the wildlife resources of the valley, such as hunting licence fees and safari earnings, have been externalised to central government or businessmen living outside the area.
The severity of the poaching problem and the enormity of the financial consequences are best illustrated by the fate of the black rhino and elephant populations in the whole Luangwa Valley.
Serious investment in bringing destructive poaching under control would allow wildlife populations to stabilise and increase. This, in turn, would allow an opportunity to promote a change to the sustainable use of these wildlife resources, including legalised hunting and culling.
A major effort to exploit these resources in a sustainable fashion is represented by the Luangwa Integrated Resource Development Project (LIRDP).
It incorporates the South Luangwa National Park and the adjacent Lupande Game Management Area with a human population of 28,000.
The project incorporated several component programmes, which include agriculture, soil survey and land-use studies, marketing and cooperatives, Tsetse control, forestry, fisheries, women's



activities, water development, wildlife management and the development and maintenance of roads and other infrastructure.
The objective of the project is to "improve the standard of living of the people of the project area through sustainable use of the full range of available resources".
LIRDP emphasises sustainable use of non-agricultural resources (i.e. wildlife, forestry, fisheries and water) in addition to agricultural resources. A major objective is to replace the illegal over-exploitation of wildlife with legal sustainable use.
The wildlife management component of the project gives top priority to the protection of wildlife, particularly rhinos and elephants.
A pilot project in part of the Lupande GMA has been operating since 1986 in which a village-based cooperative has been permitted to cull a restricted number of 'surplus' hippos. The meat has been sold locally and the hides and other products marketed in Lusaka. The resulting profits have already funded a much needed health clinic. As a consequence, the local people have begun to appreciate the community value of managed wildlife.
Wildlife protection and management will run in parallel with the promotion of increased tourism.
Small cooperatives have been initiated which now cultivate and supply fruit and vegetables to the lodges. The latter previously obtained all their supplies from distant markets. In addition, more lodges will provide a market for Luangwa arts and crafts.
Most of the project activities will be implemented by local communities themselves, with technical and administrative support.
The project depends crucially on community participation.
The discussions with local leaders helped in problem identification, which greatly benefitted the evaluation and endorsement of the plans and proposals.
LIRDP is seen by the government and donors as a crucial element in the implementation of Zambia's national Conservation Strategy. It is viewed as a pilot project to demonstrate the real benefits of applying conservation principles to development.

566 90 - 3/69

Integrated systems
Africa, Namibia, case study, ecological grazing management, holistic resource management, economics, productivity, resource conservation employment, land-saving effect, production risk, GDI

OTZEN, U.

**Ecological grazing management - A development alternative for brittle environments - the case of Namibia.**

German Development Institute (GDI), Frauenhoferstr. 33-36, D-1000 Berlin 10, 1989, 22 pp.

In extensive grazing management under Namibia's semi-arid soil and climatic conditions a new form of ecological resource use based on the Holistic Resource Management (HRM) method has been successfully developed over the last twenty years. This method is governed by four principles: firstly, the indissolubility of the symbiosis of the lithosphere, atmosphere, vegetation, fauna and microorganisms; secondly, the natural difference between brittle and non-brittle ecosystems due to soil and climate; thirdly, the time factor as an important dimension of the natural regenerability of ecosystems; and fourthly, the holistic view of the abiotic, biotic, time and anthropogenic components of ecosystems which are not left to nature but managed by man.
Only if these principles are observed - the working hypothesis has it - is there any guarantee that farming systems, especially at brittle natural locations, will remain capable of sustained development. A comparison of the profitability of farms with traditional resource management and farms with ecological resource management clearly reveals that, where the HRM method is applied, both greater efficiency of resource use and higher factor productivity can be achieved.
However, ecological grazing management on a larger scale would be possible only if the following requirements were satisfied: the teaching of a wide range of technical and organizational know-how, which must be combined with a new understanding (rediscovery) of natural nutrient, energy and reproduction cycles; farms of an appropriate size for ecological reasons; an additional economic input requirement in the form of either labour or capital, which are interchangeable depending on factor price ratios; and finally, an agricultural market policy which largely curbs cyclical supply and price fluctuations.
To meet the additional need for agro-holistic know-how, farms of an appropriate size and labour or capital input per farm, the agricultural policies of countries with similar natural production conditions should ensure the following:
- as a general rule, training, research and extension services should be geared to the ecology at the level of individual farms;
- inputs in the form of investment credits for the improvement of existing farms or of additional skilled labour should be made available to individual farms, groups of farms, local communities or cooperatives or at national level;
- land ownership should be reformed in countries where the structural requirements for ecological viable minimum areas are not satisfied;
- an agricultural market policy should ensure that cyclical supply and price fluctuations are largely curbed and that producers stop thinking solely as quantity adjusters and concentrate more on quality production.



For development policy this approach would mean abandoning the intensive grazing management method once imported from Europe and based on the theory of high performance per unit area (rotational grazing, strip grazing) in favour of a theory of resource conservation, in this case the HRM method. Instead of measures largely geared to increasing short-term marginal productivity per unit of factor input, the restoration of natural nutrient and energy cycles and the preservation of the regenerability of natural resources should have priority in government promotional policies.
Another major implication for an ecologically oriented development policy would be the diversion of hitherto widespread input and structural improvement subsidies, primarily designed to increase production, to the creation of farming systems which have a high carrying capacity and remain viable in the long term.
As with other farming systems in the tropics and subtropics that need to be ecologically reoriented, e.g. fallow, shifting cultivation, ley, permanent cultivation, perennial cropping and agroforestry systems, extensive grazing management requires additional labour or, alternatively, capital. This basic conclusion must be taken as a guide for the development policy of any country wanting to avoid such disadvantages and hazards of conventional agricultural development as the destruction of resources, loss of quality and pollution and to experience the blessings of ecological agricultural development. These blessings are likely to be reflected not only in the actual stabilization of resources but also in an effect on employment, a reduction of production risks due to the climate and a land-saving effect, all of which are of prime importance for agricultural development in most Third World countries.
Author's Abstract

567 90 - 3/70

Integrated systems
Asia, Taiwan, study, integrated agriculture, aquaculture, duck-fish farming, pig-fish farming, irrigation ponds, rice paddy, ICLARM

CHEN, T.P. and YENPIN LI

Integrated agriculture-aquaculture studies in Taiwan.

