# EFFECT OF ALLEY FARMING ON WEED INFESTATION AND FLORAL COMPOSITION

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**Key words:** *Leucaena leucocephala*, weed control, weed flora, weed density

**Abstract:** *Alley cropping with Leucaena leucocephala (Lam.) de Wit, caused a shift in weed flora away from fast-growing annual weeds that are characteristic of frequently cultivated fields to shade-tolerant, less-competitive weeds. Alley cropping caused a greater decline in weed density over time than was observed in arable fields without alley cropping. This beneficial effect was reduced by the upsurge of shade-tolerant weeds and the build up of Leucaena volunteers where the Leucaena hedgerows were allowed to seed during a fallow period. Weed suppression was greater in Leucaena plots that were cropped every other year than in continuously cropped plots. One weeding within three weeks after planting maize was enough to minimize weed-related yield loss in the Leucaena alley cropping system, while plots without Leucaena hedgerows required twice as much weeding to minimize yield loss in maize by weeds.*

## 1. Introduction

Weed pressure varies with land use intensity as well as how the land is managed. Generally the longer the fallow the less the competition of weeds with crops. One of the most widely used weed control methods has been to allow land to revert to its natural vegetation (bush fallow); in the savanna the land reverts to grasses and in the forest zones, to trees. A feature of this plant succession is that the growth of annual herbaceous plants is suppressed. During the fallow period, the weed seed population in the soil is so depleted that when the bush is cleared, weeds are seldom a problem in the first year of cultivation.

Increasing human population density has resulted in a widespread decline in the length of the bush fallow from over ten years to less than three years in many parts of the tropics. Moreover continuous cultivation without a bush fallow rest period to return organic matter to soil leads to soil impoverishment and this increases weed infestation.

Kang et al. (1984) have described alley cropping as a stable alternative to shifting cultivation which retains the basic features of bush fallow, one of which is to provide shade which suppresses undergrowth and prunings which fix atmospheric nitrogen. Although the shading of speargrass by hedgerow species has been reported to be an effective control measure [Aken'Ova and Atta-Krah 1986; Siebert and Kuncoro 1987; Ngambeki and Wilson 1983] little information is available on the effectiveness of hedgerow shading on weed control. Anoka et al. (1991) reported a shift in weed flora after two years of *Gliricidia sepium* and *Leucaena leucocephala* hedgerow fallows. The study reported here was undertaken to assess the effect of *Leucaena* alley cropping with different types of fallow periods on the degree of weed infestation and its floral composition.

## 2. Materials and Methods

Two separate experiments on alley cropping were conducted at the International Institute of Tropical Agriculture (IITA) in Ibadan, southern Nigeria.

### Experiment 1. Effect of *Leucaena* hedgerows on weed density and floral composition

The experiment was set up in 1987, to investigate the long-term effects of *Leucaena* hedgerows on weed infestation. The treatments were set up in a split plot design. The main plot treatments consisted of no hedgerows, *Leucaena* hedgerows pruned and cropped every year, and *Leucaena* hedgerows pruned and cropped every other year. This set-up allowed for the study of the effect of *Leucaena* hedgerow fallows on weed growth and persistence. The test crop was maize, planted at a density of 40,000 $ha^{-1}$. Subplot treatments compared a control with no weeding; weeding once; weeding twice; and a chemical control of weeds. Weed density was assessed by a monthly count of weeds in three fixed 0.5 $m^{-2}$ quadrants located along one of the diagonals in each of the unweeded but cropped subplots. Two destructive samplings of weeds were done in subplots that were weeded twice at 3 and 6 week intervals after planting maize. Weeds were identified for species distribution and their biomass determined by oven drying at $80^0$ C.

### Experiment 2. Effect of type and duration of fallow on weed density

This experiment is part of a long-term study set up in a split-plot design to assess the effect of type and length of fallow on weed density. Main plot treatments consisted of fallows of natural bush regrowth, *Leucaena* hedgerows, and *Pueraria phaseoloides* (Rox.) Benth. Subplot treatments consisted of continuous cropping without a fallow period; cropping for a year followed by a fallow of one year; cropping for one year followed by a fallow of two years and cropping for one year followed by a fallow of three years. Weed density assessment was similar to what was done in the first experiment. The test crops in experiment 2 were intercropped maize and cassava.

