39 88 - 2/19

Farming systems research and development
Africa, review, on-farm research, on-farm trials, alley farming, parameters, variables, constraints
SUMBERG, J. and OKALI, C.
Farmers, on-farm research and the development of new technology.
Expl. Agric., 24, 1988, pp. 333-342

The farming system approach to agricultural research is predicated upon an appreciation of the whole farm enterprise and, most importantly, of the relation among its component parts. Incorporating this `holistic' view of the farm and farm family into specific research strategies has not been straightforward. One fairly drastic approach has been to establish farm families on `model' or `unit' farms located either on experiment stations or within farming communities, thus providing researchers with an opportunity for detailed study of new farming technology. Perhaps the more common approach, however, has been through the use of research on farmers' fields, which has taken forms ranging from standard crop variety trials to detailed studies of the availability and use of family resources.
The identification of constraints in existing production systems and of constraints on the performance of packages of new, `improved' technology are key objectives of Farming Systems Research. On-farm trials are viewed as a means of validating a given package, and the role of the farmer is to highlight, through his or her own action and attitudes, institutions, knowledge, input availability and credit. In this scenario, everything which is seen as limiting the package's performance is a constraint or variable which can and should be addressed. The whole system is therefore open to question and, given these assumptions, is justifiably subject to manipulation. Much of the subsequent research, including on-farm activity, revolves around removing these constraints in order to close the gap between the package's performance on the experiment station and on farms.
Looking to more complex technologies such as systems which can potentialy produce crops, wood, fruit and fodder, it is obvious that a traditional experimental approach seeking to identify management treatments which maximize output, often in itself difficult to define, becomes unwieldy and unrealistic. It is, therefore, the farmers themselves who hold the keys for developing and evaluating these systems.
Drawing on experience with alley farming in West Africa, it is shown how the farm family can be incorporated fully throughout the process of technology development. The example is used to clarify the role of researchers in participatory technology development.

40 88 - 2/20

Farming systems research and development
South America, Columbia, on-farm trials, design, farmer participation, fertilizer, rock phosphate
ASHBY, J.A.
Methodology for the participation of small farmers in the design of on-farm trials.
Agric. Administration, 22, 1986, pp. 1-19

The results of this study, comparing the objectives of experimental designs for evaluating the potential of new fertilizer technology under farmer conditions with different types of farmer participation, show that formal procedures can be adopted by on-farm researchers to familiarize themselves with farmers' informal research and experimentation, and to integrate this into technology testing by involving farmers in the design of experiments.
Farmers' participation in experimental design can be an effective way of introducing into on-farm testing procedures the values and goals of farmers which are not readily apparent to researchers, even with second-hand knowledge of the farming system. This study found that fertilizer practices followed by a minority of farmers proved to be the leading edge of farmer experimentation when diagnostic work focused on understanding farmers' informal research, and provided important insights into how farmers themselves would test and evaluate new fertilizer technology. When, however, diagnostic study focused on understanding representative farmer practices, information on farmer experimental practices did not emerge relevant to setting objectives for on-farm testing. The development of a `Farmer Design', an experimental design addressing questions about the likely performance of the new technology formulated by discussion with farmers, involved a smaller number of farmers than survey research and qualitatively improved the feedback to scientists in a shorter time than the collection and analysis of survey data. The `Farmer Design' not only provided important feedback to researchers about criteria relevant to the use of the technology under location-specific circumstances, but also raised significant basic research questions about potential improvement in the technology. These findings highlight the importance for on-farm research programs to institutionalize methodology which enables farmers to make an active contribution to setting objectives and defining evaluation criteria for testing new technology. Farmers and researchers alike need to understand that farmer participation may not result in significant improvements in farmers' practices in the short run, and adoption of one of the technologies tested need not be a primary goal of farmer participation. An important pay-off from farmer participation in the design of experiments is creating familiarity among farmers with scientific modes for evaluating technology, and among researchers with farmers' criteria for judging the utility of a technological innovation. Institutionalizing the development of a `Farmer Design' into a diagnostic phase of on-farm research can be rapid, with the important function of building the missing link between formal research systems and farmer experimentation.

