SHRUBS AND TREE FODDERS FOR FARM ANIMALS

PROCEEDINGS OF A WORKSHOP IN DENPASAR, INDONESIA, 24 – 29 JULY 1989

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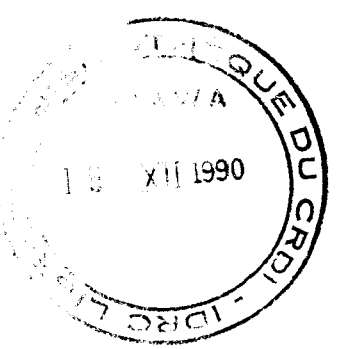

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Abstract

This publication presents the results of an international meeting held in Denpasar, Bali, Indonesia, 24–29 July 1989, that focused on the use of shrubs and tree fodders by farm animals. Through 26 papers, the workshop addressed feed-resource availability, use by ruminants and nonruminants, processing methodology, economics, and development issues. These aspects and the current knowledge on shrubs and tree fodders were further highlighted by country case studies detailing prevailing situations and policy matters. A special session was held to discuss the successful development and results achieved in the three-strata forage system in Indonesia. The workshop concluded with important working group discussions on the priorities for further research and development, and on the potential for the wider use of shrubs and tree fodders in the developing world.

Résumé

Cette publication présente les résultats d'une rencontre internationale tenue à Denpasar, Bali, Indonésie, du 24 au 29 juillet 1989 et qui a porté sur l'utilisation des arbustes et fourrages végétaux par les animaux d'élevage. Les 26 communications qui y ont été présentées traitaient de la disponibilité des ressources alimentaires pour les animaux, de leur utilisation par les ruminants et les non-ruminants, des méthodes de transformation, des aspects économiques et des questions du développement. Ces sujets et les connaissances actuelles sur les arbustes et les fourrages végétaux ont ensuite été étudiés plus à fond dans le cadre d'études de cas de divers pays exposant les circonstances particulières de chacun et les questions liées aux politiques. Une séance spéciale a porté sur la mise en place et les résultats des systèmes de production de fourrages végétaux en trois strates en Indonésie. L'atelier s'est terminé par d'importantes discussions des groupes de travail sur les priorités de recherche et de développement pour l'avenir et sur les possibilités d'utilisation élargie des arbustes et des fourrages végétaux dans les pays en développement.

Resumen

Esta publicación presenta los resultados de una reunión internacional celebrada en Denpasar, Bali, Indonesia, del 24 al 29 de julio de 1989, y la cual centró su atención en la utilización de forrajes elaborados a partir de arbustos y árboles para alimentar a animales de granjas. En 26 trabajos presentados al seminario, los participantes abordaron temas tales como la disponibilidad de recursos alimentarios y la utilización de los mismos por rumiantes y no rumiantes, metodologías de procesamiento y cuestiones de economía y desarrollo. Estos aspectos y el conocimiento que se tiene actualmente sobre los forrajes de arbustos y árboles se vieron subrayados aún más por estudios de casos por países en los que se detallaron situaciones existentes y cuestiones de políticas. Se celebró una sesión especial para discutir el desarrollo y resultados exitosos alcanzados en Indonesia con el sistema de forraje de tres niveles. El taller concluyó con importantes discusiones de los grupos de trabajo sobre las prioridades existentes en el campo de la investigación y el desarrollo y sobre el potencial que encierra la amplia utilización de arbustos y árboles en el mundo en desarrollo.