## 3. Results and Discussion

### Experiment 1.

Alley cropping caused a definite shift in weed flora over time and across treatments (figure 1). In a four-year period of continuous cropping without hedgerows, the weed flora shifted from a dominance of shade tolerant *Synedrella nodiflora* Gaertn. to the fast-growing, highly competitive and resource-demanding wild poinsettia (*Euphorbia heterophylla*). In treatments where *Leucaena* alleys were cropped every year, the weed flora shifted from a mixture of broadleaf weeds to one dominated by wild poinsettia. Wild pointsettia accounted for only 4% of the weed vegetation in 1988, but rose to over 40% by 1992. In plots where *Leucaena* was cropped every other year with one year fallow, *Synedrella* and volunteer *Leucaena* seedlings dominated the weed flora; grasses were completely shaded out, and the density of wild poinsettia was low.

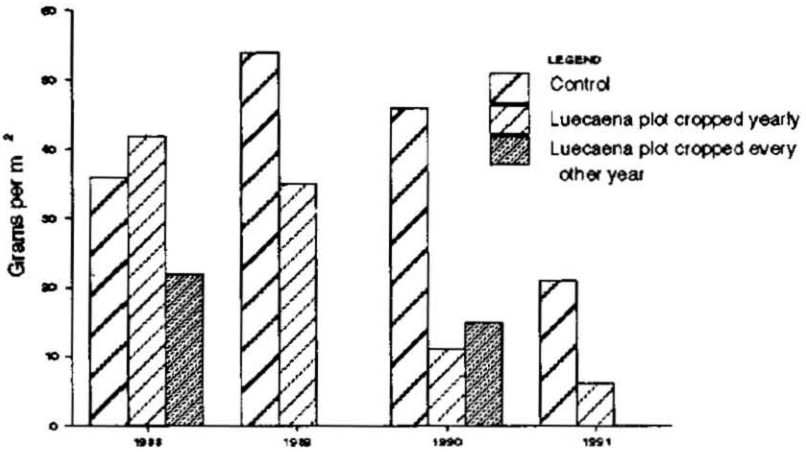



**Figure 1**. Effect of alley farming on shifts in weed flora

Alley cropping did not significantly suppress weeds, but instead caused a shift in the flora from weeds that are very competitive with crops to those that are less competitive with crops during the early growth stages such as *Syndrella*, which persist because of their tolerance to shade (figure 1). The beneficial effect of this shift away from weeds that are more efficient than crops in exploiting growth resources during early weed-crop association is to minimize the detrimental effect of weeds on crops. Weed biomass was greater in unweeded maize without *Leucaena* than in unweeded maize plot with *Leucaena*, possibly because the weeds in the latter were less competitive with crops than weeds in the former (table 1). There was no difference in weed biomass in the unweeded plots with no maize, whether fallowed or not, confirming that weeds in plots with or without *Leucaena* hedgerows exhibit different sensitivities to competition.

Weed density in an Alfisol that was cropped every year declined from 450 plants per $m^{-2}$ to 150 plants per $m^{-2}$ in four years (figure 2). In plots with *Leucaena* hedgerows where the alleys were cropped every other year, there was only a slight reduction in weed density, possibly because of the presence of *Leucaena* volunteers in this treatment.

**Table 1. Effect of alley cropping and weed control on maize yield in an Alfisol (first rains, 1990).**

| Treatments | Weed control method | Weed biomass at 6 WAP* | Maize yield |
|---|---|---|---|
| | | ($g\ m^{-2}$) | ($kg\ ha^{-1}$) |
| Control (no hedgerow) | No Weeding (cropped) | 216.8 | 3635 |
| | Weeded (3 WAP) | 46.8 | 4163 |
| | Weeded (3 + 6 WAP) | 14.5 | 4809 |
| | Meto + atra. (2 + 0.5 $kg\ ha^{-1}$) | 127.5 | 3959 |
| | No weeding (uncropped) | 239.3 | - |
| *Leucaena* alley (cropped yearly) | No weeding (cropped) | 139.0 | 3493 |
| | Weeded (3 WAP) | 10.8 | 4214 |
| | Weeded (3+6 WAP) | 14.0 | 3474 |
| | Meto + atra (2+0.5 $kg\ ha^{-1}$) | 83.3 | 3067 |
| | No weeding (uncropped) | 206.3 | - |
| *Leucaena* alley (cropped every other year) | No weeding (cropped) | 129.5 | 2815 |
| | Weeded (3 WAP) | 14.5 | 3650 |
| | Weeded (3+6 WAP) | 20.8 | 4049 |
| | Meto + atra (2+0.5 $kg\ ha^{-1}$) | 62.5 | 3519 |
| | No weeding | 202.8 | - |
| **Means for main plots** | | | |
| no hedgerow | | 128.9 | 4141 |
| *Leucaena* alley cropped yearly | | 90.7 | 3562 |
| *Leucaena* alley cropped every other year | | 86.0 | 3508 |
| SE | | ns | ±83 |
| CV % | | 8.9 | - |
| **Means for weed control subplot** | | | 3314 |
| No weeding (cropped) | | 161.8 | 4009 |
| Weeded (3 WAP) | | 24.0 | 4110 |
| Weeded (3 + 6 WAP) | | 16.4 | 3515 |
| Meto. + atra (2+.05 $kg\ ha^{-1}$ | | 91.1 | |
| No weeding (uncropped) | | 216.0 | |
| SE | | +16.3 | +170.4 |
| CV % | | 55 | 15.8 |