41 88 - 2/21

Farming systems research and development
Africa, book, review, farming systems, on-farm experimentation, rural development, projects, exploratory surveys, extension, farmers, agricultural research, cropping systems
STEINER, K.G.
On-farm experimentation handbook for rural development projects.
Sonderpublikation der GTZ, No. 203, 1987, 307 pp., ISBN 3-88085-342-8 (GTZ/CTA), TZ-Verlagsgesellschaft mbH, Postfach 1164, D-6101 Roßdorf, FRG

Rural development projects aim to improve the living standard of the rural population in developing countries. One of their main activities is to introduce improved farming methods that produce higher and sustained yields.
However, the adoption of new methods by small resource-poor farmers, by far the majority in developing countries in the tropics, has generally been disappointing. Over the last few years it has become obvious and generally accepted that this is not due to farmers' ignorance but to the inappropriateness of many of the methods. In many countries it was mainly the large farmers, those with better access to resources (resource-rich farmers), who profited from agricultural research, simply because their production conditions were comparable to those of research stations.
Awareness is now increasing among agricultural scientists that past efforts were often based on an inadequate understanding of small farmers' conditions and production goals. Because their resources are limited, small farmers are frequently forced into enterprise (or crop) diversification. Diversification allows less time for individual enterprises, making it difficult for the small farmer to adopt complex technologies, i.e., farming practices and materials requiring a lengthy learning process. Technologies for resource-poor farmers, therefore, should be inexpensive, should utilize primarily resources available on the farm, and should not require a great deal of learning time or management.
The author has concentrated his efforts since 1983 on initiating and supporting on-farm experimentation programmes in GTZ-supported projects in Africa. Despite problems in the starting phase, good results were obtained in most of these programs, hence this handbook. The handbook has been greatly influenced by the view of the International Institute of Tropical Agriculture (IITA) regarding on-farm research, because of the author's close working contacts with that institute.
The handbook focuses primarily on improving cropping systems, but on-farm experimentation is also suited to test the performance of livestock components within farming systems.
The book is intended for use in rural development projects, to give project staff (agronomists, socioeconomists, extension specialists) a tool with which to conduct exploratory surveys and organise on-farm experimentation programs. As development projects are usually not equipped or mandated to conduct proper research,

the term on-farm experimentation (OFE) is preferred to "on-farm research", even though on-farm experimentation in the stricter sense of the word does not encompass the diagnostic phase, i.e., the exploratory survey.

42 88 - 2/22

Farming systems research and development
Africa, tropics, study agricultural research, IARCs, IARs, impact of research
JAHNKE, H.E. et al.
The impact of international agricultural research in tropical Africa.
Sonderdruck der Gesellschaft für Agrarprojekte in Übersee mbH, Duvenstedter Damm 19, 2000 Hamburg 65, FRG, 1986, 23 pp.

The annual growth rate of per caput income in tropical Africa has been steadily decreasing since 1960 to an almost negligible present level. Whatever small the growth rates of agricultural production may have been, they have been due mainly to expansion rather than productivity increases. Self-sufficiency in food production has steadily decreased, and tropical Africa has lost the ability to feed itself. Food grain imports have risen dramatically and so has the proportion of imports on concessional terms.
It is certain that the physical environment constitutes a constraint to agricultural production in some areas, but on the whole there is considerable potential. It is also true that some areas are overpopulated in relation to their capacity, but on a continent-wide basis, tropical Africa can hardly be called over populated. The constraints to exploiting the existing agricultural potential may lie more in social and political fields. There is the enduring legacy of viewing agriculture as a second-rate subject. According to the World Bank, this translated over the last two decades into a consistent bias against agriculture in pricing, taxing, exchange rate and investment policies.
There appears to be several obstacles to such a development path in tropical Africa: 1) the great ecological diversity and ecological specificities appear to make a direct transfer of technology difficult; 2) added to this is the political-administrative diversity of many small countries and 3), as mentioned, the general bias against agriculture, resulting in lack of inputs, unfavorable prices, deficiencies in marketing, etc.
On the other hand, the FAO studies clearly show that, at present level of technology and inputs, one half of Africa will not be able to meet its food needs by the year 2000.
The challenge is there, but an analysis by crop consumption and self-sufficiency in tropical Africa also shows - in addition to diversity - the specificities of Africa. Thus, successes in plant breeding and other fields of biological technology in the past have neither matched well with Africa's production and consumption pattern nor given recognition to the deficiencies in complementary inputs (little of the area is irrigated, fertilizer distribution

