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A Field Guide on the Use of *Sesbania Sesban*
for Alley Cropping in the Highland Region
of Rwanda

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A FIELD GUIDE ON THE USE OF *SESBANIA SESBAN* FOR ALLEY CROPPING IN THE HIGHLAND REGION OF RWANDA.

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INTRODUCTION

Soil erosion control and fertility maintenance are key constraints to sustained food production in the zone serviced by the Farming Systems Research Program (FSRP). Agroforestry is suggested as an intervention that might offer solutions to the above two and related problems. In the interim, Sesbania sesban is rated the most promising candidate agroforestry species due largely to its fast and prolific growth habits. However, our experiences with Sesbania in this region have signaled that mishandling of the shrub could lead to serious disappointments on the part of the user. This manual sets out our practical experiences on the use of Sesbania for alley cropping. The major highlights are key environmental features of the FSRP area, uses of Sesbania as perceived by farmers and how it is established and managed to realize its potential for soil fertility maintenance and erosion control. Even though the manual is primarily directed at extension agents, researchers who intend to work on Sesbania in an agroclimate analogous to the FSRP zone may find some of the caveats in this guide helpful.

FACTS ABOUT THE FSRP AREA

The FSRP area is characterized by

1) High altitude ranging from about 1500 m to 2600 m. Most farmlands fall between 1800 m and 2200 m.
2) Steep slopes. Common slopes on farmlands range between 40% and 70%.
3) Acid soils with a pH range from 4.3 to 6.7 with a mean of 4.8.
4) Relatively high and frequent rainfall compared to other parts of Rwanda. Annual rainfall is between 1100 and 1500 mm, and the daily probability of rainfall during the cropping seasons from September to January and from March to June is 80%.
5) Low temperatures. The FSRP area is in a cool environment compared to other parts of Rwanda. The mean temperature range is 13-22 C, but temperatures lower than 5 C have been recorded.
6) Population density of more than 300 persons/km^2 in the Ruhengeri Province where FSRP is based. Thus, the fundamental constraint to productive agriculture is scarcity of arable land. Population pressure leads to continuous cultivation of marginal land on hillsides that normally would serve as pasture.

The consequences are

1) lack of vegetation to protect the environment;
2) loss of fertile top soil via erosion; and
3) low crop yields.

BENEFITS OF AGROFORESTRY AS PERCEIVED BY FARMERS

Stakes for Climbing Beans

Under good soil conditions, climbing beans yield almost twice as much as dwarf beans. A major constraint to widespread cultivation of climbing beans is lack of stakes. Agroforestry with Sesbania provides about 70% of the stakes needed by pole beans within a period of 6-8 months after establishment of the shrub.

Erosion Control on Steep Slopes

Soil erosion is the most conspicuous problem in the FSRP zone. Mechanical structures, e.g terraces, once prescribed as remedial measures have limited appeal principally due to the high cost of construction, an inadequate number of trained personnel to supervise construction at farm level and lack of proper maintenance to ensure sustainability of the terraces. Planting of Sesbania hedgerows along the contours not only minimizes the amount of soil loss, but also improves the productivity of the soils in the alleyways through periodic addition of nutrient-rich organic materials. The erosion control capability of Sesbania hedgerows becomes even more efficient if they are combined with bands of grasses such as Setaria along the contours. By this combination, development of natural terraces becomes discernible after two seasons of cultivation in the alleyways.

Fodder for Livestock

Commercial inorganic fertilizers are not popular among farmers in the region due to their high cost and unavailability. Manure from livestock (small ruminants and cattle) constitutes the main source of accitional soil nutrients. Raising of livestock is also hindered by a lack of sufficient fodder. Clippings from the fast-growing Sesbania and the interplanted grasses supply an excellent mix of fodder for livestock even during the dry spells.

Improvement of Soil Fertility

With respect to agroforestry, improvement of soil fertility is a slow but sure process. The soil fertility aspect of agroforestry with Sesbania operates through the following mechanisms:

- nitrogen fixation;
- recycling of leached nutrients;
- conservation of applied nutrients;
- protection of soil against erosion; and
- provision of organic materials from roots and prunings to improve biological and physical properties of the soil.