*Note:* *WAP = weeks after planting maize

Weed biomass per unit area is affected by the density and type of weed, soil fertility, light and water availability and weed/crop competition for these growth factors. This was significantly less in plots with hedgerows than in those without. The higher weed biomass in plots without *Leucaena* is partly due to the fact that shade-tolerant weeds are less competitive with crops than weeds that flourish in unshaded plots (figure 3).

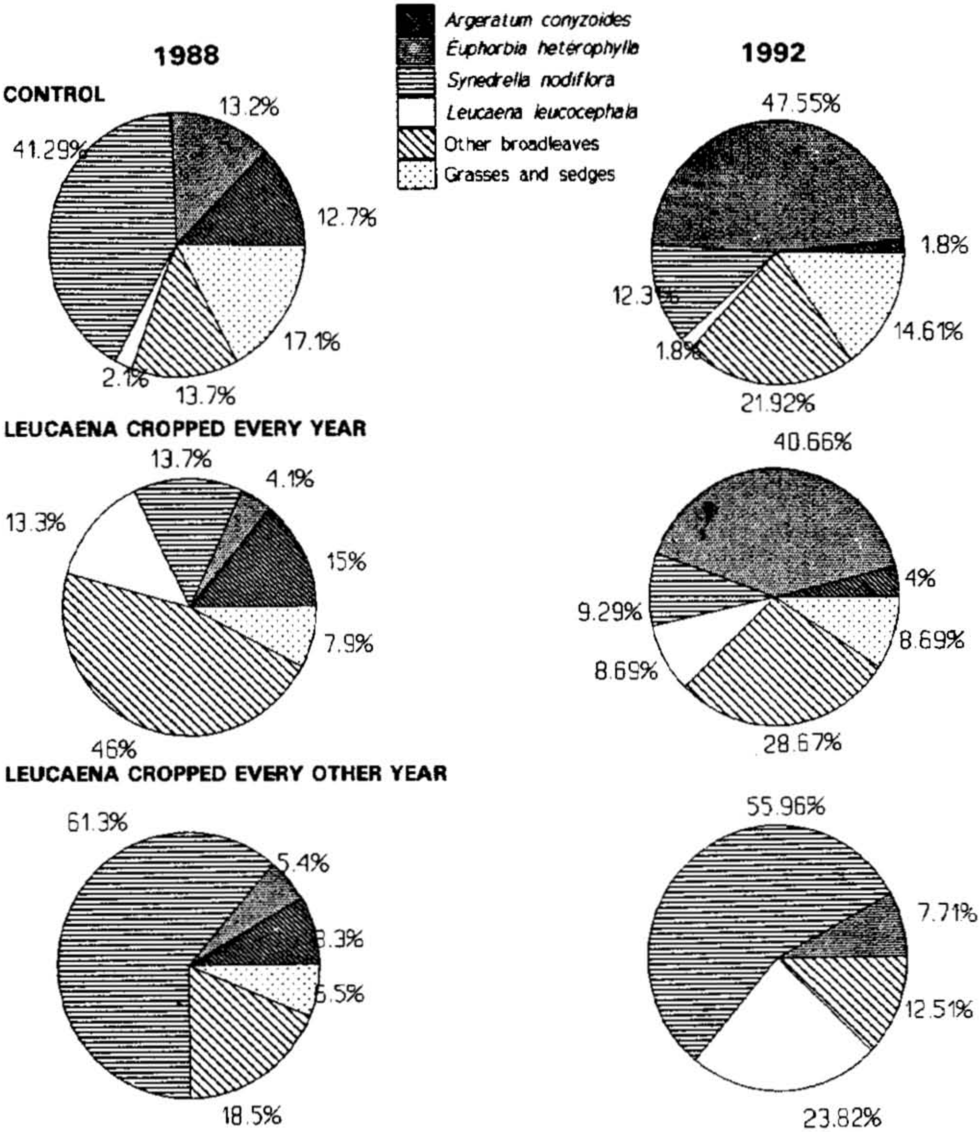
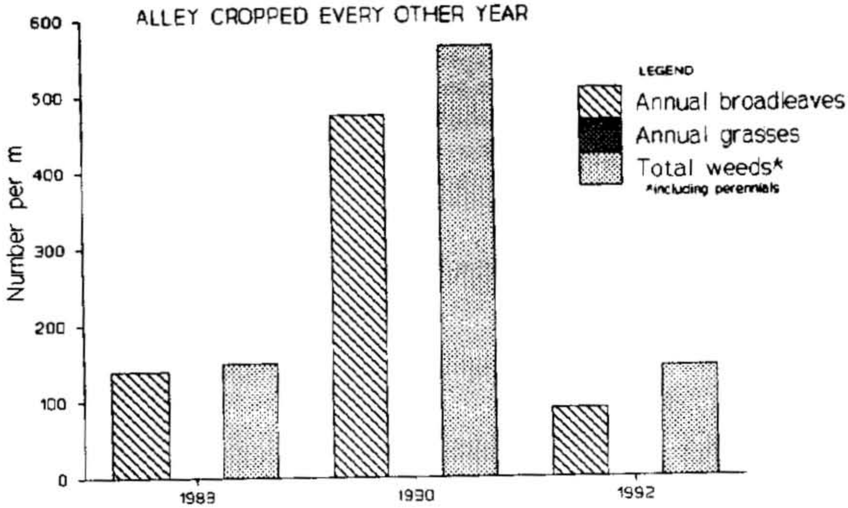