functions poorly). This may be another reason why the Green Revolution has by-passed Africa.
Widespread interest and some concern about the effectiveness and usefulness of international agricultural research centers (IARCs) have resulted in the present impact study. Impact assessment becomes especially serious, however, when one adds to this general interest the particular concerns about Africa's deep economic and agricultural crisis. The more general question to be answered relates to the role that agricultural research and IARCs, in particular, can and do play in overcoming Africa's crisis. To investigate this problem is the aim of the Impact Report on Tropical Africa, of which a summary is presented here.
The report is divided in two parts. Part A contains general considerations and sets the framework for actual impact assessment. It introduces the diversity of problems with which research is faced on the African continent, and it investigates the present state of IAR and national agricultural research (NAR) activities. Part B presents a detailed impact assessment concentrating on the collaboration between the Consultative Group on International Agricultural Research (CGIAR) system and NARs and discussing research impacts on agricultural production. This part brings in the country perspectives as they emerged from the nine country case studies in tropical Africa. Of course, not all of the perceptions received can be generalized. In tòtal, however, these perceptions describe a rather concise view of IAR activities in tropical Africa, which is presented in the report. Considering the abundantly available `top-down' reviews of the CGIAR system, the recipient perceptions should be a most useful source of information for guiding future allocative decisions. In fact, this has been one of the major reasons for the emphasis given to country studies in the overall impact study.
The system of IARCs with all their different types of activities on the whole performs well by any standard but has not yet had the expected impact in tropical Africa. Tropical Africa constitutes the biggest challenge to the system and begs answers to a number of far-reaching questions.
The centers have already taken initiative to meet African needs and, in fact, an implicit compromise between global and regional responsibility would best describe the present state of affairs. In whichever way the system responds to the African challenge, it should be very modest in its expectations for achievements in Africa. Agricultural development is a complex process.
The lesson to be learnt is that development is not a painless and self-sustaining process that comes about and is accepted voluntarily. The development process, instead, has to be backed by strong political and social support. There are not many African governments at present that are benevolent and farsighted enough to give proper attention to this process.
Therefore, a realistic view of IAR in the overall development process is necessary. Expectations in the attainment of development by research efforts should not be too high. Research is only one component in that process. The IARCs make up only one component of research. Whatever reactions there might be of the system to the African challenge, modesty is the key word when it comes to specifying expectations.

43 88 - 2/23

Farming systems research and development
Africa, review, humid tropics, farming systems research, IARCs, IITA
LAL, R. et al.
Farming Systems Research relevant to the humid tropics, with special reference to tropical Africa.
In: Proc. Workshop on Farming Systems Research, 1986, pp. 18-23, ICRISAT, India, Patancheru, A.P. 50234, ISBN 92-9066-119-4

Over the last two decades, remarkable progress in agricultural production has occurred where there are strong national research services and infrastructure. In the humid tropics, particularly in Africa, lack of these essentials has prevented farming methods from keeping pace with modern technology and production potential. Simultaneously, the traditional land-extensive farming systems have been placed under tremendous pressure by a growing population that, in sub-Saharan Africa, is expected to quadruple in 44 years. Despite the large proportion of the work force in agriculture, labor is a scarce resource, constituting 80-90% of production costs for smallholders. Migration away from rural areas further compounds this scarcity, and farm size is often limited to an area that can be managed wholly by the farm family.
In many African countries, the farm labor force consists almost entirely of women and children, yet women farmers have limited access to credit, fertilizer, extension services etc. These facts have important implications for new technology design.
In the humid region of tropical Africa, farming systems are based chiefly on the root crops cassava, yam and plantain, grown in rotation with bush fallow. Though such systems require few purchased inputs, they are becoming increasing inefficient, as fallow periods - formerly 7-15 years - are becoming shorter because of population pressure on land. Mixed cropping is the rule, and organic farming, using mulch and household wastes, is practised around homesteads.
The majority of farmers in Africa and Asia are smallholders, who lack the education and resources to use the benefits of modern agricultural technology. Therefore, research priority must be given to the production constraints of the smallholder farmer.
A new technology may be a simple component, a subsystem or a whole package. Examples of simple and complex improved technologies developed at IITA include the following:

- improved varieties, e.g., a cassava variety resistant to bacterial blight and mosaic, a 60-day cowpea variety, a streak-resistant maize variety, and hybrid maize;
- intensified cropping systems for smallholders, based on improved cropping patterns, e.g., mixed cropping combinations with cassava/maize, cassava/cowpea and maize/soybean;

- fertility maintenance through a mucuna cover crop or through the integration of food crop annuals with woody perennials, as in alley cropping systems.
- a no-till package for grain crop production to minimize soil erosion, improve soil physical conditions and reduce labor inputs.

