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Land Use Planning With Rural Farm Families and Communities: Participatory Agroforestry Research

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Introduction

Household-based approaches to farming systems research (Chambers,1981; Collinson,1981; Hildebrand,1981; Rhodes,1981; Zandstra et al. 1981) served as the basis for system-level methodology development at ICRAF (Raintree,1983). An interdisciplinary team , led by an anthropologist, adapted rapid appraisal and technology design procedures to agroforestry applications. Much of the initial development of the method and its further refinement were based on field experience in Kenya in cooperation with Kenyan government institutions and non-governmental organizations (NGO's). Field tests have also been conducted at several sites in Asia, Africa and Latin America through collaboration with national and regional institutions.

The diagnosis and design (D+D) methodology takes a problem-solving approach with an emphasis on farmers' priorities for fulfillment of basic needs (ICRAF,1983). The major needs categories are: food, water, fuel, cash, shelter and infrastructure, savings/investment, and social production. Initial rapid appraisal and technology design focussed on the individual farm as the management unit and on individual heads of household as farm managers.Agroforestry designs for prototype farms were intended to serve the felt needs of the household-as-a-unit within farm boundaries.

Recently ICRAF has devoted more attention to the division of labor, difference in interests, differential access to resources, and distribution of benefits within households and within communities. In the field tests of the D+D the potential applications and the needs for agroforestry (AF) technologies have often extended beyond and within the farming system as a unit. The problems encountered thus far on-farm and in rural development and watershed management projects have indicated the need for rapid appraisal, technology design and implementation at varying scales of analysis. Larger-than-farm analysis is particularly important for diagnoosis and solution of watershed problems (including conflicts in land and water use) soil and water degradation; development problems affecting the landless and near-landless; and use of common, public, and otherwise shared lands by farm households. On the other hand, intra-household analysis is needed to deal with environmental and production problems that affect household members differently based on age, sex, kinship and marital status.

For cases where the farming system has been identified as the primary focus, there is a need to identify and influence farming systems opportunities and limits that reside (or originate) in the next larger systems of which they are a part, or in sub-units of the farm household. A brief look at the next level in the hierarchy can indicate whether the external constraints on farming systems are changeable, and whether the sub-systems and/or larger systems are resilient enough to support

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such changes if introduced. Such constraints may be ecological or socio-economic. In the case of farming system dependence on opportunities within the larger system (abundant labour, free fuel, abundant water) the sustainability of these resources and their availability to the farm household must be considered. The mixed management of "free" goods such as water and fuel, with owned land, cattle and equipment, and the combination of family, communal and paid labour in many rural production systems requires a scale of analysis beyond the farm. Changes in farm technology may affect the larger systems and then feed back indirect impact on the farm household in the form of changing prices, availability or quality of basic resources (fuel, water, food, shelter, raw materials; or production inputs (agro-chemicals, labour, equipment). The results may also be a change in demand for farm products. Both production and sustainability of farming systms are subject to "boomerang" effects from technology change (farm-ecosystem-farm or farm-community-farm).

The interdependence between household members and the farming system is equally important. Intra-household units may vary according to circumstance, distinguishing between: men, women and children; wage-earners and non-wage earners; heads of household and "others"; producers and dependents. The differential demands of existing and new technologies on these groups, their distinct knowledge and skills, and the variable returns for their respective inputs will influence the welfare of the entire family and the farm as a whole.

Family composition affects both household and individual needs and priorities for AF interventions. Women, men, and children in the same household have different knowledge, interests and responsibilities with respect to specific land units and landscape features, specific plants and animals, and particular activities. Among households there are also distinct types; a woman-headed household with young children cannot be treated the same as a household with several adults (men and women) and school-age children. Neither will a given household remain static; future developments must be considered in AF technology design (e.g. land sub-division, marriage, out-migration, re-distribution of labour and control between men and women, or by age group). Projects geared toward specific farming systems or agroforestry production research per se would be concerned with ecosystems and intra-household analyses primarily in this context. Individual - farmhousehold - ecosystem interactions are viewed with respect to their eventual impact on the farm. A more explicit emphasis on sliding-scale (intra-household, farm, ecosystem, community, region) diagnosis and design is appropriate for regional development and settlement projects, and for special interest projects for fuelwood production, watershed protection, environmental rehabilitation or large scale diversification of agricultural and forestry production. All of these serve a broader client group than a particular type of farm household. Projects directed towards

women, children or specific socio-economic groups also require multiple-scale analysis.

There is, in fact, little doubt that we need to treat intra-household, community and ecosystem issues within agroforestry research for rural development. What is not so clear is just how to do this in a way that is practical, frugal and yields useful results for rural people. A first approximation variable scale D+D is emerging from observation, analysis and participation in field research projects in Kenya and elsewhere.

The most direct source of ideas, questions and results have been the continuous contact with farmers and the surrounding community in Kathama sub-location, Machakos District, Kenya. The Kathama project is a small methodology development project initially based on farming system surveys and on-farm trials of agroforestry innovations (Raintree, 1983; Rocheleau and Hoek, 1984; Vonk, 1983). ICRAF and Wageningen University collaborated in the initial field work and ICRAF is continuing the project (on a limited scale) as a vehicle for testing implementation approaches and viable scale diagnosis and design.

The experience from both the original trials and the variable-scale follow-up are presented in order to demonstrate the empirical and practical basis for the methodological and research policy conclusions which follow

This case illustrates the evolution of the methodology-in-general (Figs. 1 and 2) and the self-correction of the project and technology designs in response to social, economic, biological and physical performance criteria. The experience in this community also illustrates the general importance of social factors in existing production systems, and in the planning, testing and dissemination of new technologies. In particular, the project has called our attention to the need for designs that transcend farm boundaries, both within and without, according to both social and ecological criteria. More importantly, this case has provided the stimulus and the opportunity to refine diagnoses and to re-design technology trials to reflect within household and community level criteria within a farming systems project.

Initial Surveys and Farm Trials

Following a descriptive study of the local farming systems and a botanical inventory (Gielen, 1982; Fliervoet, 1982) ICRAF initiated a two year test of the D+D methodology (Vonk, 1983). The initial diagnostic exercise identified farm-level potentials and problems that could be addressed by agroforestry interventions (Figs. 3 & 4, Table 1). The farmers' objectives, basic household needs, current strategies for problem-solving, and available resources guided the design of promising agroforestry technologies (Raintree, 1983). Ten farmers agreed to test these "best-bet" options on their farms (Vonk, 1983).