**Figure 2.** Long term effect of *Leucaena* alleys on weed density in an Alfisol



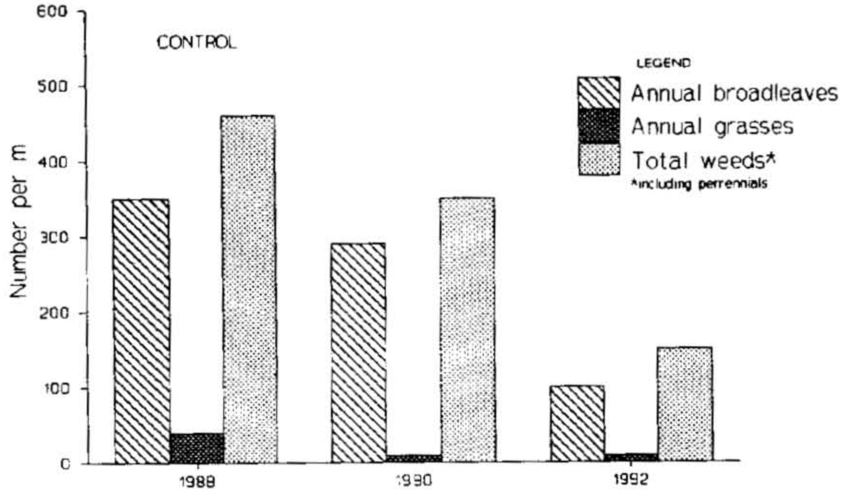




**Figure 3.** Effect of alley cropping on weed biomass at 3 weeks after planting

**Experiment 2.**

Weed density was higher in the natural bush fallow than in managed fallows of *Pueraria* or *Leucaena* (table 2). Weed seedlings were highest in plots that were cropped every other year irrespective of the fallow type. Weed seedling density was highest after bush fallows and lowest after *Pueraria* fallows, across all fallow durations in this study. Weed seedling density trend was bush fallow > *Leucaena* > *Pueraria*.

**Table 2. Effect of cropping intensity and type of fallow management on weed density**

| Fallow Management | Cropping frequency (crop/fallow years) | | | | |
|---|---|---|---|---|---|
| | Continuous | 1/1 | 1/2 | 1/3 | Mean |
| | | | ($no\ m^{-2}$) | | |
| Bush | 113.1 | 135.1 | 130.1 | 123.7 | 125.5 |
| *Leucaena* | 97.4 | 107.5 | 99.7 | 100.3 | 101.3 |
| *Pueraria* | 46.7 | 87.1 | 71.1 | 46.8 | 62.9 |
| SE± (for main plot x subplot interaction) | | | ns | | |
| Mean | 85.8 | 109.9 | 100.3 | 90.4 | |
| SE± (for main plot and for subplots means) | | | 19.2 | | 10.8 |

ns = not supplied

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# OPTIMIZING THE PLANNING OF ALLEY FARMING WITH EXPERT SYSTEMS

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**Key words:** alley farming, decision aid, **Expert Systems**