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Session IV: Country Case Studies

Session V: Processing, Methodology, and Economics

Development and evaluation of agroforestry systems for fodder production

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Abstract *— Agroforestry, which integrates tree management, food production, and environmental conservation, has a potential role in rural development. This paper outlines how agroforestry systems that incorporate fodder production as a main objective can be developed. It focuses on the basic criteria to use, species selection, management practices, and the advantages and constraints involved. A method of evaluation and strategies for future consideration are also discussed.*

Résumé *— L'agroforesterie, qui associe la gestion des arbres à la production alimentaire et à la conservation de l'environnement, a, potentiellement, un rôle à jouer dans le développement rural. Les auteurs donnent d'une manière générale comment créer des systèmes agroforestiers dont la production de fourrages est le principal objectif. Ils s'attachent aux critères à employer pour choisir les espèces, aux méthodes de gestion et aux avantages prévues et aux obstacles à prévoir. Ils discutent également d'une méthode d'évaluation et de stratégies à envisager.*

Resumen *— La agroforestación, que abarca la explotación de árboles, producción alimenticia y protección del medio ambiente, desempeña un papel importante en el desarrollo rural. Este trabajo expone de qué manera pueden desarrollarse los sistemas agroforestales para los que la producción de forrajes es el principal objetivo. Se concentra en los criterios básicos de los regímenes de explotación, selección de especies, y las ventajas y limitaciones que involucran. También se efectuó el análisis de un método de evaluación y estrategias para su posterior consideración.*

Introduction

The need to increase food production to meet the demand of rapid population increases is a major problem faced in most parts of the world, especially in developing countries. The problem has been aggravated by shortages of arable land for agricultural activities because of biophysical and environmental constraints.

One approach to solving the problem of food supply has been to formulate appropriate technologies for various land-development strategies. Our increased understanding of tropical environments (social and ecological), based on practical experience and scientific knowledge in related disciplines (agriculture, forestry,

ecology, soil science, and rural economics), has led to alternative approaches to land development.

Consequently, because the role and value of trees and other woody perennials is being increasingly recognized in the everyday life of the rural population, agroforestry systems have been developed and described (e.g., Escalante 1985; Johnson and Nair 1985; Michon et al. 1986; Poschen 1986). Common agroforestry systems include agrisilvicultural (trees and crops), silvopastoral (trees and livestock), and agrisilvipastoral (trees, crops, and livestock) systems.

For fodder production, silvipastoral and agrisilvipastoral systems are predominant. Torres (1983) recognizes these systems as "animal agroforestry"; a generic name for all agroforestry systems that include animals as a component. One of the most significant developments in "animal agroforestry" is the expanding role of trees as a component in fodder production. This development has largely contributed to meeting the growing demand for food and, subsequently, enhanced the socioeconomic condition of the rural population.

This paper describes the development and evaluation of some agroforestry systems for fodder production, with the main emphasis on the role of trees in fodder production. A method of evaluation and strategies for future consideration are also described.

Criteria for development

Planning for development must be made at all levels of operation in agroforestry systems. Developing such a system is a task complicated by many factors (social, institutional, biophysical, environmental, and economic). It involves many steps, which are carried out according to need and standard procedure. The goal of the agroforestry system (e.g., fodder production) is very important, as it defines the scope and direction of the activities throughout the whole duration of the system. Once the goal has been established, the appropriate method of assessment must be determined. Torres (1983) identified the major role of the system as a productive or a service role. It is important to recognize these roles in planning the development of an agroforestry system for fodder production.

To develop an effective and efficient agroforestry system, certain criteria must be met. These criteria have been emphasized by Raintree (1984) in the "diagnostic and design methodology" of agroforestry for rural development.

Productivity

Fodder production should be in line with anticipated output. Because land is a fixed input, to increase its productivity, other productive agents (e.g., labour, technology, fertilizer, species) must be considered. Choosing fertile land is a major advantage. Therefore, land can be used to bring the land into the "highest and best use" (Barlowe 1986).

Productivity is essential at all levels of operation and is influenced considerably by the quality of the land. This is particularly important when the agroforestry

system is implemented on marginal land, where other inputs are required in considerable amounts to improve the system's productivity.

Sustainability

Sustainability is essential. However, it must not be ensured at the risk of decreasing yield, increasing soil erosion, and increasing nutrient loss. Factors that must be considered to maintain the land for continuous production are species, slope, scale of operation, management practice, and timing of operations. When developing a new system, the system should produce maximum output in an optimum time period.