ESTABLISHMENT

Transplanting tubed seedlings is the common method of establishment, but direct sowing is also possible. Seedlings are raised in the nursery for 4 months. For Sesbania, inoculation with rhizobium is not necessary. Neither is seed treatment prior to sowing. Germination generally is good. Addition of manure to the nursery soil improves the vigour and growth rate of the seedlings. The following establishment sequence is suggested for the FSRP area (see Fig. 1-8):

- prepare land;
- apply the normal rate of manure for food crops;
- plant food crops (except pea, if possible), preferably in rows;
- wait for emergence of food crops;
- mark points of equal heights on the slope (contours) with the help of a level or A-frame and pegs.

  For practical purposes, the following formula is tentatively proposed for determination of alley width between hedgerows on slopes (30 - 59% in one category and > 60% in another):

$$W = \frac{100K}{\%S} + 1$$

where

W = alley width (m)

S = slope (%)

K = shrub factor calculated as : $\frac{\text{biomass yield of double row}}{\text{biomass yield of single row.}}$

1 = compensation factor (assuming 0.5 m space is left on either side from the hedgerows in each alley).

Using the lower figures of the slope ranges, this formula gives alley widths (W) for slopes > 30% but less than 60% to be approximately 6.0 m whereas W for slopes > 60% approximates 3.5 m.[1] For < 30% slopes, W could be anything between 6 m and 8 m. Values of W exceeding 8 m may reduce the impact of the prunings on soil fertility maintenance, unless combined with high rates of manure application. The above formula is based on the notion of two rows of Sesbania staggered at 0.25-cm centers along a contour in a hedgerow.

plant the shrub bearing in mind the rules in point 5 above and at the onset of the rainy season and plant grasses, say Setaria, between the shrubs in the hedgerows about 4 months after planting the shrubs to alleviate competition between the two.

MANAGEMENT

The problem of management of Sesbania lies with its regeneration after cutting, which also determines its longevity. In the FSRP operational zone, coppicing of Sesbania is found to depend on agroecological zone, land type, age, height and time of cutting.

Key facts to remember when dealing with Sesbania in this area are

- do not remove all leaves when planting in relatively low altitudes and warm environments, especially on sloping and eroded upland soils with low water retention;
- severe shading and consequent reduction in yields of food crop near the hedgerow;
- possible death of plants due to coiling of root of seedlings, a condition that arises when overgrown seedlings are transplanted from the nursery;
- do not cut back below 50 cm when the shrub is more than a year old;
- Sesbania may die if the main stem is split or cracked when the shrub is cut back;
- except in the swampy valley bottom, avoid pruning of Sesbania at the end of the rainy season;
- maintain a small nursery close to the farm to supply seedlings to replace plants that may die as a result of cutting with a blunt knife, diseases and pest infestations or old age ;
- do not think that mere planting of Sesbania can do the magic of turning totally impoverished soil into a virgin farmland in a matter of a few months. On very poor soils where most food crops would normally refuse to grow, Sesbania does grow, but its performance is only mediocre. Under such circumstances, initial application of manure or fertilizer (N and P) improves growth dramatically.

SOIL PRODUCTIVITY ANALYSIS

This is a measure of the land's ability to produce food crops on a sustained basis. An obvious setback with agroforestry commonly expressed by users is the displacement of food crops by shrubs, in turn reducing overall productivity of the system. The key word in agroforestry land use systems is sustainability; this can be realistically assessed by examining yields over time using the formula

$$Yaj = (1 - S/W) \times Ya \times 10{,}000/(W \times L),$$

where

Yaj = adjusted yield in kg/ha
S = food crop row spacing, in meters
W = alley width, in meters
Ya = unadjusted yield, in kg/plot
L = length of plot in meters.

The sustainability aspect of agroforestry is visualized in Fig. 9, which shows a yield decline in the non-agroforestry plots and an increase in yield in the agroforestry plots over time. Supplementation with fertilizer or manure improves the system by speeding up 1) the growth of the shrubs, hence decreasing the time between establishment and cutback, and 2) the rate of decomposition of the cut back and pruned materials with concomitant release of nutrients to food crops. The resulting effect is a shortening of the period after which one begins to see the soil productivity value of agroforestry. The benefit of agroforestry can also be determined at any point in time.

[1]The reader should exercise caution in applying these distances, particularly with regard to steeper slopes. Alley widths less than 6 m. cause losses due to shading and reduction of area planted to food crops that tend to discourage adoption by more land-constrained farmers.