***Abstract:*** *Expert Systems software can aid in problem diagnosis and solution and in identification of information gaps to optimize the alley farming systems. The preliminary stage in the development of a decision support system for alley farming using on-station and on-farm experiences is described. More precise data on soil, climate and species responses are needed to fine tune the decision support system package being developed.*

## 1. Introduction

Expert Systems software is a computer program that offers solutions to complex problems by mimicking human reasoning through the use of an information base gathered from human experts [Plant and Stone 1991]. Expert Systems captures hard gained-experience and puts it into the hands of a young scientist, a new extension agent, or other relatively inexperienced persons [Nagegele et al. 1987, Yost et al. 1988]. As such it serves as an excellent tool for organizing accumulated experience into a rational problem-solving methodology that is open for others to examine and use. Expert Systems provides a means of reducing the loss of valuable experience when seasoned personnel retire [Yost et al. 1988].

The two main objectives of this work are: (i) to structure alley farming technology, as derived from the research and on-farm experience of the International Institute of Tropical Agriculture (IITA), into a comprehensive and problem-solving decision-support system, and (ii) to identify, as a result of assembling available knowledge, information gaps in the design of alley farming systems and in solving problems in existing alley farming systems.

## 2. IITA Alley Farming Expert Systems

The goal of the IITA-AFS Expert Systems computer program is to transfer IITA's experience with alley farming/cropping systems to others in order to replicate the benefits that have occurred and to further test and compare the technology in soils and climates different from the experience in southwestern Nigeria. For example, experience with high base soils is not clearly transferable to low base status soils [Szott et al. 1991, Evensen et al. 1991, Garrity et al. 1994].

The IITA-AFS Expert Systems program is in its preliminary stage of development, identifying problems associated with establishing new alley farming systems and problems in sustaining the productivity of the hedge and the associated crops.

Because of the potential for alley farming in West Africa and because alley farming was first developed at IITA (Nigeria), the prototype decision-aid concentrates on recommendations for new alley farming trials in this region.

The program attempts to eliminate gross errors likely to occur from inadequately planned alley farming systems — such as inappropriate species for the soil/weather conditions or for the farmer's purpose, or inappropriate soil management.

Alley farming predictions are complex because of the difficulty in quantifying crop, hedgerow, soil and weather requirements. Consequently, rather than attempt quantitative predictions, our approach has been to recommend successful practices based on a comparison of the soil and climate of a given site with a non acid Alfisol at Ibadan and an acid Ultisol at Onne, both in southern Nigeria (i.e., transfer by analogy, Nix 1984) As experience increases our system can be updated, expanded, and deepened to include transfers based on principle rather than analogy. It follows that the program described here will not always ensure a successful alley farming system, but it will identify common failures of species selection and management.

## 2.1 Using Expert Systems software

The Expert Systems program is user-friendly, providing explanatory help at each stage or state of enquiry. The software runs on MS-DOS personal computers with either a hard disk (preferable), or a high density floppy disk (1. 2MB 5 1/4 inch or 1. 44MB 3 1/2 inch diskettes). The software uses the MS-DOS operating system 2.0 or higher. The person installing the software should have the ability to create and delete MS-DOS files, while the user of the installed software needs only to press numbered keys, and take time to learn to operate the software.

## 2.2 IITA-AFS Expert Systems architecture

Presently, the IITA-AFS decision-making process can be divided into five major areas: (i)intended cropping system (alley farming/cropping or separate tree plantings) and main crops, (ii) benefits expected by farmers from the trees, (iii) availability of inputs, (iv) site/soil characteristics, and (v) species requirements. The proposed decision tree for the planning of new alley farming systems is presented in a flow chart (figure 1). An additional module will be incorporated during a later stage of development covering hedgerow establishment and management.

2.2.1 *Intended cropping system.* Although IITA-AFS is primarily designed for the evaluation of alley farming systems, the knowledge base may also be helpful to those who prefer to plant a tree species separately, perhaps in a woodlot, without an associated food crop. This option permits the system to recommend forage gardens or woodlots in addition to alley farming systems. The user may choose to assess the suitability of tree species for specified uses and rainfall regimes. Thirteen species are included in this branch of our knowledge base. The user may select this option at the beginning of the run or later if an appropriate alley farming system for the user's conditions is not found.

If alley farming is the system of interest to the user, he may choose either to evaluate a potential alley farming system or to view alley farming guidelines or excerpts from recent review articles. The first step is the selection of a food crop, which is usually of the most importance to the farmer. The choice is assumed to have been made by the farmer before the consultation; IITA-AFS is generally not designed to aid the farmer in choosing the food crop.