Another important aspect that requires attention is the carrying capacity in a grazing area. Grazing pressure should be introduced in an agroforestry system by limiting the number of units in a particular unit of land. In the long run, this practice will greatly improve the overall production system.

If sustainability has to be pursued, carrying capacity and the previously mentioned factors should be combined. Many alternatives can be evaluated and attained through increased knowledge on cropping pattern, yield, growth, rotation, and cost.

Adoptability

Fodder production is normally associated with people involved in agroforestry management. The agroforestry system must be perceived as desirable by a majority of people. It should have a value that can be perceived objectively by the community. The choice of species, management practices, and tree–crop interface must be fully integrated with the sociocultural practices of a particular land-use system. It is also important that the ultimate assessment be made by the beneficiaries. The system should be periodically evaluated to provide current quantitative information on its use.

Farmers are usually surprised and suspicious when informed that *Gliricidia* spp. is a valuable fodder for ruminants in India (Atta-Krah and Sumberg 1987). This is because gliricidia has been perceived by farmers as a tree of poor fodder value. It is necessary to make local farmers aware of the potential uses and roles of certain species.

Marketability

In some cases, a prime objective might be to increase the level of income of the rural people through fodder production. The system should be able to support an excess of marketable goods. An effective and efficient marketing distribution, either at the farm, community, or national level, should be established. Hegde (1987) pointed out that an ideal marketing network should

- ensure minimum support price to the producers,
- ensure best selling price,
- create additional demand,

- reduce marketing costs, and
- generate additional employment.

Tree species for fodder production

Trees have been a source of feed since ancient times, and continue to be an important feed source in many areas of the world. Species used for fodder production in agroforestry should have the following characteristics (FAO 1987):

- ability to fix nitrogen,
- suitable fodder,
- ability to withstand lopping, pruning, and coppice management,
- fast growth, especially in early stages,
- easy adaptability to planting site and local environment,
- ability to withstand shading intensity,
- resistance to pests and diseases, and
- multiplicity of function (e.g., wood production, erosion control).

The relative importance of each factor varies from one ecological zone to another, depending on needs and priorities.

Tree fodders are useful as protein supplements in a mixed diet of grasses or pasture legumes (Singh and Osman 1987). However, the feeding pattern of the particular animal must first be understood. A scientific understanding of the relationship between weight gain and diet is necessary. In some cases, trees are toxic when used alone; *Leucaena leucocephala* is a good example.

Brewbaker (1987) and FAO (1987) list species that are significant in terms of ecological and economic value for fodder production; the most popular among these are *Acacia aneura*, *Acacia nilotica*, *Cajanus cajan*, *Desmanthus virgatus*, *Gliricidia sepium*, *Leucaena leucocephala*, *Prosopis* spp., *Pterocarpus erinaceus*, *Pterocarpus marsupium*, and *Sesbania grandiflora* (FAO 1987). Of these species, the most promising are *G. sepium* and *L. leucocephala*. Extensive research on various aspects of these two species has been conducted, with the aim of increasing their potential as fodder trees (Pound and Cairo 1983; Wiersum and Dirdjosoemarto 1987). The suitability of *G. sepium* and *L. leucocephala* as fodder trees is because of their following prominent characteristics: fast growth, nitrogen fixation, nitrogen-rich leaves, tolerance to pruning, ability to coppice vigorously, good fodder value, high foliage productivity, vigorous tap-root development, dry-season leaf retention, and high digestibility.

It is important to note that some trees have advantages over others in particular agroforestry systems. Pound and Cairo (1983) noted that *L. leucocephala* was not as effective as *G. sepium* and *Erythrina poeppigiana* when used in a living-fence system. Leucaena does not strike from stem cuttings and normally has to be raised from seedlings.