The technology trials included species combination trials of promising multipurpose (exotic) trees, methods of tree establishment in cropland and grazing lands, hedgerow intercropping of Leucaena leucocephala and Cassia siamea with maize and pigeon pea to improve soil moisture and fertility, and fodder/fuelwood lots to produce high quality fodder at the end of the dry season. The study incorporated monitoring of labour inputs for establishment and farmers' reactions and suggestions during establishment and early growth. The changes suggested by farmers reduced labour for land preparation and provided a simple low-input alternative for rehabilitation of individual plants in small plots of grazed woodland (Vonk, 1983).

As information began to filter back from the continued monitoring of the 10 farm trials, there were strong indications of interaction between on-farm AF technologies and management of the surrounding environment. Three of the participating farmers attempted to propagate their own new seedlings for independent continuation and expansion of species trials, fodder lots, and hedgerow intercropping. Two of the three failed (and others refrained from trying) due to water shortage and difficulty of access to permanent water sources. The one participating farmer who succeeded in growing his own seedlings has had prior experience with a home citrus nursery and has a permanent water source on his property. For most families, however, access to water involves use of public sources.

While the hillside springs and the nearby Athi River are considered public domain, ease of access is influenced by location of owned property and means of transport. This implies a need to consider such differences between farms in planning for plant propagation, which may in turn influence AF technology designs and/or choice of species. Alternatively, plant propagation for some or all of the farms might be organized at the group or community level, near water-sources, on either a private or public basis.

Further discussions with farmers also raised the issue of within-household distribution of labour for plant propagation. While men were the main participants in the farm trials, women were required to collect and transport the water for seedlings in the farm nurseries, and the women were unwilling to continue this extra task when water shortage forced them to obtain the domestic water supply from the Athi River (2-5 km distance), carrying water on their backs in containers. This demonstrates the need to involve women as individual beneficiaries/clients, and to consult them about feasibility if they are to play the role of water-bearers for plant propagation.

Other issues of major importance that surfaced in farm trials included pest control, browsing damage by domestic and wild animals, and the need for protected fodder reserves. As in the case of water for nurseries, fodder production and animal management involves use of off-farm resources and the cooperation

of other farmers (control of herds and more careful management of gathering). Any interventions of this type would require a closer consideration of land tenure, use rights and terms of access to land, water and plants.

While most of the land in the study site was adjudicated over 10 years ago, exclusive use by one household applies only to cropland (permanent, terraced), home compounds and small grazing plots. Woodlands and large holdings of wooded grazing land are controlled by single households but are perceived as conditionally available to the larger community or to sub-groups thereof (Cantor, 1984). Many smallholders depend heavily on this system of discretionary common use of private land. They obtain most or all of their fuel, fodder, timber, thorn-fencing and minor forest products from off-farm sources. Access is unevenly distributed between households and also varies with seasonal and periodic drought, the latter being an emergency and considered just cause for granting broader privileges than usual. Use of such lands and terms of use vary considerably.

Gathering rights for fuelwood are seldom compensated. Most commonly the practice is referred to as "borrowing", with the understanding that "borrowers" take deadwood, small stickwood, and the least desirable species. Some gathering without permission also occurs in the denser, more remote woodlands (Cantor, 1984). Many larger landholders also grant dry-season grazing and browsing rights to several other households based on kinship or other social ties or in exchange for cash or services. When the cropping season ends, 'social fences" fade and roadside, woodland and gully sites provide grass, shrubs, and high-protein pods to supplement on-farm fodder. Changes in animal management for fodder tree protection would necessarily involve the community-at-large. Enrichment planting in public lands and common-use private lands would also require group decisions and maintenance.

While fodder and fuelwood are almost free goods, fencing material, timber and charcoal trees are perceived as commodities to be purchased directly. In some cases charcoal makers may rent access to land for tree harvesting and burning (Hoek, 1983). The favoured species for charcoal and timber also produce pods and/or leaf fodder, so these commercial activities impinge strongly on actual carrying capacity of shared lands for domestic animals and on the production of gathered food, fibre, medicines and fuelwood.

Group Activities/Watershed Trials

The D+D for the community and surrounding watershed was initiated as a separate, parallel study. It identified excessive runoff and soil erosion as major problems (Table 2) limiting individual farm production as well as threatening water supply and road networks throughout the area (Rocheleau and Hoek, 1984).

overharvesting of valuable multipurpose trees (acacia tortilis, terminalia brownii) for single-purpose exploitation (charcoal) has also depleted common-use and shared sources of fodder and forest products for the community-at-large. Overgrazing, overstocking, and lack of alternatives for cash earnings and savings/investment also contribute to economic hardship and ecological instability throughout the Kathama sub-location (Table 2).

The drainage network emerged as the predominant structural landscape feature in need of stabilization; it formed the basis for further stratification and detailed study at the Kathama site. A more detailed qualitative analysis, including informal interviews, cartographic analyses, aerial photographic interpretation and detailed field observation, was conducted in three small catchment sub-units. The detailed landscape analysis identified the major sources of excessive runoff, points of concentration, and sites of sheet and gully erosion (see Hoek, 1983 and Rocheleau and Hoek, 1984 for detailed maps, discussion and technology designs). Most residents are aware of these problems and their causes. Some have constructed cut-off drains and check-dams in gullies to prevent or contain gully erosion, and most farmers have terraced their croplands; much of the construction on and off-farm has been carried out by self-help groups. Gully and drainage control structures appear on private, public, and boundary lands, usually at or near the site of damage to roads, paths, homesites, or cropland. In spite of interest and awareness, the overall drainage work is ad hoc and represents the cumulative (and often unanticipated) effect of many separate decisions and actions by groups and individuals upslope on the private and public land and water resources immediately downslope.

The watershed level D+D exercise indicated additional needs for multipurpose trees as well as for better planning of the soil and water conservation aspects. Discussions with individuals and women's groups about fuelwood and fodder availability and management revealed that smallholders rely very heavily on off-farm fuelwood and fodder sources and many consider fuelwood supply a problem. The current role of gully sites as off-farm grazing lands and fuel wood sources for many households, further strengthened the cause for maintaining these productive functions at such sites under a sustainable system.

