

Reprint from: W.H. Diemont and A.C. Smiet (eds.) 1991 Proceedings Workshop Low - Input Agriculture in Acid Upland Soils, SECM, Bogor, Indonesia. Special Publication Nr. 2. p 10 - 15.

#### PRINCIPLES OF HEDGEROW INTERCROPPING

Meine van Noordwijk

Institute for Soil Fertility Research, P.O.Box 30003, 9750 RA Haren, the Netherlands

#### Low External Input Sustainable Agriculture (LEISA)

As indicated in the preceding paper, alternatives for shifting cultivation systems are needed in many tropical areas. To be acceptable to farmers such systems should be economically viable; this usually means that they should not rely on expensive external inputs, but that they should make full use of local natural resources of soil, climate, vegetation, crops and animals as well as of available human resources. Such alternatives may be sought in the context of a broad new movement, which arose from a critical evaluation of the "green revolution" approach. Characteristics of this search for Low External Input Sustainable Agriculture (LEISA) are given in table 2.1. Although broad concepts and desirable characteristics have been defined, application to any particular situation is not easy and usually compromises are necessary.

Table 2.1 Key elements and desirable characteristics of Low-External-Input Sustainable Agricultural systems (LEISA).

#### Key elements:

- \* crop combinations with an emphasis on crop varieties tolerant to the most important stress factors of soil, climate and diseases. Local selection of crop cultivars means that hybrid seeds are not useful, because such seeds cannot be reproduced and further selected locally.
- \* emphasis on leguminous cover crops and multipurpose trees as part of cropping systems.
- \* soil conservation by maintaining a permanent soil cover rather than by labour- and cost-intensive terracing.
- \* biological and mechanical weed control.
- \* cropping and fertilization practices aimed at a reduction of nutrient losses to the environment.
- \* biological or integrated pest and disease control.

#### Targets:

- \* reasonable yields per unit labour.
- \* long-term sustainability rather than maximization of yield on a short-term basis.

#### Research and development:

- \* emphasis on indigenous knowledge: "traditional" farmers are not regarded as ignorant but as keepers of an important heritage of practical ecological knowledge on how to deal with the environment.
- \* emphasis on indigenous experimentation: "traditional" agriculture is not a fossilized system without any change; many farmers are continuously trying to improve crops and/or the system as a whole by experimentation, selection of suitable seed stocks and socio-economic innovation.

## Hedgerow intercropping

The concept of "hedgerow intercropping" or "alley cropping" was developed at the International Institute of Tropical Agriculture (IITA) in Nigeria. It was developed from proven practices of using trees on crop land, as practised in Flores and other parts of Indonesia, especially using *Leucaena* sp., and in S.W. Nigeria, especially with *Gliricidia sepium*. Trees are regularly pruned and thus low hedgerows are formed. Tree biomass is used as a mulch on the alleys between the hedgerows where food crops are grown. The main aim of hedgerow intercropping is to allow a higher intensity of land use with low external inputs, while maintaining the basic merits of the bush-fallow system.

Kang *et al.* (1989) gave the following description: "In alley cropping, arable crops are grown between hedgerows of woody shrubs and tree species, preferably legumes, that are periodically pruned to prevent shading of the companion crop(s). The shrubs and trees grown in hedgerows retain their functions as observed in the bush-fallow system, i.e. nutrient recycling, mulch and manure source, weed suppression and erosion control (Figure 2.1). The inclusion of leguminous, woody species also provides free nitrogen to the production system. Alley cropping can, therefore, be regarded as a bush-fallow system with improved management (table 2.2), combining cropping and fallow phases to increase the land-use intensity."

If the trees have a broad and deep root system and the crops have a shallow root system, the trees may act as a "safety net", recovering nutrients leached from the crop root zone (Figure 2.2). Through the prunings these nutrients can be recycled to the crops via the topsoil.

