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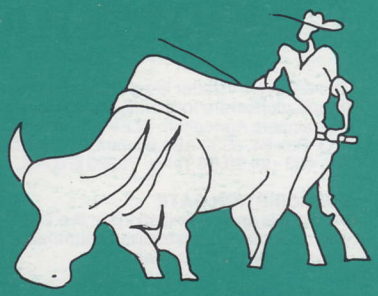

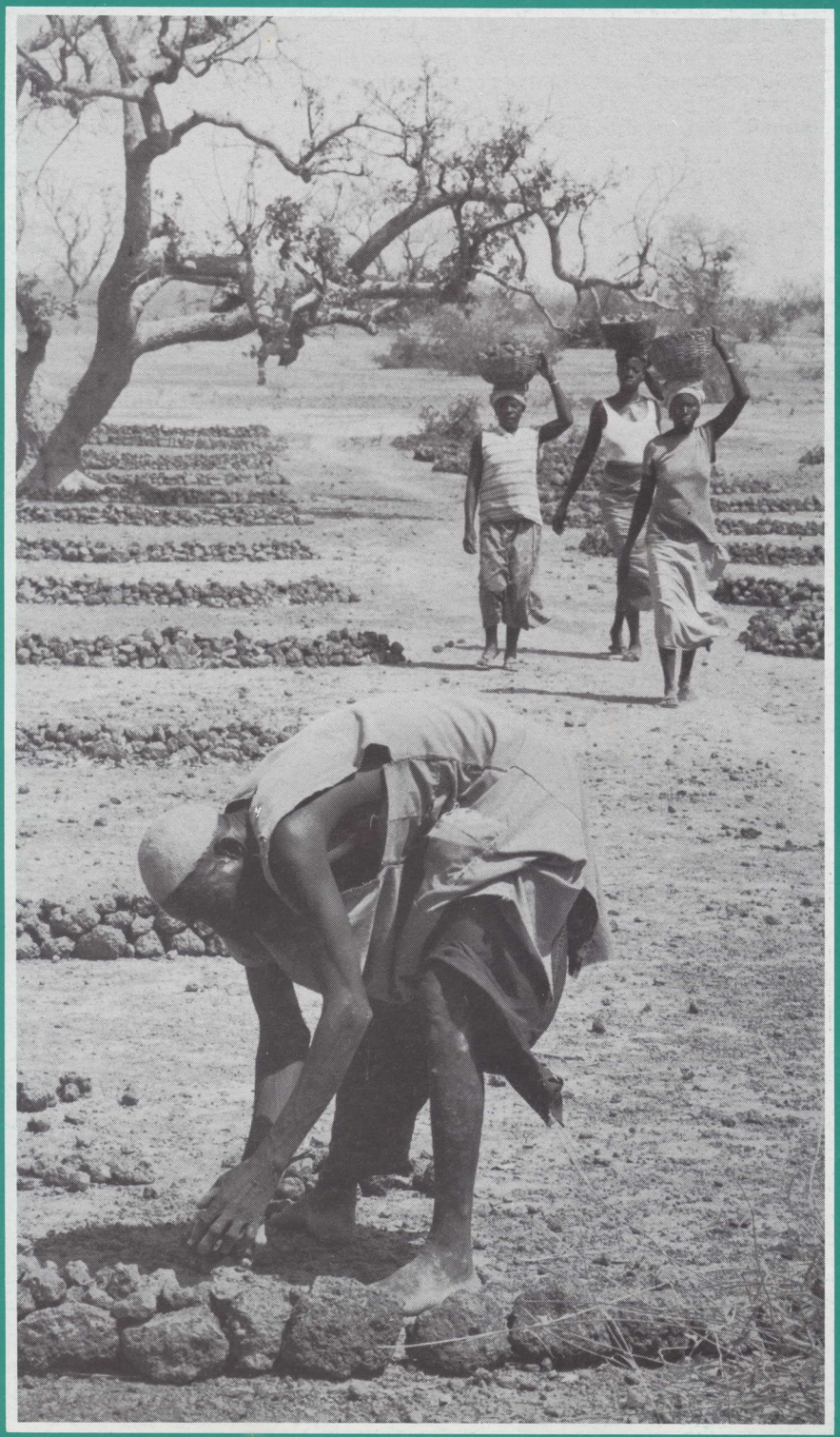

NEWSLETTER

ILEIA - DECEMBER 1988 Vol.4, No.4

Informationcentre for Low External Input and Sustainable Agriculture

Enhancing Dryland Agriculture

Colophon

The ILEIA Newsletter is a publication of the Informationcentre for Low External Input and Sustainable Agriculture (ILEIA), Kastanjelaan 5, P.O. Box 64, 3830 AB Leusden, The Netherlands. Tel. 033 - 94.30.86 Telex: 79380 ETC NL

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Cover photo: Farmers in Burkina Faso constructing permeable stone bunds. Picture taken by Jeremy Hartley/OXFAM.

Dear Readers,

In this Newsletter you will find a collection of articles and information on dryland agriculture in the semi-arid zone. We tried to find some important clues for this difficult zone. As an editor, one has to be a bit lucky but we hope that we present you some thought provoking ideas and some information on 'promising' technologies to optimize the use of local resources.

We found an important ally for the 'low-external input and sustainable agriculture' approach: The Congress of the United States Office of Technology Assessment (OTA), which recently published an important policy paper on their 'resource enhancing' approach to low-resource agriculture. As dryland agriculture is mostly low-resource agriculture we consider their approach of high relevance for dryland agriculture. The paper is reviewed in the article 'Enhancing dryland agriculture'.

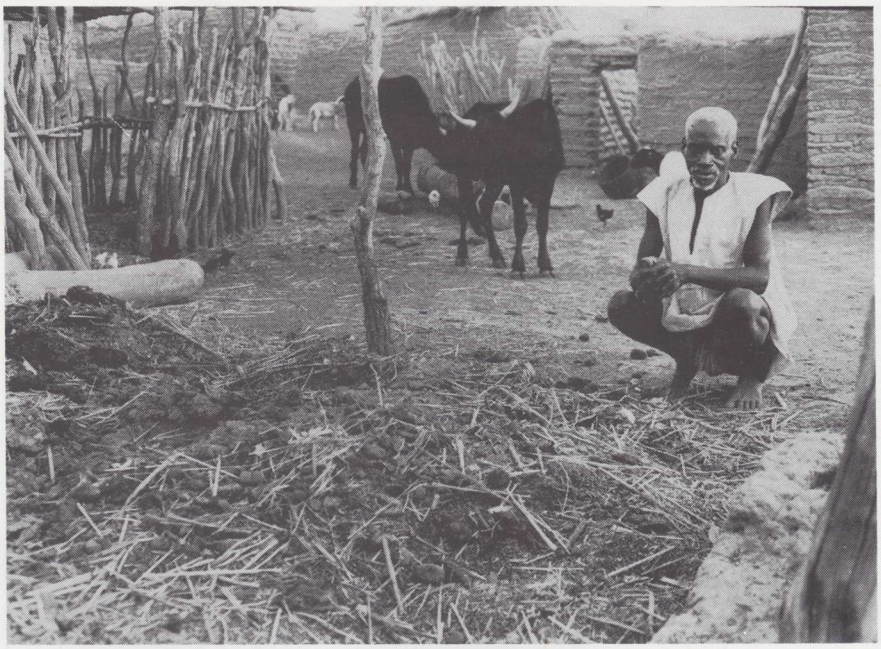
We also would like to ask special attention for another important publication: 'A case study on farmer innovations and communications in Niger' from the Communication for Technology Transfer in Agriculture (CTTA) project. The CTTA had a look in the technology kitchen of farmers in Niger and came to remarkable conclusions (see page 24). One of these conclusions is:
'So long as farmers' own research efforts and their wealth of communication resources are ignored, much of donor investments in R and E institutions and projects will be lost. Like it or not, both R and E depend for their success on farmers' own, informal systems of technology validation and transfer for success'.
What more needs to be said....?

The ILEIA Newsletter in 1989

The following topics will be treated:
Vol.5,No.1 : miscellaneous and discussion on the preceding topics
Vol.5,No.2 : Agriculture in Humid Regions
Vol.5,No.3 : Pest Management
Vol.5,No.4 : still open for your suggestions

If you want to present your experiences or if you want to reflect on preceding topics, like 'Integrated Nutrient Supply', 'Diversity', 'Microclimate Management', 'Integration of livestock and crop production', 'Agriculture in Tropical Highlands or in Drylands' or - very important - 'Participatory Technology Development' do not hesitate but write to ILEIA.
Closing dates for contributions are: No.1: February 1st; No.2: April 15th; No.3 August 15th.
But before 1989 starts all staff members of ILEIA would like to wish you

A GOOD AND INSPIRING 1989 !



Farming Systems Experiences from South Mali: Yet the production of organic fertilizer might be the best option available... (photo: Jos Kronenburg).

Farming Systems Experiences from South Mali

Jos Kronenburg

The 'Projet de Recherche sur les Systemes de Production Rurale' (PRSPR) in Sikasso, Republic of Mali is an applied research endeavour of the Royal Tropical Institute, Amsterdam, The Netherlands in collaboration with the 'Institut d'Economie Rurale' of the Government of Mali. During the 1970s, it was conceived as a consequence of a renewed interest in a holistic approach to the research of farming methods called 'farming systems research' (FSR). It propagates a multi-disciplinary approach to the study of the intricate nature of farmer behaviour. FSR attempts to take into account the whole gamut of environmental, cultural, social, political and economic conditions which determine farmer's decision making. Farming systems research's proposition is respect for the knowledge of small farmers and the potential of traditional agriculture.

However, after eliciting this knowledge after completing the description of the existing farming practices in 'all' its ramifications, system researchers seem to be confronted with a dilemma on how to proceed. For, whose priorities will be chosen to guide the research efforts for the removal of constraints to progress? Louise Fresco does not eliminate the possibility that system researchers will emphasize productivity considerations for one single farm crop over less tangible cultural or social considerations that might include farmer priorities. This is likely to be true for other single technologies aimed at improving farm productivity. As such, FSR is reminiscent of a directive approach to the change of farming practices. This impression is compounded by the apparently dominant role of the researcher in on-farm investigation and the formulation of recommendations. FSR conducted in that way is not fundamentally different from the more traditional approach which combines agricultural research on research stations with farmer persuasion by extensionists. FSR thus conducted remains prescriptive in nature and retains a strong technicist bias.

Diverging approaches in farming systems research

The multi-disciplinary team of PRSPR did discuss the approach it should follow in order to attain its long term goal in the most effective way. This goal was considered to be: '..... an equitable distribution of resources in South Mali while maintaining the ecological equilibrium, and farmer's involvement in designing development endeavours'. For the purpose of reflection two 'ideal type' research approaches with opposing orientations were developed. On the one side one finds a 'researcher- centred' approach and on the other side a 'farmer-centred' approach.

In the 'researcher-centred' approach it is assumed that the FSR- researcher is the one who possesses knowledge relevant to farmers behaviour. The researcher is to conduct experiments and it is he who is most indicated to design new technologies to improve farmer living conditions. If the farmer heeds the researcher's advice he will arrive at what is the most appropriate solution to his problems. Within the context of the 'researcher-centred' approach the farmer listens and does what the researcher tells him to do. It implies superiority of the researcher's knowledge.

The FSR-researcher applying a 'farmer-centred' approach assumes that the farmer possesses considerable knowledge accumulated on the basis of experience. It is also assumed that the farmer 'knows' best his own problems. This experiential knowledge is grounded on his intimate contact with his own social, economical, political and environmental reality. The 'farmer-centred' researcher solicits a large degree of farmer participation in on-farm experiments. The researcher listens with respect to how farmers perceive their own reality. In dialogue with each other they attempt to discover new solutions to farmers' problems.

The actual practice of FSR appears to hover between these two extreme approaches combining elements of the two 'ideal types'. An analysis of the advantages and disadvantages of the two approaches allows the researcher to make a conscious choice concerning the direction he wants to develop his research approach. In the beginning of 1987, a consensus emerged in the PRSPR-team to orientate its efforts towards 'farmer- centred' research to attain its long term goal. It was obvious, however, that the way this orientation would be shaped depended on the type of research at hand and the personal inclination of the individual researcher.

Role of the 'farmer-centred' researcher

What would be the role of the researcher in 'farmer-centred' research? Since the assumption is that the farmer knows best his own problems, it is a task of the researcher to create means that enable the farmer to articulate his poblems, order them according priority, analyse them to find their causes and search for solution. During this process the researcher is a partner in dialogue with the farmer. His main attributes are skills in systematic analysis, designing experiments which give reliable results and knowledge which comes from beyond the horizon of the farmer. Screening the outcome of the dialogue, the researcher can formulate options for solutions of farmer problems, each option accompanied by its advantages and disadvantages to enable the farmer to make informed decisions.

Agriculture-livestock linkages

One of the themes of the PRSPR is the study of relations between agriculture and animal husbandry. In South Mali the main function of keeping cattle appears to be the production of oxen for animal traction. A secondary function is the provision of organic fertilizer for the production of food and cash crops. So far a training model for draught- oxen has been developed. In close co-operation with farmers and agents of the extension service, research has been conducted on how to improve farm equipment for draught-animals. Also better feeding of draught-oxen before the ploughing season has been a topic of investigation, resulting in recommendation on the cultivation of fodder crops (cow-peas), the preservation of harvest residues (peanut leaves) and the establishment of artificial pastures with the graminea *Brachiaria ruziziensis* and the legume *Stylosanthes hamata.* The latter also contributes to the improvement of soil fertility. By-products from the agro-industry such as cotton-seed based feed are used to condition oxen during the dry season. Research has also been undertaken to improve organic fertilizers: crop stalks (sorghum) are used as bedding in cattle kraals and for the production of compost.

Degeneration of the vegetation

Research by CILLS/'Sahel Club', Paris, suggests that in South Mali one needs per ha cultivated land between 0-2 ha natural pasture land to maintain the necessary oxen for draught, depending on the various degrees of agricultural products/by-products they are fed. For the replacement of draught-oxen one needs 8 ha pasture land per ha cultivated land and to maintain the natural fertility with organic fertilizers only, the need is 15 ha natural pasture

land per ha cultivated land. These figures are based on the premise that the natural pastures are well managed. However, recent field-studies by the PRSPR suggest degeneration of natural pastures due mostly to overgrazing. An extended period of lower than average rainfall also contributed to this fenomenon.

There are a number of forces which enhance the likelihood of overgrazing. The need for draught-oxen has increased as a consequence of the introduction of ox-drawn equipment by the Cotton Board of Mali (CMDT) and foreign donors. In order to have the necessary oxen permanently at his disposal, farmers need to maintain a herd of minimal 16 head of cattle. This and the tendency of farmers to invest their surplus income from cash crops (cotton, cereals) into livestock vastly increased the claim on natural pasture land by the sedentary rural population. Simultaneously with the expansion of ox-drawn practices the cultivated area increased, reducing the area available for grazing. Incidental motorization in agriculture added to the latter process.

It is not difficult to understand that under the above described developments interests of pastoral people and those of sedentary farmers are increasingly encountering conflict. At issue is a decreasing area of natural pasture land for an increasing number of livestock. A direct consequence of this situation is the earlier mentioned deterioration of the natural vegetation.

Dilemmas of 'solutions'

Reducing stock-numbers to offset the effects of overgrazing is an obvious suggestion from the 'researcher-centred' scientist. However, experiences elsewhere in Africa have proven this to be an extremely difficult exercise, in the case of individual ownership of livestock and communal grazing grounds. For, the tendency is that each livestock owner tries to optimalize land-use by maximizing his livestock numbers. Even on ranches with communal land-ownership, such as found in Kenya for group-ranches, regulation of livestock numbers meets numerous problems. The CILLS/'Sahel Club' report concludes, that the major constraint to agricultural production in the Sahel is lack of fertile soils. On the basis of prices during the period 1980/1985 it recommends as an alternative option the integration of animal husbandry with intensive agriculture. For the South of Mali this means an agricultural production system based on cotton (with NPK-fertilization), in rotation with leguminous crops (with P-fertilization and grain crops (maize, sorghum, millet). Livestock production can be enhanced by increasingly available agricultural by-products from intensive agriculture. However, this well-studied advice faces farmers reality. During 1986/1987 the world cotton price dropped considerably. Consequently the Cotton Board of Mali tried to limit the area for cotton cultivation. In the same period cereal production was such that when Mali's grain stores were filled the price for cereals on local markets tumbled from 55 F CFA to as low as 15 F CFA per kilo. The potentially large meat market of neighbouring Ivory Coast is being saturated by cheap imports from the subsidized meat stocks of the EEC and low-priced meat from Argentina. Thus, farmers aiming at higher production levels have to sell their produce for low prices if no markets can be found. They then risk not to be able to pay the credit for the chemical fertilizers they applied.

A 'farmer-centred' approach

If from the agro-ecological point of view soil fertility is the main constraint for increasing productivity, from the macro-economical point of view it is lack of fertilizers due to balance of payments considerations. The parameters of the ecological potential of South Mali, the national and international market, the political and monetary policies of the government are all together determining the limits of farmers' decision-making. The farmer needs to reckon with all these inter-related external factors in order to find the most appropriate response to his problems. It is here where a 'farmer-centred' researcher plays his role. He enables the farmer to discover his space for manoeuvre in order to allow him to elaborate an adequate strategy. This might mean continuing with labour intensive practices such as the production of organic fertilizer from the by-products of crops and livestock. As the agro-ecologists argue in some areas it is theoretically possible to replace the nutrients harvested in the form of cereals, fodder crops, meat and other agricultural products with organic fertilizers such as compost, manure from livestock corrals or legumes in the cropping system. It is however unlikely that it happens to the extent that soil fertility is sustained because of transport problems. Moreover, according to the calculations of the agro-ecologists it is simply not possible to maintain soil fertility in large parts of Sub-Saharan Sahel and savanna zones on the basis of organic matter alone. The ratio cultivated land-pasture land does not allow livestock to produce sufficient manure to do so. Besides, any manure coming from pastures also affects the quality of the pastures. Thus from this perspective, even maximum use of organic matter can only slow down the depletion process of soils but it cannot stop it. Yet the production of organic fertilizer might be the best option available under the circumstances the farmer finds himself in. Even when economic conditions are favourable for the application of mineral fertilizers, utilization of organic matter will always be necessary. Use of mineral fertilizers only contains the risk of degradation due to loss of soil structure. In combination with organic fertilizer the need for mineral fertilizer will diminish, enhance an efficient use of it and reduce the effect of erratic water availability, thus diverting economic risks for the farmer. In the meantime it seems to be well adviced to urge farmers in South Mali to produce as much organic fertilizer as they are able to. Similar, 'less-than-optimum' technologies for other farming system constraints might be indicated given the farmer's external conditions and the resources he has access to. And it is he who is likely the one best placed to judge which additional knowledge will suit him best to solve his immediate problems.