Other "leverage points" for application of AF or combined AF/soil and water conservation technologies included: the degraded hillslope grazing lands (sources of excessive runoff and sources of fuelwood and fodder for many households); the roadsides and boundaries (often under-utilized, and also points of concentration and channels for runoff); soil conservation structures on croplands (often unstable and/or unproductive); and home compounds (points of concentration for runoff, convenient for closer management/protection of plants). The resulting integrated landscape design in cross section view (Fig. 5) shows

the fit of these technologies into a productive sustainable agricultural landscape.

In order to better evaluate the feasibility and probable effects of the proposed design, a parallel ecological and spatial analysis was conducted to quantify some of the existing conditions and potential changes in a representative small watershed on the Kanzalu Range. Results included areas of different land use and land cover categories, the total length and area of various linear landscape features and the relationship of various land cover types (including linear features) to runoff, erosion and production problems and potentials (Table 3). The analysis also extended to the functional relationships between various structural landscape features, land uses, land tenure and family composition.

Household surveys (Cantor, 1984) indicated a marked division of labour, control and interests within and between households, with respect to present and future management of fuel and fodder supplies and the wooded grazing lands in general. Based on qualitative and quantitative analyses of the survey (Rocheleau and Cantor, forthcoming) two major criteria differentiated the households with respect to needs, priorities, and available resources for AF technology development: size and quality of landholdings (eg. land value and productive potential) and family composition (male vs. female-headed, male vs.female-managed, and number of resident family members of working age) .

The land size and quality was closely related to the division between "borrowers" and "lenders" of fuelwood and grazing land. There is a general division of interests between the two groups, with the former needing to integrate subsistence production of fuel and fodder into intensified food and cash crop production on their limited smallholdings. and the latter tending toward conversion of lands currently used by borrowers into crop production or private fodder-and-woodlots (all semi-commercial enterprises).

Cutting across this land-based division of interests are three types of households with labor-based differences. Within this watershed 33% of the households are headed by women, 47% are headed by men, and another 20% are managed by women.In the latter case the male head-of-household lives and works away from home, returns at intervals ranging from monthly to annually, and retains varying degrees of decision-making authority in the household. The women are farm managers and make most or all of the day to day operational decisions, but consult or defer to the men in planning decisions (eg. new cropping systems or land uses).These types of households would usually be designated "male-headed", but have very distinct needs, constraints, and resources compared to households with resident male heads. With few exceptions , woman-headed and woman-managed households have less labor available than those headed by men,have different priorities for allocation of labor (subsistence vs commercial; domestic vs whole-

farm; group vs. farm), and have different types of labor exchange and other reciprocal arrangements for use of grazing land, fuelwood, and draft power.

Smallholder households headed or managed by very young or very old women present both a challenge and a special opportunity to AF research and extension in this area. These women are extremely limited by labor (often only their own) but even more so by lack of mobility and time. Mothers of very small children, and older infirm women were particularly interested in concentrating fodder and fuel resources (currently gathered off-farm) on croplands, home compounds, small lots, and boundaries. The additional real labor for establishment and management (including fodder lopping) would be more than compensated by the accommodation of their mobility and time constraints for off-farm activities.

These household types are more than academic categories; they imply distinct sets of technology designs and landscape niches at the farm level, and set the context for reconciliation of conflicting interests at the community level in watershed scale designs, land use plans and project organization. While men-headed largeholder households want timber, cash crop trees, and living fences to better protect their croplands and grazinglands, the smallholder women-headed households want fodder and fuel close to the home and low-input cash crops that can combine with food crops and that can also be consumed on-farm. The first group may well lead the way in grazing land improvement, sylvo-pastoral technologies, and development of commercial tree crops, while the latter group are the logical choice to pioneer intensive production of fodder and fuel in croplands and on boundaries , and introduction of multi-purpose cash and food crops into subsistence cropping systems. These two contrasting groups with conflicting interests illustrate the potential for design of complementary technologies at the watershed and community scales. Recognizing that the conflicts may not always be easily resolved, and new ones may develop later, the survey information was used for grouping clients, stratifying designs, and integrating research and project management to serve the groups separately, within a larger context of landscape design.

While the potential benefits of the AF designs were estimated during the first cycle D+D (Rocheleau and Hoek, 1984), several questions remained as to feasibility, and distribution of costs and benefits, given the existing conditions and practices in Kathama. These questions were left to the second cycle of D+D, on-site trials with self-help groups and selected households (to complement the continuation of the second cycle on the original 10 farm trials).

The team initiated a small pilot project within the Kalama catchment to further explore the research methods, technologies and organizational activites necessary to implement the landscape design within the D+D context. The exercise also provided a

practical context in which to test and evaluate the method, the design and the component technologies for application in similar environments in the Machakos District (ranges and hillslopes, Zone 4). The specific objectives of the pilot project were: 1. to develop AF methods suitable for implementation, monitoring and evaluation of larger-than-farm scale group projects; 2. to build rapport with the groups and assess their organizational and technical capabilities and potential; and 3. to modify AF designs and implementation plans to fit "2".

The implementation consisted of weekly work sessions with five self-help groups at two sites chosen by the team and the groups respectively. An analysis of the time and labor required to implement the original design revealed a vast discrepancy between group capabilities within the public works context, and the demands of the overall plan. How-ever, the entire emphasis on public works was repudiated by the qualitative information from observation of, and participation in, group work sessions.

The groups were found to be small associations of individual households (20-50) engaged in exchange/rotation of services and pooling of resources for the benefit of individual members and their households. While the results of the household survey confirmed the importance of group labor for individual management, they also revealed a defacto exclusion of some types of households from participation in group activities and benefits. Women heads of small households (usually very young or elderly women) who were isolated geographically from relatives and/or the community -at-large, reported being unable to attend group activities due to limited mobility (due to sole responsibility for child care and domestic work,or due to ill health). By contrast, some of the wealthiest and/or largest households found group membership unnecessary. The self-help groups are thus not fully communal in either objectives or in composition. As in other AF studies (Dove,1983) the difference between communal groups and associations of independent households proved critical to project and technology design.