RESEARCH HIGHLIGHTS

- Sesbania is a fast-growing shrub. Its average growth rate ranges from 26.4 cm/month on the eroded hillsides to 62.2 cm/month on the flat and moist valley bottom soils.
- Dry matter yield from cut backs at one year after planting averages 3000 kg/ha in the high altitude cold environment and 2100 kg/ha in the relatively low altitude and warm ecozone.
- Initial growth is reduced by intercropped pea crop.
- Application of farmyard manure at the rate of 2.5 tons/ha increased the growth of Sesbania by about 30%.
- Sesbania shows significant growth even during the dry season after root establishment.
- Based on one season's results, the common practice of applying high rates of manure (10.0 tons/ha) is unnecessary if prunings of Sesbania are also added. The highest potato yield of 21 tons/ha was obtained from plots where prunings and 5 tons/ha of manure were applied. Plots that received only prunings yielded 20 tons/ha. These two treatment were significantly different from the control plot where neither prunings nor manure were added. Yields of pole beans were similarly improved by alley cropping with Sesbania.

  A strategy being experimented with at the FSRP is a combination of Sesbania and Leucaena or Calliandra in a hedgerow. This mixture of species takes advantage of Sesbania's fast growth to satisfy farmers' short-term needs and robustness of Leucaena or Calliandra to meet farmers' long-term requirements.

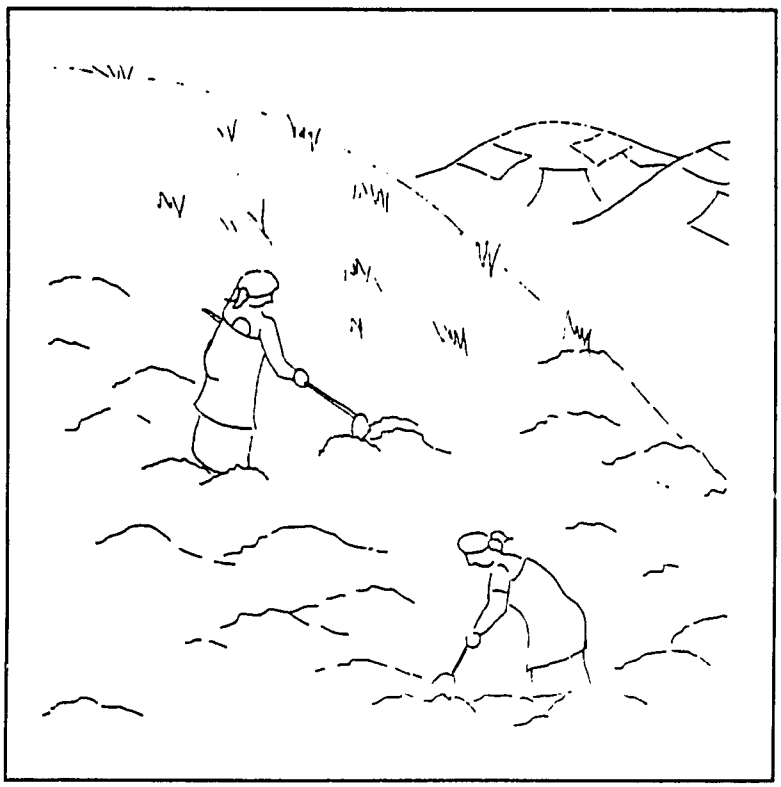

Fig. 1. Prepare the land.