During this pragmatic process that aims at solving the most pressing problems it is likely that awareness grows about the causes of 'external constraints' and the causes of 'lack of access to resources'. On the basis of these new insights, it follows that a multi-disciplinary 'farmer-centred' research team shapes, together with farmers, adequate strategies in order to resolve these, probably less urgent but more structural, obstacles to development. Such a strategy, inevitably, needs to incorporate broader society interests in its goals to attain long-term stable results.

Jos Kronenburg has been teamleader of the PRSPR. Presently he is working at the Royal Tropical Institute, Mauritskade 63, 1092 AD Amsterdam, The Netherlands. The views and interpretations in this article are those of the author and should not be attributed to the Royal Tropical Institute, PRSPR or affiliated organizations, or to any individual acting on their behalf.

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Enhancing Dryland Agriculture

Different organizations (CILSS, World Bank, FAO, OXFAM, IFOAM) have recently evaluated and reconsidered the agricultural development efforts in the Sahelian and Sudanian Zones and have analysed possible new niches for interventions. As Jos Kronenburg already indicates, the margins for sustaining and improving agriculture in the semi-arid zone seem to be very small. In fact most reports are rather pessimistic as successful cases are few. General opinion is that the semi-arid zone is, or soon will be, over-exploited and that degradation of the ecosystem is advancing fast bringing agriculture in this zone further in a downward spiral. Expectations for a short term improvement of this situation is not seen as realistic, taking into account the following factors: The further increase of the population; the emerging insight that the decrease of rainfall and the increase of climatic instability will not be temporary; the high prices for external inputs like chemical fertilizers; the continuous low prices for agricultural produces on the international market; the poor communication and commercial infrastructure; and the absence of a sincere political willingness to change the world market system and the international debt crisis.

Still there are also positive signs: - the local population is more and more ready to take initiatives to improve their situation, not only with short-term but also with long-term investments (Nelson,1988; ENDA 1988) and a new approach to development assistance in agriculture is emerging (OTA, 1988). Although successful cases are scarce, a number of promising technologies can be identified, which could provide a base for the development of sustainable agriculture (OTA, 1988). This article gives a summary and discussion of the findings of a recent study on the agricultural situation in Africa by the Congress of the United States Office of Technology Assessment (OTA): 'Enhancing agriculture in Africa, a role for U.S. development assistance' (OTA, 1988). Although OTA has studied the agricultural situation in Africa, the proposed approach is also highly relevant for other low-resource tropical regions like most dryland areas.

Low-resource agriculture

OTA has gathered information on agricultural production throughout SubSaharan Africa, looked closely at specific 'promising' technologies such as agroforestry, small scale irrigation, soil and water management and the improved use of animals. As a result they draw the conclusion that low-resource agriculture has a sizable and untapped potential to contribute to increased food security and that low-resource agriculture should be enhanced in order to reach its full potential.
According to the report, no viable alternative to low-resource agriculture exists today. Agriculture can be enhanced using an approach that builds on the best of existing African agriculture while taking advantage of external inputs, information and improved techniques.

The 'resource enhancing' approach

From its analysis of how low-resource agriculture is practiced, OTA found four fundamental concepts that provide insight into why low- resource agriculture has been successful in the past and how these potentials might be enhanced in the future.
On the basis of these concepts OTA developed its resource-enhancing approach to redirect development assistance and improve its effectiveness.

1 - Most African agricultural systems although once sustainable, are no longer keeping pace with the increasing demands being placed on them. Thus, development assistance should be designed to place a high priority on sustainability; acknowledge the importance of sound natural resource management as a basis for improved and stable agricultural production; ensure that resource-poor farmers are the first to benefit from development assistance to manage natural resources better; focus on enhancing the capability of Africans to assume primary responsibility for their development.
2 - The heterogeneous mixture of resource poor farmers and herders have responded to a high degree of uncertainty and vulnerability with diverse and flexible strategies. Often these strategies minimize risks while seeking optimum stable yields, commonly at the expense of maximum yields. Therefore, development assistance should accommodate a flexible and diverse approach, enhancing the agriculturalist's ability to manage risks and encourage diversification and indigenous experimentation and innovation; have available a variety of interventions so that the ones most appropriate to the varied and changing needs of resource-poor agriculture can be met.
3 - Local resources - such as local people's knowledge, practices and institutions, plus indigenous plants and animals- reflect the adaptations to the diverse local conditions and have largely been untapped by development assistance agencies. Thus, development assistance should be designed to build on local participation especially of the women, to use and strengthen local organizations and to build on local resources.
4 - Low resource agriculture is based on farming systems that have interacting ecological, social and economic components and these farming systems are in turn linked to other larger systems beyond the farm. Development support activities should account for the integrated nature of low resource agriculture and should improve links between farms and external systems such as markets, research and extension systems and transportation networks.
This approach should be long-term, dynamic, flexible and incorporate a mixture of strategies. It should build on the strengths inherent in African agriculture and support the ongoing evolution of how low resource agriculture is practiced.
Much development assistance has bypassed the majority of farmers and herders because it emphasized external resources.

'Much development assistance has bypassed the majority of farmers...' (Photo taken in Burkina Faso, VIDOC KIT, Amsterdam).

Promising technologies

Although one of the most important lessons to arise from the past development assistance failures is that to be successful, technical interventions must match the specific constraints shaped by local social and environmental conditions and therefore standard solutions can not be used, the many specialists involved in the study of OTA are convinced that a number of 'promising' technologies exist, which will be able to secure food production in Africa.
The research literature on Africa is filled with promises of technological success. Yet the adoption rates are very low. How can a promising technology become an adopted technology?

The answer of the OTA team is that technologies never may be seen apart from the overall approach to technology development. The OTA report stresses that technologies only can be promising under the condition that a resource enhancing approach to development assistance is followed. Sequential changes to farming and herding technology are likely to be important. E.g. resource-poor farmers and herders in semi-arid regions may be most able to adopt technologies in this sequence:

1. water-harvesting or run-off/erosion management systems,
2. increased use of organic fertilizers
3. increased use of trees/shrubs or perennial grasses
4. introduction of chemical fertilizers
5. introduction of improved cultivars.

This could be a way to modernize gradually.
Resource-poor farmers and herders rely primarily on resources internal to the farm or their immediate environment. Consequently, technologies to support low-resource agriculture should also emphasize the use of internal resources as the first step in agricultural intensification. Thorough economic analysis is needed to determine the feasibility of all technological interventions, especially those requiring externally purchased inputs. Even when a technology has been used successfully in one case, its feasibility under local-specific conditions must be evaluated. Technologies do not operate in isolation and they are affected by non-technical as well as technical factors. National level decisions on issues such as fixed crop prices, land tenure, access to credit for women and incentives for conservation, affect farm level decisions. Farmer and herder participation in identifying problems and acceptable solutions would enhance the effectiveness of technology development. Existing agricultural practices could be a starting point of a process combining the best of traditional and modern agriculture.

Although Africa will benefit from global agricultural research, greater emphasis has to be placed on region-specific solutions. Risk aversion by strategic use of diversity within the ecosystem and technological flexibility deserve a high priority in technology development.

Common characteristics

OTA found that technologies that offer the greatest promise for contributing to the food security of resource-poor farmers and herders share common characteristics, including:

Table 1: Promising Technologies and Practices by Agro-ecological Zone

Technology and practices	Zone
Improved use of soil and water resources	
Recession farming	A,S,H
Water harvesting microcatchments	A,S
Planting and building bunds on the contour	A,S,H,T
Tied ridges	A,S
Drainage practices	H,T
Terracing	A,T
Minimum tillage, mulching and other soil-conserving vegetation practices	S,H,T
Improving soil fertility	
Biological nitrogen fixation	A,S,H,T
Vesicular-arbuscular mycorrhizae	A,S,H,T
Manuring	S,H,T
Phosphate rock	A,S,H,T
Commercial fertilizers	A,S,H,T
Small scale irrigation	
Gravity diversion: channeled systems	A,T
Gravity diversion: poldered systems	A,S,H
Mechanically fed: water lifting	A,S
Mechanically fed: water pumping	A,S,H,T
Improved cropping practices	
Intercropping	A,S,H,T
Home gardens	A,S,H,T
Agroforestry	
Dispersed field tree intercropping	A,S
Alley cropping	S,H,T
Windbreaks	A,S,H,T
Live fencing and other linear planting	A,S,H,T
Genetic improvements	
Crop breeding	A,S,H,T
Animal breeding	A,S,H,T
Improved use of animals	
Mixed crop/livestock systems using small ruminants	A,S,H,T
Animal traction	A,S,H,T
Aquaculture	A,S,H,T
Improved systems to reduce pest-loss	
Integrated pest management	
Quarantines	A,S,H,T
Host resistance	A,S,H,T
Cultural controls	A,S,H,T
Biological controls	A,S,H,T
Pesticides	A,S,H,T
Post-harvest technologies	A,S,H,T
Improving animal health	
Veterinary support	A,S,H,T
Animal nutrition	A,S,H,T

A is Semi-Arid; S is Subhumid; H is Humid; T is Tropical Highlands

- **Technical and environmental soundness**: This means they are able to stabilize, if not increase, production while ensuring conservation of natural resources;
- **Social desirability**: This means technologies must address farmer-identified problems and constraints;
- **Economic affordability**: This means that resource-poor farmers must be able to obtain and maintain the technologies. In Africa, this generally means a need to use resources internal to the farm rather than externally purchased inputs;
- **Sustainability**: This means that technologies are environmentally, socially, and economically feasible to maintain in the long term.

Table 1 gives an overview of the technologies identified by OTA to be 'promising'. Some technologies are already in use and may be seen as traditional or developed from traditional practices, others are new and partly based on the use of external inputs.
In part II of the report, each cluster of promising technologies is elaborated and described.
In this way the report provides a general overview of the state of the art of low external input agriculture in Africa. More detailed information on the different technologies can be found in the many references.

The OTA report elaborates the implications of its conclusions for three categories: local level organizations, formal agricultural institutions and national policy bodies.
Recommendations are made to enhance low resource agriculture by e.g. training programmes, institution building, agricultural research and extension. The report examines the most important activities in these domains and concludes that many of them are not very relevant for African agricultural needs. Therefore, effective attention to low- resource agriculture will require a reorientation and possibly a retraining of agronomists, and an adjustment of the existing organizational set up.

Comments

OTA recognizes that inorganic fertilizers (for the semi-arid areas the most important external inputs) have to play an extremely important role but 'they are likely first to supplement - not be a substitute for - organic fertilizers'. The high costs of commercial fertilizers and the variability of response under on-farm conditions, especially rainfed agriculture, argue for extreme caution when extending this technology to farmers with little margin for failure. Secondly, some studies of the long-term effects of continuous use of commercial fertilizers on the soil suggest that it can actually depress yields unless large amounts of organic material, such as animal manure, are added to the soil too. Trials in Burkina Faso showed steadily declining sorghum yields over 18 years due to soil acidification, potassium

Treatment	Sorghum yield: Without nitrogen	Sorghum yield: 60 kg/ha N
	kg/ha	
Without organic treatment	*1831*	*2796*
10t/ha of sorghum straw	*1652*	*3427*
10t/ha of manure	*2409*	*3591*
10t/ha of aerobic compost	*2505*	*3688*

Table 2. Effect of different organic residues on Sorghum yield at Saria, Burkina Faso.

deficiencies, and aluminum toxicity. When used as supplement of organic fertilizers yields can increase considerably as table 2 illustrates.

The same table shows that an important increase in yield can already be obtained when sufficient organic fertilizer is used. However, in the semi-arid zone organic matter for soil fertility improvement is difficult to obtain.

Long-term sustainability can be endangered when more nutrients are removed from the field than brought back by organic fertilizers, which makes it necessary to look for external sources of nutrients like inorganic fertilizers.
When the production system is degraded the first action should be to stop the degradation process (Falloux and Mukendi, 1988). But to be successful, at the same time, a production increase should be obtained high enough to be of interest to farmers (Rey, 1988). Therefore it may be necessary to use combinations of different technologies e.g. waterharvesting in combination with improved soil fertility management, agroforestry and use of improved local varieties.

Finding the best mix

There is a widespread belief that the only option for agriculture which could sustain the growing population would be the intensive use of external inputs. A recent example is given by the Technical Advisory Committee of the Consultative Group for International Agricultural Research, in its report: 'Sustainable Agricultural Production: Implications for International Agricultural Research' (March 1988). This report holds the view that 'indigenous farm populations have learned to manage their systems quite efficiently, making it difficult to increase their production without resort to external inputs.' TAC states that 'if increases are possible at all, their rates do not exceed 1 % per year' (page 6). 'With an average increase in demand of 3 % per year, the needs must therefore be met by expanding the cultivated area with a rate of up to 2 % per year. This leads to overgrazing and reduction of fallow periods and thus threatens the sustainability.'
The TAC assumes that: 'without agriculture which uses considerable inputs, it would not be possible to meet the food demands of the increasing world population, unless more, but less suitable land were brought into cultivation, further degrading the surface of the earth'. Therefore, TAC advocates intensive research and extension to permit optimum use of external inputs.

We are in favor with such research as proposed by the TAC but, strengthened by the arguments of OTA, we hold the view that a higher priority should be given to questions as:
- 'How can the use of local resources be optimised' and
- 'How can local resources best be complimented with external inputs'.

The significance of the OTA report lies in the fact that an influential office adopts conclusions which are a step beyond the conventional agronomic concepts. The potential contribution of local resources to agricultural development are being recognized and translated into a strategic approach to agricultural development.
The report is a thorough piece of work to which an impressive number of international experts have made their contribution. We expect that it will have a positive impact on strategic planning of national and international development agencies.
Although, in our view, a further development of the 'resource enhancing' approach towards 'how to do it in the field' is still necessary, we see the report as a concrete step in the direction indicated by the Brundtland Commission.

The Editors

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Reduction of Risk by Diversity

Meine van Noordwijk
Jelte van Andel

A Theoretical Basis for Age-old Farming Systems

Many agricultural scientists trained in temperate regions are surprised by the diversity of crops and crop varieties found in tropical farming systems, not yet made uniform by a 'green revolution' approach. Understanding the background of this diversity is a prerequisite for a balanced, evolutionary approach to agriculture, based on both traditional farmers' wisdom and modern scientific possibilities.

The AGRISK Project

In the AGRISK-project of the Universities of Ouagadougou and Groningen the risks of food shortages on the Mossi plateau in Burkina Faso are analyzed from social, economic and agricultural points of view. Based on rainfall statistics the expected food grain production on district level is compared with demand for food, which follows from population density. The necessity of maintaining food reserves can then be quantified. Also the possibilities can be evaluated of using surplus grain of one region in a good year to supplement production of a neighboring region where rainfall and thus production were not adequate in that year.
The difference in rainfall between regions in one year are considerable and a substantial spreading of risk occurs if food transport and trade between regions functions effectively. Still, total grain production on the Mossi plateau almost certainly falls behind the requirements in the coming years and measures to increase production are necessary. If possible, measures taken to increase the average production should not increase the variability between years. 'Green revolution' techniques of replacing the existing cultivar diversity by one or two high yielding varieties and of a higher use of chemical inputs have to be carefully evaluated and probably modified.
In the agricultural part of the AGRISK-project the risks involved in food grain production on a farm level are studied and we think a new criterion was found for understanding the role of diversity in risk reduction.

Betting on more horses

Popular wisdom tells us that 'betting on more than one horse reduces the risks', but it does not tell us on how many and on which horses we have to bet. Confronted with the possibly 40 recognizable lines or varieties of Sorghum found on some farms in the Savannah region one wonders about their function in this context. To a certain extent different varieties are grown for different purposes (food or beer) or because of a special taste; to a certain extent they are grown on different parts of the farm, because their genetic constitution matches with a particular soil or location.
Still, a considerable number of varieties is grown on the same location and their grain can be used for the same purpose. Their function may be that relatively good years of one variety coincide with relatively bad years of another and thus the total production is stabilized.
Part of the risks involved may come from insect or disease attack, with difference in susceptibility to particular diseases or insects between the varieties. Another part may come from variability in the water regime, affecting the length of the growing season and the chances of drought halfway the growing season.

We have chosen this latter aspect for further study, so we concentrate on varieties grown on the same location and analyze the risks which are the consequence of variation in rainfall regime affecting both the water and nitrogen balance of the soil.

Niche concept applied to crops

In ecology the niche concept helps to understand the diversity found in natural ecosystems; species which differ in the environmental factor which determine their abundance are said to occupy different niches and will generally be able to coexist. In many cases niche differences will be a result of a dependence on different environmental resources.
For plants, uptake of water and nutrients from different layers of soil is a clear example of a niche difference which leads to stable coexistence in nature. Similar niche differences between crops form a criterion whether or not an agronomic advantage can be expected from mixed cropping. Being regulated by different predators or diseases is also a form of niche differentiation and similarly leads to a criterion for reducing risks in mixed cropping patterns. The niche concept can thus be used in a qualitative sense to judge whether adding a new crop (cultivar) or a new way of growing crops to the farm will be advantageous or not.

From elementary statistics it follows that the standard deviation of the total yield of a combination of two crops does not only depend on the standard

	average	st.dev.	m20
soil water storage	+	–	+
rooting depth	+ +	–	+ +
N-fertilization	+ +	+	0
flowering time	opt.	0	opt.