IITA's Farming Systems Research in the past has focused on the analysis of the existing farming systems, systems component research and new farming systems development. More recently, an on-farm adaptive research component has been added in collaboration with the national agricultural research service (NARS). Against the background of weak NARSs and a limited knowledge base in the region, efforts were concentrated on developing technical information to enhance understanding of the local biophysical environments. New technology has been developed towards land clearing and development, methods of seedbed preparation, management of acid soils, alley cropping and agroforestry, wetland management, and improved cropping systems.
These technologies are developed as low-input technologies designed to conserve soil and water, maintain fertility and meet protein requirements for balanced human nutrition. The welfare of rural women is receiving attention, and IITA is developing improved varieties with short cooking time, readily accessible sources of fuelwood and fodder, and improved storage and food processing technologies.
There is a need to develop energy-efficient tillage systems and improved tools, methods of alleviating soil compaction and erosion control, technology to utilize wetlands more effectively, and agroforestry-based systems to maintain soil fertility. Particular attention is needed to develop sustainable cropping systems that also facilitate mechanization. There is a tremendous scope for interinstitutional cooperation in developing effective research programs along these lines.

44 88 - 2/24

Farming systems research and development
Latin America, Review, CIAT, systems-based research, bean program, farmers' fields, IARCs, OFR
WOLLEY, J. and PACHIO, D.
The CIAT bean program's approach to systems-based research.
In: Proc. Workshop on Farming Systems Research, 1986, pp. 41-45, ISBN 92-9066-119-4; ICRISAT, India, Patancheru, A.P. 50234

Although CIAT has no farming systems program per se, three commodity programs - cassava, tropical pastures, and beans - conduct on-farm research (OFR). This paper deals with the bean program, which concentrates on OFR in crop subsystems that include beans and associated crops, in geographical areas where growing beans is a key enterprise. Related studies off the farm, especially of marketing and consumer preferences in grain types, are emphasized more than is usual for crops handled by other IARCs.

Because beans are grown under widely diverse conditions, the OFR by CIAT emphasizes testing general strategy rather than specific techniques, and tries to integrate technology development both on-farm and on-station.
The OFR has five objectives: 1) to build national capability in doing OFR that will aid technology development and adaptation; 2) to diagnose production constraints to help set CIAT and national research priorities; 3) to develop methodology and involve CIAT personnel on-farm; 4) to develop new technology under farm conditions; and 5) to test, monitor and understand the adoption of technologies. Throughout, the final client is the national agricultural system.
The basic model for OFR at CIAT has four stages: diagnosis; choice of trial content; experimentation, interpretation and recommendation; and, finally, interface with extension.
Five stages of trials are used: variety, exploratory, economic levels, verification, and farmer-managed trials. The last show how compatible a new technology is with the farmers' systems and how well he can manage it. From Stage 3 on, economic evaluation is done for all trials; its success depends on accurate understanding, during diagnosis, of the farmer's objectives and production constraints.
On-farm variety testing (OFVT) is a simple version of OFR designed primarily for breeders and experiment station scientists. It is used where initial diagnosis has shown that rapid, short-term impact can be expected with a change in variety and possibly some related simple changes in agronomic practices. It permits the rapid testing of new bean lines across a range of environments.
The CIAT bean program does not develop new farming systems on-station. Results obtained on experiment stations, even those using farmers' cropping systems and input levels, often do not correlate well with those obtained on farms, perhaps because of differences in topology, soils and previous agronomic practices. Station-farm comparisons confirm that such studies are better done on-farm from an early stage.
The final objective of OFR in the CIAT bean program is a national program network of research, feeding back to station research and forward to farmers' adoption of technology. Thus strong linkages are maintained with national programs throughout: in diagnosis and technology adoption the bean program has an increasingly advisory role.
While Colombia has been the base for the CIAT bean program for self education, methodology development, and training in OFR, it has now been extended to other Latin American countries, sometimes in colloboration with IARCs. In eastern and southern Africa CIAT's regional strategy for bean improvement has a strong OFR component. Results have now begun to show in Latin America. OFR procedures have been adapted and applied to beans, sole- or multiple-cropped. A training strategy has been designed to communicate the procedures and methodology developed, and various novel courses have been designed for OFR training.