In: Proc. of the ICLARM-SEARCA Conference on Integrated Agriculture-Aquaculture Farming Systems, Manila, Philippines; ISSN 01115-4389, Reprint 1986, pp. 239-242

In this paper the most important integrated farming systems in Taiwan are demonstrated. For duck-fish farming, 2,000 to 4,000 mule ducks (mallard x muscovy/ha) are used. The annual gross profit from four duck production cycles of 3,200 ducks is TN$ 256,000. The annual gross profit from fish polyculture (common and Chinese carps, eels, mullets, tilapias, etc.) from a 1-ha farm raising 2,200 ducks is NT$ 140,050 (total harvested weight of fish, 5,671 kg). Pig-fish farming was mainly all male tilapia hybrids. Waste-loading can be as high as 250 pigs/ha which produces annually 4,200 kg/ha of tilapias and 150 kg of Lateolabrax japonicus which is used as a controlling predator. The respective values of these fish crops are NT$ 193,200 and NT$ 18,000. An integrated farm keeping 210 pigs makes a gross profit of NT$ 253,000 twice a year from pig sales.
Freshwater fish farming has an important place in the inland fisheries of Taiwan. Its expansion is limited only by competition for acreage with plant crops, chiefly rice.
Polyculture is generally the practice.
The species cultured are generally the grass carp (Ctenopharyngodon idella), silver carp (Hypophthalmichthys molitrix), big head (Aristichthys nobilis), mud carp (Cirrhina molitorella), common carp (Cyprinus carpio), and mullet (Mugil cephalus) in various stocking ratios and small number of snakehead (Ophicephalus maculatus) or sea perch (Lateolabrax japonicus) to prey on small wild fish.
Almost all the freshwater polyculture farms in the southern one-third of the island have tilapias as their main crop. A considerable number of these farms raise pigs or ducks with fish.
Most of these integrated fish farms were converted from rice paddies, including some high-yielding paddies, in spite of a government regulation forbidding their conversion.
Ponds are usually converted from low-yielding farm land.
The height of the dike is about 3 m, measured from the pond bottom, with a slope of 1 in 1 (1 in 0.5 if lined with bricks). A land area of 500 m2 is reserved for the construction of the duck house or pigsty. This leaves about 0.65 ha of water area for each ha of original land.
The duck house is built on a suitable spot alongside the fish pond. In the past, the construction materials consisted mainly of



bamboos with straw (roofing). Now, cement poles, wooden beams and cement roofing are used.
The ducks raised are either the meat-producing mule duck or the egg-production native duck.
A duck house of 40 m2 in floor area will accommodate 450 mule ducks or 250 eggs producing ducks. Its cost of construction is about NT$ 18,400.
The number of ducks that can be kept in a pond of 1 ha varies from 2,000 to 4,000 depending on the depth of water and the abundance of water supply. The newly purchased ducklings generally reach the marketable size of 2,5 kg in 65 to 70 days. Soybean meal, peanut meal, rice bran, corn meal, sweet potato chips, etc. were used formerly as feeds, but pelleted feeds are now almost exclusively used.
According to a recent survey, each mule duck raised will yield a profit of about NT$ 20. The annual profit from four crops of 3,200 ducks each should therefore total NT$ 256,000.
The egg laying native ducks begin producing eggs in 120 to 150 d when they reach 1.2 to 1.5 kg in weight. For 2 yr, each duck produces about 250 eggs per year, after which it is usually discarded. The feeds used are about the same as for mule ducks. The number of egg-laying ducks on a 1-ha farm is about 1,500, which will net the farmer NT$ 90,700 in profit.
No supplemental feeds are given except in the 2 wk preceding harvest. The fish harvest after 1 yr totalled 5,671 kg, sold for NT$ 200,040. After deducting NT$ 39,990 for fish fingerling purchase and NT 20,000 for feed purchase, the gross profit from fish amounted to NT$ 140,050.
Fish farming in irrigation ponds is widely practiced in northern Taiwan, where about one-half of the 4,000 ha of irrigation ponds are used for polyculture of Chinese carps. The turnover of the pond water is large and the production is consequently low. Recently, however, the application of fertilizers, chiefly superphosphate, has increased the yield per hectare by 50 to 80% when phytoplankton feeders (silver carp) form the dominant species.

568 90 - 3/71

Integrated systems
Asia, review, farming systems, animal-fish farming, traditional farming, pig-fish farming, duck-fish farming, animal wastes, fish yields, compost preparation, liquid animal manure, fertilizer, design of integrated systems, animal feeds, marketing, economics, ICLARM, SEARCA

DELMENDO, M.N.

**A review of integrated livestock-fowl-fish farming systems.**

In: Proc. of the ICLARM-SEARCA Conf. on Integrated Agriculture-Aquaculture Farming Systems, Manila, Philippines, ISSN 0115-4389, Repr. 1986, pp. 59-71

The bulk of agriculture production in Asia is undertaken by farmers whose landholdings are small and fragmented. The application of modern technology and large-scale production are not feasible solutions to their present problems of low income and low productivity.
For centuries, the small farmers have sustained themselves by practicing various kinds of crop diversification and integrated farming systems. Aside from crop production, most small farmers have such livestock as a few head of cattle or buffalo, one or two pigs and a small flock of ducks or chickens. Where there is adequate water supply, a small fish pond is maintained.
Livestock-fowl-fish farming, combined with crop raising, is a small-scale farming system.
The small farm raises pigs and/or ducks, in addition to crops, rotated in accordance with the seasonal climatic cycle. The animals, particularly ducks and pigs, are sources of animal protein, in addition to the fish. Pigs are fed with aquatic plants combined with kitchen leftovers, and animal manure serves as fertilizer for the crops, vegetables and fish ponds. This is a system where practically nothing is wasted. An ecological balance is maintained and a sufficient variety of products are obtained to meet the farm family's needs in terms of food and cash income.
This practice and a variety of other integrated farming systems continue to be used in many Asian countries. Each system developed mainly through long years of experience of individual farmers. But, no data are available on their technology; neither is there information on economics and yields. One reason for this is perhaps because the small farmers have always been considered as operating at subsistence level and have not gained the attention of economic development planners in the past.
In recent years, however, as information on the agriculture-aquaculture production techniques used in China has spread, the importance of integrated farming systems has begun to be more and more appreciated.
Current practices in integrated farming are reviewed in this paper. The chemical composition of animal wastes and organic compost produced by Chinese methods are summarized and published



information on rates of application to fish ponds is discussed. The design of integrated animal-fish units and the formulation of animal feeds are identified as key factors in farm productivity and profitability. Economic analyses are included from selected examples of pig-fish, chicken-fish and duck-fish farms.
As far as marketing is concerned there appears to be no significant difference in the taste and texture of flesh of fish grown in manured ponds and those fed on commercial diets. It is reported that fish from ponds receiving well-treated domestic wastes taste as good or even better than fish grown in waste-free ponds.
National and international organizations are now beginning to take a fresh look at the traditional farming systems practiced in Asia, to obtain a better and fuller understanding of how these systems have sustained the small farmers and to find ways and means of making them more viable for the social and economic well-being of the small farm and rural communities.

569 90 - 3/72

Integrated systems
Review, manual, tropics, Africa, CTA, IEMVT, poultry production, poultry anatomy, physiology, breeds, strains, feeding, poultry diseases, poultry farm management, marketing, economics, rearing guinea fowl, ducks

CAB

**Manual of poultry production in the tropics.**

Publ. by CAB International, Wallingford, Oxon OX10 8 DE, UK in association with CTA, The Netherlands and IEMVT, France; Engl. Edition ISBN 0-85198-590-4, 1987, 119 pp.; French Ed. ISBN 2-11-084499-X, 1983

Poultry-keeping often holds a prominent place in the development plans of many countries. This is for economic and dietary reasons, and especially because of the preference of the consumer for poultry products and because of the interest of the population in poultry farming.
The diet of the populations of the tropical zone is most often protein-poor, both quantitatively and qualitatively.
Poultry meat is the most appropriate of all livestock meats in many tropical regions. In so far as the returns for feed mixes are increasing and where poultry production can meet the demand, consumption is on the increase and will without doubt reach a high level.
Two types of husbandry exist in tropical Africa: a modern or improved husbandry, characterized by enclosure and by supplying a complete feed to the poultry, and traditional husbandry, in which the poultry are free-ranging during the day and receive, more or less regularly, supplementary feeding made up of food scraps from the family meal or of products costing nothing, such as termites or brewer's grains, by-products of beer.
It can be stated that in tropical Africa all villages in the cereal-growing regions of Mali, Burkina Faso and Niger own large flocks which might represent 25% of the chicken flocks of certain countries.
An increase in the scale of poultry farming is expected.
Taking into account the relative stagnation of cattle production in the developing countries, consumer demand and the speed with which poultry farming of the intensive type is being introduced, rapid progress in this type of farming may be expected in the next few years.
In relation to other types of husbandry, poultry farming presents many favorable factors:
- rapid results if the farm is well run;
- modest initial outlay;
- relatively simple farming techniques, which can be acquired with a little commonsense, orderliness and perseverance;
- guaranteed outlets almost everywhere, because of the possibility of selling the products in low value units.