Table 1. The effect of changes in soil-crop parameters on grain production, calculated with 30 years rainfall data of Bobo Diolasso; st.dev. = standard deviation, m20 = expected minimum production in 95% of years; + + = strongly increasing; + = increasing; 0 = no effect; - = decreasing; opt. = shows optimum curve.

	average	st.dev.	m20
d210 monoculture	4691	1810	1723
d250 monoculture	3204	1555	654
0.3*d250 + 0.7*d210	4182	1330	2001

Table 2. Probability distribution of yields of two Sorghum cultivars flowering at different dates (d120 = day 210, d250 = day 250) and of a 30/70% combination of the two, calculated with 30 years rainfall data of Bobo Diolasso; st.dev. = standard deviation, m20 = expected minimum production in 95% of years; all yields are total above ground biomass in kg/ha (grain yields will be roughly half this value).

deviation of the yields of the two crops separately, but also on the correlation between the yields of the two crops measured over a representative number of years. In fact, the standard deviation of the total yield can be zero if the two crops show a complete negative correlation, i.e. good years of one crop always coincide with bad years of the other and vice-versa. A farming practice found in Southern Sudan may come close to this complete negative correlation between the two components: a mixture of sorghum and rice is grown on soils which in some years are flooded (so the sorghum crop fails and the rice produces grain) and in other years remain dry (so only the sorghum produces grain).
Negative correlations are not required, however, to construct crop combinations which are meaningful for risk reduction. The standard deviation of the yield of a two component system is smaller than that of each of the monocultures if the correlation coefficient of the yields of the two components is less than the ratio of the smallest and highest single-crop standard deviation. In other words, the sorghum/rice example is an extreme case of stabilization of yields by mixed cropping, but much more subtle differences between crop (varieties) leading to a partial, but positive correlation of their yields can still be meaningful for risk reduction. A partial correlation of the yields of two crops in a variable environment is an indication of a partial niche difference between the crops. If we know the yields of different crops over a period of years which reflects the environmental variability, we can now test the risk reduction obtained.

Usually risk reduction by diversity means that the production obtained in bad years (specified for a certain probability of occurrence) is higher, but that the average production decreases. Which extent of risk reduction is desirable, then depends on social and economic consideration, e.g. the price of grain on the market in bad and in average years. All these relations can be formulated and quantified. The main conclusion is that risk reduction on farm level does not follow directly from choosing components with a low variability themselves, but also from the partial correlation and thus niche differences between the components. For a farmer one or two observations of a different response of two crops to weather fluctuations may be sufficient indications of a partial correlation, to decide to maintain both crops on the farm, provided their average yields do not differ too much.

Simulation model

A problem in applying the criterion of partial correlation is, that yield data for different varieties which cover a sufficiently large number of years are rarely available. An alternative is formed by using a simulation model which describes the water and nitrogen balance of the soil under the influence of rainfall and which describes crop growth on a day-to-day basis. By running the model for actual rainfall data for a period of thirty years the average production and its variation can be estimated. First of all the effects of modifying single factors on average yield and yield-variability can be studied. For a model which we use in the AGRISK-project as a first approximation for sorghum production some results are found in table 1.
If the nitrogen level is increased, the average yield will increase, but the variability of yields will increase as well and the minimum production in 95% of the years will stay the same. In years of a small positive or even negative fertilizer effect the economic effect of using fertilizers is clearly negative.

If rooting depth could be increased, e.g. by choosing a different variety or maintaining a good soil structure, the yield increase will be accompanied by reduction of risks. An increase in the water storage capacity, e.g. by an increased organic matter content of the soil, will act in the same way. For the length of the crop's growth cycle, which in the model is represented by the date of flowering, an optimum curve is found: crops with a short cycle and crops with a long cycle give a lower average yield than intermediate cycle crops, with little effect on the variability.

Crop combinations

The length of the crop's growth cycle provides an example of 'niche differentiation'. The correlation between calculated yields of short and long cycle crops is low, so combinations of the two can lead to risk reduction Table 2 illustrates that a long-cycle cultivar, flowering at 'Julian' day 250 has a rather low average production and as a monoculture carries considerable risk. In all selection and plant breeding work such a variety would probably be discarded. Still, because of its low correlation with yields of short-cycle crops, the long cycle crop is valuable for risk reduction on the farm level. A combination of short and long cycle crops has a lower average yield then the short-cycle monoculture, but shows better yield stability and shows higher minimum-yields. Combinations may be favorable by spreading labour requirements at harvest time as well. The crop combinations do not have to be used in a mixed cropping pattern to show this risk reduction effect. In fact mixed cropping may be undesirable in certain combinations where water 'saved' by one variety for later use, would be used too early by another variety. Growing such varieties in different parts of a field is then preferable.

Conclusions

The theoretical framework for judging the role of diversity in risk reduction is still in development, but hopefully it may already help to reverse the current trend of diversity-reduction where risk-reduction is required. Yield stabilization often leads to different agronomic choices than yield maximization. The niche concept can help to extrapolate crop information and plant breeding work to the real world of the farm. Risk-reduction, diversity, complexity and long-term stability are all dynamic key elements in the survival of many resource-poor farmers and herders. Research to make these elements more understandable does not only legitimize the indigenous knowledge of farmers and herders, it also enables adapting new research methodologies to cope to a certain degree with the agricultural complexities in which farmers survive.

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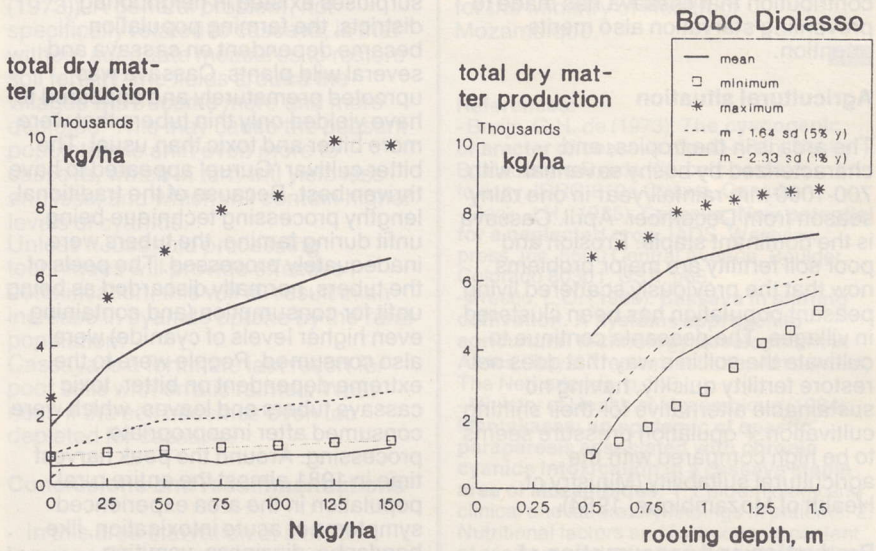

Model calculations of Sorghum yields using longterm rainfall data of Bobo Diolasso, Burkina Faso. Clearly can be seen that if Nitrogen fertilizer is used the average yield increases, but in bad years no extra yield is obtained to cover fertilizer costs. If rooting depth can be increased for instance by waterharvesting or mulching higher and more stable yields will be obtained.

Bitter Cassava as a Drought Resistant Crop

Sander Essers

A Case in Mozambique

During a severe drought in a cassava dependent area in Mozambique many of the advantages and disadvantages of cassava coincided. This case shows the importance of a bitter cassava cultivar as a - drought resistant- famine rescuer and the related problems with toxicity, and indicates possibilities to counteract them.

Even in areas that are not quite semi-arid, erratic rainfall may cause farmers to cling to crops with a large tolerance or adaptability towards these caprices of nature. Cassava is such a crop. It has the ability to withstand dry spells. Also many other advantages of this crop make that it is recently being promoted as a high yielding, drought resistant and survival crop, e.g. by the UNICEF-IITA Household Food Security Programme.
General advantages may be summarised as: adapted to a wide range of climatic conditions, and drought tolerant; high tolerance to low soil fertility and poor soil structure; high yields in energy per cultivated area and per labour input; planting and harvest time allow for a great flexibility; for reproduction, no economically valuable parts of the plant are needed (See also Fresco, 1986).
However, possible drawbacks are mentioned too, like soil depletion, poor protein content and energy density, and the potential of toxicity.
Mozambique is often mentioned as a case where cassava toxicity became manifest. However, the positive contribution that cassava has made to preventing starvation also merits attention.

Agricultural situation

The area is in the tropics, and characterized by bushy savannah with 700-1000 mm rainfall/year in one rainy season from December -April. Cassava is the dominant staple. Erosion and poor soil fertility are major problems now that the previously scattered living peasant population has been clustered in villages. The peasants continue to cultivate the soil in a way that does not restore fertility quickly, having no sustainable alternative for their shifting cultivation. Population pressure seems to be high compared with the agricultural suitability (Ministry of Health of Mozambique, 1984).

Production and consumption of cassava

Cassava was introduced to North East Mozambique about 200 years ago. By 1900 it was still not the dominant staple crop. Around 1935-40 there was a massive campaign for cassava production, because of the droughts in that period, and because of the compulsory production of cotton in family farms during colonial times.
Cassava appeared to be a reliable and highly productive staple food crop and its labour calendar did not coincide too much with that of cotton, as was the case with the more traditional sorghum.
Various cassava cultivars have spread over the area. The number of cultivars grown on the family plots and which dominate, differ strongly from one place to another. There is more reliance on bitter cultivars in the area that suffers more from less and irregular rainfall.
The main harvest of cassava is carried out in the dry season, within a months time in September/October. The fresh roots are peeled, cut into pieces and sun-dried for several weeks. After that they are stored, and consumed eventually throughout the year in the form of a paste after pounding and boiling. Sorghum and maize are harvested in May/June and account for part of the food supply around that time. The ease of pounding, compared to that for cereals, is in favour of the cassava.

The drought

In 1980/1 there was hardly any rain, causing the loss of nearly all maize and sorghum, sweet potatoes, legumes and other crops. As the commercial network had disintegrated, and no surpluses existed in neighboring districts, the farming population became dependent on cassava and several wild plants. Cassava was uprooted prematurely and appeared to have yielded only thin tubers that were more bitter and toxic than usual. The bitter cultivar 'Gurue' appeared to have thriven best. Because of the traditional, lengthy processing technique being unfit during famine, the tubers were inadequately processed. The peels of the tubers, normally discarded as being unfit for consumption (and containing even higher levels of cyanide) were also consumed. People were to the extreme dependent on bitter, toxic cassava tubers and leaves, which were consumed after inappropriate processing. Around the peak harvest time in 1981 almost the entire rural population in the area experienced symptoms of acute intoxication, like headache, dizziness, vomiting, convulsions etc. and over one thousand people have been recorded to have become paralysed. The syndrome is imputed to a high cyanide load from cassava, with a general under-nutrition, especially lacking proteins (Min. of Health of Mozambique, 1984). Although this is sad enough, it should also be stressed that during that period hardly any mortality from starvation has been observed. This would definitely have been different, had another staple dominated.
Subsequently, the poor stock of cassava diminished rapidly and in the first months of '82 there was a severe famine, causing the starvation of possibly a few thousand people. With food aid and production starting off, the situation slowly recovered over some years.

Peasants' reactions

During and after the famine, peasants were experimenting with different processing methods to obtain rapidly a suitable cassava flour without bitterness and toxicity. In the stricken area the peasants were eager to restore as quickly as possible the original diversity of crops. As the drought had vanished the reproduction material of most crops, the peasants pleaded the authorities and arranged distant living family and clan members for cuttings of sweet cassava and seeds of grains and legumes. On the other hand, in a nearby area where hardly any Gurue was grown, peasants were eager to obtain cuttings of this cultivar.

Advantages of a bitter cultivar

It is amazing that a bitter cassava cultivar 'Gurue', that was hardly known 5 years before the drought, had achieved becoming such an important and widespread crop.
Apart from the advantage of the proven drought resistance, the productivity of bitter Gurue is the highest according to the peasants and farmers. However, the production figures have been established at a nearby research station to be as high as for a good yielding sweet cultivar. Also my own measurements of productivity of 4 different cassava cultivars, planted at the same time in a mix on a farmer's field and harvested 11 months later, did not show a higher productivity of Gurue at first sight.
However, Gurue is reported to have a cycle of 18 to 24 months to come to maturity, so comparison after 11 months with cultivars with a shorter cycle is not quite fair. Gurue achieved in those 11 months about the same tuber weight per plant with only half the number of tubers. They weighed on average 1000 g per tuber to 500 g for tubers of the other cultivars. This

means less work and less losses at peeling. The research station works with good conditions. The peasants mentioned a sweet cultivar as being an evenly good producer as Gurue, but on poor soils and with drought it would fail. 'Those people are poor, they only have land on the hillside which is poor soil, so only Gurue can produce there. That is why they only have bitter cassava and have headaches.'

An observation made at the research station was that Gurue has more concurrence power: When planted together with other cultivars, it manages to utilise water, nutrients and/or sunlight best, to the detriment of the others. As the peasants are used to mixing the cultivars in their fields, this will also have been working in favour of the dominance of Gurue, both by natural survival, and by deliberate selection by the peasant that observes the differences.

Right after the famine, there was a plague of rats, attacking not only the food in the stores and homes, but also that on the fields. Peasants in a nearby area that had not suffered from paralysis, expressed their need for cuttings of the bitter Gurue. The peasants declared to know about the toxicity and bitterness of Gurue, but the rats were their biggest problem to fight now to secure food availability, and Gurue was the only field crop that was respected by the rats, swine and monkeys.

According to several peasants, dried pieces of Gurue withstand better storage pests than other cultivars do. This may be related with the cyanide content. As the people say: 'By the time that the insects get into the dried cassava pieces, it is good enough for us to eat it.' They mean that by then it is not toxic anymore. This is generally so after a few months. Quite an important property for a staple food that people have to rely on for about one year. Cyanide in cassava is not a panacea for all kinds of plagues. E.g. Gurue was as much attacked by the green spider mite and mosaic virus as were sweet cultivars.

Discussion on drawbacks

Toxicity

Cyanide is present in many plant products. The human body is able to detoxify certain amounts of cyanide, for which proteins are necessary. Cassava cyanide can constitute a problem, especially under emergency situations when traditional processing becomes inappropriate and when there is a lack of protein-rich side-dishes. Plant breeders, alerted by cases as above, focus on low cyanogenic cultivars. Considering the above observed advantages of bitter cassava, this focus should be reevaluated. Processing may offer a better way of eliminating toxicity.

Protein and energy density

It is true that cassava is poor in protein and can be, depending on the preparation, bulky for its energy content. However, as every staple food is incomplete, a diet cannot be judged solely by its staple food. It is the total package, including side-dishes that counts, and that may be well balanced if based on cassava. Still, especially in a famine or emergency situation, the supply of protein rich foods requires extra attention.

Family peeling cassava before the sun-drying

Soil depletion

The impression has been that cassava depletes soil more than other crops do. Cock (1985) argues that if compared with the produce on a dry weight base, it does not subtract more nutrients than other crops do, with the exception of potassium. It is rather the other way around: The poor quality of the soil is apparently one of the reasons for farmers' choice to produce (especially bitter) cassava. Still, as cassava is capable to utilise effectively even the minimum quantity of nutrients present in an already poor soil, further depletion, especially in potassium will occur, and a soil remains that does not support other crops well. Soils poor in potassium cause an elevation of the cyanide level in cassava (de Bruijn, G. (1973)). A general problem, not specifically related to cassava, is that without adequate measures to restore soil fertility, the fields around the villages will become more and more depleted. This may cause the peasant population to shift even more to cassava, which in turn will yield less and less, and which will contain higher levels of cyanide.
Unless household processing techniques will provide effective detoxification, this will all result in an increase in cyanide uptake by the rural population.
Cassava is a fortunate last resort for poor soils with erratic rainfall. What next, if the soil becomes even too depleted for cassava?

Conclusions and recommendations

- In this area starvation at a much larger scale has been prevented by the great dependence on cassava, which stresses cassava's fame as a famine rescuer.
- The two nutritional drawbacks of cassava, namely cyanogenic potential and lack of proteins, became manifest by extreme drought. The emergency situation and lack of other foods made that the population could not cope sufficiently with the cyanide contents of the cassava.
- Cassava cultivars containing high levels of cyanide may have important benefits for the farmer.
- Prevention of cyanide intoxication should not primarily be pursued by the development of low cyanogenic cultivars, but by
  - Enhancing agricultural practices leading to a sustainable form of production (improving soil fertility, water management etc.),
  - Adherence to processing methods that allow for sufficient cyanide removal from the tubers and leaves. For emergency situations suitable rapid processing methods may have to be developed and disseminated.
  - Enhancing the availability of supplementary foods to balance the diet.

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Composting

Abou Thiam

Soil improvement in a semi-arid Sahelian environment

Soil erosion is undoubtedly one of the greatest challenges confronting the countries of the Sahel region, which have suffered in recent years from an accelerating desertification process. The most tragic consequence of this desert creep, and of the recurrent droughts which accompany it, is that the countries are less and less able to feed a rapidly expanding population.

In the developing countries of the Sahel, the use of chemical fertilizers presents problems. These may be of several types:
- For African farmers and agricultural workers, fertilizer is often too expensive.
- The use of chemical fertilizers increases the dependence of the African farmer and his country upon imports from other countries, because such fertilizers are usually either imported as finished products, or else the energy required to produce them is imported.
- In some countries the farmers are forced to devote practically all their time to working to pay off debts stemming from the purchase of chemical fertilizers.
- When rain does not arrive and when water is scarce (as is frequently the case in the Sahel), fertilizer pellets do not dissolve properly and can 'burn' the crops to which they have been applied. They can also kill beneficial micro-organisms in the soil.
- It has been proven that plants which have received heavy applications of nitrogen (particularly through use of chemical fertilizers) suffer from increased susceptibility to parasite infestation. The need to resort to further use of chemicals (anti-parasite compounds), with all the undesirable economic and ecological consequences which result, is in large measure due to the over-application of nitrogen-laden fertilizer.

In the light of these facts, it is imperative that the use of organic fertilizer be stepped up and encouraged. Organic fertilizers not only bring the necessary nutrients to the soil, but also improve its condition and above all its ability to retain moisture. Compost is a form of organic fertilizer made by piling vegetable matter into a heap (compost heap) and allowing the heap to ferment and to rot through the action of micro-organisms in soil. Composting also describes the manufacturing of compost. Composting is particularly useful for market gardening of the intensive sort, because it brings plants a source of nutrients which can be rapidly assimilated.