45 88 - 2/25

Farming systems research and development
Review, ICARDA, Farming Systems Research, crops, pasture, livestock, production increase
SOMEL, K. and COOPER, P.
Farming systems research at ICARDA,
In: Proc. Workshop on Farming Systems Research, 1986, pp. 28-32, ISBN 92-9066-119-4; ICRISAT, India, Patancheru, A.P. 50234

The International Center for Agricultural Research in Dry Areas (ICARDA), located near Aleppo, Syria, has a regional mandate covering West Asia and North Africa and a global mandate to coordinate research on barley, lentils and faba beans,. ICARDA also conducts collaborative research on chickpeas (with ICRISAT), on wheat (with CIMMYT), and in pasture and forage improvement and livestock management.
ICARDA's mandate is based on the concept of Farming Systems Research (FSR); thus, the Farming Systems Program and the Center share a common ultimate goal of increasing both the level and the stability of production, in a region characterized by great seasonal variation in climate and by diverse social and economic conditions.
Interdisciplinary research is integral to the farming systems program and ICARDA activities. An agricultural system is determined by its natural and human resources, its historical development, and current social and economic environment. Due to the large and diverse nature of ICARDA's region, these combinations of factors result in numerous different systems, each unique in its own way. FSR does not aim, therefore, to develop an improved system of wide applicability. Work is concentrated on:

- The barley/livestock systems project in areas with less than 350 mm annual rainfall. This includes work on barley productivity, livestock management (mainly sheep) and rotations to introduce forage legumes into barley fallow or continuous barley.
- The wheat-based systems project in areas with more than 350 mm annual rainfall where wheat, food legumes and summer crops are predominant. Wheat is a a major crop in ICARDA's region and much of its work focuses on it. The work on food legumes includes on-farm evaluation of new production technology: early sowing of lentils, mechanized harvesting of lentils, and winter sowing of chickpeas.
- The intersystem research project aims to provide quantitative information on the effect of variability in climate, soils and socioeconomic conditions on the farming systems of the region, and to provide a basis for the extrapolation of research results from a limited number of locations and seasons, to other similar locations or environments that may differ in known respects.
- The cereals/livestock systems project in Tunesia focuses on agricultural and socioeconomic constraints faced by small farmers in Beja Province in a wheat/barley/livestock farming system.
- The training and agrotechnology transfer project is to be expanded substantially in the coming year.

ICARDA, in its 9 years of existence, has tried to meet the challenge of developing research results to meet the urgency of the agricultural problems faced in the region. An interdisciplinary FSR perspective has helped in understanding the complex farming systems of West and North Africa. The FSR perspective has allowed researchers to identify and focus on critical elements in these systems that can precipitate change. The farming systems program is gradually moving into collaborative research projects with national scientists to produce concrete results. These activities are being backed by ICARDA's efforts in producing improved cultivars, agroecological zoning and targeting, as well as policy research.

46 88 - 2/26

Farming systems research and development
USA, classification, terminology, farming systems research
SANDERS, D.M.
Farming Systems Research: clarification of terms and concepts.
Expl. Agric. 22, 1986, pp. 87-104

This paper systematically classifies the diverse research activities and approaches commonly incorporated under the umbrella term of Farming Systems Research into six distinct types of research. The paper proposes a new, more precise terminology reflecting this classification:

1. Farming System Analysis (FSA)
2. Farming Systems Adaptive Research (FSAR)
3. Farming System Component Research (FSCR)
4. Farming Systems Baseline Data Analysis (FSBDA)
5. New Farming Systems Development (NFSD)
6. Farming Systems Research and Agricultural Development (FSRAD)

These six types of research share some of the key concepts of FSR as originally conceived. In essence, they are all products of the post-Green Revolution conceptual shift in agricultural research and development. The new conceptual framework recognizes that small-farm agriculture in developing countries is fundamentally different from western capitalist agriculture. It thus requires a distinct institutional structure and experimental framework if agricultural research and technology development is to be effective. The research activities incorporated under FSR are manifestations of this realignment.
The primary objective of all the research activities described above is to increase the productivity of small farms. All, except NFSD, attempt to do this through the generation and transfer of technology apropriate for the goals, needs, priorities and circumstances of small farmers. They all employ a systems approach in their analysis, emphasizing interactions between elements and components of the system. They all require interdisciplinary collaboration since problem definition cuts across conventional commodity and disciplinary lines. And, finally, they all complement and build upon strategic and applied commodity and disciplinary research.