The groups requested changes in the work schedule, organization and choice of sites, because too much time was being spent on the property of non-members. Even on members' farms the groups cannot spend several consecutive sessions at the same site, but must maintain some semblance of rotation. While they might undertake gully repair at any site that impinges on members' lands or at sites where public roads and schools are threatened, the groups still find continuous long term investment at any one site unacceptable. Moreover, the group leaders insisted that future activities be limited to one or two groups, rather than the combination of five groups as was the arrangement for the first season. They blamed much of the problems in the group trials on inter-group rivalries (Mwendandu, 1983).

During the course of the group work the participants requested seedlings for their own farms and negociated group soil

conservation labor as an exchange for 15 seedlings (sampler package, multiple species) for each member. On-farm and group follow up during the subsequent planting season (no public works at that time) resulted in requests for a switch to nurseries for individual groups (located near water, at a member's home), to supply seedlings for group members' farms. Farm planting results showed that while most people planted all of the trees they were issued, they reserved the cropland sites and special care for fruit and fodder trees. Timber and shade trees planted on the home compound also received special care in some cases.

Trees planted at soil conservation sites were protected, if at all, by property owners, not by the groups as such. Since one of the two sites was badly degraded, poorly protected, and traversed by water collection and cattle paths, most of the planted seedlings died. However, the small water-harvesting structures made by the groups did foster improved growth of the natural vegetation (especially grasses and small Acacia tortilis trees). The property owners also managed to protect some of the planted grasses and seedlings located close to the home. At the other site the owner took full responsibility for planting and protection and converted a small plot just adjacent to the group site into an individual farm trial of AF for fodder and wood production and rehabilitation of a gullied grazing land.

The results from this first cycle of group tree planting influenced the choice of species and planting sites for the seedlings produced in the group nurseries the following season. After the focus of the group activities shifted to plant propagation for members' farms, two more self-help groups asked to join the project. While some groups continued to ask for advice on placement and construction of soil conservation works, they gave priority to nursery construction and plant propagation activities (fruit trees and a mixture of fodder, fuelwood and timber trees). Some groups also recruited new members interested specifically in seedlings and grasses for their farms, including one farm trial participant who expanded his fodder lot.

Integration of Group and Farm Trials

Although it was not originally planned, the farm trials and group activities became closely linked as a result of actions and decisions taken by the individual farmers and the groups themselves. They established complementary domains of group-based and household-based AF activities (tree propagation and planting is a new class of work) and they set limits on the scale of community-level group collaboration (one nursery per group, with some joint training and evaluation activities and occasional joint public works activities with tree-planting and soil conservation). This, in turn, established the social terms of reference for the further development, testing and dissemination of AF technologies in the area.

Farm trials combined with group activities had several advantages. It allowed the farmers (especially women) to speak more freely as part of a majority, when dealing with researchers or with their own families. It also stimulated new ideas and sharing of new technologies suggested by group members.

The nursery activities served to train individual farmers in the full cycle of plant propagation, and at the same time provided a forum for training and discussion re: tree planting, choice of species and sites, and management of AF technologies on-farm. The farm trials, on the other hand, provided a kind of AF "sampler" that allowed farmers (individually and in groups) to observe and discuss results within the realistic context of a neighbor's farm. People were better able to choose species (indigenous and exotic) and to consider alternative planting arrangements and management techniques, once they could see what the new trees and shrubs looked like, and how these and indigenous trees performed in new niches on-farm. The group members also contributed to the farm trials by their honest appraisal and constructive criticism of the trials; they often helped to elicit suggested modifications from the more timid or biased individual farmers.

Out of this consultation and testing came a suggested change of emphasis from alley cropping for mulch to alley cropping for fodder and fruit, with wider spacing between hedgerows. To improve soil fertility most farmers prefer concentrated mulching of cattle pens (pre-composting) with tree biomass from fencerows and dispersed trees in grazing land (a few are still interested in widely spaced hedgerows for mulch). The groups and project team also began a search for indigenous wild fruits and exotic drought-resistant marketable fruit compatible with food cropping systems and/or live fences (on inside of living fences or on internal boundaries). Both groups also initiated a search for tree-based pesticides available in the area, with the help of KENGO foresters and local herbalists. The relationship of these and other research lines to the original D + D are outlined in Table 9. Aside from these specific prescriptions for research, several general conclusions can be drawn from this experience.

Lessons from Kathma

Both farm and watershed (group) activities converged on the gap and false dichotomy between treatment of farm and larger-scale units. These themes were common to both activities:

1. the need to mobilize group labor, group skills, group learning and shared access to land and water, to support productive AF technologies on-farm (for the benefit of individual members and households);

2. the need to better integrate women into the initial D+D and farm trials and to better serve their interests in technology design and in organization of group trials/activities;

3. the need to better address questions of shared use and sustainability of farm production and to consider the production benefits to individuals from off-farm, public and shared lands;

4. the need to adjust technology designs for different production objectives and different levels of access (within households and between households) to the means and fruits of production (on and off-farm);*

5. the need to plan with farm families and community groups for technology and landscape designs that can adapt to ** land subdivision, labor pool fluctuations, land use conversions, migration, and other aspects of household and community developmental cycles.

* One appraoch would be to design separate AF options for each level of access and domain of control. Another solution would be to integrate complementary resources of different groups, whether at farm or larger-than-farm scale. Feasibility of separate vs. integrated designs will vary, depending on the existing distribution of resources, control over them, and access to them.

** In many cases the technology and landscape designs can also help to determine the future of the system by stabilizing development cycles, particularly with respect to land subdivision and land use conversion.

basis of control and ownership (Peters,1980; Roe and Fortmann,1982), and the codes of group decision-making in "communal systems" contrast sharply with both large scale commercial farm management and individual smallholder practices.

Issues of community and intra-household resource management impinge heavily on individual behavior re:management of animals, fodder, fuel and water collection, land preparation and demarcation, and seasonal migration. While the extensive grazing systems are the most widely recognized examples of communal tenure and management, similar issues arise in the management of water-harvesting, small-scale irrigation, contouring, dry season fodder banks, tree crops, and introduction of new annual crops and new practices. On-site work in communal systems will require interdisciplinary expertise, and an approach that goes beyond household-based research to treat community and within-household questions of tenure, water rights, grazing and collecting rights (fuel, food, fodder, fibre, dung). The challenge is to integrate such information into self-correcting research and rural development programs that can change to accommodate new information, new questions, and not-so-neatly nested sets of clients-as-participants.