Composting as a good substitute

In Sudano-Sahelian Africa, the most common organic or vegetable substances used for this purpose are: dung, peanut oil, fish scraps, and miscellaneous vegetable matter. Composting is a relatively new practice in the region. The PRONAT (PROtection of NATure against the enemies of culture) team of ENDA (organization for the ENvironment and Development in Africa) seized upon composting at the beginning of its research into soil fertilization problems in Senegal.
Composting appeared to the team as a good substitute practice for areas in which cultivation of one single crop -the peanut or groundnut - has exhausted the soil, a problem which is general in the Sahel region. Traditional African agricultural practices - regular application of dung, rotation of crops and leaving lands fallow for a time in rotation - maintained and in some cases even increased the fertility of the soi'. The ability of soil to regenerate itself and recover fertility is improved in a very significant way by the application of compost.

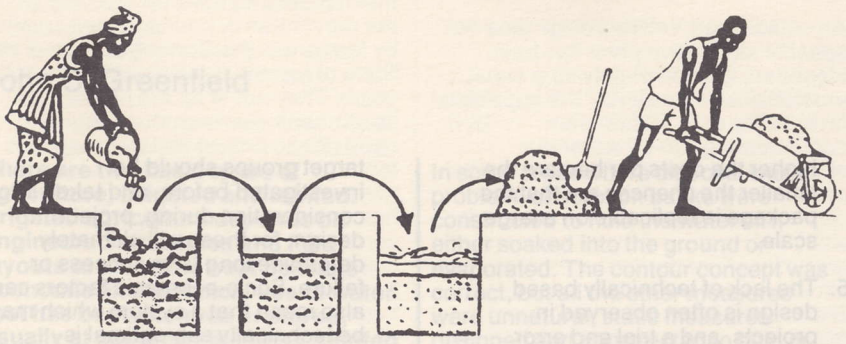
Demonstration on the preparation of compost at the training sessions of ENDA.

Training sessions

Since 1983, the PRONAT team, in cooperation with farmers' groups in the region, and with the Maisons Familiales Rurales (Rural Family Houses) who sent monitors, has organized training sessions in order to help Senegalese farmers learn about the use of compost in improving crop yield and soil productivity. Farmers are chosen by their local groups or invited by the organizers to participate in the training sessions. Though the sessions are fairly short (2-3 days), the farmers are able to learn about the benefits available with compost, and also the basic techniques involved in its production. We of PRONAT were able to produce a slide show in the Senegalese language - Wolof - which conveyed to trainees the sense of the presentations made by technicians to the group. Sometimes qualified members of the team made these presentations in the absence of research institute personnel, and sometimes farmers with practical experience in composting techniques gave hand-on demonstrations to their fellows.
After training, farmers return to their villages and pass on the knowledge gained to other farmers in the local group. Some trainees have organized compost-making demonstrations to this end.
The training sessions have come to be viewed by us as a good way of getting the practical knowledge about composting to the Senegalese farming population.

Requests by local farmers' groups

We stress that the sessions were



organized in response to requests by local farmers' groups. PRONAT assumed responsibility for the cost of organizing the meeting. The invitation of technical personnel from research institutes to make presentations to the training session was made in consultation with the farmers' groups. For its part, ENDA published a brochure printed in French and in Wolof on the subject of compost-making in 1985. Farmers who know how to read one of these languages will be able to follow its directions for making a compost heap. The well-illustrated brochure may also help some farmers learn to read.

Reasons for limited success

It must be admitted that despite our efforts, and those of other organizations active in the region, Sahel farmers are still not well-informed about composting techniques, nor very inclined to adopt them. Why have programs in this direction been so limited in scope, in Senegal as well as in the countries of the Sahel?
This results, in our opinion, from a number of factors, of which the most important are:
- Compostable matter is not very easily available. In many areas of the Sahel dung and vegetable matter are scarce. Plants grow quickly during the short rainy season (2-3 months) but they dry out just as quickly during the dry season and disappear after grazing and trampling by cattle. As for dung, the little which is available is often burned like wood, and for the rest, it is difficult to follow wide-ranging animals around with a shovel.
- The digging of a hole in which to bury the compost involves considerable labour.
- The practice of stirring and turning over the compost is repugnant to peasants for whom compost and dung are the same thing.

Chemical fertilizers

Chemical fertilizers have often been presented to rural farmers as the ultimate solution to fertilizing problems. Application of fertilizers can artificially stimulate production for a time, but tropical soils which have a very slight percentage of humus can be ruined by over- application of mineral fertilizers.

Conclusions

Compost protects and nourishes plants and soil. It reduces overall water requirements. The lack of water in the Sahel is the fundamental limitation on production. For the preferred cereal and other crops grown in Africa, compost is the solution of the future in terms of a simultaneous improvement in both crop productivity and soil fertility. The basic requirement for real development in the region is an increase in the production of food crops. Politically speaking, the drive toward self-sufficiency in food production is a top priority in all the countries of the Sahel. Teaching composting techniques should be high on the list of means toward this end. The Sahel regions suffers from very fragile soils and resists poorly the ravages of soil erosion by wind and water. Composting could rebuild and fortify this fast disappearing resource.

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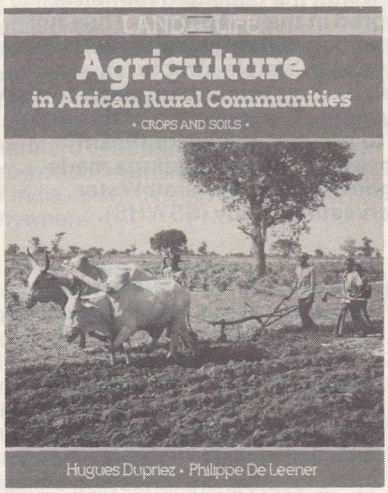
* Planifier la reforestation rural
* Initiatives paysannes au sahel
* Les pesticides au Senegal, une menace?



This book is a basic introduction to principles of crop physiology and practices of crop husbandry. The book recognises the realities of traditional subsistence farming but also introduces improved methods. As well as details of plant requirements and the importance of soil and water, it describes environmental, cultural, social, managerial and economic factors. Like other books in the 'Land and Life' series (see above), this book is aimed at practioners and students of agriculture and rural development and associated vocational and technical skills. They are ideal for self-help, adult education and rural extension projects. They are written in a clear and highly illustrated style. Fortunately now available in English and highly recommended by ILEIA!!

Available from: Terres et Vie, rue Laurent Delvaux 13, 1400 Nivelles, Belgium. US$ 15,-/CFA 4.500,-

Water Harvesting for plant production in Sub-Saharan Africa

Chris Reij

In July 1987 the World Sub-Saharan Water Harvesting Study was initiated, which started its activities with a comprehensive literature review of water harvesting for plant production and two field missions covering six countries, namely Kenya, Somalia, Sudan, Burkina Faso, Mali and Niger. The study's focus is those water harvesting systems which collect and concentrate rainfall runoff for the purpose of improving plant production in the arid and semi-arid areas of Sub-Saharan Africa. The study is further confined to systems in which the collected rainfall is stored in the soil profile. Thus full attention will be given to techniques involving simple structures, which can be constructed by resource-poor farmers. The objective of this article is to present some significant observations and findings made under the Sub-Saharan Water Harvesting Study (SSWHS).

1. There is very little literature or knowledge about traditional water harvesting (WH) in semi-arid Sub-Saharan Africa (SSA). Examples of very significant areas of traditional WH have so far been noted, in particularly in Sudan and Somalia, and these justify further study.

2. Monitoring of WH projects is an especially weak point. Few projects have been found to maintain adequate records of data as basic as costs, work rates, maintenance or even comparative yields between treated and untreated land.

3. In West Africa WH is often used as a tool to rehabilitate degraded land - and its function of capturing eroded soil and organic matter, 'nutrient harvesting', is recognised as very important in this context. In East Africa WH is less often used specifically for rehabilitation of land.

4. In terms of costs of water harvesting, two extremes can be distinguished in SSA: those projects which propose a package of simple, low-cost techniques to farmers (including training) and leave it up to them whether they want to implement them or not, and projects which implement a package of techniques themselves. In the former case the costs can be lower than U.S. $ 100/ha and in the latter case higher than U.S. $ 1,000/ha. It will be evident that the higher the costs per hectare the smaller the chances are that the package is replicable on a large scale.

5. The lack of technically based design is often observed in projects, and a trial and error approach is common. A flexible approach has been adopted by a number of projects which adapt their techniques and approaches in the light of experience. This is essential as few initial project designs prove right the first time.

6. The most widespread WH models seen for crop production, both traditional and project initiated, are variations on contour earth bunds with wingwalls around which excess runoff is drained. The stone equivalent ('cordons de pierre') seen in parts of West Africa dispenses with the need for wingwalls, being semi-permeable. Runoff is normally harvested from a catchment external to the cultivated area, in the form of overland or rill flow. In certain areas of relatively high population density, the availability of 'external' catchments is limited, and micro-catchments within the plot are being considered.

7. Where earthen bunds are used in water harvesting systems, both project and traditional, breakages are commonplace, and erosion from the breaches (and also from poorly designed overflow systems) can be severe. The role that vegetation can play in stabilising bunds, and reducing maintenance costs is often neglected. Correct surveying is also important, and the introduction of simple 'line level' or 'water level' technology is proven as one of the principle ways to improve traditional systems.

8. It is striking that in many areas where WH is practiced or being introduced, soil fertility closely follows moisture availability as a limiting factor to crop growth. This not only means that the marginal crop response to additional units of water is relatively small but also that the sustainability of the whole system is questionable, unless the fertility is addressed.

9. The development of H systems should not be merely exercises in engineering. Many projects give insufficient attention to the social implications of WH. The needs, aspiration and capabilities of the target groups should be investigated before, and taken into consideration during, project design, for these will ultimately determine long term success or failure. Socio-economic factors can also mean that a system which may be technically sub-optimal is sometimes a better choice than more technically efficient alternatives. Compromise and 'tailoring' of techniques is necessary in many situations to achieve acceptance.

10. Replicability - and thus potential adoption - is influenced by several factors, including simplicity and cost of innovations, how closely they are related to traditional techniques and how swiftly benefits are realised or perceived. The economics of WH are often ignored, resulting in some very expensive schemes which cannot have realistic hopes of expanding outside the 'project' stage.

After the literature review and the reconnaissance missions, the SSWHS is now in the process of identifying and designing field trials of promising techniques (for example stone contour bunds) in regions where these techniques may have a good potential, but where they are as yet unknown. Furthermore short studies have been proposed of traditional WH systems in Somalia and Sudan.

The Sub-Saharan Water Harvesting Study is funded by the Norwegian Agency for Development Assistance. 'Water Harvesting for plant production: a comprehensive literature review' will be published at the end of 1988 as a World Bank Technical Paper.

Information about the Sub-Saharan Water Harvesting Study can be obtained from William Critchley, 23 Burnby Lane, Pocklington, York, England or from Chris Reij, Centre for Development Cooperation Services, Free University, P.O. Box 7161, 1007 MC Amsterdam, The Netherlands.

More information:

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Moisture Conservation: Fundamental to Rainfed Agriculture

John C. Greenfield

There are two basic types of agriculture, irrigated and rainfed. Irrigated agriculture depends on engineered structures and field layouts to make the best possible economic and technical use of water that has been pumped or stored, usually at considerable cost. Rainfed agriculture, the type of farming to which the world's rural poor are by-and-large tied, depends on, and is virtually a 'victim' of, the whims of the weather. It is important that the requirements of each are not confused.

Rainfed Agriculture

Droughts have been increasingly reported in many low-rainfall areas of developing countries in the last five years. In India in 1987, the state of Karnataka reported the worst drought in more than 100 years. Yet in one of the worst hit areas of the state, farmers produced the best crop yields ever - at no extra cost to themselves. How was this done? It was achieved by the simple process of plowing and planting on the contour and so conserving moisture in-situ. Without effective moisture conservation in-situ, up to and even more than 60% of rainfall in low-rainfall areas can be lost through run-off. Farmers in Karnataka saw they could overcome this on their own fields by forming small contour furrows each capable of holding 50 mm of rainfall (and in which the seed would be planted). In normal rains, there is virtually no run- off with such furrows; the water that does not evaporate soaks into the soil and is available to the crop.

Soil conservation

Effective soil conservation is more important today than it has ever been, yet, in the rainfed areas, it is largely neglected. Man first recognised that soil erosion was a problem in the USA back in the early 1930s, when farmers had to walk off their farms in the Tennessee Valley, because they had created a 'dust bowl'. This had been caused by over- cultivation leading to massive sheet erosion by wind and water. In this case, soil erosion was recognised by the US Government's Department of Agriculture, and treated as an engineering problem. It was therefore given an engineered solution - contour banks and diversion banks to intercept the run-off and direct it to a safe disposal area (usually a natural stream or drainage line, though if these were not available, waterways were constructed).

In some areas where disposal was a problem, absorption banks were constructed to hold the water till it either soaked into the ground or evaporated. The contour concept was correct, but all the other measures were unnatural, static measures designed and constructed to hold or convey the run-off water elsewhere, thus increasing its volume and erosive capacity and reducing both effective soil and moisture conservation.

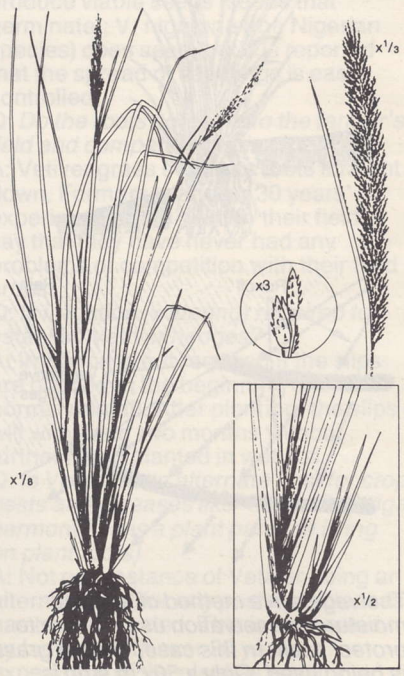
In over 30 years of working in developing countries, the author has seen expensive engineered soil conservation works fail repeatedly, in the process causing more damage than would have been the case if they had not been constructed. It was increasingly clear to him that the engineered system was not the answer - it was too costly, it was temporary, it diverted water from fields, and small farmers did not like it, especially as the earth banks removed a five meter strip of land from production and most obvious of all, the engineered system is 'unnatural'. Despite such evidence, the engineered soil conservation system has been accepted - and taught - worldwide. It has never been seriously questioned. It is **the** method of soil conservation. Until now there has been no satisfactory alternative soil and moisture conservation system. However, under a World Bank-supported project in India (Pilot Project for Watershed Development in Rainfed Areas) an alternative system of soil and moisture conservation in-situ that is particularly suited to developing countries (though the principles are applicable to any rainfed area) has been developed. This system is based on soil stabilization through vegetative contour barriers of Vetiver grass, *Vetiveria zizanioides,* 'khus' in India. These Vetiver hedges are already in use for more than 100 years by farmers in the Gundalpet area of the State of Karnataka, India.
(*Ed. note:* Also indigenous soil conservation techniques and practices in Africa like stone bunds, stone terraces, pits, trash barriers, soil bunds, mulching, etc., are better adapted to the needs, constraints and possibilities of small farmers (Chris Rey, 1987, ILEIA 1986)).

Vetiver Grass

The author worked with Vetiver grass in the Fiji Islands over thirty years ago, and has followed its progress since. The idea of using Vetiver grass as a vegetative means of soil and moisture conservation originated in the West Indies over 50 years ago. While it was extremely successful there, it has remained largely unrecognized elsewhere as a soil and moisture conservation measure, possibly for the same reasons as the author never promoted it: - 'the island was too small, the soils too specific and the climate too special for anything that did well under those conditions to be recommended for wider acceptance.'

Over the years, the author searched for Vetiver grass in Africa, Southeast Asia and South America, finding it growing at some research stations as an essential oil plant (its roots produce oil of vetiver, a perfume base) but never in sufficient quantity or showing a sufficient range of adaptability to promote the grass for trial. However, in 1985 he was stationed in India where Vetiver grass is native. A challenge was therefore to determine if it could be grown successfully in semi-arid areas of India - if so, it could be grown almost anywhere.

A search was immediately started for Vetiver grass. It was not difficult to find. Indeed, it exhibited a wide range of adaptability, from over 2,000m in the Himalayas where it is covered with snow during winter to the blistering deserts of Rajasthan, the swamps outside Delhi and the wastelands of Andra Pradesh. Convinced that this was the grass with the greatest potential for soil and moisture conservation, the author returned to Fiji



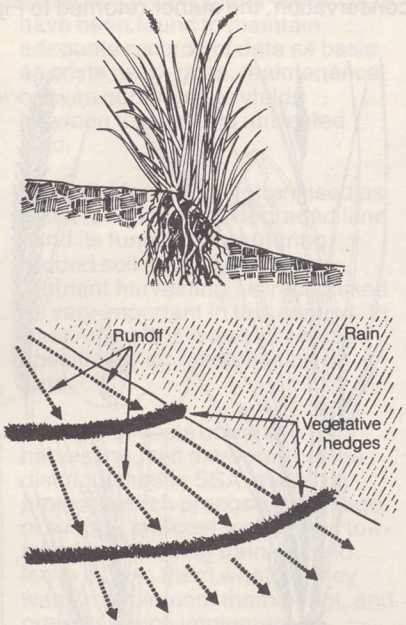
Vetiver grass.

to examine its performance there and talk with farmers who had by now over 30 years experience with Vetiver grass. Before recommending it for extensive trial in India, it had to be confirmed that Vetiver grass did not become a weed in farmers' fields; that it lasted as a hedge, so filtering soil from run-off; that it did not compete with farmers' food crops; and that it was not an intermediate host for pests or diseases of economic crops. Findings were favorable on each of these concerns. It was clear that Vetiver grass is the right, indeed the only, plant for the long-term control of soil erosion and to promote in-situ moisture conservation.