The contents of the book are:
- Part one - Anatomy and physiology of poultry
- Part two - Breeds and strains of poultry
- Part three - Feeding
- Part four - Poultry diseases
- Part five - Poultry farm management
- Part six - Merchandising of poultry products
- Part seven - Economics of poultry farming
- Part eight - Rearing Guinea fowl, rearing ducks

This manual describes very clearly the necessary know-how for poultry keeping in developing countries. It is therefore recommended for all with an interest in this sector.

570 90 - 3/73

Integrated systems
Review, book, tropics, developing countries, environment, cattle, pasture species, pasture establishment, pasture management, forage production, feed sources, coconut yields, economics of cattle, small farm operation, FAO

REYNOLDS, S.G.

**Pastures and cattle under coconuts.**

FAO Plant Production and Protection Paper 91; ISBN 92-5-102722-6, 1988, 311 pp; FAO, Via delle Terme di Caracalla, 00100 Rome, Italy

Summaries on the pasture-cattle coconut system are the following:

- There are large areas of tree crops found in the tropics, some portion of which can be integrated with pastures and cattle. With almost 9 million hectares the coconut pal (Cocos nucifera) is the tree crop most suited to integration, with its wide spacing and high incidence of solar radiation reaching the ground surface.
- It is important to realize that there are both advantages and disadvantages to intercropping, an appreciation of the various environmental factors, which play an important role in the pasture-cattle-coconut system, is needed. Factors such as tree spacing, competition, shade and shade tolerance, fallen fronds, trampling and soil compaction, pests, and cattle damage to young trees must be taken into consideration.
- The use of cattle as "sweepers" or "brushers" to keep indigenous grasses or weeds under control on large plantations is being replaced on the more progressive plantations by beef and dairy herds grazing improved pastures to provide an important second source of income.
- As the degree of shade in coconut stands is influenced by a number of factors such as tree density, height, age and variety, pasture species have to be identified for different light transmission classes.
- While a number of grasses have been evaluated worldwide in the coconut environment, species most suited to the reduced light conditions are sodforming stoloniferous grasses that form short to moderate height swards, provide moderate carrying capacity, do not compete excessively with coconut production and allow fallen nuts to be easily located, are cheap and easy to establish from cuttings, compete well with aggressive weed species and maintain a reasonable balance with companion legumes under grazing.
- Although it is difficult to give general recommendations about stocking rate because of the many factors which influence carrying capacity, it is probable that under light transmission conditions of about 60-75% good long term production can be maintained with about 2 a.u. ha-1.This would decrease markedly with increased shade and could increase to 2.5 a.u. ha-1 where light transmission values exceed 80%.
- Although continuous and rotational grazing systems have both advantages and disadvantages, under coconuts the use of rotational grazing is likely to be more appropriate on both improved and native pastures because of the need to collect coconuts, control weeds and pests, apply fertilizer, and to use sound pasture management. Under heavy shade grasses have a tendency to lose their competitive advantage thus swards can become legume dominant unless pasture is carefully managed.
- Good weed control is essential. Various surveys have identified weed infestation as the major problem in many coconut pastures. Management must be aware of this at the outset and provide the necessary expertise.
- Under the high light conditions of old coconut plantations liveweight gains and mild yields comparable with, but somewhat lower than those from pastures under open conditions, are possible. Under shady conditions yields will be much reduced. Under light transmission conditions of about 60-75% with 2 a.u. ha-1 liveweight gains of 200-300 kg ha-1 should be achieved.
- Where seasonal forage production is a problem and the grower is unable to ensure year round feed supply for his cattle there are various supplementary feed sources which should be investigated such as: banana, cassava, cocoa pods, copra cake, gliricidia and leucaena, oilpalm, rice by-products, sugar cane, sweet potato, urea and various oil cakes and meals.
- When improved pastures are established there is likely to be a slight initial depression in coconut yields due to soil/root disturbance and the nutrient demands of the sown pasture. However, provided that soil moisture and nutrient levels are adequate, as long as sufficient nutrients are applied in the form of fertilizer to match the expected offtake of pasture where soil fertility is low, and assuming that adequate stocking rates are used, then coconut yields should be unaffected or may even increase. The farmer, however, should not expect to sustain high pasture and nut production with only low inputs.
- Introducing cattle into coconut plantations under good management is likely to: reduce weeding costs (by reducing labour requirements); increase copra production from a better recovery rate of fallen nuts; result in income from beef sales; release labour for other tasks such as replanting coconuts, pasture establishment and stock control; increase gross farm income; reduce depending on one crop and may bring about a more complete use of available feeds by using various crop by-products and crop residues.
- Forage cultivation and cattle-raising-under-coconuts is becoming widely accepted as one of the methods by which the smallholder farmer can increase his income and food supply. Various livestock feeding systems based on banana leaves and

stems, sugar cane, napier grass, leucaena, gliricidia, rice straw, copra cake and rice bran as well as various conventional grasses and legumes have already given promising results in a number of countries.
Author's summary, shortened



571 90 - 3/74

Integrated systems
Review, book, temperate zone, semi-arid zones, sheep production systems, proceedings, symposium, traditional management systems, fecundity, genetic improvement techniques, breed development, feeding systems, health control, evaluation of new techniques

FAYEZ, I. et al.

**New techniques in sheep production.**

Butterworths, London, UK, ISBN 0-408-10134-2, 1987

The book is a result of a Symposium that was jointly organized by the University of Zagazig in Egypt and the University College of North Wales and held in Bangor in August 1986. It was the intent of the meeting to address several key areas concerning productivity in sheep, as well as the feasibility of practical application, with a specific focus on sheep production systems in temperate and semi-arid regions.
Presently, the sheep industry in many parts of the temperate and semi-arid regions are undergoing rapid changes. These changes are likely to have an influence on the traditional patterns of sheep production in semi-arid environments in which reassessment, possible improvements and a search for new direction are inevitable. Under these circumstances, the availability of recent knowledge in terms of advances on the subject, and opportunities for practical application that can improve prevailing management systems are thus very timely: this book thus makes a valuable contribution and adds to existing knowledge on sheep production. Traditional management systems are likely to continue, however, application of the new knowledge that this book provides enables improvements and progress and higher levels of performance to be achieved.
The book is organized into eight sections: review of current production systems and the scope for improvement, methods for increasing fecundity, genetic improvement techniques, breed development, feeding systems, management and health control, and evaluation of new techniques. A total of 24 chapters are presented under these sections written by specialists who provide up to date information and valuable discussion of individual aspects of the main theme. The first section reviews current production systems with respect to wool, meat and milk. This section would have been more complete had it also included a chapter on the role of sheep in a systems context especially in semi-arid regions, relating their products and the types of production systems, including mixed cropping, in the context of development issues that can together address the use of the available resources and economic production.
The book will be of interest to senior and postgraduate students and contains much useful information that will be of interest to sheep husbandrymen, technical advisers and all those concerned with small ruminant production.

sheep husbandrymen, technical advisers and all those concerned with small ruminant production.