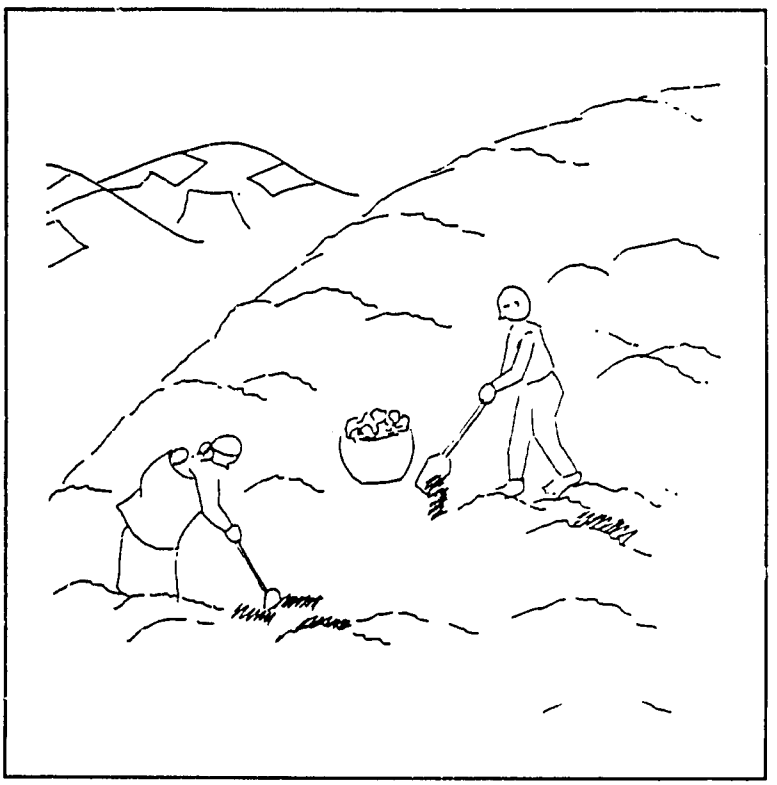

Fig. 2. Fertilize with manure

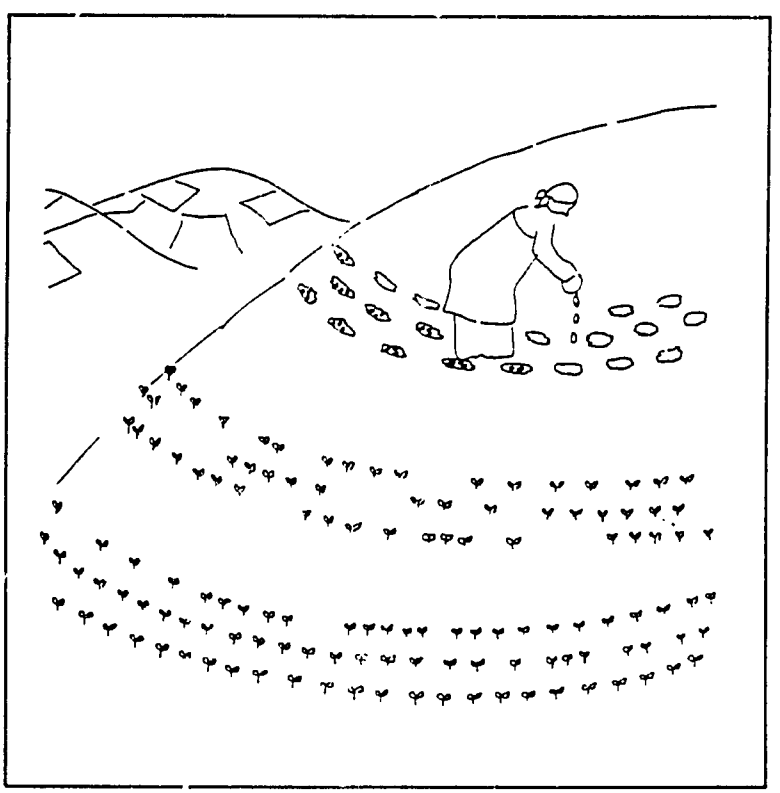

Fig. 3. Plant food crops along contours.