Moisture Conservation

Since in India farmers have generally had bad experience with engineered soil conservation measures and are often reluctant to hear about 'soil conservation', the system is described to them as 'moisture conservation'. Farmers' attention was obtained initially by the fact that at no extra cost, they could increase their yield by 50% if only they plowed and planted on the contour. In the first year, results were excellent (see Table 1). In the second year, farmers in Karnataka who practiced only contour planting produced excellent crops of groundnuts and pigeon pea, while their neighbors using the traditional system of planting with the slope (less than 2% in this case) produced nothing at all; even a 'catch-crop' of late-planted chick pea failed. In fact, the experience suggested that the area classified as a severe drought zone was really a man-made problem of 'not understanding moisture conservation', and taking advantage of it.

Moisture conservation in-situ is not itself sufficient, however. Fields must be stabilised with vegetative (Vetiver grass) barriers to protect them from high intensity storms. In arid areas Vetiver hedges take three seasons to establish, but once established, they are permanent. (In the wet tropics the hedges establish in five months).



The vegetative method of soil and moisture conservation uses nature to protect itself. In this case, Vetiver grass is being used. Only a 50 cm strip is taken out of production.

An established Vetiver hedge (and no suitable alternative plant has been identified) will completely stop sheet erosion (this is erosion of the superficial layer of the soil). Rather than concentrating run-off water into streams and so becoming more erosive, vegetative hedges slow run-off, spread it out, and filter out the silt while letting the water ooze through the entire length of the hedge, but not allowing it to concentrate anywhere. Silt trapped behind the grass barrier spreads back across the field. Vetiver grass grows through the silt in its immediate surroundings, so over the years forming a natural terrace. In Fiji on 50% slopes, terraces three to four metres high have formed behind the grass hedges; this is soil that would have been lost to the farmer, and the country, forever.

The Vetiver grass-based, 'moisture conservation in-situ' (MCI-S/Vetiver) system can be used worldwide. As a result of the work in India, the system has already been introduced to Nigeria, Somalia, Sri Lanka and Indonesia, the Philippines, Thailand, Burma, Nepal and now China. The U.S. Department of Agriculture sent a representative to New Delhi to collect cultivars of the plant for introduction and trial in the U.S., but now Vetiver has been found growing in Louisiana and Florida. The system is a applicable for rainfed tree-crops as it is for other crops.

The work underway in India represents a major break-through in food production for small farmers worldwide, giving them a better chance for survival in the 21st century. The vegetative system is cheap, replicable and sustainable. It is 'the farmer's system', he can do all the planting and maintenance without any assistance. It costs at the very most one-tenth the cost of engineered systems. Moreover, it extends the range of cultivation. With engineered soil conservation systems, arbitrary limits on cultivation are set for the production of food crops; 12% was the maximum 'safe' slope with up to 65% slope for forests only. With this system of contour plowing (or hand-cultivating) and planting between the stabilising hedges, food crops and sugarcane have been produced safely on 100% (45 degrees) slopes. Vast areas of land, hitherto classified as unstable, can now be safely used for production so long as the vegetative hedges are established and maintained. The time has come to widely promote this vegetative soil and moisture conservation system.

Recent Information

Since originally writing this article, six months ago, the author has travelled extensively round the world gathering information on Vetiver grass; where it grows, and what problems it may have had, and how successful it has been at preventing sheet erosion. The following points are highlights of the most recent findings:

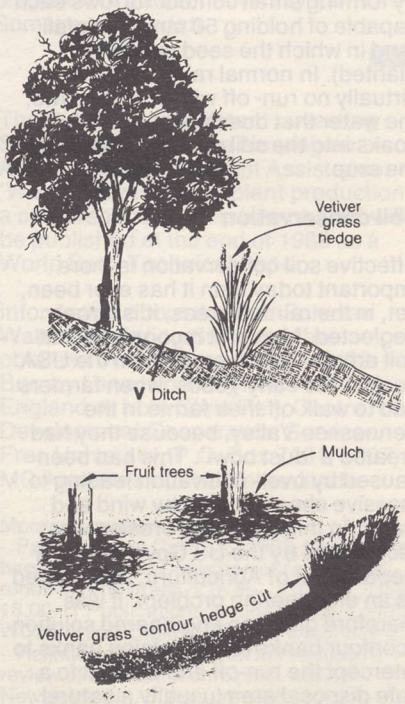
a) Vetiver hedges have been maintained and used extensively for the prevention of boundary soil erosion by farmers in the Gundalpet area of the State of Karnataka, India, for over 100 years! They never let the plants form seed heads, but keep the hedges cut short (30-50 cm) so that they can also feed the fresh regrowth to their cattle. It has never been a problem to them, and has prevented soil erosion. They can control the hedges' width at about 50 cms, on these 'flat areas' and it is permanent. This has been the most interesting finding so far, and confirms all our hopes for this system, and its longevity.

b) On the Island of St. Vincent, in the West Indies, Vetiver grass has been stopping erosion on all slopes up to and over 100% for over 50 years, and in some areas, has built up natural terraces to an average height of four meters.

c) It was observed in Trinidad, stabilising road embankments totally preventing any erosion on the 100% slopes of 'scree', shale, and red yellow podsolic soil, and this in 2,000 mm rainfall areas.

d) It has been found growing successfully on the side of the ring road, round Kathmandu, meaning that it can withstand the rigors of climate in that area, and that it can be successfully grown from there right down to the equator.
It has also been recorded growing throughout the Terai of Nepal.

e) We are now taking MCI-S into the Himalayas, but there we are using



The collection of runoff has the effect of doubling or tripling the amount of annual rainfall.

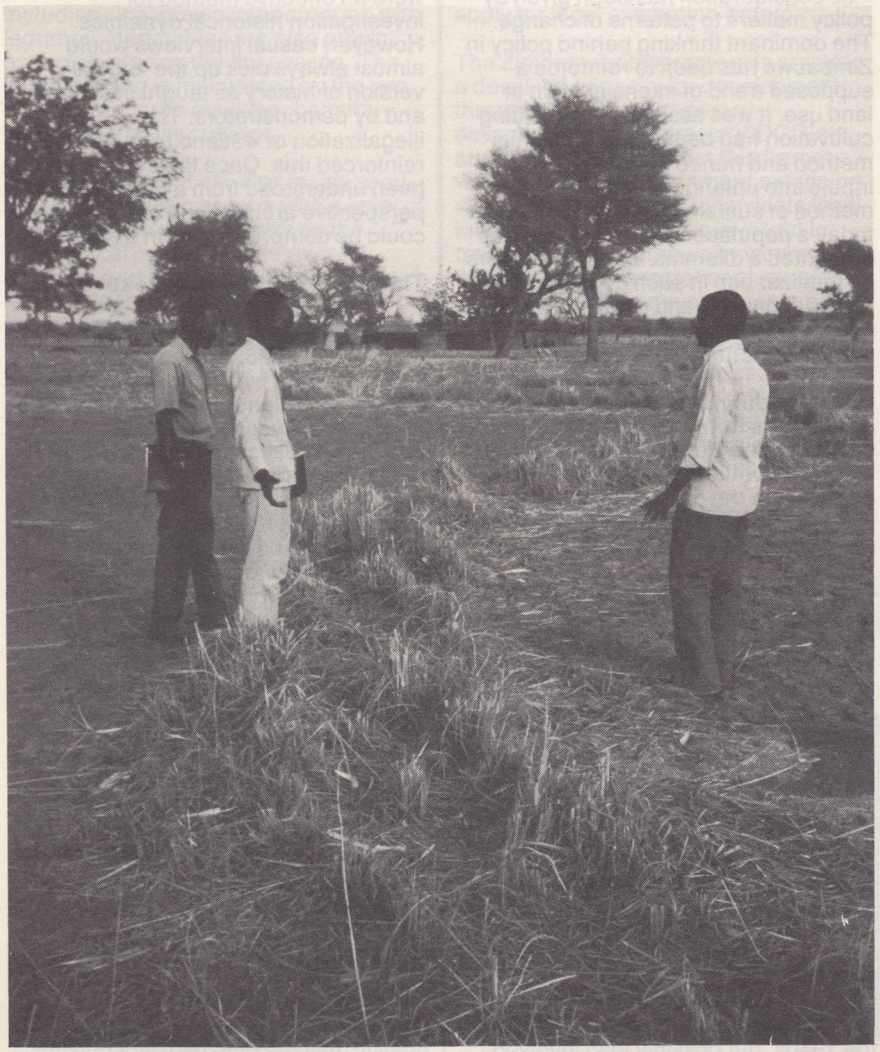
Treatment	Yield (kg/ha) of Sorghum Lowest	Highest	Average
1. Project recommended contour cultivation for in-situ moisture conservation	1151	5320	2187
2. Sown in soil conservation earth banked area (bunded) across the slope	960	2512	1500
3. Bunded areas sown with the slope	836	1828	1345
4. Sowing in unbunded areas across the slope	980	1910	1283
5. Sowing in unbunded areas, traditional practices, no attempt at moisture con-servation (control field)	285	725	510

Table 1. Crop cutting trials in 1986.

Practices 2 and 3 cost the farmer an average of Rs. 4,000/ha to establish. Practices 1, 4 and 5 are of equal cost to the farmer. Practice 1 just requires a change of management to plough on the contour.

indigenous shrubs that have their crowns (offsets) beneath the surface (so that the shrubs will not die by browsing animals) and transplanting them as hedges throughout the watershed areas. These shrubs act as Vetiver grass does, and supply essential fuelwood in a three-year cycle. We have so far identified more than 100 different indigenous plants for this purpose.

f) It has satisfactorily established on the almost 'bauxite' borrow pit of a large dam in the Kandi Hills, Sri Lanka, where it was planted using 'crowbars' to make the planting holes.



In West Africa, among others Burkina Faso, Andropogon grass is sometimes used as contour hedge, (Photo: Bertus Haverkort)

g) It has stopped 'rill erosion' on the sides of a dam at ICRISAT in Hyderabad, where it was planted (as a hedge) into granitic gravel on the 45 degrees side-batter of the dam, less than 12 months previously - and this during a drought (it received no water from the dam, which was dry!).

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Answers to questions raised in the field after the first edition of the field handbook on khus usage.

Q: *Where can the grass be found as a source of planting material?*
A: Between the latitudes 22 degrees North and South, it can be found in most areas where there is a permanent waterbody; be it stream, lake or swamp, it survives as a climax plant.
Q: *Does Vetiver grass survive drought?*
A: The plant is extremely drought tolerant; 'slips' for planting have withstood 60 days without rain. In arid areas it is essential that hedges are formed on the contour to ensure their survival by intercepting all runoff.
Q: *Does Vetiver seed?*
A: Vetiveria ziznioides does not produce viable seeds (seeds that germinate); V. nigritana (the Nigerian species) does seed, but it is reported that the spread of seedlings is easily controlled.
Q: *Do the roots spread into the farmer's field and compete with his crops?*
A: Vetiver grass sends its roots straight down. Farmers with over 30 years' experience of the plant in their fields say that they have never had any problems of competition with their field crops.
Q: *Is irrigation (watering) required to establish Vetiver hedges?*
A: Irrigation is not required if the slips are planted at the beginning of the normal rainfall. After planting, the slips will withstand two months without further rain if planted in wet soil.
Q: *Is Vetiveria an alternate host for crop pests and diseases like 'Striga'? (Striga hermonthica is a plant parasite living on plant roots).*
A: Not one instance of Vetiver being an alternate host for any pests or diseases has been revealed. This is supported by farmers with over 30 years' experience of the plant as a soil conservation measure.

Farmer-based Research and Extension

Phiri Maseko, Ian Scoones and Ken Wilson

Although Zvishavane in Zimbabwe is a semi-arid area, receiving annually around 500 mm of rainfall, conventional development has largely ignored small patches of natural wetland. However, local farmers have identified these resources as critically important. A process of farmer-based research developed within the Zvishavane Water Resources Project (ZWRP), an indigenous NGO, has generated strategies for improving the productivity and sustainability of these wetlands. Community workers work with local farmer groups and village committees to research, plan and implement projects. This article describes how the project evolved and discusses the perspectives.

How it all started

For their theses Ian Scoones and Ken Wilson, British PhD students, conducted research into the ecology of the production systems of Zvishavane. Long term rural residence gave the opportunity for informal discussion and observation. There was no external requirement for the research to come up with any particular development proposal. This open-endedness allowed research to be directed along lines identified by farmers.

Individual interviews with farmers in their fields and at their homes provided the best framework for enabling an understanding of the basic issues. We needed to understand farmer terminology and local environmental classifications before we could properly enter into dialogue. Farmers pointed out that there were different kinds of environments in the region with different ecologies. This was an essential component for recognizing the different kinds of development initiatives that could work in different places. Similarly it was necessary to tap indigenous knowledge about the problems of farming before subtle statements about relative costs and benefits could be understood in a development context. The long period of rural residence and practical experience of working alongside farmers was necessary to limit the imposition of 'outsider' perceptions.

With this framework we were able to initiate a series of group meetings. Farmers who attended were those who themselves wanted to develop wetland areas. The main aim of these meetings was to provide a space for the articulation of local knowledge, and to translate it into practical measures. At these meetings a series of issues critical to wetland development were discussed, such as soils, hydrology, cropping systems, competition and integration with grazing.

A group of local people became involved in these regular research meetings. Mr. Phiri Maseko (now project coordinator of the Zvishavane Water Resources Project (ZWRP)) was one of them. He had been experimenting for many years with micro-irrigation development on wetlands and had developed considerable skill in well and small dam construction.

Historical dynamics of land use and colonial law.

Although it is now well recognised that African farming systems are dynamic, little consideration has been given by policy makers to patterns of change. The dominant thinking behind policy in Zimbabwe has been to reinforce a supposed trend of intensification of land use. It was assumed that shifting cultivation had been the pre-colonial method and hence putting fertility inputs into uplands was the only method of sustaining production under today's population pressure. This has presented a dilemma for policy makers as fertilizer use in such dry areas is barely economic and cattle populations cannot be kept high enough to provide sufficient manure.

However, during the research discussions farmers presented a wider scenario. They knew that an intensive system of wetland farming was dominant in the pre-colonial era. This system had largely been abandoned in the colonial period due to a variety of factors.
One factor was the opportunity provided by the arrival of ox-drawn ploughs. This made the returns on the labour of opening large topland fields much more attractive than they had been when digging by hand was involved. Farmers thus shifted more of their attention to such places, farming more extensively.

Administrative banning of wetland was linked to environmental concerns (especially in regard to settler drainage techniques). Yet in practice the implementation of banning also reflected the need to limit African production to ensure white farmers economic survival. This has been shown conclusively for winter wheat in the 1940s, but possibly also involved other crops such as maize, rice and vegetables on a more local basis.

With today's increasing land-use pressure farmers recognise that intensification is necessary, but is only really viable on such wetlands. This is because only with sufficient water returns on inputs can be realised. Furthermore, in this dry region where the sandy uplands cannot be continuously farmed without great fertility interventions, these wet bottomlands maintain productivity due to higher clay contents and (perhaps) nutrient in-flows.

An understanding of historical dynamics thus led to a different conceptualization of the problem and hence identification of different development opportunities. Had we relied on secondary source material we would not have understood this historical process. We found that unstructured key informant interviews were an effective method for investigation historical dynamics. However, casual interviews would almost always pick up the 'official' version of history as taught in schools and by demonstrators. The illegalization of wetland farming had reinforced this. Once the system had been understood from a local perspective archival and other material could be comprehended in a new light.

The Farm of Mr Phiri Maseko

Mr Phiri Maseko joined the research team in mid 1986. He had been experimenting with the development of a patch of wetland within his 4 hectare plot for many years. Due to his nationalist politics during the Smith regime he was denied work. He was determined to develop his plot of land so as to support his family. He made a number of discoveries about how to manage this land by controlling the hydrology. This involved him in a long battle with conservation officers, and he went to jail three times. However, eventually they had to concede that he had achieved a system that effectively conserved the land as well as greatly raising its productivity.

The main advantages with farming the wetlands in this area are that they stabilise production through maintaining more constant water availability. This enables successful farming during dry years, and in the dry season. Also they are usually clay-rich and the soils tend to have higher organic matter than the sandy toplands. However, there are also problems. When rains actually fall heavily they become very wet making land preparation difficult. Water logging can damage crops and soil fertility, and

occasionally surface flows result in soil erosion. A 30m x 15m pond was dug on the upper margin of the wetland, where water naturally seeps out of the ground on encountering layers of clay. This pond captures water from heavy rains, preventing it being lost from the system, and storing it for future use. Concurrently the damaging effects of surplus water in the fields are prevented. Together with a series of wells, water is then circulated within the wetland to achieve supplementary irrigation, both during dry spells in the rainy season, and also during the dry season. A third component of managing hydrology was the careful identification of areas where water would flow during exceptional thunderstorms, and turning them over to Kikuyu grass.

With this water supply, Mr Phiri Maseko then developed an intensive integrated system. Banana groves were established below the dam in areas often too wet for cultivation. Within these bees are kept. Fish are farmed in the pond, and reeds suitable for basket-making are grown for sale. Several hundred fruit trees, especially citrus and mango, are planted within and around the fields where they make use of the water supply, and provide a valuable cash income as well as a food crop. A very diverse cropping system is possible, with all the major cereals, including rice, grown inter-cropped with legumes. Vegetables are also grown, especially during the dry season. The cattle holding is maintained by the use of abundant crop residues, banana leaves and grass cuttings.

The management of water in this semi-arid area thus allows for a whole level of intensification which improves the economical position of the dryland holdings and minimizes risks. Other farmers in this area are forced to rely on large harvests in the few good rainfall years, eking out on storage and remittances from towns in the intervening years.

Participatory research and extension

The farmer groups are invited to visit and investigate Mr Phiri Maseko's farm. Their excitement with what they see is rooted in their own awareness of the historical significance of wetland use. Many of the farmers have themselves wanted to make similar kinds of innovations but have felt constrained by the law.
The direction in group meeting methodology is towards developing with the farmers an understanding of the hydrology and soils of particular wetlands within that area. A model is thus developed for discussing potential land-use innovations. This provides base-line agreement of the issues and options for specific extension at local sites. Working in groups enables the cross-checking of information and ideas. Farmers often dispute issues with each other, and this deepens their understanding of the complexity of the system. Farmer knowledge, like science, includes disagreement, debate and uncertainty.

Farmers enjoy these meetings as they learn from each other, and gain in confidence in their own abilities.