Some agroforestry systems for fodder production

Many agroforestry systems have been identified and many could be excellent land-use alternatives for fodder production (see Torres 1983). However, research on the role of trees in fodder production is still limited. Most research has concentrated on *L. leucocephala* and *G. sepium*. These species are widely used as components in browsing systems, alley cropping, and living fences. The practice and management of these systems may differ from place to place depending on socioeconomic, environmental, biophysical, and institutional conditions. However, the main concern is that the system must be able to play a role in fodder production and help meet the growing demand for food.

Browsing system

The browsing system is suitable for arid and semi-arid regions. In this system, woody components provide fodder, mainly as a protein-rich supplement during the dry season, and animals often browse a wide range of trees. Individual trees with palatable foliage are often grazed by animals that are not tied or fenced. In this situation, animals can seriously damage the trees.

There are normally two applications of the browsing system (Nair and Fernandes 1985):

- *Planting multipurpose trees in grazing areas*: trees are planted in the grazing area, mainly for fodder, other commercial produce (timber, fruit trees, firewood), and as shelter for the animals.
- *Cut-and-carry forage production*: trees are usually cultivated as a monocrop in a zonal form of agroforestry and cut either by hand or mechanically and fed fresh to animals, either chopped or unchopped, as a component of the diet.

Alley cropping

Alley cropping was originally developed to maintain soil fertility for food crop production. The system began to be used for fodder production after introducing nitrogen-fixation trees as a component. The additional amount of nitrogen added to the system helps improve the fertility of agriculture lands.

Alley cropping offers many advantages to the farmers. Besides maintaining soil fertility and fodder supply, it also prevents shading and provides green manure or mulch to the arable crop (Nair 1984).

Arable crops are normally planted in the interspace (or alleys) between rows (usually 4 m apart) of planted trees or woody shrubs, which are pruned periodically during the cropping season. The planted trees or woody shrubs are mainly for fodder production. The popular species used as fodder trees include *L. leucocephala*, *C. cajan*, and *G. sepium* (Fig. 1). These species are well-known for their high protein content and suitability as animal feed. An animal component (small ruminants) could also be introduced into the alley-cropping system.

Trees are pruned at the end of 1st year and subsequently managed through

Fig. 1. Alley cropping of *Leucaena leucocephala* and maize in Malaysia.

periodic prunings of the regrowth. This is to ensure that food crops are not shaded (Atta-Krah and Sumberg 1987).

Living fences

The living-fence system of fodder production is common in tropical America (Budowski 1987). The trees in this system are used not only for fodder but also for fuelwood and food. The use depends on the priority and need of the particular area. Trees also act as windbreaks and protection for wildlife.

According to Budowski (1987), living fences refer only to those areas established by planting large cuttings that easily produce roots and on which several strings of barbed wire are attached to keep livestock in or out. In this case, a single row of trees are planted.

Using living trees as fences reduces input costs. New branches will also contribute to filling up an "old" fence.

Species choice is very important. Th tree must be a fodder tree, easily propagated, able to grow quickly at initial stage, and able to withstand frequent lopping and strong wind. Common species used in living fences include *L. leucocephala, G. sepium, E. poeppigiana.*

Home gardens

Home gardens are a common feature in the tropical world. It is one of the most stable agroforestry systems. A home garden consists of a mixture of perennials and annuals of different heights, forming a multistoried structure approximating the forest structure. In many countries, multipurpose trees are used. They provide shade to lower plants, wood for fuel, and foliage for fodder. *Leucaena*

leucocephala is again the most commonly used species in home gardens, especially in the Philippines and Thailand.

Fodder production in this system is limited. However, the prospect of using home gardens to raise small ruminants is quite promising.

Merits of agroforestry

The agroforestry systems that have been developed and identified have their own qualitative and quantitative merits. These merits can be both tangible and intangible (Table 1).

Agroforestry is an alternative land-use system that can increase food production by combining livestock and trees in a unit of land. As such, land is used at its optimum level of production thus increasing its capacity to benefit the rural population. This is important where the income level of the rural population is low, soil fertility needs to be maintained, and long-run food production needs to be increased. The system is even more promising where land is the limiting factor in livestock grazing.