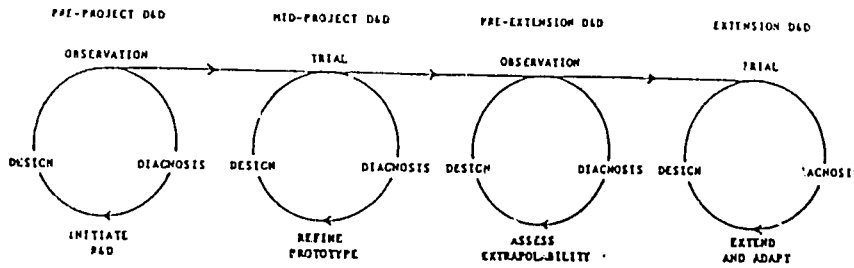


FIG. 1 : D&D AS AN ITERATIVE PROCESS IN THE PROJECT CYCLE
(Source: Raintree, 1983; ICRAF, 1983)

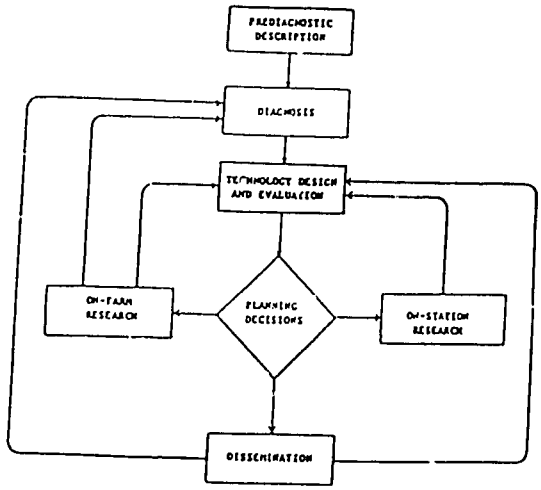


FIG. 2 : DIAGNOSIS AND DESIGN (D&D) PROCESS
(Source: Raintree, 1983; ICRAF, 1983)

D&D is an iterative process which continues throughout the life of a project as part of its internal guidance system. Note feedback linkages.

TABLE 1 SUMMARY OF FARM LEVEL DIAGNOSTIC AND DESIGN INDICATIONS FOR A TYPICAL FARM (3.5 ha) AT THE KATHAMA RESEARCH SITE. (From Vonk 1983, Raintree 1983)

KATHAMA
MACHAKOS DISTRICT
KENYA

SITE SUMMARY OF AGROFORESTRY DIAGNOSIS AND DESIGN INDICATIONS ON A REPRESENTATIVE FARM

SITE DESCRIPTION	LAND USE SYSTEM DIAGNOSIS		AGROFORESTRY POTENTIALS
	HOUSEHOLD SUPPLY PROBLEMS	PRODUCTION CONSTRAINTS	
Climate Semi arid-sub-humid **Soils** Sandy loams over sandy clay loam to sandy clay; imperfectly drained in places **Farming System** Mixed farming **Crops** Maize, beans, pigeon peas, cowpeas **Livestock** Zebu cattle, goats and sheep **Economy** Subsistence farming **Population Density** 172/Km^2 **Growth Rate** 3.4%	**Problems in Basic Needs Supply Sub-Systems** **FOOD** - Seasonal staple food shortages normal, must purchase; drought related crop failure on avg. of once in every five years; low milk and meat production due to dry season feed shortage for livestock **FUEL** - Insufficient production from own land, must purchase fuelwood for household and cottage industry uses; lack of large trees for brick burning. **SHELTER** - Lack of construction quality timber and poles, must purchase; lack of large tree for brick burning; lack of fencing and shade trees. **RAW MATERIALS FOR HOUSEHOLD INDUSTRY** Must purchase fuelwood for brick making. **CASH** - Low net household income due in part to cash outflow for staple foods, fuelwood, and construction wood; savings and earning potential of livestock enterprise limited by dry season feed shortage **CONSERVATION PROBLEMS** Erosion Declining Soil Fertility Degradation of grazing land vegetation	**Antecedent Causal Factors** **Crop Land** 1. Low fertility and declining yields 2. Lack of manure 3. Low available moisture 4. Oxen too weak for dry season ploughing/planting; hence inefficient use of limited soil moisture. 5. Soil erosion and water loss due to heavy runoff. 6. Waterlogging on low spots 7. Labour bottleneck at ploughing and weeding time; 8. Insect pests. **Grazing Land** 1. Small grazing area 2. Insufficient dry season feed production. 3. Insufficient production of fuelwood **DESIGN CONSTRAINTS** Low capital Low available labour Long dry season, frequent droughts Termites & other pests	**Specific Problem-Solving Agroforestry Potentials** 1. Elimination of dry season feed gap by planting of multipurpose fodder trees in grazing areas and as hedgerow in cropland with concomitant erosion control effects and fuelwood and mulch coproduction possibilities; improved feed situation should allow dry season ploughing/planting. 2. Cut-and-carry fodder trees for increased pen feeding and usable manure production. 3. Alley cropping/mulch farming with leguminous and other trees to control erosion, increase water infiltration, conserve soil moisture, improve soil fertility and structure, reduce the need for tillage and lessen the labour requirement for weeding, insect repellence 4. Hedgerows and living fences of high-yielding fuelwood species and fruit producing thorn bushes (as a hedge against famine in bad years, for supplementary livestock feed in average years). 5. Multistorey fruit trees with undersown grass-legume pasture.