The research meetings played several interacting roles. They directed us to new development options provided the local knowledge, stimulated farmers to implement own projects and promoted the diffusion of the ideas. The development options were matched to local situations. A uniform package for water development will not work, especially in a variable and patchy environment. But most importantly the process of involving farmers and establishing a local research and extension capacity led to the empowerment of the local communities. Farmer-based research should not be used simply for more effective extraction of knowledge which then forms the basis for typical 'top-down' development. Research should be seen as an opportunity for devolving power and establishing local capability for development.

Institutionalizing the Farmer Research and Extension Link

Out of the open-ended informal research meetings the need evolved to start a project (ZWRP) to support this process of technology development and adaptive implementation by farmers for which it was necessary to apply for legal exemption orders.

The Zimbabwe Government is creating a devolved capacity for development through the village and ward development committees (VIDCO's and WARDCO's). Within this frame work the role of Government extension workers and NGO's is to facilitate local initiatives. The project is involved in training VIDCO community workers in technical and organizational aspects of village level water development and the establishment of farmer groups for exploring the possibilities of wetland development. The challenge remains to improve the project's capacity to enhance the ability of people at village level to research and critically analyze the local situation, then plan and effectively implement their own projects, these include the construction of wells, small dams, micro-irrigation systems, water harvesting and erosion control measures. The participatory research techniques developed will be the focus for this continuing training and empowerment process.

Lessons learnt

This description of the early phases of the Zvishavane Water Project is not supposed to be a blueprint; all situations require different responses. However, we feel a number of lessons have been learnt.

Firstly there is the need for money to be made available for 'bottom-up' research with farmers, without the constraints of a particular project objective. This is rarely acknowledged by donor agencies.

Secondly, it is often the case that local farmers have already identified 'development windows'. These may be hidden from conventional project identification surveys. A little support for an existing trend or innovation may have a greater and more positive impact than the establishment of a full project 'package' from scratch.

Thirdly, involving local people in the research process provides a basis for creating local capacity for organising and managing a projec if it arises.

Finally by establishing an authentic, critical research process for identification of development opportunities this will enhance the ability of the local community to reflect on and act on their development needs. Having a local research capacity also ensures that the project responds adaptively to local requirements.

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Mr. Phiri's family fishing in his full pond at the end of the rainy season. (Photo: Ken Wilson)

Tree Planting for Soil Conservation

Douglas Steinberg

The need for a holistic and flexible approach

Niger, a landlocked Sahelian country, has undergone severe environmental degradation during the last twenty years. Demographic pressures, without substantial changes in traditional agricultural practices, have resulted in widespread erosion of the soil's fertility. The growth of extensive rainfed farming in order to feed the growing population has brought marginal land, traditionally used for pastures, into cultivation. Fallow time has been reduced, or sometimes eliminated. The reduction of vegetal cover has left the land exposed to wind and water erosion, as fields have been cleared of trees, shrubs and grasses for cultivation, wood for fuel and construction and fodder.

Despite the increasing area brought under cultivation, crop yields diminish as the soils become impoverished. Barren fields, left open to the winds, suffer greater evaporation, and young crops often die before they can establish themselves. Violent monsoon winds can destroy maturing crops in just hours.

In response to farmers' request for assistance in protecting their land from wind erosion, CARE worked with the Nigerian Forestry Service to plant windbreaks in the Maggia Valley beginning in 1975.
In the 1,500 km² Maggia Valley, the windbreaks are planted 100 meters apart, across the width of the valley, about two kilometers long. Recent windbreak plantations combined Neem, *Azadirachta indica*, with *Acacia nilotica*. The Maggia Valley windbreaks thus became two tiered and more aerodynamic (the lower growing Acacia on the windward side of a belt and the taller Neem on the lee side) than plantations in the first years, when only Neem trees were used. With continued support from the Valley communities, over 400 km of windbreaks have been planted.

Evaluation of windbreaks

In 1984-5 CARE conducted evaluations of the windbreak plantations in the Maggia. Using a questionnaire, the team of enumerators interviewed 420 Valley residents from 17 villages. The study on agricultural production found that fields within mature windbreaks were producing yields that were roughly equal to the fields outside the windbreaks, but on less land. Due to the effects of shading, 17% of the area was removed from cultivation in the windbreak zone. Per unit of cultivated land, the farms inside the windbreaks yield about 15% more.

Significantly, overall biomass inside the windbreak zone has also greatly increased, by 68%, and this is important since farm residue is used as fodder, fuel and for thatching. In effect, the land protected with windbreaks produced the same yields, and valuable fodder and wood products as well.

The respondents to the survey overwhelmingly remarked an increase in crop yields in fields protected by windbreaks, and only 4% claimed a decrease. The survey respondents proved to be very sensitive to the environmental conditions, citing serious and growing problems with wood collection for fuel. They indicated that wind erosion was their most serious problem, though water erosion was a close second.

Farmers' problems resolved?

Have the farmers' problems been resolved? Yes, and no. Wind erosion of the fields on the Valley floor has been greatly reduced with the plantation of windbreaks. Crop yields are improved for fields within the windbreak zone. Biomass production is increased with possible benefits toward increasing the amount of organic matter in the soils. And useful fodder and wood products are being produced.

The windbreaks have improved the farmland in the Valley, but this land is limited. Many farmers have other parcels outside the valley, on the plain above, where they try to add a little more for their families to eat, on land that is compact and crusted with laterite.
In search for more land, and for wood, the farmers have created the circumstances that threaten the rich land in the Valley with water erosion. In recent years the streambed of the Maggia has been subjected to erosion of the embankment, eating into some farmer's fields. In some places, the stream banks have been densely planted with *Prosopis juliflora* in order to hold the embankment firm. The plantations seem to be effective after only a short amount of time. But they are a medicine for a symptom; the underlying cause remains unresolved.

The windbreaks of the Maggia Valley show that wind erosion can be addressed in a specific locality through treeplanting. Satisfactory results can be achieved in a relatively short time, and the techniques are not complicated nor inappropriate to the farming communities. But tree planting does not address the whole problem.
Although the approach has been very focused in its scope, with the advantage of tackling a problem on a small enough scale to permit its completion, it does little to stem the growing problems of the entire watershed. It is telling that the farmers cited water erosion as a close second to wind erosion as one of their problems.
Admittedly the holistic, integrated and flexible approach can often appear to be a mammoth effort, but the greater view of the area can help stem further degradation in easy steps.

Broadening the approach

The holistic approach implies that an area beyond the point of severe degradation be addressed by making an analysis and plan for the rational, sustainable use of the entire area. It means looking at how an area satisfies the various needs of the population living there (or passing through, as in the case of herding people), pin-pointing stress areas that are under considerable threat or susceptible to it, and finally drawing up a plan for the use of the land. Use patterns in the area can take on different objectives. Some areas, such as brushland, may be used on a rotational basis for wood cutting, pasturing and regeneration. Some farm areas may be slated for intensive cultivation, with animal or chemical inputs, depending on local means. Still other areas will be needing some form of restoration in order to control degradation and assure long-term use under new demographic conditions.
The planning process must include the participation of the target populations. Analysis of current land uses cannot occur without contact with the people, including those who are absent for a great part of the year. And a plan cannot be implemented unless it is understood and accepted by the people.

Other conservation activities

Some of the conservation and restoration activities, in addition to tree planting, that may be appropriate include the construction of contour berms and micro-catchments and the protection of natural regeneration.

The restoration of the soil in the upper reaches of a watershed is equal in effect to conserving water, as fast flowing water is the culprit, the offender in the soil erosion. On gentle slopes, water can be slowed and infiltration

encouraged with contour berms, shallow rock or earth walls that follow the contour of the slope. The steeper slopes require a measure more resistent to the force of the water. Here, micro- catchments, V or crescent shaped trenches that catch water and hold until it infiltrates, are necessary. Trees planted behind the contour berms or in the micro-catchments benefit from the retained water and show good survival -- but the sites are usually entirely unappropriated for exotic species such as Neem and eucalyptus. Only hearty species such as the native *Acacias* and *Combretum* or *Prosopis juliflora* can survive under these conditions.

Work like this often involves heavy labour -- carrying rocks, swinging a pick -- as well as marking the contour with a simple water level. It is not work which people take to freely, especially since it often occurs on no one's own land. To encourage farmers in the work of this kind that CARE-Niger has accomplished, food rations are distributed. But a further encouragement is that the effects are immediate. Unlike the windbreaks which take five or more years before their effect can be felt, the remedies to water erosion are effective, assuming they are well done, with the first rains. And with improved water retention and the soil particles that are deposited as runoff is slowed, some crops can be grown on fields that have long been barren.

Massive efforts

Contour berms and micro-catchments are massive efforts which require a large measure of project assistance. They are activities that are limited to perhaps the most valuable watershed, the one which feeds into the reservoir for the irrigated fields at Galmi. The reservoir which serves the irrigated fields -- a major source of export income for the region -- is threatened by siltation from the totally denuded watershed slopes. The watershed has the added advantage of being relatively small, and so feasible. Similar remedies are being planned for the upper Maggia Valley, in recognition of the need to address the Valley's problems from a more global point of view.

But these kinds of interventions are not a panacea for Niger's soil conservation. They are massive efforts and Niger's population is too thinly spread to muster the forces needed for large-scale soil conservation works. Furthermore, micro-catchment and other physical devises are not appropriate to sandy soils where water infiltrates but drains rapidly without the organic matter to help retain it. In sandy soils catchment trenches usually just fill in soon with wind-blown sand.

The strategy that must be promoted must be extensive, and passive in its nature. This strategy, which has hardly taken hold in Niger, focusses on the protection of the natural regrowth of native species. Trees scattered in fields can afford many of the same benefits as windbreaks. They reduce the effects of the wind, reduce the force of falling rain, provide fodder and wood products, and in the case of *Acacia albida*, they have a very positive effect on crop production.

Protection of naturally regenerating field trees need not require costly inputs, and this will allow large-scale application. It may not even be necessary to take measures to protect the regrowth from browsing animals as native species are thorny and fairly resistent. Rather, it is from the hoe of the farmers that the trees need to be protected, and a little colored flagging to help remind the farmers. The activity becomes somewhat passive as the farmers are encouraged to merely leave trees that are already growing in their fields. No protection devices need to be invented; no costly nurseries or plantations.

Shading

One problem, however, with leaving trees in fields is shading. The farmer is not malign. He has not cleared trees from his fields without purpose. Trees and crops are often incompatible, and in the choice between agricultural needs and trees, the trees lose. Introducing large numbers of shadegiving trees into farmers' fields will not respond to the farmers' needs. The *Acacia albida*, however, proves to be very compatible with agriculture, as it loses its leaves during the rainy season -- the only Sahelian tree to do so -- while other trees can shade out crops.

In areas which suffer a scarcity of natural regeneration of *Acacia albida*, farmers can be encouraged to protect other species existing on or close to the boundaries of their fields. This leaves the interior of the fields open for crops. The field boundary trees can provide protection from wind erosion, and they serve to delineate fields and stave off land disputes. Also, field boundaries can be planted or seeded with *Acacia albida* or other valuable native species or even perennial grasses such as *Andropogon guyanus*.

Conclusions

Field border plantations may be easily adapted by farmers since many already protect grasses or *Euphorbias* along field boundaries. But many farmers will need much convincing before they abandon their preference for bare fields or for fastgrowing, non-thorny exotic species, such as Neem. Village extension in forestry is undeveloped and a long way from reaching the number of farmers needed to make an appreciable impact on the environment. And in the final analysis not one strategy can do it all. Several approaches must be combined and planning must include farmers and respond to his needs. Forestry activities aimed at conserving soils must be adapted to many factors: the types of soil, the use of the land, the economic needs and social pressures must all be considered before any choice of action can be taken. The holistic approach seeks to consider the problem of soil erosion beyond the site of erosion, looking at the surrounding areas where the causes of erosion often originate. The planning and extension must include everyone, especially groups of people who don't often get a change to give input, such as women or herders who are absent much of the year. The plans must consider the potential of the entire area, and attempt to use the different parts rationally.

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The multi-purpose use of the Tuna plant

Tonnie Tekelenburg

Agricultural Development in the Bolivian Highlands

The valleys of Cochabamba face a drought period of eight months. Outside the irrigated central valley, the lands are poor and eroded, because of which the yield of food production is very low. Traditionally, grain is cultivated in this area. In addition to this, the national policy causes grain prices to remain lower than the cost of production, because of subsidized import and food aid. Six farmer communities were looking for an alternative and they attached new values to an old cactus.

Don Berno lives in Machaca Marca, a 'quechua comunidad' (farmers village) in the department of Cochabamba Bolivia, and he is a farmer who speaks with emotion about the future of his children.
There won't be enough agricultural land and he is very well aware of the fact that the yield will decrease each year, because of erosion of the soil. The production of wheat and maize in a rainfed agricultural system yields hardly any income any more. His livestock is strongly weakened in the dry season, and expansion is undesirable, because the grazing pressure is very high already and causes overgrazing.
In past times, outsiders have tried to increase the production of potatoes and grain, without results however. Nor has renewed afforestation with Eucalyptus been a success, because a great percentage of trees dried out. A Bolivian answer to this Bolivian problem had to be found.

The project I'm working reintroduces the prickleless cactus (Tuna) to the farmers, because the Tuna is expected to improve the current situation for the mixed farming system. There will be improvement from an ecological as well as an economic point of view. This multi- functional plant is being planted at a quickened pace and is flourishing well on chalky, rocky grounds.

The Cochabamba Area

In general, the area can be described as subtropical highland, between 2200 and 2800 metres above sea level, covered with thorn-bushes. The rainfall averages between 500 and 600 mms per year within a rain period of four months, December till March.
The differences between the temperatures of day and night are very big because of strong radiation during the night. During the hottest month, the maximum day temperature is recorded round about 30 degrees Celsius and during the winter season the night temperature falls down close to the freezing point. The ground is mainly chalky with a pH-value between 7 and 7.8 and is characterized by a thin top layer on a rocky subsoil. Different forms of erosion can be found in this area.

Production characteristics of the Tuna plant

The Tuna cactus *(Opuntia Ficus indica Mill.)* has a very wide area of distribution. In ancient Mexican civilizations the Tuna plant played an important part in culture and religion. During the middle ages the Tuna was planted along great parts of the African coast to harvest its fruit (desert figs) during long journeys to India, as a remedy against scurvy. In Australia, the Tuna plant became a real plague and later on it was biologically controlled. Furthermore, the Tuna plant is found in the Andes, from the desert coast of Peru to the inland of Bolivia.

Two kinds of root are to be distinguished. First of all the thick and spongy roots, which are able to bind water for a long time and support the plant.
Secondly, the plant has small roots that only function for one rainy period. For the most part, these roots die with each dry period and thus they cause a rapid formation of organic material in the ground, which explains the ground protecting characteristics of the Tuna plant. In a four year old Tuna cultivation an organic matter content was measured, which was twice as high as the content of a newly cultivated piece of land. The two year old leaf disks can be used for new cultivation. Ground with a high pH-value and sloping land cause prosperous growth. The Tuna plant grows rapidly, we measured 1.6 disks per plant per half year.

This is a high growth rate and it leads to the fact that already after a period of three years, the fruit can be harvested. The fruit consists of a thick rind with a lot of prickly hair. Depending on the variety, the pulp differs in colour and sourness, it is full of seed and very tasty.

The multiple use of the Tuna plant

The plant not only generates income, but is also fit for food consumption and on top of that it shows favourable side aspects:
- Tuna is not a plant or cultivation to be introduced anew, but one to revalue.
- Tuna does not compete with traditional food cultivation on scarce agricultural land, because it grows exactly on those spots where food crops can't be cultivated.

Tuna plants. The white spots on the leaves are colonies of Cochinilla (Photo: Tonnie Tekelenburg)

Tuna product	single expl.	multiple expl.
fruit	15-20 tons	5 tons
cattle fodder	40-100 tons	20 tons
Cochinilla	150-200 kilos	100 kilos

Table 1: Production Forecast of 1 ha. Tuna (in single and multiple exploitation)

Food consumption. As a dish-fruit, the desert fig is highly valued and it is known to have a slightly growing market with high prices. Per hectare, 15-20 tons of fruit can be produced, in dry years too. A bigger rural production in the future will create a possibility of semi-industrial processing or processing at home.

In Peru, where fruit prices are much lower, the Tuna is processed into liquor, marmalades and dried fruit pulp (Turkish Delight). Furthermore, in the project area, honey is harvested on small scale, as a side product.

Cattle fodder. Another possibility in making use of the Tuna plant is cattle fodder. In dry periods, Tuna leaves are tasty for cattle as well as goats and to a lesser extent also for sheep. A study has shown that cattle and goats kept their weight for three months on a diet of just Tuna. Tuna contains a low amount of proteins, but a high percentage of roughage and several minerals and vitamins. Therefore, Tuna is mainly fit as cattle fodder in dry periods, when there is no other cattle fodder available. In Africa, experience exists with Tuna in processing it to ensilage, however, it hasn't come that far in Bolivia yet.

Cochinilla. Table 1 mentions apart from fruit and cattle fodder also a third possibility, namely Cochinilla. This is an insect *(Dactilopius Coccus costa)* that sucks up the juice of Tuna leaves by means of a long stabbing snout. The Cochinilla is used as raw material for carmine pigment. At the moment Peru controls 75% of the world's production of this insect. The European bio-dynamic movement DEMETER forecasts a large market for this pigment in food and pharmaceutic industries, because chemical food pigments will be more and more replaced by natural organic pigments because of toxicity. The first experiment of introduction of the insect in the project area progresses smoothly, in two years time, the first harvest for sale may be expected.

Erosion control. A fourth possibility for using the Tuna plant exists in reafforestation in order to fight erosion. Thus the long-term use for reafforestation is combined with the short-term use for agricultural production and income generation by fruit, cattle fodder and Cochinilla. Erosion is fought against with the help of Tuna cultivation in three different ways. First of all, by means of introduction as cattle fodder, the overgrazing of natural overgrowth is reduced. Secondly, Tuna itself causes the formation of organic material necessary for soil protection. Finally, infiltration ditches are dug (30 cm x 30 cm x 5 m) to fight a quick outflow of rainwater, the Tuna plants benefit from the water thus caught.