As the system becomes acceptable to smallholder farmers, the cost of inputs decreases. This is a definite advantage in developing countries because small-scale farmers lack cash and cash flow. In living fences, for example, planting with *G. sepium* will reduce the requirement for wire mesh, thereby saving the farmer a considerable amount of money.

Trees are fully used in agroforestry. Leaves, pods, and bark are used as fodder. Stems and branches are often used as firewood, helping to overcome energy-supply problems.

Table 1. Facilitating factors in the implementation of agroforestry systems for fodder production.

Factor	Components
Ecological	• Efficient use of natural resources • Decrease the hazards of environmental degradation
Economic	• Increase production per unit land • Various components might be used as inputs for production of others, thus decreased commercial inputs • Increase tree production and reduced cost of tree management
Socioeconomic	• Provide employment opportunities and regular income • Tree products can be obtained in off season • Require low management skills • Low risk in tree and livestock management • Production can be directed toward self-sufficiency or marketing
Psychological	• More easily acceptable to the local population
Political	• A tool for settlement of shifting cultivators

Source: Wiersum (1981).

Scientific land-use management could be applied to agroforestry. Therefore, research in this area is becoming more important for the optimum use of land resources.

Intensive development of agroforestry systems can promote and accelerate rural development by creating employment opportunities, improving infrastructure facilities, and generating linkages among all sectors in the economy. As such, participation in agroforestry projects should be encouraged to further improve the standard of living of the rural poor.

Weaknesses of the system

Agroforestry systems are not without problems. Many are associated with socioeconomic, sociocultural, biophysical, institutional, and technological aspects of the system (Table 2).

The rapid development of a system relies heavily on the socioeconomic situation of the rural people, particularly the farmer who is involved in tree fodder production. Lack of educational facilities, low income level, lack of farmer participation, lack of entrepreneurship, and lack of working capital are some problems that may deter system development.

Another weakness in agroforestry is the lack of research and development. Scientific research is urgently required on the use of tree fodders for certain animals, feeding habits and patterns, management practices, arrangement of the system, and matters related to participation.

It is often difficult to introduce tree management for fodder production into a new area. It is easier to introduce new and better species if trees are already part of the traditional land-use system. The long production period of a certain species may be unattractive to local farmers. The risk of introducing such a system is high because of the limited financial resources the farmers have on hand.

Method of evaluation

Over the past few years, the planning and development of agricultural research at international and national research institutions has been passing through a revolutionary stage. Many new research methods have been developed as a result of the development of farming system research (FSR). Research priorities are derived from diagnostic problems and potentials in existing farming systems as well as by the use of on-farm research methods to assist in the development of appropriate technologies in agroforestry systems.

The lessons learned from past experiences in FSR have contributed to the development of a standard methodology in planning and developing agroforestry systems in various ecological and sociological zones throughout the world. Potential trees for fodder production and their characteristics, management practices, potential areas, and other environmental and technological requirements will be fully explored and identified.

As a predominant land-use system, every facet of agroforestry must be studied

Table 2. Constraining factors in the implementation of agroforestry systems for fodder production.

Factor	Components and degree[a]
Socioeconomic	• Low productivity (m) • Lack of educational facilities (h) • Low level of education (h) • Little participation from farmers (m) • Lack of entrepreneurship (m) • Lack of working capital (h) • Lack of incentives provided to farmers (h) • Disciplinary problems (l) • Motivating factors are not present (h)
Sociocultural	• Customs and traditions (h) • Lack of awareness of the system (h) • Negative image of the system (h) • No leadership at community level (h) • Local politics involved in making decision (m) • Women have no role in the system (l) • Territorial jealousy (m) • Tenure problems (h)
Biophysical	• Problems of species suitability (h) • Problems of land-use pattern (m) • Uncontrolled grazing land and protection (h) • Scarcity of arable land for fodder production (h)
Institutional	• Shortage of trained, experienced staff (h) • Lack of research and development (h) • Budget constraints (h) • Narrow framework and coverage of the official program (m) • Time and scheduling of the programs are not well coordinated (m) • Minimal extension effort (h) • Lack of training and management techniques (h) • Unequal distribution of benefits (h) • Small market outlet (h) • Lack of coordination between implementing agencies (m) • Weak organization at community level (m) • Local markets cannot absorb large supply (h) • Problems of property rights (m)
Technological	• Complicated fodder production system (h) • Lack of appropriate technology (h)