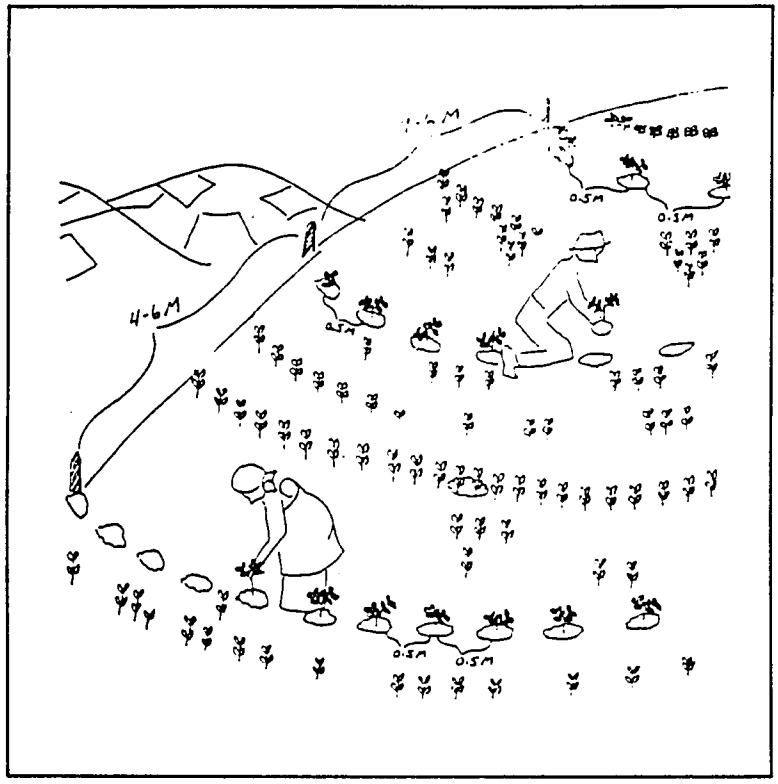

Fig. 4. Mark contours at 4 to 6 m. Plant shrubs along contours 0.5 m apart.

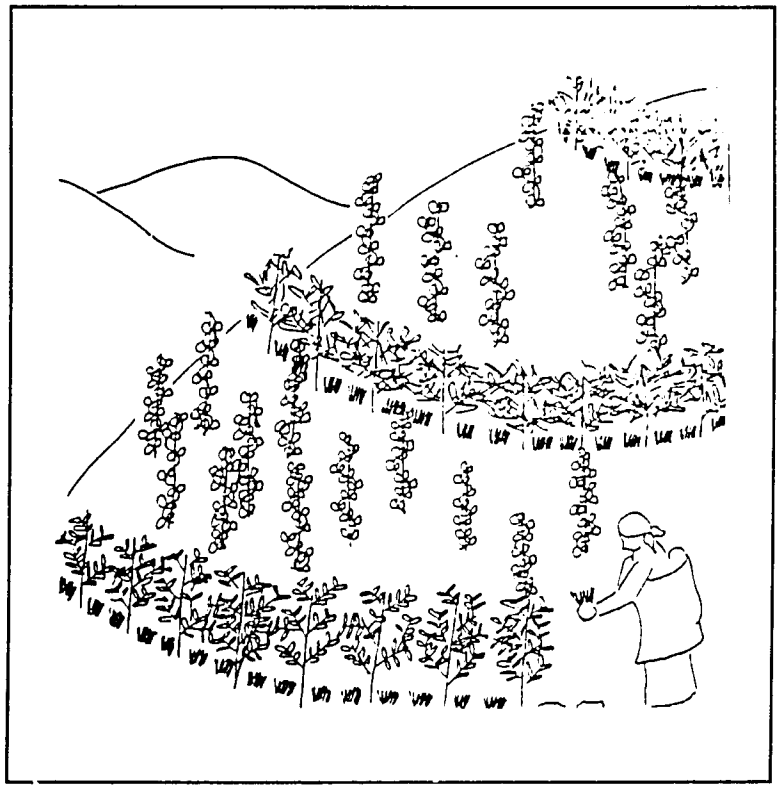

Fig. 5. When shrubs are chest high, plant grass in spaces between.

Fig. 6. At 1 year when shrub is 4 m high, prune to waist high.