90 - 3/75

572

Integrated systems
Review, developing countries, energy, agricultural development, sustainability, CTA

KYRITSIS, S.

**Le rôle de l'énergie dans le développement agricole. (The role of energy in agricultural development.)**

In: Agriculture in the Year 2000 - The case of ACP Countries -, Int. Forum, Athens, Greece; Greek Government and CTA, Netherlands; ISBN 92-9081-0440, 1990, pp. 95-97

The basic source of energy for agricultural production is solar energy. Plants transform CO2 from the atmosphere and produce the biomass.
Additional sources of energy are fuel for machinery, human effort, fertilizers, pesticides, etc., in other words, all direct and indirect forms of energy other than solar.
In 1987, the developing countries, with 76% of the world's population accounted for only 34% of the world energy consumption, out of which 41% came from renewable sources of energy (water and biomass), whereas in the developed countries, the share of renewable sources of energy was limited to 9%.
In developing countries, the greater part of energy consumption, and chiefly of energy need, occurs in rural areas.
The greatest energy consumption takes place in thermal energy which is generated from the direct burning of wood, with an extremely small degree of efficiency, thereby aggravating the final per capita energy consumption levels.
Prospects for the future are bad, as developing countries, even if they were to regulate the increase of their population to 1.3% in the next 3 to 4 decades, would have to multiply their food production by 5 in Africa, by 3 in Latin America and by 1.75 in Asia. Despite the fact that Africa and Latin America have undeveloped agricultural lands available which Asia does not, developing countries will have to intensify their agricultural activity and to provide employment for their inhabitants in order to cope with food shortages. Consequently, considerable quantities of energy are required in the developing countries.
The development model for the majority of developing countries will have to turn to:
- further intensification of agriculture, especially in Asia, due to the limited agricultural land available;
- the creation of many new jobs, thus developing small-size industries and businesses;
- keeping the population away from the big, over-populated urban centres;
- taking measures to integrate underprivileged social strata in the development process.

Most of the developing countries are situated in the tropical regions. This geographic area is relatively poor in extractable

energy sources, but rich in wooded biomass, as it comprises 50% of the forests and 40% of the biomass of the world.
Deforestation affects 11 million hectares per year, and the biomass destroyed annually amounts to 1 billion tons. This is happening at a time when the wood crisis has for many years constituted a basic problem for many African and Asian countries. FAO reports that in some countries of East Africa, 40% of the family income is spent on wood and charcoal.
The basic energy source available here is biomass. This source of energy is renewable under certain conditions and closely linked to the decentralized consumption of energy.
The use of biomass for energy is a new technology which has been making steady progress in Western Europe in the last few years. It is capable of:

- maintaining and increasing the production of biomass, through the proper exploitation of abundant solar energy;
- increasing the output level of biomass used for domestic fuel consumption;
- providing new forms of energy, such as motion and electric power;
- creating small, local enterprises for the production of charcoal and other products from biomass that is difficult to transport. In turn these will supply the enormous demand of cities and regions with little biomass, thereby establishing a reverse flow of capital to rural areas.



573 90 - 3/76

Integrated systems
Pacific, Asia, review, livestock, indigenous farming, integrated farming systems, socio-economy, technology generation, technology transfer, planning policy, production inputs, strategy for action, CTA

SASAKI, M.

**Livestock based integrated farming systems in the Asia - Pacific region.**

In: Proc. of the Seminar on Smallholder Livestock Development, Western Samoa, 1985, pp. 1-3; available from CTA, Postbus 380, 6700 AJ Wageningen, The Netherlands

Integrated farming and production system has been practised for centuries in the Asia and Pacific region. A producer grows a few crops to feed the family; some domesticated animals such as a few cattle or buffaloes, several pigs and a small flock of ducks or chicken for draught power, meat, milk, eggs or other animal products. Wherever adequate water supply is available a small fish-pond is maintained. A few trees in a nearby wood are maintained and used as fuel to cook as well as to provide forage to feed the stock. This "traditional" or "primitive" agriculture is practised by one family, sometimes by a group of families or by a community as a unit. Livestock sector has already been playing a central role in these "indigenous" farming systems.
In the past, most developmental activities in livestock production have been concentrated only in and around urban areas to satisfy the requirements of urban community. Livestock development has for a long time under-estimated or sometimes completely neglected a role of rural small farmers despite the fact that they possess and operate the majority of livestock wealth of the country in the region. As a result, in spite of many extensive developmental programmes in the past, the rural poor have been essentially left without any appreciable improvement.
Future integrated farming systems have to be viewed through multi-disciplinary approach. Socio-economic research studies of selected villages already practising successful integrated farming system should be undertaken and utilised as a model for others with proper modifications. Pilot village project, demonstrating improved techniques of integrated farming, should convince farmers to increase their net profits in the near future. It may often be advisable that the farmers be shown the tangible benefit first before shifting their conventional farming into new integrated practice.
Farmers should be aware of the opportunities available for them to improve their productivity and how to get necessary assistance from their government.
One of the most serious problems in the past, on the agricultural administration in the region, was the exclusion of small farmers themselves from the developmental planning and processes.

574

90 - 3/77

Integrated systems
Africa, Senegal, Guinea, Sierra Leone, Madagascar, review, prawn farming, indigenous species, agriculture

SPORE

**Prawn farming: an attractive prospect.**

SPORE, 28, 1990, p. 6

Prawn farming remains underdeveloped. Only 1.7 million tons per annum are harvested from the sea, but world consumers (mainly Japanese, Chinese, North American and European) would buy more if more were available. Entrepreneurs in Latin America and Asia have already seen that farmed prawns could fill this gap in the market, and are ready to exploit it. In the past five years they have produced some 500,000 t, and they are becoming rich on it.
Africans would like to install rearing pools similar to those used elsewhere along their coastlines and have been experimenting in a modest way for the past two years with a few small prawn farms along the east coast. The results have been encouraging.
At Ziguinchor in Senegal, a four hectare farm has been financed by the Senegalese government and the French Ministry of Cooperation to carry out research into the ways in which prawns adapt to the African inland environment.
African coastal prawns, mainly Penaeus duorarum, do not respond well to farming processes. Their growth rate is slow and they carry a virus which multiplies in rearing pools. The solution was for African aquaculturalists to obtain their larvae from other continents.
Near Conakry in Guinea, SEPIA (a French company) has found a way of farming Penaeus vannamei, a species from South America. In Sierra Leone a businessman is experimenting with several hectares of pools. In Gambia a 100 ha project has progressed this year to the production stage. And in Madagascar the France Aquaculture Company plans a 1000 ha farm with a projected production of four tons/annum. In Cameroon, in the Congo and in Nigeria small projects will begin in the near future. The production planned for the next five years is limited, a maximum of 2000-3000 tons.
Apart from the fact that local prawn varieties are not suitable for farming, there are further handicaps for Africa to overcome. Unlike Asia and Latin America, there is not such a strong tradition of aquaculture and therefore the technology is less advanced. Furthermore, the sites are not always favorable. On the west coast the drought has accentuated the salinity of the available water and prawns do not thrive in water that is too saline. And often, between Nouackchott and Libreville, the ground is too loose to make good ponds.
It is for this reason that France Aquaculture company prefers East African sites.
Madagascar seems to offer the best prospects. The sites are easy to develop, the salinity level is satisfactory and because of the