Table: 2

SUMMARY OF AGROFORESTRY DIAGNOSIS AND DESIGN FOR THE COMMUNITY AND SURROUNDING WATERSHED

SUPPLY PROBLEMS	SUSTAINABILITY PROBLEMS	CONTRIBUTING FACTORS	AGROFORESTRY POTENTIALS OF COMMUNITY LEVEL
FOOD - Low grain yields throughout sub-location; dependence on imports from other districts, food relief in drought years.	Declining yields predicted on existing crop land; poor yields and land degradation anticipated for newly opened marginal lands.	High cost of fertilizers, inadequate supply of manure, and low soil fertility; inadequate labor for weeding at peak demand periods; introduction of grain crops inappropriate to ecological zone; expansion of grain crops onto marginal sites (steep, dry, gullied).	Promote fruit and nut trees to supplement diet through group nursery projects. Mix group vegetable gardens with tree nurseries. Promote mulch (green manure) strategy through group participation in farm trials to determine best species, management.
WATER - Inadequate supplies for domestic and agricultural use; uneven distribution of access by wealth, relative location; inadequate development of municipal sources	Existing water sources subject to deterioration by siltation, flooding lowered water table.	Excessive runoff on grazed lands upslope reduces infiltration and groundwater recharge; floods and siltation plague impoundments, dry river-bed wells.	Use group contacts to locate nurseries, veg. gardens at permanent waterholes on group member's property. Combine water-harvesting with AF experiments using available materials, soil conservation groups; use MPT's and grasses to protect impoundments.
FUEL - Charcoal and brick-burning trees scarce throughout sub-location; high expenditure of time and labor to procure fire-wood; uneven distribution of quality, quantity by land facets, farm size.	Browsing keeps trees at shrub size; Degradation of source areas (soil compaction) is preventing regeneration of favored species.	Overgrazing hillslope woodlands and small plots downslope by all households on slope.	Promote zonation of fuelwood production on upper slope, trade for food; convert selected gullies to ravine woodlots (fodder lots if controlled access). Increase fuelwood production in boundary lands of finely sub-divided landscape.
INFRASTRUCTURE - Drainage roads inadequate to service sub-location; lack of integration within each network and between networks.	Existing roads, drains, crossings threatened by gully erosion, siltation individual (piecemeal) decisions to modify drainage and paths.	Frequent movement of cattle upslope causes severe gullies in midslope woodlands; flash floods remove even trees in gullies; use of sledges for water carts erodes roads, disrupts drainage.	Divert drainage from selected drainage channels to croplands and/or fodder lots. Use vegetation (MPT's, grasses) to define and stabilize permanent drainage and road network, while producing poles, fuel.
RAW MATERIALS - Commercial charcoal and brick-burning tree sources depleted throughout sub-location; shortage of construction poles - purchased from other locations.	Degradation of source areas in over-grazed over-harvested woodlands is preventing regeneration of pole wood species; degradation will hamper future efforts to re-establish favoured species.	Lack of training and infrastructure (physical and organizational) to propagate desired species within the sub-location.	Plant polewood trees on internal farm paths and along roads. Integrate charcoal and brick-burning trees into ravine woodlots, fencerows Develop nurseries, seed collection with self-help groups.
CASH - Reliance on charcoal as cash crop by poor small-holders; almost no off-farm employment; marketing disadvantage relative to nearby towns; remittance income from absentee men sporadic.	Remittance income dwindles, becomes less dependable with time away, and rising urban unemployment; charcoal stock being depleted in adjacent source areas - enterprise not sustainable as is.	Land cannot accommodate new full-sized holdings of young families, food crops given priority; promoted cash crops high risk for zone (cotton), market for other cash crops unreliable.	Integrate fruit (citrus, guava) and nut (macadamia, cashew) trees into terraced cropland, with concurrent organization of market channels already used by a few farmers. Integrate training into group trials, nursery work.
SAVINGS/INVESTMENT - Dry season fodder gap forces [illegible] of goats, sale or loss of cattle; land prices prohibitive - shortage of arable plots.	Degradation and subdivision of grazingland; widespread conversion of grazing areas to cropland preclude maintenance of herd size under current practice.	Best dry season fodder trees (pod trees) have been harvested for charcoal; animals allowed to range freely during long dry season; land conversion to crops.	Use MPT's to sub-divide larger grazing lands for rotation. Use N-fixing species planted in strips or microcatchments to reclaim degraded grazing areas; Plant pole trees for cash on farm and along roads, with tree rights assured (group, individual, through chief)

Table 4a. Original D&D

ORIGINAL DIAGNOSIS	ORIGINAL DESIGNS	RESEARCH PRIORITIES/PROGRAMS
FARM LEVEL		
Cash Problems		
Poor animal production due to dry season fodder gap;	Enrichment planting in grazing lands	Establishment trials, several spp; various site preparation planting, and mgt.techniques.
High seasonal cash outlays for staple food purchase	Fodder and fuel lots (cut and carry) on small unused plots	Same as above diff-ent spacing and land pup. .technique
Off-season animal sales due to both of above.	Multistorey fruit tree stands over grass and legume cover(fodder)	(low priority)
FOOD PRODUCTION PROBLEMS		
Low yields and crop failures Soil capping - late tillage; poor soil moisture;poor soil fertility;soil erosion.	Hedgerow intercropping for mulch, (with N, O.M. additions and protective cover for better soil moisture,lower temp.) and stick wood as by-product	Cassia siamea and Leucaena leucocephala at 2.5 m between-row and 0.5 m in-row with maize and pigeon pea, on cropland.
FUELWOOD SHORTAGE		
High dependence on off-farm sources; fuelwood purchase,charcoal tree purchase by some.	see above, plus: Hedgerows and living fences with fruit bearing spp. and high - yielding fuelwood spp.	spp. trials along fencelines and in lots (low priority)
COMMUNITY LEVEL		
Cash		
No facilities for plant propagation marketing, and farmer training to support farm level technology tested (above) at farm level. Degradation of grazing lands.	Provision of "sampler" seedling packages (13 spp.) and some training to group members in soil conservation projects.	Follow-up to seedling distrib. on 60 farms re: survival and placement by spp. Qtrly follow-up at 30 farms re: performance, damage, maintenance,farmer assessment, farmer learning.
Net purchase of construction wood from other communities.	Involvement of groups in establishment of fodder and timber spp. upstream of gully sites.	
Food		
Inadequate storage & credit & mktg. facilities at community level.	Low priority	Not pursued
Degradation of gathering sites	See survey, below	Interviews with groups re: wild fruits and other foods preferred spp.? dwindling ssp? (in amt.or access)
Fuel		
Depletion of favoured spp. for fuel and charcoal in Kathama itself, and uneven distribution of what remains.	Distribution of sample fuelwood spp. see survey below.	Follow-up of sampler seedlings as above, special attention to fuelwood spp: suvival? willingness to plant more? where on farm?
Savings Investment		
Need community-level support for improved savings mechanisms; alternative investments	Low priority	Informal polling of groups re: alternative investments, group savings,preferences of farmers.
Disinvestment in land resources and infrastructure at community scale (degradation of grazing and gathering lands,water supply, roads and paths)	Involvement of groups in resting AF(fodder and fuel trees with grasses, and living structures) into public soil conservation works.	
	No design pilot [illegible] on use of off-farm resources (water,fodder, fuel groups labor [illegible] materials)	

Table 4 b. Revised D&D

Feedback D&D

From Farm Trials

- Hedgerow intercropping is still risky mainly due to apparent water competition esp. with pigeon pea, but farmers interested in "Zonal mulch".
- Pest control, water harvesting and browsing damage problems on grazing land left most farmers with mgt. of existing trees as best option.
- Water supply for on-farm nurseries poses a problem for most individual farmers - public supplies or access to others' private supplies is needed for nurseries (if seedlings used).