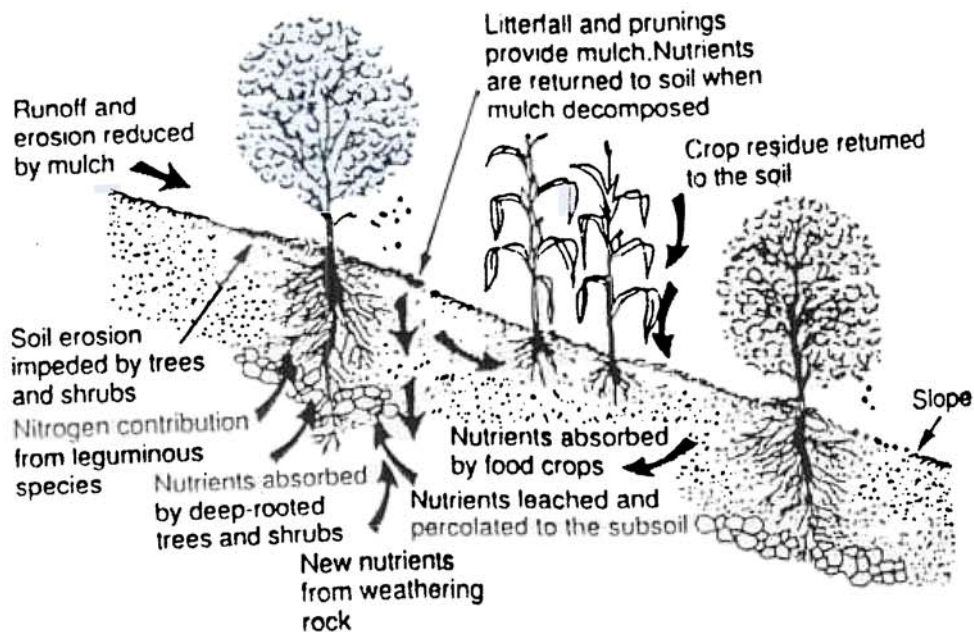


Figure 2.1. Schematic presentation of the "hedgerow intercropping" or "alley cropping" concept (Kang *et al.*, 1989).

Table 2.2 Differences in management of traditional bush fallow and alley cropping system (after Kang et al., 1989).

Bush fallow	Alley cropping - hedgerow intercropping
* Mixed native woody species are retained	* Selected woody leguminous species are planted
* Irregular planting pattern	* Grown in hedgerows
* Before cropping, trees and shrubs are cut back and burned to release nutrients	* Trees and shrubs are periodically pruned; prunings are used as mulch or green manure
* Fire used for controlling tree growth	* Pruning used to control tree growth
Allows short-term cropping on the whole field (less than 50% of the rotation time)	* Allows continuous cropping on the major part of the field (on more than 75% of the land)

Hedgerow intercropping is a specific form of agroforestry, the integration of trees, crops and/or animals in a farming system. The role of the trees in this system is on the one hand to produce directly useful products (firewood, fodder, fruits, nectar for honeybees, etc.) and on the other hand to maintain soil fertility. The number of management options in agroforestry systems is so large and the time needed to perform an experiment so long (several years at least), that a direct trial-and-error approach is not efficient. Research is probably more successful when it is part of a "diagnosis and design" process. The interaction between trees and crops can be negative as well as positive and to guide proper choices we should know the bottlenecks for a given situa-



Figure 2.2. Tree roots as a "safety net" for leaching nutrients

tion. To help in the analysis of particular situations, Young (1989) formulated ten hypotheses about the role of trees in agroforestry systems on the soil (table 2.3).

Table 2.3. Ten hypotheses on agroforestry effects on soil fertility (Young, 1989).