established fishing industry all the necessary infrastructure is in place.
If Africans have decided to launch into farming, it is because there are several good reasons for doing so. Above all there is a price advantage. Europeans will be the main customers since there is virtually no local market. The prawns will arrive deep frozen by ship, and will, in the context of the Lomé Convention, be subject to a tax saving of 5% of their value, which makes them highly competitive on the international market.
Moreover, the days of the great Asian and South American prawn empires would seem to be numbered. In Ecuador the environment is so threatened by the land clearance caused by the aquaculturist that no further planning permission for pools is being issued. In Thailand production has droped by several thousand tons because too many pools have been dug and the water has become polluted. With only a few hectares of prawn farms, Africa has still a long way to go.
More information from:
France Aquaculture - Michel Autrand
BP70 - 29263 Plouzane - FRANCE

575 90 - 3/78

Integrated systems
Australia, survey, sustainable agriculture, conventional agriculture, economics, fertilizer, pesticides, credit, fuel, machinery, labour, land, input-output relation, financial benefits, prices

WYNEN, E.

**An economic comparison of sustainable and conventional farms in South-Eastern Australia.**

In: Sustainable Agriculture: A new Direction; Proc. of a Symposium; Nat. Ass. for Sustainable Agriculture, Australia Ltd; 1987, pp. 25-35

Results from a survey amongst sustainable and conventional cereal farmers in south-eastern Australia are presented in this paper. The data pertain to the financial year 1985-86.
The survey was carried out in Queensland, New South Wales, in Victoria and South Australia. Of the twenty farmers interviewed, nine were considered to be fully sustainable, five semi-sustainable, and the rest farmed in a similar way like the conventional system.
In this paper only the results of the fully sustainable farms, which have been under this kind of management for more than five years (eight farms), are discussed. The data presented here include physical and financial aspects of the farm.
The sustainable farmers interviewed are compared with groups of other farmers. The first group consists of farmers in the proximity of the sustainable farmer, who are cereal growers.
Other characteristics on which the conventional farmer was chosen were similarity of soil type, local climate, and farm size to that of the sustainable farm.
The picture emerging from the comparisons discussed in this paper is that the sustainable farmers interviewed used less inputs, and therefore incurred lower cash costs, than the conventional farmers. Differences in the cash returns (cash receipts and farm cash operating surplus) were not statistically significant. Looking at other measures (returns to land and capital) the sustainable farmers were also very comparable to the conventional farmers. This is mainly because, in general, sustainable farmers incurred lower costs for machinery. Even when wheat prices for the two categories of farmers were assumed to be equal, the returns to inputs indicated that sustainable farming can be viable as compared to conventional farming.
Apart from the financial benefits to producers; there are other aspects to farming which have not been touched upon yet. The fact that sustainable farmers spend less on inputs than conventional farmers implies that losses are reduced in years with adverse conditions, such as drought years. This reduces the risk factor in farming. In a country like Australia, where droughts are common occurrences, this factor must be of some importance.



576 90 - 3/79

Integrated systems
Review, handbook, arid zone, semi-arid zone, desert range, water supply, transhumance facilities, fencing, range management, contour dykes, flood irrigation, syphons, FAO, UNEP, UNESCO, WMO, CTA

OREV, Y.

**A practical handbook on desert range improvement techniques.**

Interagency Group on Agricultural Biometeorology, Geneva, Switzerland, 1986, 163 pp.

In the most of the arid and semi-arid zones of the world, the density of the population has increased considerably during recent decades.
The natural resources of these areas are deteriorating to an increasing extent.
A large proportion of the population living in these zones has abandoned a nomadic mode of life, to settle in places offering the best opportunities for agricultural development. This process of settling permanently has been accompanied by a diversification of activities which has led to substantial changes in land utilization, in the social and economic system. Perhaps changes in the local climate due to overgrazing and other activities are also caused.
These processes lead to a deterioration in natural ecosystems, resulting in the destruction of the vegetation and the deterioration of its potential for production, and in the decreased fertility of soils and their ability to store water.
This handbook deals with the following subjects:
- Domestic and stock water
- Transhumance facilities
- Fencing
- Range management
- Runoff use
- Flood irrigation
- Appendices

In a work dealing with the improvement of ranges in arid zones, two chapters are devoted to the problems of mobilizing, managing and utilizing water resources.
The other chapters deal with the main problems concerning the development of the ranges.
There are appendices to the document in which a series of practical hints are given.
This handbook is intended for the use of village level workers, for agricultural extension workers and foreign experts.
The choice of low cost methods was confined to what can be achieved by a village community or even a nuclear family unit.

577 90 - 3/80

Integrated systems
Asia, Papua New Guinea, review, book, traditional methods, crops, husbandry, appropriate technology, self-help technology, extension, resources, rural development

TWOHIG, A.

**Liklik Buk - A sourcebook for development workers in Papua New Guinea 1986.**

Melanesian Council of Churches; Liklik Buk Information Centre, ATDI, Unitech, PMB, Lae, Papua New Guinea; ISBN 9980-56-005-3; 1986, 354 pp.; Distributed by: Village Equipment Suppliers, P.O.B. 2172, Lae, Papua New Guinea

Liklik Buk gives community-level leaders and trainers in Papua New Guinea better access to rural development information sources, with the goal of village self-help action. It includes short, rich articles on crops, livestock, processes, designs, health and animating rural development; references to books, pamphlets and organizations; plus comments and editorials from a broad range of contributors. Information given on particular topics is not complete, but it is basic, technically sound, and helps the reader define an interest and find further information.
Some basic information can be found in each of the major sections, but since many problems have several aspects to a solution, additional information is also found in other sections.
Liklik Buk is for the direct use of village people; it is meant to be for their benefit. It is primarily a support for those who have dedicated themselves to working with village people: teachers, business development officers, pastors, university students, overseas volunteers, or village leaders. It gives inspiration, new ideas and helpful information.



578 90 - 3/81

Integrated systems
Review, book, tropics, milk production systems, research, nutrition, reproduction, rearing of ruminants, on-farm application, CTA

PRESTON, T.R.