From Groups

- Groups are not public works or purely communal in orientation; they are associations based on exchange/rotation of labor on members' lands to benefit individual members and families.
- Follow-up of "sampler" seedlings indicated greatest interest in fruit trees and fodder trees, both on croplands (for estab. and protection)
- Group requests for nursery project, participation and results show need for training plus simpler, cheaper methods of plant propagation, and pest control(confirms fruit and fodder priority; would consider local wild fruits)

- From surveys plus Interaction of Groups and Individual Farms:

- There are 3 main design client-groups;

1. Labor-short, land-poor, limited mobility families.
2. Largeholders interested in investment over long term .
3. medium-small holders interested in mixing fruit trees ,fodder,improved practice into cropland.

- Subdivision of lands is a critical issue, as is land conversion; we need to plan present placement and spacing of trees accordingly.
- Use of boundaries is especially important to smallholders, as is use of gullies, roadsides are also heavily utilized by same, but lack definition re: rights of use (for example, for new trees). Women and poor men may be able to use gullies and fencerows. Most are willing to start with fencerows.(for fuel, timber)
- Some members have tried boma-mulching(pre-composting with tree biomass in corrals) and some have pits for rough-composting, other group members interested in increasing "Manure" yield from corrals.

Changes in Research Programs and Priorities for Farms and Groups

Priority 1:fruit trees in cropland and internal fencerows. questions:spp? spacing? combinations?mkts? processing or storage? multiple uses? (food, cash; fodder and fuelwood by-products?

Priority 2:fodder trees in cropland, intercropped or in small plots (one terrace)

questions: spp? spacing on risers? or in lots? fodder production? effect on crop production? cut vs. once-a-year browse?

Priority 3:Use of tree biomass for pre-composting (" boma mulching") and composting (combine with fuelwood production).

Question: fencerow or dispersed trees? best spp.? timing? quantities? labor input? nutrients and O.M. in mix? effect on soil? yields? farmer assessment.

Priorities for related systems research (support)

Priority - 1a. propagation methods with and without nurseries (e.g. cuttings, direct seeding; and bare-root and stumping)

1b. Pest control for propagation, establishment (local resources)

Priority 2:serves 1, 2, and 3:should be included in each case. Landscape planning with families and groups, accounting for access to,and ownership of, different places within -farms and within - communities.

Time-series planning to account for tenure and access shifts, land subdivison and land use conversion at farm and community level. Develop and propose various components, mixtures, arrangements and social organization options, determine with clients most acceptable avenues to pursue, then monitor performance as-per-usual in 1, 2, 3 above.

Priority 3:also serves 1, 2, 3 and 2 above (landscape) Training and Extension approaches- assessment of alternative approaches and techniques (for Kathama and other similar areas) decision points, and decision criteria (usable by research, development, and extension field personnel).