Finally, there are some additional advantages of the Tuna plant, which are however not generally exploited in Bolivia for the moment:

1. By allowing cattle to graze in the Tuna cultivation, some grasses that are fit for the production of brooms get a chance to grow.
2. Parts of the plant are used in herbal medicine.
3. The young leaves of the Tuna are prepared as vegetables in Mexico.
4. The Tuna plant is also used in clearing troubled water. Small clay pieces and other organic material sink down.
5. The Tuna juice can be used as an adhesive means in agricultural spraying and in the processing of clay stones.

Introduction of the Tuna plant

The introduction of the Tuna plant in the project area raised many questions, on agricultural and technical aspects as well as socio- cultural aspects. During the first year cultivation was begun collectively as well as on private property (by means of a middle-term loan). The collective cultivation turned out a failure, because too little attention had been paid to the cattle. Nevertheless, both alternatives will be continued, because the population now recognizes the necessity of protective measures. Furthermore, it had to be investigated whether alternatives were available for reducing the weight of the planting material, because transportation causes problems for remote villages. On an experimental piece of land, Tuna plants, which were cut to pieces, were planted on a special seedbed. In the first experiment, a multiplication factor of 2.25 was recorded. However, this is still too low, further investigations will have to be conducted.

Migration regularly occurs from the project area to the coca production areas of the tropical lowlands. Although Tuna doesn't compete with food crops regarding agricultural land, it is also important to know whether Tuna competes with the labour time needed for traditional cultivation or with migration. Investigation revealed that labour in the Tuna plantation i.e. the planting as well as the maintenance, coincides with the periods of average migration. From this the conclusion may be drawn that Tuna labour does not coincide with important sowing and harvesting periods, nor with some important religious festivities, because farmers will be in their village most of the time during these festivities and farming activities. Most of all, the Tuna plant appears to compete with migration, which is considered to be a positive side- effect because of the illegal agricultural practices of the production of cocaine in the tropical lowlands.

The introduction of the Tuna plant does not stand on its own, but it is included in an integrated project with activities in the field of public health service, organisation, information on many aspects of agriculture and cooperative production by women groups. These women groups are also involved in the cultivation of Tuna, because of their traditional responsibility for the livestock.

Conclusions

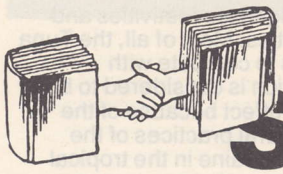
Farmers show a great interest in the Tuna plant, which was familiar, but not all possibilities of which were exploited. The plant has been revalued and for the time being, attention will be focussed on four of its most important possibilities in use: fruit, cattle fodder, Cochinilla and soil protection.
In cultivating Tuna all aspects of the agricultural ecosystem coincide. With the help of the Tuna plant eroded soils are being recovered for agricultural purposes. The cultivation, and the investigation accompanying it, are being continued at great speed by as well as for the benefit of the inhabitants of one of the driest and poorest areas of Bolivia.

Request

Any person who has similar experiences with the Tuna plant and/or Cochinilla, in Africa as well as in Latin America, is kindly requested to respond to this article. Criticism is also welcome.

Send your reactions to:
Tonnie Tekelenburg
Casilla 2521
Cochabamba, Bolivia

References:
- **El Nopal,** Instituto nacional de investigaciones Forestales y CONAZA, Publicacion Especial no. 34, Mexico 1981, 85p.
- Enserink, H.J., 1978. **De ongestekelde cactus, botani, ecologie, teelt en gebruik,** paper in Dutch for the Agricultural University Wageningen, Dept. of Tropical Crop Production, Wageningen, 71p.
- Fopex, 1985. **Manual de cultivo Tuna y Cochinilla,** Fondo de promocion de exportaciones no tradicionales (FOPEX) diciembre 1985, Lima Peru, 49p.
- DEMETER, 1981. **Estudio de mercado sobre los colorantes naturales en los paices europeos.**
- Medina,G.J.T., Acuna M. and de la Cruz C., J.A. (1985). **Opuntia Revegetation: An Agroecological Restoration Alternative for Deteriorated Rangelands in Coahuila, Mexico.** In: Arid Lands, Today and Tommorrow. Proceedings of an International Research and Development Conference, Tucson, Arizona, US, 1985. Westview Press, Boulder, Colorado, USA.



SOURCES

High Density Forestry

A new approach to tree planting is being developed in Gujarat State, north of Bombay, India. In this extremely dry area (40 inches of rain yearly but the past few years barely 4-6 inches has fallen) thousands of farmers (some 9.000 ha) are following the recommendations of Dr. V.J. Patel on High Density Forestry. The philosophy behind HDF is that because of the decreasing rainfall and a rapidly dropping water table it is necessary to plant deep-rooted crops. When trees are planted close to each other, the search for nutrients and sunlight forces roots to penetrate deeper and trunks to grow taller and faster. Dr. Patel provides water through a drip irrigation system and adds fertilizer. Also growth regulators and retardants are used.
Leucaena leucocephala is spaced 60 x 60 cm and *Eucalyptus* 45 x 45 cm. Biomass output is claimed to be 3-5 times of what is obtained with a conventional 2 x 2 m. spacing. Trees are cut in a 3-4 year cycle. *Prosopis juliflora, Acacia tortilis, Tectona grandis* and *Azadirachta indica* are also used.
Dr. Patel's centre has put out several interesting publications, including Wastelands Development Trough Agroforestry, The Role of Prosopis in Wasteland Development, A New Strategy for High Density Agroforestry, and An Integrated Approach Towards Plant Growth Regulators for Planned Yield. For information, write to Dr. Patel, Jivrajbhai Patel Agroforestry Centre, Surendrabag, Gujarat, India. (from NFTA News, No.6, May 1988)

A similar development was reported by Mr.K.R. Datye of the Centre for Applied Systems Analysis in Development in Bombay, involved in the development of HDF/cropping systems based on waterharvesting, protective irrigation and the use of compost and mulch. Additional income possibilities are created by new technologies for processing of agricultural produces (wood, fruits, fibers, etc.). Alternative, cost effective technologies are developed for water storage and conservation. Many different appropriate species (crop, fodder, fruit, wood) are selected. Two modules for a 1 ha resp 2 ha farm are simulated under different rainfall regimes.
Several publications are available a.o.: Role of Non-Agricultural Incomes and Socio-Economic Aspects of Management of Drought; Ecologically Sustainable System of Water Management.
For information, write to K.R. Datye, Centre for Applied Systems Analysis in Development, 44 S - Bhagatsingh Road, Bombay 400 039, India.

The Bharatiya Agro-Industries Foundation (BIAF), Kamdhenu, Senapati Bapat Marg, Pune - 411 016, India, has published several documents on Wasteland Development:
- 'Handbook of Wastelands Development' by N.G. Hegde, 1987;
- 'The Greening of Wastelands, Proceedings of the National Workshop on Utilization of Wastelands for Bio-Energy'. Hedge, N.G. and P.D. Abhyankar, 1985.
- Shaping your land; Planting and Aftercare of Fruit Trees. Fully illustrated training aid booklets.

Integration of Goat Husbandry for the Benefit of Rural Poor.
K. Sharma and N.K. Bhattacharyya, 1988. Wastelands News Vol IV, No.1. Society for Promotion of Wastelands Development, Shriram Bharatiya Kala Kendra, 1, Copernicus Marg, New Delhi - 110 001, India.
Growing evidence provided by scientist all over the world suggests that goats are not responsible more than men for problems of erosion and deforestation. Even in harsh environments the goat ensures a considerable income per head per year and has be found to be 40 - 160 percent more economical than sheep and 130 percent than cattle.
Agroforestry of wastelands combined with improvement of goat husbandry with people participation, particularly women, tribals and children can bring about improvement in soil status and fertility and thereby regeneration of production in fragile ecozones.

Small Ruminant Collaborative Research Support Program has published several reports on a.o. goat production systems:
- **Goat Herders** in Piura, Peru.
Avi Perevolotsky, 1985. Tecn. Rp. Series No.33
- **Goat Production within the Farming System of Smallholders of Northern Bahia**, Brazil.
George Primov, 1984. Techn. Rep. Series No. 35
- **Peasant Production in Northeast Brazil: The Case of Goat Production in Cariris Velhos, Paraiba, Brazil.**
Marisa C. Neumaier, 1986. Techn. Rep. Series No.73

The reports identify the socio-economic role of goats within the structure and operation of existing peasant production systems and try to identify the problems and potentials of increased production and marketing of goats and goat dairy products.
The first study concludes that 'the notion that goats seriously damage the environment seems to derive not from any empirical evidence but rather from a congeries of ingrained socio-economic and cultural prejudices against goats and their keepers, scientific biases and international development 'fad-isms', production-related conflicts, and bureaucratic politics'.

Dep. of Rural Sociology, Univ. of Missouri-Columbia, Sociology Building, Columbia, Missouri 65211, USA.

Unconventional livestock: Classification and potential uses.
K.J. Peters, 1987. ILCA, P.O. Box 5689, Addis Ababa, Ethiopia.
This paper attempts to classify unconventional livestock according to their size, ecological affinity and economic importance. It also discusses their use in systems with limited production resources, their complementarity with conventional livestock, and the potential of multipurpose species for specialised production of products vital for the sustenance of the human population.

Tropical feeds, feed information summaries and nutritive values.
Bo Gohl, 1981. FAO Animal Production and Health Series No.12. Via delle Termi di Caracalla, 00100 Rome, Italy.
A wealth of information on the feed value of grasses and legumes.

Nitrogen fixation by tropical legumes in Sub-Saharan Africa: Potential and limitations.
I. Haque and S. Jutzi, 1984. ILCA, P.O. Box 5689, Addis Abeba, Ethiopia.
This paper surveys the many limits on legume N fixation encountered in Sub-Saharan countries and discusses the various production systems in which legumes make an important contribution.

L'arbre dans les systemes agroforestiers traditionnels dans la province du Bazega, Burkina Faso, influence du Karité, du Nir et de l'Acacia albida sur le sorgho et le mil.
Abdoulaziz Maga, 1987. Institut de la recherche en biologie et ecologie tropicale. Available from SNV, B.P. 625, Ouagadougou, Burkina Faso.
This study identifies the role of the mentioned tree species in the farming system and their influence on crop yields. Messures to reintroduce the trees are investigated.

Trees as Savings and Security for the Rural Poor.
Robert Chambers, 1988. Gatekeeper Series No.SA3, IIED Sustainable Agriculture Programme, 3 Endsleigh Street, London WC1H 0DD, England.
The importance of trees as savings, security and sources of cash for the poor is only now beginning to be recognised. The priority is to reverse official policies and attitudes, to give small farmers full rights to do what they will with their trees, and to ensure fair prices through freedom to market without hindrance. Only when poor are trusted, will they readily plant and protect trees. only if policies and practices are changed so that they are trusted, will they benefit in full from the value of trees.

Proyecto FAO/Holanda/INFOR, Apartado Postal 140016, Lima, Peru. New Publications:
- **Agroforesteria tradicional en los Andes del Peru.** Un inventario de tecnologias y especies para la integracion de la vegetacion lenosa a la agricultura.
Carlos Reynel and Carmen Felipe-Morales, 1987.
- **Proyecto comunal de reforestacion.** Una propuesta metodologica para que la comunidad campesina planifique y evalue su proprio desarrollo. Chris E. van Dam and Arjen Hettema, 1988.

Agroforestry in Agricultural Education, with a focus on the practical implementation (English, Spanish).
Joachim Boehnert, 1988. ISBN 3-8236-1117-8, 182 p. US$ 35,-. Verlag Josef Margraf, Eichendorffstr. 9, D-8074 Gaimersheim, FR Germany.

Logo of 'Seedling', bulletin of ICDA's Seeds Campaign working on conservation of genetic resources.

NEW

Global Perspectives on Agroecology and Sustainable Agriculture IFOAM 1986 Conference Proceedings

Patricia Allen and Debra Van Dusen (Ed.). IFOAM, c/o Okozentrum Imsbach, D-6695 Tholey-Theley, West Germany. Copies: IFOAM 1986 Conference Proceedings, Agroecology Program, Univ. of California, Santa Cruz, CA 95064, USA. Price: US$97,50

The 730 (!) page volume Report Proceedings of the Sixth International Scientific Conference of IFOAM (1986) - two volumes - reflects the growth of interest in sustainable agriculture. For two reasons the conference aimed to cover concepts, experiences, disciplines and international perspectives in such a comprehensive manner:

a. to demonstrate the necessity of interdisciplinary collaboration and of an appreciation of one another's particular interest to those involved in the many fields of sustainable agriculture;
b. to communicate the seriousness and depth of agricultural sustainability as a concept and workable alternative to (relative) outsiders.

In the past decade IFOAM shifted its earlier almost exclusive focus on temperate agriculture to a global one. Furthermore, the conference organizers wished to cover the whole array of ideas, issues and actions in sustainable agriculture. This resulted in a report composed of an overwhelming number of 5-15 pages long articles dealing with just about everything under the sustainable agriculture sun.
On the one hand there are articles that speak of theoretical and fundamental aspects of agroecology, on the other hand there are case studies and specific farming systems analyses.
Whatever the viewpoint of the many authors may be, they all agree on one unescapable conclusion: sustainability is the prime criteria that should guide agricultural development.

The articles are not intended to serve any particular user group and indeed the majority of articles do not seem to be of immediate use to field oriented individuals and organizations. A good number still deals with typically temperate situations, other research reports deal with topics too specialized to be of general interest.

Fortunately, the articles are quite accessible in terms of language and degree of difficulty. For grassroots oriented organizations the main value of this IFOAM Report could wel be its potentials as a reference resource for internal staff development: the wide scope of topics discussed and wealth of insights, opinions and experiences presented offer ample opportunity for study and reflection.

Bert Ruitenbeek, October 1988.

A Case Study on Farmer Innovations and Communications in Niger.
Constance M. McCorkle et al. (1988). Communication for Technology Transfer in Agriculture (CTTA).
University of Missouri-Columbia, College of Agriculture, Dep. of Rural Sociology, Sociology Building, Columbia, Missouri 65211, USA.
CTTA researchers observed and described farmer- to-farmer communication networks in relation to the transfer of farmer innovations. Emphasis was placed upon farmer-to-farmer information flow with related flow opportunities for involving research and extension in farmer networks. Field research was conducted in seven villages with and without cooperatives, expatriate projects, and resident extension agents; located on and off roads; and located near to and far from urban areas. The team found that Nigerian farmers are open to, seek out, and apply new agricultural ideas; plan, implement, and evaluate on-farm research trials; and demonstrate a sophisticated understanding of the complex interactions among the many variables they manage. The case studies also show that there is a rich body of local knowledge in agriculture that could be useful to farmers throughout the Sahel. Rich communication networks exist and are linked by individuals and groups.
Some of the conclusions of the study are:
- very few technologies offered by research and extension are deemed appropriate by farmers, and
- farmers reinvent technologies coming from formal research, but there appear to be poor feedback loops to research and extension that show how farmers are thinking about and changing these technologies.

Based upon its findings, the team recommended that efforts be made to:
- strengthen farmer-to-farmer communication of indigenous agricultural knowledge;
- strengthen farmer feedback loops to research and extension;
- allow farmers to participate in trials of new technologies;
- offer farmers greater opportunities and incentives to more systematically experiment for themselves;
- use interactive radio and television, and other mass media, with priority topics determined by farmers, to disseminate findings and practices;
- mobilize women's and young people's associations to participate in on-farm experiments, and cultivate cooperatives as major conduits of agricultural information.

A study that needs particular attention!

The Greening of Aid: Sustainable Livelihoods in Practice.
Czech Conroy and Miles Litvinoff (Eds.) (1988). Earthscan Publications Limited, 3 Endsleigh Street London WC1H 0DD, England. 320 p., US$ 9.95.
A book based on the papers of the IIED Conference on Sustainable Development, London, 1986. Using examples from Asia, Central and South America, Africa and the Carribeans, the book shows that there are forms of development which allow people to control their own resources while improving their condition and enhancing their environment.

La matrise des crues dans les bas-fonds.
Petits et microbarrages en Afrique de l'Ouest.
Sylvain Berton (1988). Dossier No.12/Le point sur. GRET, 213, rue La Fayette 75010 Paris, France. ISBN 2-86844-027-4, 474 p..
A technical report on how to construct small dams and 'micro' dams in a responsible way.

L'irrigation au Sahel. La crise des périmètres irrigués et la voie Haalpulaar.
Geert Diemer and Ellen van der Laan (1987). ISBN 2-86537-193-X, 226 p.. CTA/dition Karthala, 22- 24 Boulevard Arago, 75013 Paris, France.
A very interesting book that analyses why the small-scale irrigation systems in use with the Haalpulaar in the Senegal river valley do function so well compared with large-scale irrigation schemes.

Women and Environment in the Third World, Alliance for the Future.
Irene Dankelman and Joan Davidson (1988), Earthscan Publications Ltd., 3 Ensleigh Street, London WC1H 0DD, England. ISBN 1-85383-003-8, 256 p., US$ 14,-.

Third World women play the major role in managing natural resources. They are the first hit and the hardest hit by environmental mismanagement, yet they are neither consulted nor taken into account by development strategists. This important new book contains well documented case studies and interviews with leading women conservationists from the Third World, and gives a clear account of women's problems in relation to land, water, forests, energy and human settlements. It also looks at the lack of response from international organisations and at the ways women are organising to meet environmental, social and economical challenges.

Environmentally sound small scale agricultural projects. Guidelines for planning.
Miguel Altieri (au), Helen Vukasin (ed) (1988), CODEL/VITA Publication, Revised edition. 162 p., US$ 14,-. VITA Publications, P.O. Box 12028, Arlington, Virginia 22209, USA.
This very practical manual explains in an easy understandable way, how a small-scale project can be based on ecological principles and participation of the population involved. Special attention is paid to soil management, water management, pest management and agroforestry. The booklet can be used for planning as well as for training. References are given for further reading on special technologies.

NETWORKING

Agricultures Actualité -
Making the Alternative Work Groupe d'Etudes et de Services pour l'Economie des Ressources - GEYSER, attn. Christophe Beau, Vacquieres, 34270 St Mathieu de Treviers, France.