**Développement des Systèmes de Production Laitière sous les Tropiques. (Milk production in the tropics.)**

Centre Technique de Cooperation Agricole et Rurale (CTA), Postbus 380, 6700 AJ Wageningen, The Netherlands

Attempts at developing milk production in tropical countries have been subject to a depressing number of failures - perhaps more than in any other sphere of agricultural development. Those involved in this field have come to realize that the production technologies of the developed world were completely inappropriate for tropical countries, and are now directing their efforts to adapting and improving existing systems.
T.R. Preston, author of the book "The Development of Milk Production Systems in the Tropics", published by CTA, believes that the most economical way of satisfying the growing demand for milk in developing countries is to improve existing breeding and rearing systems, which are based on multiple-use animals, rather than the specialist milk or meat systems prevalent in developed countries.
Preston's study is based on research on the nutrition, reproduction , and rearing of ruminants and explores the creation of viable milk production systems, making recommendations for their on-farm application.
The book, which is short, simple, and practical, treats all the questions relevant to the setting up of these systems: food, reproduction, rearing and housing.
Abstract from SPORE

579 90 - 3/82

Integrated systems
Europe, Netherlands, study, experimental farm, integrated farming, integrated pest control, integrated control techniques

VEREIJKEN, P.

**From integrated control to integrated farming, an experimental approach.**

Agriculture, Ecosystems and Environment, 26, 1989, pp. 37-43

Integrated control or integrated pest management (IPM) is not being practised to any large extent in arable farming. The reasons for this are discussed in this paper.
Many of the techniques explored as parts of integrated control programmes, such as economic injury thresholds, insect pest monitoring with sex pheromones, use of selective pesticides and others, have already been incorporated into present-day pest control practices so far primarily based on chemicals. These techniques have led to much more rational and efficient use of them.
The question remains why so few non-chemical control methods and techniques, have been adopted by the farmers.
Current cropping systems aim almost exclusively at maximum profit by maximum yields. This approach asks for high yielding varieties and a plant nutrition which make crops attractive and vulnerable to most pests and diseases. Therefore the potential yield cannot be realized without protection by a so-called "chemical umbrella".
Un till now, specialists in crop protection mainly restrict themselves to rationalizing and optimizing control.
In the meantime world-wide intensification of agriculture is still proceeding, increasing pollution of the environment and destabilization of the agro-ecosystems.
A more basic approach called integrated farming is suggested. Preliminary results of an experimental farm at Nagele, The Netherlands, indicate that considerable savings of pesticides can be achieved along with a better income for the farmer. An overall strategy for integrated control of pests, diseases and weeds is described in general terms. It is concluded that automated guidance systems should be developed to bridge the gap between research and practice.
Only in long-term farming as in Nagele (The Netherlands) can such delicate interdisciplinary activities be brought to a successful end.
The author's conviction is that computerized guidance can bridge the gap between research and practice. This system should enable farmers to act at a higher level of knowledge by using a detailed program, based on a survey of all possible decisions.
This guidance system should comprise the following elements:
- warning procedures based on the crop, growth stage and previous cropping, certain decisions being recommended;



- models of decisions and advice for pests, weeds and diseases control but also for fertilization, timing of operations, etc.;
- general information on disease observations, use of pesticides, properties of cultivars, susceptibility of pests to biocides, etc.;
- registration of relevant inputs and outputs for optimum management, exchange of information and study.

Guidance systems for the main crops in the area around Nagele are currently being developed and tested with the help of a pilot group of farmers before they are transferred to the farmers.

580 90 - 3/83

Integrated systems
Latin America, Colombia, Llanos, plains, on-farm study, pasture improvement, cattle productivity, native grasses, economics

CIAT

**Pastos mejorados aumentan productividad del ganado. (Improved pastures raise cattle productivity.)**

Informe CIAT 1987 (CIAT Report 1987); Centro Internacional de Agricultura Tropical (CIAT), Ap. Aéro 6713, Cali, Colombia; 1987, pp. 57-61

Cattle grazing a grass/legume combination of Andropogon gayanus and Stylosanthes capitata increase their reproduction and therefore raise farm incomes. These are the findings of a six-year, onfarm study of the use of new pasture technology in the Colombian Llanos. These plains, in northeastern Colombia, cover some 17 million ha and are notorious for the poor quality of their native grasses.
The low nutrition of the native savanna causes lower birth rates, more embryo mortalities, prolonged anestrus, abortions, and predisposes cattle to infections. Undernourishment also stunts growth and postpones first conception. Heifers typically weigh around 250 kg when they mate, a low weight for reproducing unless their nutrition is immediately improved.
It has been recognized that in the Llanos cattle productivity is related to the quantity and quality of forage. However, the forage grasses and legumes must be able to tolerate the acid soils, low fertility, and long dry seasons of the region.
Since 1979, pasture trials on seven farms in the Colombian Llanos have evaluated the A. gayanus and S. capitata association under the operating conditions of commercial farming. Some heifers were grazed 100% of the time on improved pastures. Others were divided equally between improved pastures and native savanna. Still others were grazed on improved pastures until they reached 300 kg and mated; after this they were put on the savanna. One herd grazed only native savanna 100% of the time.
For heifers that had total access to improved pastures, their weight at first conception was 276-314 kg. They reached this weight at 30 months of age. Fifty percent of them calved for the third time by 1986.
The heifers grazing the improved pastures half the time weighed at first conception approximately the same as those that had full-time access. However, their weights went down significantly by the second conception and they did not calve for a third time within the same period. The herd that grazed all the time on native savanna conceived at 40-44 months and weighed only 250-265 kg.
On on-farm cows that grazed native savanna grasses reached weaning time weighing less than 270 kg whereas those that had access to the improved pastures weighed more than 300 kg.



For cows grazing improved pastures 100% of the time, the interval between the first and second birth was 566 days and between their second and third, 532 days. Those grazing improved pastures until they reached 300 kg, followed by a period on native savanna, had 574 days between the first and second birth and did not reconceive. Those that grazed half the time on improved pastures and half on native savanna had 598 days between their first and second birth and, likewise, did not reconceive. Those that grazed only native savanna gave birth only once. The ones on improved pastures reached their third conception during the same period.
The superior reproduction is reflected in the weaning ages, which were less than 7 months for the groups with total access to improved pastures, more than 7 months for those with controlled access, and more than 8 months for those grazing the native grasses. The weights when weaned of the second birth were 8%-13% higher for those having total access to the improved pastures as compared with those with controlled access.
In economic terms, the use of improved pastures produces a very good internal rate of return: 33%. The initial investment is equivalent to the gross income of the traditional system for one year. In many cases, only a small percentage (less than 10%) of the total farm area needed to be sown in the better grass and legume in order to realize these profits.
This test of the pasture technology under commercial conditions verifies the value of A. gayanus and S. capitata. It shows to be a winning combination to improve cattle productivity in the Llanos and should encourage use of the technology in similar areas of Latin America.

581 90 - 3/84

Integrated systems
Review, booklet, tropics, beekeeping, colony composition, species, races, daily life, beekeeping, honey harvest, wax processing, diseases and pests, eastern honeybee, AGROMISA, CTA
SEGEREN, P.

**Beekeeping in the tropics.**

Agrodok 32; Agromisa, P.O.B. 41, 6700 AA Wageningen, The Netherlands in association with CTA, The Netherlands, ISBN 90-72746-13-9, 1988, 83 pp.