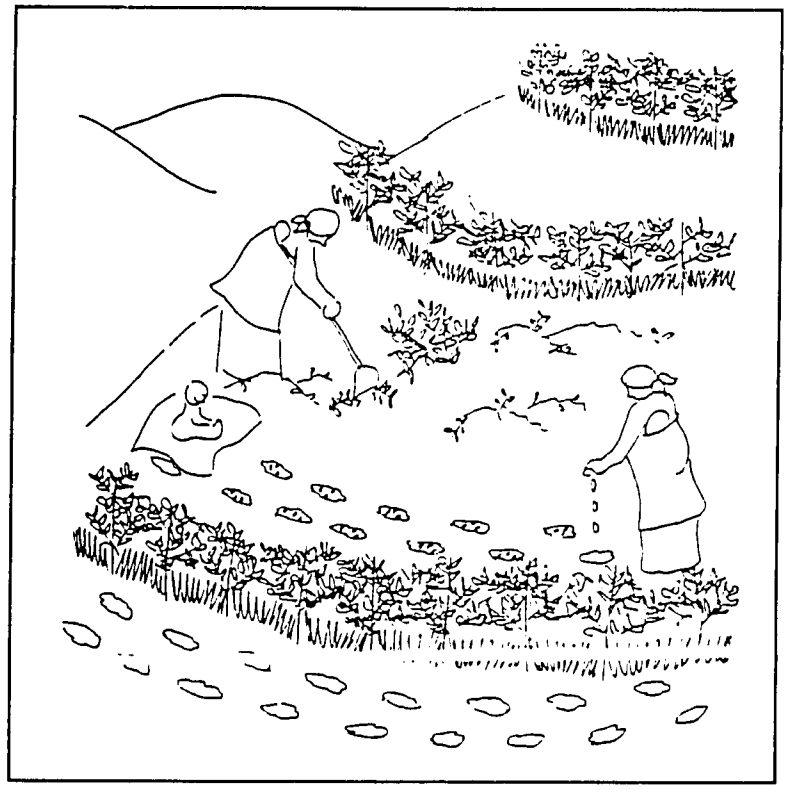

Fig. 7. Incorporate leaves as green manure; plant next crops.

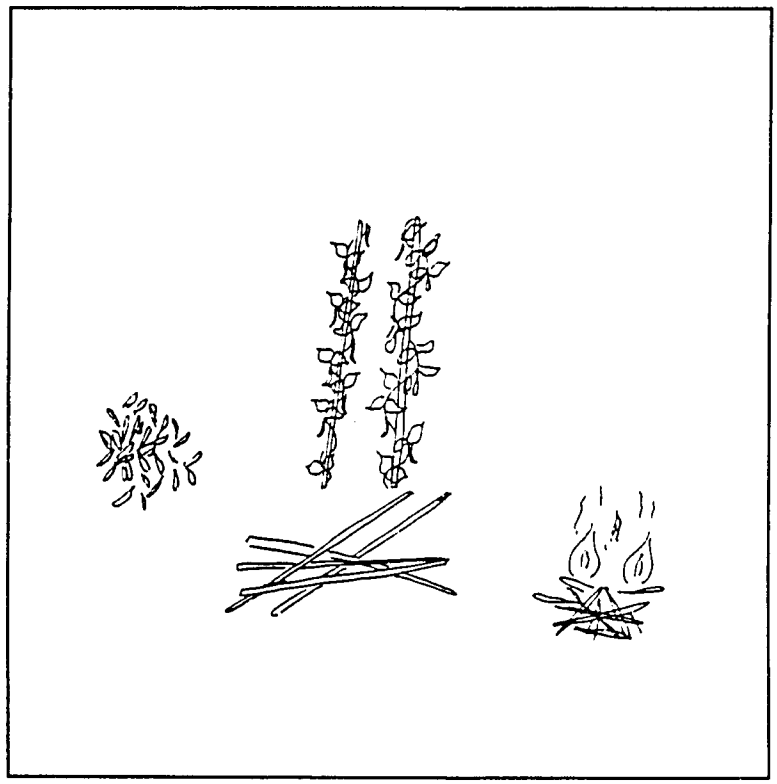

Fig. 8. Leaves = green manure; large branches = bean stakes; small branches = firewood.

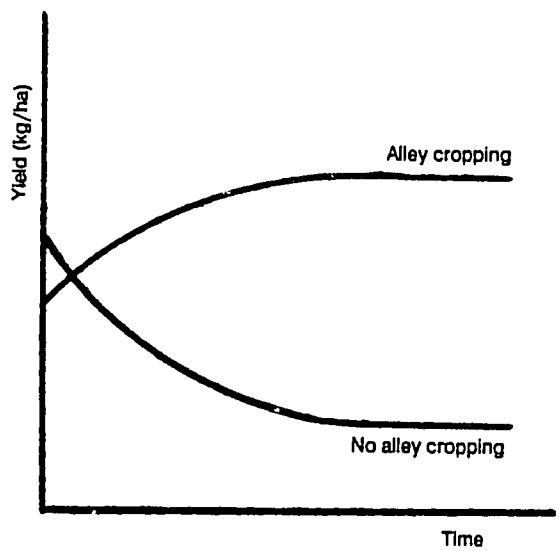

Fig. 9. Yield sustainability in alley cropping.