B

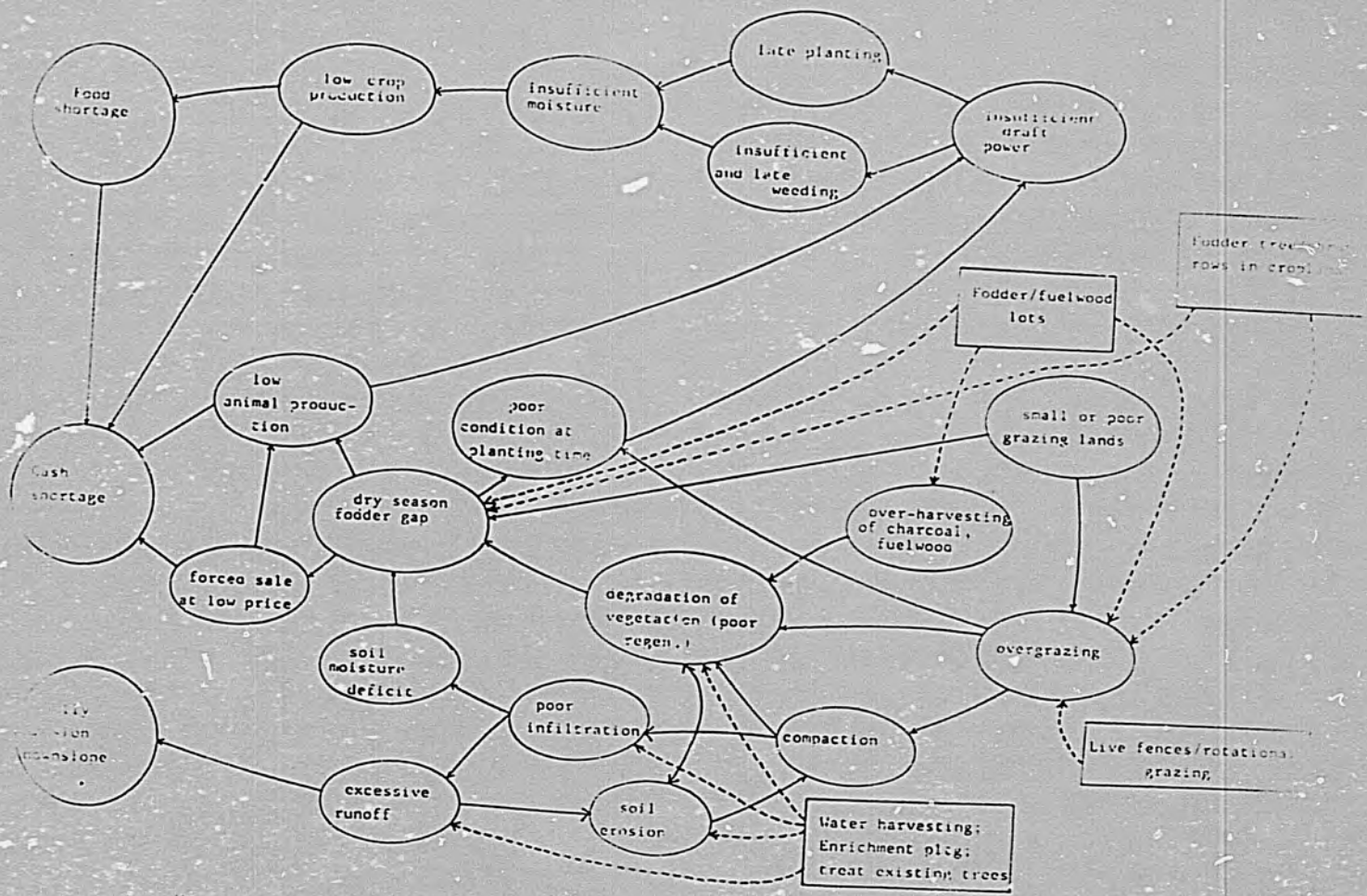
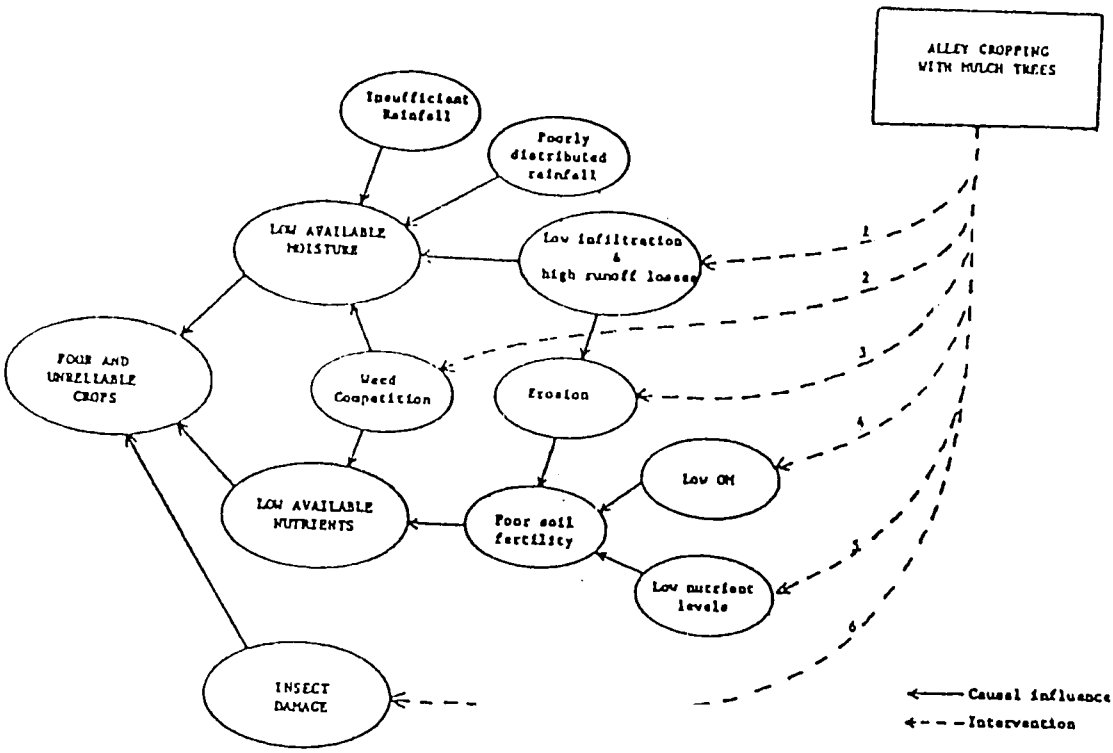


FIG. 3 : CAUSAL DIAGRAM OF ANIMAL PRODUCTION PROBLEMS AFFECTING FOOD AND CASH SHORTAGES.

(Adapted/updated from ...)



Potential Mulch Trees

N-fixing	Insect-repellent
Leucaena leucocephala	*Adhatoda vasica*
Mimosa scabrella	*Azadirachta indica*
Sesbania bispinosa	*Derris indica*

Potential Interventions

1. Improved infiltration, reduced runoff
2. Weed control with reduced labour
3. Reduced splash and runoff erosion
4. Increased organic matter
5. N-fixation and nutrient pump action of deep penetrating roots
6. Use of insect-repellent mulch species.

FIG. 4 . DIAGNOSIS AND DESIGN - CAUSAL DIAGRAM

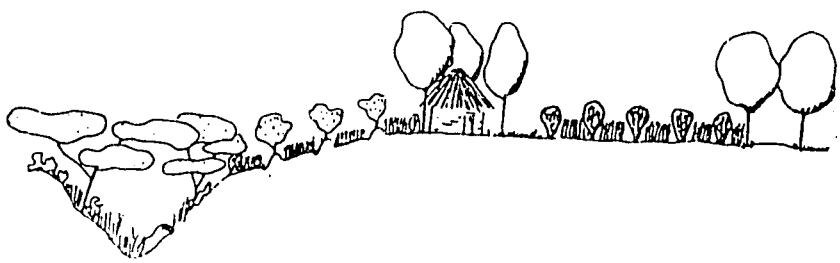
The partial causal diagram depicts causes of food problems in the mixed farming system of Kathama, with suggested technological interventions. (Source: Raintree, 1983).

FIG. , : INTEGRATED AGROFORESTRY SOLUTIONS NESTED IN THE LANDSCAPE

Tree, shrub and grass combinations

on the farm

on boundaries, in gullies and along roads



Landscape Niche Affected:

Gully and grazing lands		Cropland	Home compound	Internal boundary zone	Cropland	Road
erosion control in gully and grazing land for: Improvement of the drainage condition by -checkdams and natural vegetation - control of grazing and improvement of grass, fodder and fuelwood production	Living fences	grass and fruit trees on the benches of the terraces for: -erosion control -improvement of fruit, fodder, wood and grass production	trees around the home and boma (corral) for: fodder production, shade, shelter and decoration	grass for: erosion control, production of fodder	hedgerow system: trees are planted in rows between the crops to: -provide mulch, fodder and wood -control erosion, improve drainage condition	trees along the road or path for: shade and decoration, improvement of drainage condition

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