This book deals with beekeeping in the tropics. It provides information on how to work with the western honeybee (Apis mellifera). At the end of the booklet one can find some information on the eastern honeybee (A. cerana).
Although the basics of beekeeping are the same all over the world, the management of bees must be adapted to the species and race of bee, the climate and the vegetation.
An experienced beekeeper can take care of about 100 hived bee colonies. During certain times of the year (preventing swarming, collecting the honey and feeding the colonies) this will be a full-time activity. At other times of the year there will be time left over to spend on other activities.
The honey yield depends largely on climate and vegetation. For the western honeybee these are the average yields (in kg) per year:

| | | | |
|---|---|---|---|
| Oceania | 35 | Russia | 11 |
| N. America | 26 | Europe | 9 |
| S. and Central America | 25 | Africa | 6 |
| Asia (excl. Russia) | 12 | | |

The greatest value of beekeeping lies in the fact that bees pollinate agricultural and horticultural plants.
This constancy makes bees very valuable to plants which need to be cross-pollinated. If there are enough bee colonies in the area at flowering time the plants will give higher yields and the quality of the fruits will also be better.
Bees gather an average of 100 to 200 grammes of pollen per colony per day; 30 to 50 kg per year! Pollen can contain up to 35% protein. It can be eaten dry or added to other foods. Pollen is sold to the perfume industry and nowadays also for consumption.
If one wants to improve beekeeping in his area, start with the existing local methods and try to improve these step by step instead of introducing an entirely new method.
The AGRODOKS are published by Agromisa and can be ordered from:
AGROMISA
P.O.Box 41
6700 AA Wageningen
The Netherlands



582 90 - 3/85

Integrated systems
Africa, Zambia, study, integrated rural development, sustainability, cultivation system, oxen utilization, relish supply, commodity supply, cooperative development, village self-reliance, beekeepers, craftsmen, associations, institutional sustainability, SLE

RAUCH, T. et al.

**The sustainability of the impact of the integrated rural development programme (IRDP) Zambia/NW-Province.**

Schriftenreihe des Fachbereichs Int. Agrarentwicklung der TU Berlin, Nr. 116, ISBN 3-924333-70-X, 1988, 258 pp. + annex; available from: Verlag J. Markgraf, Postf. 105, D-6992 Weikersheim, F.R.G.

This report is the result of a three-month survey carried out by a study team from the Centre of Advanced Training in Agricultural Development (CATAD) of the Technical University of Berlin. All team members, except for the team leader, are participants of the Centre's 26th one-year training course which prepares junior professionals for assignments in bilateral and multilateral development organizations. The team was composed of one agronomist, one geographer, one agricultural economist, one land use planner, one social-scientist, and one forest engineer/economist. The study was conducted on request of and in close cooperation with the Integrated Rural Development Programme/North Western Province in Zambia.
The Integrated Rural Development Programme (IRDP) in Zambia's North-Western Province was inaugurated in 1977. Its major goal has been to improve the living conditions of the majority of the small-scale producers (farmers, bee-keepers, craftsmen) mainly by increasing their productivity and production. The approach has focused on providing these small-scale producers with access to inputs, credit and markets and to institutionalize such a mass-oriented service system after it has proved to be feasible and attractive for the target groups. Meanwhile the major targets (set for 1990) in terms of number of participants and production have been achieved. More than half of the rural households are actively involved. The services have been handed over to local agencies.
The role of IRDP is now limited to
- providing some support to such agencies
- strengthening the organization of its target groups
- monitoring of all IRDP-initiated activities.

The major question at this stage of the programme has to be whether its achievements have a fair chance to be sustainable.
The IRDP's approach to safeguard a sustainable improvement of the living conditions includes the following measures:
- Promotion of the introduction of cultivation systems supposed to safeguard sustained soil fertility (instead of continuity with the prevailing maize mono-cropping).

- Promotion of the organization of target groups in order to strengthen their self-help capacity(thus reducing the burden of service agencies) and to enable them to articulate their needs and interests effectively (e.g. group approach within the Work Oxen Project, Village Self-Reliance Scheme, promotion of cooperatives and associations).
- Reduction of dependence on external inputs and external markets and on subsidies in order to reduce the impact of unreliable external economic factors.
- Support for the service institution which have taken over functions from IRDP in order to institutionalize the small-scale producer-oriented service systems that have been established by the IRDP.

The survey focused on those aspects of sustainability which require investigations on target-group level, i.e. the emphasis was on the aspects of ecological and social sustainability. As any assessment of the sustainability of the impact of a programme is not possible without an up-to-date knowledge of that impact, a general analysis of IRDP's impact on the various sections of the target population was included in the survey.
The findings of this study are mainly based on a sample survey carried out in six selected agricultural camp areas.
The authors conclude that the aspects of sustainability analysed in the study are so manifold that it is not easy to extract generalizing conclusions on the sustainability of the IRDP. Nevertheless, some common features are becoming obvious by a comparison of the findings on the various topics covered by the survey: The immediate risks for sustainability of the programme's impact on target group level (with regard to the cultivation patterns as well as with regard to the organizational structures) seem to be less threatening than expected.
The efforts of the IRDP to safeguard sustainability by introducing more adjusted cultivation patterns and new organizational structures have been too ambitious. The recommended intercropping packages are too sophisticated. The attempts to promote organizations which do represent the interests of the poorer sections would require massive interventions into social processes on the village level which are beyond the scope of a regional project.
Consequently, the IRDP's interventions directed towards the sustainability of its impact on the village level should be limited to a support of the people's own attempts by improving the information flow. This can be done without creating new artificial structures by using the existing communication channels.



583 90 - 3/86

Integrated systems
Latin America, Honduras, integrated development programme, project study, costs and benefits, environmental benefits, sustainability, programme evaluation, IIED

BUNCH, R.

**Guinope integrated development program, Honduras.**

In: The Greening of Aid - Sustainable Livelihoods in Practice -, Eds. C. Conroy and M. Litvinoff: Earthscan Publ. Ltd. in association with Int. Inst. for Environment and Development, London; 1988, pp. 40-44

In January 1981 the Guinope Integrated Development Program was initiated.
The root problem in the Guinope area was severe soil deterioration caused by erosion and the continual monocropping of corn.
The extension methodology of the programme has been as follows. A very limited number of innovations that respond to the limiting factor in local agricultural production are introduced through field demonstration and the use of farmer-run, small-scale experiments on the people's own land. These technologies must be inexpensive and easy to understand, produce significant increases in yields and be directed at the traditional crops of the villagers. They include soil conservation practices and the use of chicken manure and/or chemical fertilizer.
These technologies are taught largely in the fields through hands-on-activities of the farmers, the emphasis being practical rather than theoretical. All classes are taught by village farmers who have previously had success with the same technology.
As agricultural success increased basic grain supplies beyond what was needed locally, incomes rose, and people wanted to grow cash crops, as well as to prepare more varied and healthy meals for their families. A series of classes in nutrition and hygiene has begun, as well as training in growing vegetables, both for local consumption and as cash crops.
The programme has improved the environment in a number of ways.

- Land fertility has been increased, and probably ensured on a long-term basis, by the near elimination of agricultural burning; by the introduction and widespread use of chicken manure; by the use of locally produced cow manure and compost; by the introduction of a number of tropical green manure crops; and by a more informed use of chemical fertilizers. Over 198 km of contour drainage ditches, 80 km of contour grass barriers and 31 km of contour rock walls have been built by local farmers in the process of protecting some 449 ha of hillside land from water erosion. None of this work was paid for or done by the programme; all was done by the farmers, convinced it was in their own interest.
- Air and water quality have been improved. Tons of chicken manure used to be dumped into the rivers around Tegucigalpa,

but the demand for this product has now virtually eliminated the practice. The near elimination of agricultural burning has greatly reduced the quantity of smoke in the air from February to May.