A new step in availability of information on Organic Agriculture for French speaking countries!
GEYSER started already in September 1986 with the publication of the Bulletin aimed to supply interested persons and organizations with information on technical aspects of organic agriculture in both industrialized countries and developing countries. Many articles, books, magazines, reports, these, and now even videos in different languages are checked, reviewed and a photocopy-service is offered. Also some articles are included and iformation on initiatives, conferences, etc..
Autumn 1988, GEYSER expanded its format and the new quarterly issue abstracts some 75 documented experiences or research on organic agriculture, which are available through their photocopy service. A good initiative and even though there are 'only'some 10 items on tropical agriculture it is a worthwhile source of information and possibility for linking in the global organic network.
If you speak/read French:
we recommend to use their facilities!

Survival in the Drylands - Regional NGO Workshop Segou, Mali, September 14 - 17, 1988.

How can the effectiveness and impact of African NGOs in the arid zones be strengthened? This central theme was discussed at the workshop in Segou, Mali, for which NGO leaders and development workers from 16 NGOs from Burkina Faso, Ethiopia, Kenya, Mali, Niger, Senegal, Sudan and Uganda came together.
The meeting was convened within the Drylands Programme of the International Institute of Environment and Development (IIED), England.
The workshop stressed the importance of:
1. the need for African NGOs to achieve a degree of financial self-reliance and thus greater autonomy;
2. the strengthening of the capability of NGOs to undertake their own research on dryland issues;
3. more attention by donors to the institutional development of African NGOs;
4. disseminating information on NGO activities to policy makers and the public;
5. regional co-operation a.o. through the transfer of experiences among NGOs;
6. the formation of regional NGO working groups on specific issues to develop common policies.

The meeting urged that international agencies, bi-lateral donors and Northern NGOs should consider what measures they have to help implement the above recommendations. IIED was asked to assist and coordinate all possible support for the follow-up process.

The Drylands Programme of IIED wants:
- to provide an information clearing-house and contact point for discussion among the numerous institute and individual researchers at work on dryland issues, and
- to enable development practitioners at local level to share and learn from the experience of others confronting similar needs.

Apart from workshops, like the above mentioned, the Programme publishes, in English and French, the Bulletin HARAMATA. The word, from Fanti language, means 'Dry wind of the Sahel'. The aim of the bulletin is linking NGOs and research, thus hopefully carrying seeds of change and hope. More information: Camilla Toulmin, Drylands Research Programme, IIED, 3 Endsleigh Street, London WC1H 0DD, England.

Folk Therapies and Prophylaxes (both natural and supernatural) for Livestock Health, Disease or Injury

Call for Papers and References

We are seeking to open a dialogue with persons who have worked on the above mentioned topics with any ethnic group of the world, including the U.S. and Europe. Therefore, papers on and references to ethno-veterinary medicine are being sought for publication of an annotated bibliography and preparation of an interdisciplinary anthology on the subject worldwide. This effort is directed by Dr. Med.Vet. E. Mathias-Mundy, with the assistance of Dr. C.M. McCorkle, and T. Schillborn van Veen, DVM. Interested parties should contact Dr. Mathias-Mundy at: CIKARD (Center for Indigenous Knowledge for Agricultural and Rural Development) 318 Curtiss Hall, IOWA State University, Ames IA 50011, USA.

Also Maria Niamir is working on how indigenous knowledge of natural resource management can and has been incorporated into development programmes. More information: Maria Niamir, 12 Via delle Mole, Albano Laziale, 00041 Rome, Italy.

Women in Agriculture Issue, June 1988 IRETA's South Pacific Agricultural News, USP/SOA, Private Bag, Apia, Western Samoa.

The Institute for Research Extension and Training in Agriculture (IRETA) treats in their monthly Bulletin specific themes of direct interest to the agricultural situation of South Pacific Islands, like e.g. Traditional Agriculture (July 1988), Nutrition (October 1987), Fishing (March 1988), etc..
The June 1988 issue focussed on 'Women in Agriculture'. Descriptions are giving on the agricultural activities of women in the different islands: husking coconuts, feeding and caring for the pigs on Tuvalu; cultivation, pig and poultry raising and fishing on Niue; preparing the land, planting the crops, do the weeding and harvesting in the Solomon Islands. Women's programmes in Kiribati are reviewed and background information is given on 'Breaking out of Role Models'. Recommendations in regard to agriculture include:
- agricultural extension officers and the Ministry of Agriculture should work closely with women's organizations;
- invitation for training should be channeled through women's organizations;
- women should be invited to join the agricultural experiments.

Women, extension workers and agriculture
Training at the International Agricultural College Deventer.

An 8-months' in-service training programme for persons involved in home-economics, nutrition or primary healthcare extension focussing in particular on the productive role of women in agriculture. The curriculum will consist of the following blocks:
1. Orientation
2. Planning and the agricultural cycle
3. Organisation and access of women to extension and other rural development instruments
4. Managing the livestock component
5. Assessing data for appropriate research.
6. Analysis.
7. Technology.
8. Special Project.

More information: International Agricultural College Deventer, P.O. Box 7, 7400 AA Deventer, The Netherlands.

Environmental News Digest Bulletin
Sahabat Alam Malaysia, FOE Malaysia, 43 Salween Road, 10050 Penang, Malaysia.

This bulletin is a compilation of news and articles taken form over 300 international periodicals and magazines on development and environment, with special emphasis on Third World issues. The news is categorised under 14 sections: pollution, natural resources, energy, economics, legislation, management, multinational;s, health, wildlife, agriculture, toxic chemicals, working environment, disarmament, and urban environment. Each issue has 60 pages and the bulletin is published 6 times per year. The subscription rate for a year is US$40/(by airmail) or US$30/(by sea mail).

Ancient Technology to combat Indian Drought
'People's technology to fight drought'. Panoscope, No.8, September 1988.

In a country ravaged by drought, Dr. Prasad's unorthodox methods of searching for water are proving successful. Being a professor at Sri Venkateswara University, Tirupati, in Andra Pradesh State, Prasad says he locates underground aquifers by surveying the surface for clues like termite mounds and certain species of trees he calls 'bio-indicators'. Near a date palm entwined with a banyan tree, water gushed out a borehole at the rate of more than 9,000 litres per hour. Scientific research had shown no sign of water. Back in 1981 Prasad identified 300 well sites in Rayalseema, the driest region. These wells are producing water today. Prasad found in ancient literature (1,500 years ago) a list of bio-indicators including 30 plant species, half a dozen animals such as the moisture loving tree frog, and insects sensitive to dryness and hence always moving to regions of higher humidity. Because even illiterate people can recognise the bio-indicators and rapidly locate well sites, and it costs nothing, Prasad calls it the people's technology to fight drought. Experts, however, are not convinced, yet. The World Bank, in a letter to Prasad, said the presence of tree species that grows deep roots may indicate that the tree is tapping an aquifer for its own needs, but not that there is enough water for high-yielding tube wells.
Prasad says he is not surprised at this reaction, because the Bank is not doing anything to help locate water in hard-rock areas. 'Ordinary village folk believe in traditional methods,' he says.
'That is all the encouragement I need.'

Pest Management

Integrated Pest Management in Rice in Indonesia, successful results

In November 1986, Indonesia became the first nation in the developing world to implement Integrated Pest Management (IPM) in rice. As part of the IPM program, President Soeharto prohibited the use of 57 widely used environmentally harmful pesticides and restricted the uses of others. For more than 20 years Indonesian farmers had been urged to use pesticides to keep down undesirable insects and thus increase their yields. The broad use of pesticides had been considered a factor - along with new strains of rice, irrigation, and increased use of fertilizers - in Indonesia's achieving self-sufficiency in rice production in 1983, after years of being the world's largest importer of rice, its basic food. However, in 1985, Indonesian rice production was seriously threatened by severe damage from the brown planthopper. Even extremely high dosages of insecticides could not stop these outbreaks. Research showed that the brown planthopper was a pest because of - not in spite of - insecticide applications, and that it was kept under good biological control by indigenous predators. Only when these predators were killed by unnecessary insecticide treatments did the brown planthopper escape natural control and become a serious pest. The attack of brown planthoppers a.o. brought the Indonesian Government to launch the IPM programme which is being implemented with support of the International Rice Research Institute (IRRI) and the Food and Agriculture Organization (FAO).

This programme emphasizes crop protection by mainly cultural methods:
- planting synchronously in order to avoid different plant stages growing at the same time in a given area;
- introducing a rice-free fallow period, when another crop or no crop at all is grown;
- using pest resistant varieties;
- conserving the natural predators;
- using insecticides only when absolutely necessary, basing the use on damage thresholds instead of on the calendar;
- using insecticides that do not seriously harm the natural predators.

After three rice harvest the following results are reported:
* the use of insecticides by farmers trained in IPM techniques has dropped from an average of 4.5 applications per season in 1986 to an average of 0.5 applications in 1988.
* the use of the deadly organophosphate pesticides has been reduced by an estimated 60 percent;
* rice production per hectare has risen from 6.1 tons in 1986 for farmers using 'normal' applications of insecticides, to 7.4 tons during the first harvest of 1988 for farmers practicing IPM methods.
* the cost of insecticide application per hectare of rice has dropped from 7,600 rupiahs in 1986 to 2,200 rupiahs in 1988 as a result of farmers' being trained in IPM.
* there has been a saving of up to $50 million to the Government from the phasing out of pesticides subsidies.

The key element in IPM's success has been the retraining of farmers in their fields. A challenging nationwide IPM training effort has been started to teach basic ecological pest and disease management to about 700,000 farmers a year in order to reach 2.5 million of the about 10 million rice farmers. In 1994 this operation has to be concluded.

References:
- Integrated Pest Management in Rice in Indonesia. Status after three crop seasons, perspectives for farmers' training. FAO Jakarta, Indonesia, 1988, 12 pages.
- Escape from the pesticide treadmill: Alternatives to pesticides in developing countries. Hansen, M., 1987, Institute for Consumer Policy Research Consumer Union, USA.
- PAN-Europe Newsletter Vol. 2, No. 7, July 1987. 22 rue des Bollandistes, 1040 Brussels, Belgium.

Rural Production and use of Plant Preparations for Crop and Post-Harvest Protection (1986) Project Consult, Savignystr. 41, 600 Frankfurt/M 1, Fed. Rep. of Germany.
Available from: GTZ-GATE, P.O. Box 5180, D-6236 Eschborn-1, Fed. Rep. of Germany.
The primary aim of this study is to encourage interest in an approach to crop and storage preservation that is relatively safe for man and the environment.
It is, however, not a 'handbook of crop protection'. A great deal of additional research is needed and the authors request readers to test plant preparations and exchange questions, suggestions, criticisms and successful applications. This will be facilitated through the new informationcentre on Natural Plant Protection, which Project Consult will start soon.
The 20 plants that seemed to be most important regarding both their effectiveness for protection and their potential for additional application are described in detail with their preparations. Fortunately, the study is now published in English, thus enabling a wider audience.

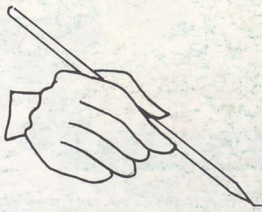
Ecological Impact of Pesticide Use in Developing Countries
Report by the Dept. of Toxicology at the Wageningen Agricultural University. Copies can be obtained from: IRPTC-IPCS-Committee, P.O. Box 450, 2260 MB Leidschendam, The Netherlands.
The report starts with the importance of analysing pesticide side- effects and an overview of future trends in pesticide use. Then it continues to discuss the reported ecological effects of pesticide use in agricultural pest control and vector control. The report is meant to assist authorities in the difficult task of risk evaluation in the registration procedure for which it supplies eco-toxicological data on pesticides, based on the results of several field studies.

Use of Ethnoecology in Agroforestry (AF) Systems Research: An Example of AF Technology and Pest Management Research in Kenya.
Diana Rocheleau, c/o Ford Foundation, Silopark House, City Hall Way, Nairobi, Kenya.
Paper presented to the F.S.R. Conference Arkansas, USA, 1987.
Careful combination of methodologies in two sub-fields of ecology, ethnobotany and agroecology, provides researchers with a rich selection of tools for studying existing 'natural' ecosystems, traditional AF and recent innovations by rural people.
An example is given on the use of combined methodologies for the study of indigenous plants in AF systems and the design of pest management technologies (termites) in Kathama, Kenya. Both studies converged toward a more integrated approach to pest control (termites), species selection (for different purposes), land use planning and the interaction of these for the development of agroforestry systems in Kathama.

Fighting Pests the Natural Way.
PAN-Europe, 22 rue des Bollandistes, 1040 Brussels, Belgium. 45p., 1988. Price Bf. 130,-- (US$ 3.50)
PAN Europe has produced a report on alternatives to synthetic pesticides. Besides a general introduction to the problems associated with the use of synthetic pesticides, the report gives an insight into natural pest control, especially in developing countries. Biological, biotechnical and physical methods of control are outlined, as well as the importance of crop rotation, soil tillage and field hygiene. A variety of instructions are given for the production of easy-to-make, low-cost pesticide sprays based on protective substances in plants, which should provide the incentive for individual use. Integrated Pest Management and locally adapted agriculture are also discussed. The report ends with a list of institutions and organizations which can give further information.
Also available in German.

Escape From The Pesticide Treadmill: Alternatives to Pesticides in Developing Countries
Michael Hansen (1987), Institute for Consumer Policy Research, Consumers Union of US Inc., 256 Washington Street, Mount Vernon, NY 10553, USA or IOCU, P.O. Box 1045, 10830 Penang, Malaysia, 1987, 177 p., many ref., Price US$ 12.-,.
For the first time the author brings together successful case studies in developing countries of large-scale applications of alternative pest control methods. The six case studies are well documented and clearly indicate that alternative pest control practices can be both economically and biologically feasible. The case studies include the control of the pests attacking cassava in Africa, soybeans in Brazil, bananas in Costa Rica, cotton in Nicaragua, rice in South East Asia and coconuts in the South Pacific. Integrated Pest Management (I.P.M.) is discussed critically. The general conclusion of the publication is that I.P.M. can work very well in developing countries.

International Symposium on Integrated Pest Management
From 8 - 15 February 1989 the German Agricultural Society will organize a symposium in Bad Dürkheim, Germany on 'Integrated Pest Management in Tropical and Subtropical Cropping Systems'. The objectives of the symposium will be the exchange of experience between plant protection experts from North and South, between experts from tropical and subtropical countries and between research, extension services and practice. There will be discussions about evaluating the possibilities of chemical, integrated and biological plant protection are to be evaluated in food crops under the climatic, economic and structural framework conditions in the tropics and subtropics and what recommendations are available for future developments. The basis for the discussions will be provided by experience from applied research and future-oriented field work. For more information please contact DLG Symposium Integrated Pest Management, att. Dr. Riest, Zimmerweg 16, D- 6000 Frankfurt 1, Federal Republic Germany.



READERS WRITE

Integrated farming strategies

Dear Editors,

With great interest I took notice of the contents of 'Integration of livestock and crops in a smallholding, a project in Sri Lanka' by Sander Essers, that appeared in ILEIA Newsletter Vol. 3, No. 4, 1987. The article illustrates very clearly the benefits of mixed farming enabling a farmer to make optimum use of resources available on a farm of limited size. The degree of success of future farming in developing countries will undoubtedly depend to a large extent on progress to be made in the re-utilization, or recycling, of basic materials needed for the growth of crops.

As a soil fertility specialist, I am accustomed to look upon plant nutrients present in soil as the most essential basic materials for a permanent utilization of soil as a substrate for crop production. Thirteen nutrients are essential for plant growth, and every soil contains these nutrients but ordinarily not in optimal quantities and ratios. In tropical soils, nitrogen and/or phosphate are usually the nutrients limiting crop growth most. On the smallholdings in Sri Lanka, nitrogen is continuously introduced through the growth of legumes, but phosphate has to come from soil sources.

It is rightly emphasized in the article that also in a subsistence-type farming system earnings derived from products sold on the market are very essential. It must then be realized that these products contain certain amounts of the above mentioned 13 essential nutrients. Nitrogen thus exported from the farm can be replenished by atmospheric nitrogen fixation taking place in the legumes grown, but other nutrients present in sold products can be re-introduced onto the farm only through the use of chemical fertilizers. Such fertilizers are expensive, especially when they have to be imported from foreign countries.

This letter is written mainly to draw attention to the fact that Sri Lanka has a large, but sparsely used reserve of alkaline rock phosphates. The deposit is of magmatic origin, which accounts for the low solubility of the phosphate. Use could now be made of the fact that legumes have a special ability to mobilize and utilize rock phosphates (see ILEIA Vol. 3, No. 1, 1987, p.13). In a mixed-farming system, the phosphates in the forage derived from the applied rock phosphate will be recovered in the manure of animals kept in a feedlot. After biogas production, the residue can be employed for improving the fertility of soil used for arable crop production. The organic manure is not only beneficial in supplying nutrients, but also improves soil physical characteristics highly essential for raising soil productivity.

When in such integrated farming systems phosphate is the primary limiting factor, application of rock phosphate to legumes can raise not only the quantity but also the quality of fodder, thus leading to better animal health and higher animal productivity. In case other mineral nutrients are lacking as well, a search should be made inside a country for minerals containing these nutrients. To give an example, next to rock phosphate Sri Lanka also has known serpentine deposits that could be used as source of magnesium to crops grown on soils low in this nutrient.
In the article, mention is made of the use of *Glyricidia* and *Leucaena* as woody alley-cropping leguminous species in which atmospheric nitrogen fixation can take place. When acreage is not the major constraint, thought could be given to growing less permanent leguminous forage crops, such as *Pueraria* and *Mucuna*, which are both very aggressive growers capable of utilizing sparsely soluble rock phosphates. With such non-woody legumes, crop rotation could be practiced as a means of controlling soil-borne diseases and of improving crop health and, thus, crop productivity.

With ever increasing population densities and stagnant abilities to buy expensive farm inputs, developing countries will have to rely more heavily on integrated-farming strategies as described in your article and in this letter.

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Low external-input agriculture means to us: agricultural systems which make optimal use of locally available natural and human resources (such as: climate, landscape, soil, water, vegetation, local crops and animals, labour, local skills and knowledge) and which are economically feasible, ecologically sound, culturally adapted and socially just. The use of external inputs such as mineral fertilizers, pesticides, tractors, hybrid seeds, is not excluded but has to meet the above-mentioned criteria of sustainability.

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