[a] The degree shows the relative importance of each factor influencing the effective implementation of fodder production in a particular area: h, high; m, medium; l, low. The way it affects either enhances or impedes a particular system in which the factor exists.

and better understood. Only then, can a rational and sound approach be suggested as to how, why, and in what manner such a system should be developed and implemented.

The need to evaluate tree fodder production arises because of the

- variety and complexity of agroforestry systems for fodder production,

- heterogeneity in management practices with respect to ecological, geographical, and social conditions,
- greater weight given to conservation in most countries practicing the system for fodder production, and
- different levels of operation that may exist as a result of constraining factors in tree fodder production.

The International Council for Research in Agroforestry (ICRAF) developed an evaluation method called diagnostic and design (D & D). The main purpose of the D & D methodology is to identify priorities for research, to develop and test sound agroforestry technologies, and, subsequently, to disseminate these technologies around the world. The practical objective of ICRAF's D & D methodology is to assist agroforestry workers to formulate and develop a good agroforestry system that can be implemented and studied. The approach is problem oriented in nature and is appropriate for evaluating agroforestry systems for fodder production.

Basically, the D & D methodology involves several stages (ICRAF 1983; Raintree 1984, 1987):

- *Prediagnostic stage*: environmental description of the study area, identification of distinctive land-use system, and preliminary description of the selected land-use system(s).
- *Diagnostic stage*: information gathering on land-use problems and potentials, diagnosis of major land-use problems and potentials, and design specifications for problem solving and potential alternative technologies.
- *Technology-design stage*: appraisal of alternative technologies for further consideration, design of selected technologies (general and specific), and ex ante evaluation of the proposed design technology.
- *Follow-up planning stage*: identification of research needed to develop and test the components suggested in the proposed technology, identification of further topics for further survey or redesign of a similar technology, and guidelines for implementation of follow-up project activities.

The D & D methodology can identify and formulate an appropriate technology that can be implemented in a particular area. Further evaluation of the system should also be done through intensive on-farm or on-station research.

Strategies for effective implementation

To ensure effective implementation, the following policies and strategies are recommended. The degree and manner in which the proposed strategies should be followed may differ from one area to another based on socioeconomic, biophysical, institutional, and technological improvements and advancements.

- Optimize integrated land-use capacity in both private and public land for fodder production.
- Strengthen land tenure and other legal aspects in relation to property rights and the right to use the land and other land resources.

- Inculcate an awareness and positive attitude into rural farmers with regards to fodder production as a means of improving socioeconomic conditions.
- Identify market demands and outlets for outputs.
- Encourage product diversification in a unit of land to increase land capacity and bring the land to its full potential.
- Promote participation in tree fodder production through social forestry programs or other rural development projects.
- Strengthen research and development in areas where further improvement on existing systems is required (also, prioritize research areas, level of research, and scope).
- Enhance extension services to provide and expose rural farmers to available technologies in fodder production.
- Increase institutional support for the desired objective, which is in line with government policy to increase food supply and eradicate poverty in rural areas.

Conclusion

In view of its potential in helping to meet the increasing demand for food, energy, and environmental conservation, agroforestry is an important form of land use. However, it is not the only solution to land-use problems. Even though agroforestry offers great possibilities in fodder production, its development must be properly planned and evaluated. Success will be achieved if a more holistic approach is adopted and the research support is provided to put new technologies into practice.

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