- In various ways the programme has had a significant impact on the quantity of forest around Guinope. By controlling erosion on people's land, the need for migratory agriculture has been eliminated (ending migratory agriculture could save millions of hectares of forest around the world, and is much more easily accomplished than has been previously thought).

Increased productivity has meant that most farmers are now actively farming less land than they did before, so that land above what a farmer can use intensively either has been left idle to grow back gradually into pine forest, or is being used in a more extensive (less labour-intensive) manner. Thus hundreds of hectares previously used for agriculture are now covered by trees.
By using small-scale experimentation, keeping simple accounts of their experiments and then sharing their results with each other, large number of small farmers can continue to develop their own agriculture long after the programme has closed its doors. What will be sustained is a loose-knit federation of village-level agricultural clubs that will co-ordinate experiments and share results. The vegetable producers' association will continue to 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.
Most of the technologies used in Guinope's agricultural development either were replicated from previous World Neighbors agricultural programmes in Guatemala or were standard practices of non-mechanized agriculture. But one major technology, that of small-farmer-adapted green manure crops, was largely developed by the Guinope programme and its sister programme in El Rosario.
The technology is now being applied by at least a dozen development agencies throughout Honduras, and major government programmes now use contour ditches, grass barriers, rock walls, green manure crops. The government has also sent many of its agronomists to the Guinope programme for training, and has initiated four new programmes that are attempting to apply the overall Guinope approach.



584 90 - 3/87

Integrated systems
Asia, Philippines, study, farming systems, livestock, smallholders, grain production, crop residue, cropping systems, plant biomass, plant breeding, grain legumes, varieties, root crops, feeding value of crop residues, forage, fodder trees, sustainable agriculture, on-farm experimentation, DSE

CALUB, A.D.

**Livestock in smallhold farming systems.**

In: Proc. of an Int. Training Course on Sustainable Agriculture (Ecofarming) and On-farm Experimentation, SEARCA, Los Baños, The Philippines, 1988, pp. 81-92

Asian smallhold farmers, with landholdings of about ± 2 ha, generally practice mixedfarming. They grow one or more crops, livestock, and poultry, and may also engage in off- and nonfarm activities for supplement income.
In coping with farming for subsistence to self-sufficiency, they allocate resources and inputs to crops before they do to livestock. Livestock are consequently marginally productive. Profit maximization among alternative enterprises is apparently not the sole basis for their decisions in allotting inputs; it is more on yield and/or return stability. Livestock become peripheral to but provide a safety net for all the uncertainties in crops. Increased profitability from livestock may not also be as important as the savings feature of ownerships.
A high degree of integration is maintained; the crops provide grain for the farm family while livestock provide draft, meat, and milk, consume crop residues, and return manure as fertilizer to the crops. Reevaluating this crop-livestock integration is how farming system research (FSR) can help the farmer. Increased cropping intensity does not automatically result in more but sometimes less animal feeds. Some crops like shallot and tomatoes do not have suitable residues for livestock. Available crop residues in the rainy season may not be fully utilized by the farmer because of plentiful weeds and labor constraints, aside from his inability to sun-dry them for storage.
New dimensions in successful crop technologies can be pursued. Cowpea, for example, is a crop that can potentially replace soybean in pig and poultry feeds. It is less selective of soil conditions as well as soil moisture limitations. Seed is also more easily stored. A large mixed-feed market exists, but production has to be large enough for processing in commercial feed mills. Perhaps a contract-growing scheme between feed mills and small farmers can be worked out.
Crops for the smallhold farm need to be more dual, that is, multipurpose. Although grain and residual fodder yield are generally negatively correlated, variability within germplasm materials indicates some potential for high yields of both. Plant breeders are expected to vitally influence future developments in

this regard. Multiple cropping also needs to address both grain and fodder. Intercropping cowpea, for instance, has been shown to have no effect on corn yield. Cowpea fodder supplements the feed value of the corn stover in terms of additional protein. Other legumes like siratro may also be intercropped with cowpea, with corn-cowpea, and so on, allowing the slow-start siratro to persist through the dry season after harvesting the main grain crop.
Author's summary



## IV CROPPING SYSTEMS

585 90 - 4/64

Cropping systems
Africa, Nigeria, Savanna zone, ultisol, intercropping, cassava, maize, groundnuts, productivity, field trials, split plot design, LER, varieties

IKEORGU, J.E.G. and ODURUKWE, S.O.

**Increasing the productivity of cassava/maize intercrops with groundnuts (*Arachis hypogaea* L.).**

Trop. Agric. (Trinidad), 67, 2, 1990, pp. 164-168

Cassava/maize intercropping is the most popular and productive bi-specific mixture grown in tropical Africa, Asia and Latin America. This mixture has also been shown to be superior to other cassava-based mixture in terms of total calorie yields/unit area/unit time although gross returns and LER were highest where cassava/maize intercrops included other low-growing crops.
Despite their high productivity, cassava/maize intercrops are often combined in traditional agriculture with low-growing crops such as melon (*Citrullus lanatus*), okra (*Abelmoschus esculentus*), cowpea (*Vigna unguiculata*), amaranths (*Amaranthus spp.*), groundnuts (*Arachis hypogaea*) and several leafy vegetables. This is because cassava and maize are the dominant species of most multi-specific complex mixtures with up to seven crops. There is a concensus from these reports that total yields are higher although the yield of the low-canopy crop is often reduced. Since cassava is often planted in low fertility soils, companion crops like legumes usually improve the nitrogen economy of the soil.
Groundnuts used to be a major cash/export crop in Nigeria; it was produced mainly by small-scale farmers who constitute more than 70% of the farming population in Nigeria. About 95% of groundnuts planted in Nigeria and 56% in Uganda are grown in mixture with other crops. General crops are by far the most common component crops grown with groundnuts and the general observation is that groundnut yield is readily reduced by competition from the cereal crop. In the cassava growing areas of Nigeria, both maize and cassava are intercropped with groundnuts in two or three crop mixtures.
This study was initiated to investigate the effects of inclusion of groundnuts into a cassava/maize system on yields of component species, and total land productivity of a cassava/maize/groundnuts mixture in a low fertility soil.
Cassava tuber yield was decreased by 12% in cassava/maize/-groundnuts intercrops where groundnut population was 100 X $10^3$ plants $ha^{-1}$ or more. Cassava yields were not reduced in cassava/maize and cassava/groundnuts bi-specific mixtures. Grain yield of maize at 50% of sole crop optimum population tended to be higher in mixtures than under sole cropping at equivalent

this regard. Multiple cropping also needs to address both grain and fodder. Intercropping cowpea, for instance, has been shown to have no effect on corn yield. Cowpea fodder supplements the feed value of the corn stover in terms of additional protein. Other legumes like siratro may also be intercropped with cowpea, with corn-cowpea, and so on, allowing the slow-start siratro to persist through the dry season after harvesting the main grain crop.
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