The six research activities do, however, differ significantly, even within these common dimensions. Their specific objectives, functions and products are quite distinct. It is these differences which require that a more precise terminology should be employed to distinguish among the six types of research.
The differences, as well as the similarities, among the six types of research are clearly seen when they are compared in terms of the degree to which they incorporate the key concepts of FSR as it was originally conceived.

47 88 - 2/27

Farming systems research and development
Africa, Ethiopia, energy flow, smallholder farms, ILCA, study
GRYSEELS, G. and GOE, M.R.
Energy flows on smallholder farms in the Ethiopian highlands.
ILCA Bulletin, 17, 1984, pp. 2-9

Energy flows on smallholder farms in two areas of the Ethiopian highlands are studied in this paper. The overall farming system and the resource base (especially human labor and animal traction) in these areas are described and an outline is given of how these resources are used. The use of energy in the household system is then discussed and the prospects for improvements in energy use in both farm and household systems are assessed. The authors conclude that any major improvements in present energy use will have to rely on technologies which are simple, effective, and easily implemented and maintained. Energy problems must be seen in the wider perspective of agricultural and ecological development. Changes in the overall energy use on smallholder farms will be slow unless a proper infrastructure and adequate extension and technical support services are established.
Authors' abstract, revised

48 88 - 2/28

Farming systems research and development
South America, Columbia, CIAT, yield gap, experiment, farm yields, technology, bean, cassava, fertilizer
SANDERS, J.H. and LYMAN, J.K.
Evaluation of new technology on farms: methodology and some results from two crop programmes at CIAT.
Agric. Systems, 9, 1982, pp. 97-112

The yield gap between experiment station and farm yields in the production of food crops in developing countries has been frequently noted, and various quantitative attempts have been made to separate its components. In two food crops in Latin America one principal hypothesis of the authors for the continuation of this yield gap over time is that many successful technologies on the experiment station do not pass a set of reasonable farm-level criteria. Farm testing is the logical extension of the research evaluation process once a technology has been identified on the experiment station and regionally tested for adaptation. Farm testing is an especially important component of the research process in developing countries, where communication links between farmers and researchers are weak and farmers often do not have the information and management experience to combine and modify various technology components, adapting experiment station or regional trial observations to their own environments and production systems. The research problems on the farm are different from those on the experiment station or in regional trials, so there are important distinctions in design and analysis in the farm trials. The evaluation process developed here identified the technologies later adopted by farmers. For the unsuccessful technologies, information was provided from the farm trials to the breeders and other scientists on further design requirements. The results of the farm trials substantially modified the recommendations for farmers, which would have been arrived at utilizing the results from the experiment station and/or regional trials.

49 88 - 2/29

Farming systems research and developement
Africa, Sub-Sahara, ISNAR, traditional agriculture, farming systems, agricultural research services, management, organization, technology transfer
JAIN, H.K.
Role of research in transforming traditional agriculture: an emerging perspective.
ISNAR Reprint Series, No. 4, 1988, 5 pp.; ISNAR, P.O.B. 93375, 2509 AJ The Hague, Netherlands