2.2.2 *Farmer's expected benefits from the trees.* The second step is to determine what benefits the farmer expects from the tree or shrub species. Tree species are rated according to suitability for the following purposes: (a) green manure; (b) forage; (c) fuel; (d) timber; (e) stakes and poles; (f) erosion control; (g) fence; (h) food; (i) tannin or gum; (j) weed control [table 1, from McDicken and Brewbaker 1984]. IITA-AFS calculates a cumulative rating (Use Index) for each species based on an unweighted average of the ratings it receives for each of the selected uses.

**Table 1. Selected nitrogen-fixing trees and their ranking for various purposes** [adapted from MacDicken and Brewbaker 1984]

| Species | Suitability | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | a* | b | c | d | e | f | g | h | i | j |
| *A. nilotica* | 1# | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *A. senegal* | 1 | 1 | 1 | 4 | 4 | 1 | 4 | 2 | 1 | 1 |
| *F. albida* | 1 | 2 | 1 | 2 | 2 | 1 | 4 | 4 | 1 | 1 |
| *P. tamarugo* | 1 | 1 | 1 | 2 | 2 | 1 | 4 | 2 | 4 | 1 |
| *A. lebbeck* | 1 | 1 | 2 | 2 | 1 | 1 | 4 | 5 | 1 | 1 |
| *A. saman* | 1 | 1 | 5 | 1 | 1 | 1 | 4 | 4 | 4 | 1 |
| *C. cajan* | 2 | 1 | 2 | 5 | 4 | 1 | 4 | 1 | 5 | 1 |
| *G. sepium* | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 5 | 5 | 1 |
| *C. calothyrsus* | 2 | 2 | 1 | 4 | 4 | 1 | 4 | 5 | 5 | 1 |
| *S. grandiflora* | 1 | 1 | 3 | 4 | 4 | 1 | 4 | 2 | 2 | 1 |
| *L. leucocephala* | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 2 | 4 | 1 |
| *F. macrophylla* | 2 | 2 | 1 | 4 | 5 | 1 | 5 | 5 | 5 | 1 |
| *P. falcataria* | 1 | 2 | 1 | 2 | 1 | 1 | 5 | 5 | 5 | 1 |

*Notes:* This ranking is used in IITA-AFS to rank species according to the farmer's selection of products.
*Symbols: (a) green manure; (b) forage; (c) fuel; (d) timber; (e) stakes and poles; (f) erosion control; (g) fence; (h) food; (i) tannin or gum; (j) weed control
# = Ratings: 1=excellent; 2=good; 3=fair; 4=poor; 5=unsuitable.

2.2.3. *Availability of inputs.* The third step allows users to specify whether lime, fertilizers, labor inputs are available. The user may choose between moderate and minimal input strategies. Recommendations are based on the farmer's access to inputs. To the farmer, improvements compatible with minimal input strategies may involve recommending a tree species adapted to the environment, timing the tree establishment, possibly adding a small amount of starter fertilizer, and a statement about labor requirements.