1. Agroforestry systems (AFS) can control erosion, thereby reducing losses of soil organic matter and nutrients,
2. AFS can maintain soil organic matter at levels satisfactory for soil fertility,
3. AFS maintain more favourable soil physical properties than agriculture, through a combination of organic matter maintenance and the effects of tree roots,
4. Nitrogen-fixing trees and shrubs can substantially augment nitrogen inputs in AFS,
5. The tree component in AFS can increase nutrient inputs, both from the atmosphere and from the b and c soil horizons,
6. AFS can lead to more closed nutrient cycling and so to more efficient use of nutrients,
7. The cycling of bases in tree litter can help reduce soil acidity or check acidification,
8. AFS may augment soil water availability to crops,
9. AFS can be a useful component of systems for the reclamation of degraded soils,
10. In the maintenance of soil fertility under AFS the role of tree roots is at least as important as that of aboveground biomass.

Young (1989) also presents evidence for the ten hypotheses - some hypotheses (especially 7 and 8) are still rather speculative and require further research. Certainly not all hypotheses are true under all conditions for all combinations of trees and crops. Maybe, even, the opposite is true and a careful process of diagnosis and design is required to obtain systems which fulfill the major requirements for a particular site. In developing a system a large number of management options should be defined (table 2.4). For the choice of trees, a list of desirable characteristics can be made (table 2.5) and local experience with various tree species can be evaluated in this context before choices are made. Characteristics such as rooting pattern depend as much on the soil profile and tree management as on the tree species. If erosion control is important a relatively slow decomposition of leaf litter and prunings is to be preferred to protect the top soil for a long period. On flat land rapidly decomposing species may be preferred as they are more effective in feeding the crop.

Table 2.4 Management options for hedgerow intercropping.

- 
- \* Choice of tree species and cultivars
  - \* Choice of intercrops
  - \* Distance between hedgerows
  - \* Pruning height of the trees
  - \* Pruning frequency + timing
  - \* Removal of stems (firewood) from the prunings
  - \* Use of prunings as green manure or as animal fodder to make brown manure
  - \* Surface application or incorporation of the prunings
  - \* Root pruning by making ditches alongside the hedgerow
  - \* Basal and additional fertilization for the crops
- 

Table 2.5 Desirable tree characteristics for hedgerow intercropping.

- 
- \* Tolerant to regular pruning
  - \* High biomass production without too much shade to the companion crops, a dense hedge form is ideal
  - \* High nitrogen content of the prunings
  - \* Good nodulation and high rate of  $N_2$  fixation
  - \* Decomposition rate of the prunings synchronous with crop demand
  - \* Deep root system, extracting nutrients from the subsoil; tree performance in dry periods may give an indication
  - \* Few superficial roots in the zone where crop roots develop
  - \* Prunings and loppings acceptable as animal fodder
  - \* Flexibility in management: if left unpruned for a longer period a canopy dense enough to control weeds should be formed and acceptable stakes, poles or firewood produced; edible fruits or commercial products such as resin further add to the attractiveness of the tree
  - \* Resistant to insect attack and diseases
- 

In table 2.6 some tree species are listed with which positive experience in hedgerow intercropping has been reported. The list is far from complete. Given the large number of possibilities and the limited experience ample scope still exists for discovering and developing new systems of alley cropping, adapted to the ecological requirements of a particular site and attractive in the socio-economic context of a given area.

Table 2.6 Tree species used for hedgerow intercropping experiments (for further data see Kang et al. 1989, Young 1989 and Von Carlowitz, 1986).

---

Leucaena leucocephala  
Gliricidia sepium  
Cassia siamea  
Acioa barteri  
Alchornea cordifolia  
Flemingia congesta  
Sesbania grandiflora  
Inga edulis  
Erythrina spp  
Cajanus cajan  
Albizia various species  
Peltophorum pterocarpa

---

#### References

- Kang B T, A C B M van der Kruijs and D C Couper 1989 Alley cropping for food crop production in the humid and subhumid tropics. In: Kang B T and L Reynolds (eds.) Alley farming in the humid and subhumid tropics. IDRC, Ottawa, pp 16-26.
- Von Carlowitz P G 1986 Multipurpose tree and shrub directory. Nairobi, ICRAF 265 pp.
- Young A 1989 Agroforestry for soil conservation. CAB International, Wallingford, 276 pp.