The population pressures of the 1960s were basically responsible for major policy decisions to give an new direction to world agriculture, which had evolved for most of its 10,000 years around traditional practices. It was decided during this period to mobilize science and technology to transform this kind of agriculture into highly productive systems of farming. The concept of genotype-environment interactions was used to synthesize crop varieties which would take full advantage of improved levels of agronomic management. The newly discovered plant-type genes in wheat and rice have been extensively used in the process of genetic reconstruction of traditional cultivars of these crops which had been bred more for adaptation to stress environments than for high grain yields. Many developing countries took bold policy decisions to reorganize and strengthen their agricultural research services in pursuance of these objectives. The new agricultural technology developed in this way has already made a significant impact on food production in some of these countries, more particularly in Asia and Latin America.
The impact has been much less in Africa, where the national agricultural research systems are in an early stage of evolution following their colonial history. It has been argued that the problems of agricultural production in sub-Saharan Africa are only

quantitatively, not qualitatively, different from those of developing countries in other parts of the world. Africa also offers considerable potential for significant advances in agricultural production through the application of the new technology, and this must be the approach in the short term. In the long term, however, the problem of agricultural production in Africa will require a different kind of production technology for its relatively large areas of lands characterized by moisture and fertility stress. This new technology must be based on efficient techniques of soil and water management, with the agronomists playing a key role supported by soil scientists, water technologists, plant breeders and scientists from other disciplines. The multidisciplinary approach becomes particularly important in this context.
The paper concludes with a brief discussion of ISNAR's collaborative work during the past 6 years with a number of sub-Saharan African countries to strengthen the organization and management of their agricultural research services.
Author's summary

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88 - 2/30

Farming systems research and development
Farming systems, integrated sytems, land-use planning, permaculture
STRANGE, P.
Permaculture: practical design for town and country in permanent agriculture.
Ecologist, 13 (2/3), 1983, pp. 88-94

Permaculture (permanent agriculture) is an agricultural system that does not depend on limited resources such as water, soil and forests. The principles of permaculture are based on observations of natural ecosystems and on traditional polycultures. It aims to work with, not against, nature, and thus establish a system that will be self-sustaining, a kind of cultivated ecosystem, based on maximum understanding and minimum interference. A sustainable agriculture has four requirements: 1) it must produce more energy than it consumes, 2) it must not destroy its own base, i.e., the soil, 3) it must meet local needs, and 4) it must gain its own nutrients on site. The natural systems which satisfy these requirements are forests and tree systems, lakes and swamps. Basic principles, design, water sector planning for sun and wind; zoning; structures; urban strategies and the political dimensions receive special attention.
Abstract from WAERSA, revised

III INTEGRATED SYSTEMS

51

88 - 3/1

Integrated systems
Asia, Nepal, temperate climate, monsoon rainfall, slopes, anthropologic pressure, ethnic variety, transhumance, animal husbandry systems
SWISS ASSOCIATION FOR TECHNICAL ASSISTANCE
Transhuming animal husbandry systems in the Kalingchowk Region (Central Nepal).
Report of Swiss Association for Technical Assistance Kathmandu: Integrated Hill Development Project, Oct. 1979

Rugged ground, extreme differences in altitude and a temperate climate with monsoon rainfall causing layers of varied vegetation zones, make the region being studied typical of the southern Himalayan slopes. A great ethnic variety and a strong anthropologic pressure on the natural environment are also characteristics of these regions in Nepal.
Animal husbandry is extremely dependent on the outside environment as far as the re-stocking of animals and the sale of the products are concerned. Besides constraining factors influence production factors and processes, leaving the stock farmers with only a limited margin of possible activities.
The production factors are extremely sensitive and can very easily become limiting. The alpine and subalpine grasslands which are used as summer pastures are few in number and have a limited area, so that most of the fodder is obtained when the herds are in the forest. Without being overgrazed, the grazing lands are all being used to their fullest extent, so that any increase in livestock numbers would cause extreme damage to the pasture lands in their present state. Winter fodder is provided only with difficulty and is still insufficient. Capital, available manpower and the right to use the pastures are the decisive elements which have to be taken into account when choosing an animal husbandry strategy. A change in any one of them can affect the running of the animal husbandry system, making it change from one category into another.
The distribution of the different genetic types causes different stock-farming regions to appear, which depend on different geographical zones and bear witness to animal husbandry history: dairy farming prospects in the Bigu region, mainly the production of young bulls and heifers in the Phulbin region, less prosperous dairy farming in the Dolangsa region and, in the south of the study zone, dairy farming which used to be prosperous but it is now on the decline as the animals have aged.
The annual movements of the herds allow the animals to use the different vegetation levels, the forests in particular; stock farmers (usually related) who have banded their herds together follow the same route from year to year. The ovine flocks are moved separately.
The dairy technology is identical to that in the main animal husbandry regions of Nepal (Khumbu, Langtang etc.) During the lacta-