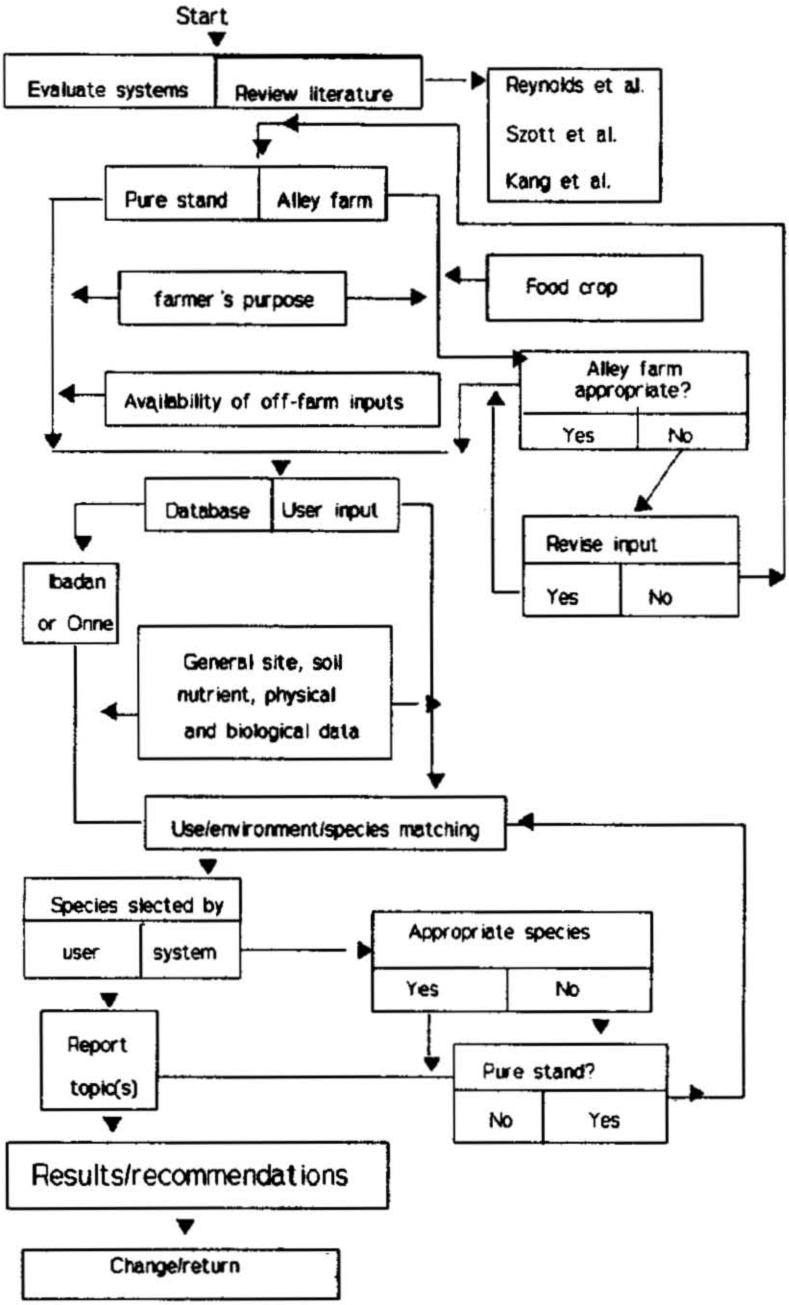


**Figure 1. Example of user or database input**

2.2.4 *Site/soil characteristics.* The fourth step is to ask users to describe their sites. Data may be entered by the user or retrieved from a database that currently includes Alfisols and related soils from Ibadan and Ultisols from Onne. Site data that may be requested includes mean annual rainfall, field slope, mean length of annual dry season, soil fertility levels (i.e., soil pH, P, Ca, Mg, Mn, K, S, and micronutrients), physical properties (i.e., % clay, compaction, crusting, drainage, and color) and biological conditions (estimated adequacy of indigenous populations of rhizobia and vesicular-arbuscular mycorrhizae (VAM) and of conditions for their establishment and growth). If soil fertility data is available, estimated fertilizer requirements can be given for the no input case or alternative strategies might be proposed for the minimal input case. Each species is also rated for its adaptation to the rainfall regime (in terms of mean annual rainfall) at the site. This rating is made on a scale from 1 to 5 with values having the same meaning as in the Use Index described above.

2.2.5 *Species selection.* The fifth step is for the user to select the tree species. The user may view a table of ratings before selecting a species. Although many woody perennials have received some research attention as potential hedgerow species, adequate information for only three species (*Leucaena leucocephala, Gliricidia sepium,* and *Calliandra calothyrsus*) was considered useful for recommendations generated by IITA-AFS. If the user prefers, IITA-AFS will exclude those species that are poorly adapted to the user's environment — based on mean annual rainfall data (table 2) — before selecting a species.

**Table 2. Hedgerow species and rainfall regime associations**

| Rainfall regimes, median annual (mm) | | | |
|---|---|---|---|
| <599[1] | 500-1000[1] | 1000-1600[1] | >1600 |
| ardic[2] | ustic | ustic | udic |
| *A. lebbeck* | *A. lebbeck* | *A. lebbeck* | *C. calothyrsus* |
| *A. senegal* | *C. cajan* | *C. cajan* | *S. grandiflora* |
| *F. albida* | *F. albida* | *C. calothyrsus* | *P. falcataria* |
| *P. cineria* | *G. sepium* | *G. sepium* | *F. macrophylla* |
| *A. nilotica* | *A. nilotica* | *A. saman* | *D. barteri* |
| | *L. leucocephala* | *L. leucocephala* | |
| | *S. grandiflora* | *S. grandiflora* | |
| | | *F. macrophylla* | |
| | | *D. barteri* | |

*Note:* This list includes species not suitable for alley farming such as *S. grandiflora* and possibly some others due to thorniness etc.

[1] Alley farming *per se* is generally not recommended for rainfall less than 1200mm.

[2] Approximate soil taxonomic moisture regimes; soil moisture regimes are defined on the basis of soil moisture content, as rainfall does not precisely reflect soil moisture content.

General recommendations for alley farming systems are presented within the following categories, which can be accessed individually or in combination: field preparation, seed pre-germination treatment, seed inoculation procedure, planting instructions, field maintenance, and forage production systems. Some topics on individual tree species are also available. A summary report and a complete, detailed report from the run may also be requested. These reports contain recommendations that are based on the site conditions and management considerations specified by the user.

### 3. Problems, Possible Solutions and Future Goals

Several knowledge gaps have been identified during the development process of IITA-AFS. The major gap has been the lack of response functions of the various tree species to soil, weather, and management conditions. When no inputs are available the match between hedgerow species, crop species, soil and weather must be precise to suit the farmers' purposes. If inputs are available, then there is a need to identify the significant limiting factors and determine what is required to remove these limitations. Acid tolerant species must be selected if the soil is high in toxic Al or other acidity factors. Information on rainfall distribution and soil properties, water availability, erosion, and crop performance are scarce. Currently, the system recommends species based solely on annual rainfall requirements, which is a poor substitute for data on soil moisture stress.

Because the goal of the system is to select species based on the degree to which they provide the product and services the farmer wants, the ideal situation would be to be able to predict species performance under a variety of conditions. However, such information is rarely available in quantitative algorithms necessary to develop the simulation models that can predict leaf or wood production, N additions, etc. Consequently, the best current experience with the species must be obtained and combined as objectively as possible, e.g., from simple reports of how the species compared with an index species.

Future plans include expanding this prototype software with new information reported through the Alley Farming Network for Tropical Africa (AFNETA) regions. Expansion to AFNETA locations can proceed by selecting locations for gradients in rainfall, soil acidity, soil erosion hazard, and altitude. The rules and procedures developed at IITA will be generalized for these sites. Researchers can assist in this work by making their findings available to the AFNETA network.

#### 3.1 Application of system

There is a great need to be able to examine the *what-if* scenarios so the farmer or person recommending an alley farming system can explore the consequences of changes in management, such as, time of pruning, pruning height, different tree species, associated crops, different input levels, labor availability, etc.

From our preliminary experience in structuring the database on alley farming we note that the majority of the alley farming experiments have been anecdotal — that is, the systems seem to give good results or they do not — the causes often are unidentified because multiple benefits are possible from an alley farming system and the overall success depends on which benefits are priorities for the farmer.

The controversial benefits seem to be centered around yield increases of the associated crop and improved soil conditions [Szott et al. 1991; Evensen et al. 1992; Hawkins et al. 1991]. Some of these uncertainties appear related to minimizing competition between the hedgerow and the crop, and use of the technology on soils extremely low in nutrients in the first place. It is seldom clear how weed suppression or soil erosion control relates to these results.

Ultimately, simulation models should be the best method for such predictions, but clearly neither the response relationships necessary for such systems, nor the minimum datasets are available for such quantitative predictions. Preliminary attempts to describe competition among crops is discussed by Caldwell and Hansen (1991). Until such time as functional simulation models are available for alley farming systems (we estimate 10-15 years), we will have to make do with current experiences which provide useful diagnoses within the limits of current knowledge.

Until that time when species characteristics, requirements and responses to cultural practices are known, PLANTGRO, a computer-based system described by Hackett (1991) could be utilized. This system consists of plant, climate, and soil files. While each of these files can be built separately, they can be brought together to assess species suitability for the specified climate and soil. While this is clearly not new, the flexibility of the data files is innovative. Data files need not fulfill a rigid format or amount of detail available on plant, climate, or soil. The system has been designed with a distinctly practical point of view. Plant response to soil and weather conditions can be qualitatively characterized using ranking and reference species, to detail mathematical relationships. This method of recording response data could be useful not only for decision aids such as described in this paper but also for simulation models, which are needed for yield and maturity prediction.

This approach seems to be a good repository and template for alley farming species information. Not only is the information useful to the potential user but it is used together with climate and soil data to make predictions of performance and identify limiting factors. The files list are not so much ideal examples but illustrate the concept of minimum datasets as a guide to data collection and standardization. Some of the factors that we think should be quantified, described, or at least identified in ranking species applicability for alley farming include the following.

1. Rapid growth rate, high productivity
2. Availability of seed and ease of establishment
3. Ability to tolerate severe pruning
4. Resistance to diseases/pests/adverse conditions
5. Multipurpose nature

Such a tabulation of information would improve the diagnosis and prediction systems and further efforts at the evaluation of alley farming management options before committing resources to field implementation.

## 4. Conclusion

This expert system is in its preliminary stage. A framework for diagnosing potential problems in planning an alley farming cropping system has been identified. About 200 rules have been developed to implement this preliminary decision making strategy. We expect that research within the AFNETA network will greatly aid the knowledge base by providing soil, climate data, species responses from their on-going experiments.

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