ALLEY CROPPING:
A promising alternative to shifting cultivation in Papua New Guinea

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INTRODUCTION

In the humid and sub humid tropics, throughout Africa, Asia, South America and Oceania, shifting cultivation is still the main food production system. However, as population numbers increase, pressures to find enough land also increase. Agriculturalists throughout these regions have been faced with the question of finding suitable systems to produce more food on a small area.

Alley cropping is one system that has been devised and is being tested among other systems. This article briefly outlines the system, and lists some of its attributes. It focuses on where it can be relevant and possibly adopted in Papua New Guinea, and discusses some practical points in establishing alley cropping.

WHAT IS ALLEY CROPPING?

Alley cropping is a system under which crops are grown in alleys (narrow passages) formed by usually leguminous (nitrogen fixing) trees or shrubs. It is a technique in which the farmer plants selected legume species together with his economic crop species to perform some of the beneficial roles of a bush fallow. These trees or shrubs are fast growing and are periodically cut back to use the prunings as mulch or green manure on the cultivated crops growing in the alley.

Trees and shrubs to be used in alley cropping should have the following desirable characteristics:

- can be easily established
- are fast growing
- have a deep root system
- produce heavy foliage
- regenerate readily after pruning
- can be easily eradicated
- provide useful by-products

Two of the legumes currently being researched and used in alley cropping in parts of Nigeria are *Leucaena leucocephala* and *Gliricidia sepium*. Both these legumes are commonly used in many areas throughout Papua New Guinea.

Maize growing in Leucaena alley - IITA

Maize growing in Gliricidia alley - *IITA*

SOME BENEFICIAL ASPECTS OF ALLEY CROPPING

A major advantage of alley cropping over the traditional shifting cultivation and bush fallow systems is that the cropping and fallow phases can take place at the same time. This will enable the farmer to crop for a longer period without returning the land to bush fallow. The ratio of land under cropping phase to land under fallow phase is usually 2:1 to 4:1 in a simultaneous fallow system. This means that of a total land area under simultaneous fallow system 60 to 80% of it can be under cultivation at any one time.

Because the alley species like Leucaena are deep rooted, nutrient recycling and "pumping up" from parent material below, along with nitrogen fixation, is continuous.

See table 1 below for nutrient yields in prunings of four woody species tested for alley cropping.

Alley cropping can be very useful in areas where farmers are forced to cultivate steep slopes. Erosion prevention can be achieved by planting the alley hedges on contours and mulching the soil between the hedges with the prunings. Areas under the fallow phase can be sown to a cover crop or "live mulch" like *Pueraria phaseoloides* which will further reduce the leaching of nutrients and prevent any bad effects of raindrop splash on the soil.

Weed Control

Weed control is effective under alley cropping as both the shade from the alley hedges and the "pruning mulch" applied to the soil suppress (keep down) weed establishment.

Yields

Continuous farming is possible with low inputs under alley cropping. Experiments continuing since 1979 at the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria have shown that by removing the Leucaena prunings from the plots, maize yields were reduced to about 30% of the yield from mulched plots.

On application of 80 kg N/ha maize yield in mulched plots was increased from 2.0 to 3.7 t/ha. Similarly in 1985 grain yield from maize grown under zero tillage in the 5th year of cultivation was higher in the Leucaena mulch plots than in the control. In control plots maize yield peaked with an application of 90 kg N/ha while under Leucaena alley cropping maize yields were significantly higher with half the application of nitrogen.

By-products

Several useful by-products are also derived from alley cropping. Apart from being used as mulch the young shoots and leaves of prunings can be fed to livestock such as goats. The older branches and sticks can be used as firewood or stakes for yams and other climbing crops.

Yam (D. rotundata) on Leucaena stakes obtained from alley stake lots - IITA

Dead and live in-situ Leucaena stakes in the field at IITA

In some areas in Papua New Guinea, like parts of the East Sepik where Leucaena poles are used for houses, building materials can also be obtained from alley cropping.

SITUATIONS UNDER WHICH ALLEY CROPPING COULD BE ADOPTED

Alley cropping can be adopted in areas with increasing pressure on land due to population increase, such as parts of the Chimbu Province, Gazelle Peninsula, parts of the Maprik District in the East Sepik Province and small off-shore islands. Also in these and other areas where farmers are often forced to cultivate steep slopes. Alley cropping practised on these slopes can improve soil conservation and nutrient recycling.

Rehabilitating grassland areas in many parts of the country could be possible under alley cropping. The inclusion of deep rooted tree species would improve nutrient recycling and improve the top soil through mulching with it's subsequent increase in the activity of small animals and micro-organisms (bacteria, protozoans and fungi) which live in the soil. This will mean soil conditions are favourable for more and different types of trees to grow and takeover from the grass. Farmers practising yam based cropping systems in grassland areas would produce regular supplies of staking material which would affect their staking labour requirements and yam yields favourably. These would include the Wosera area of the Maprik District and parts of the Central Province.

Institutions like boarding high schools, tertiary institutions and correctional institutions which grow some of their food could also find alley cropping an attractive new idea. Arable cropping land within institutional boundaries is usually limited and such land under alley cropping will enable an area of land to be under cropping for a longer period of time. The by-products of the system should give even more reasons for institutions to adopt alley cropping. Finally the adoption of new ideas by institutions will help increase the spread of such ideas through students, trainees and detainess learning the practices and taking them wherever they go.

A FEW HINTS TO INTERESTED FARMERS

Once it has been decided that an area of land is to be brought under alley cropping, a suitable tree or shrub should be chosen. The existing vegetation is cleared and the hedges should be sown together with the food crops. With Leucaena this could be done by direct seed, which is the cheapest method or by transplanting. Gliricidia can be established using hardened stem cuttings 50 cm or more in length.

Leucaena seeds should be treated to get good germination. With the hot water treatment seeds can be immersed in hot ($90^{o}C$) water four or ten times their volume and allowed to soak in the gradually cooling water for 12-24 hours. For a more reliable treatment, thoroughly stir 1 part of concentrated (98%, 36N) commercial grade sulphuric acid into 10 parts of seed. The black slime should be rinsed in running water 60 minutes after adding of acid to seed.

An alley width of 4m is usually satisfactory, however it can be adjusted depending on local requirements. For example in Nigeria, 2 m alley widths are used to allow staking of yams on live stakes or on dead stakes left where they had been growing. Spacing of trees or shrubs within rows can be 25-100 cm depending on the species. When deciding on the height of pruning one should consider shading effect on other

crops and the physical strain on persons doing the work.

A convenient height would be 75-90 cm as bending over or reaching up would not be required to carry out pruning. Alley hedges should be layed out in an east-west orientation to minimize the shading effect on the crops in between. On sloping land hedges should be planted on contours as a soil conservation measure.

Pruning intensity will depend on the crop and the hedge shrub or tree species. Generally less pruning is required when the crop is high and the hedge is low, but during cropping, pruning every five to six weeks is required. To improve nutrient uptake by crops, pruning can be dug into the soil as opposed to mulching on the surface. Observation showed that Leucaena prunings were a more effective source of nitrogen when incorporated into the soil.

Aspects of alley cropping which require some attention are control of weedy hedges, labour requirements of system and other requirements of the hedge species. Leucaena if used and not looked after properly can give rise to volunteer plants which may become weeds. If seeding is allowed to take place then seedlings should be slashed at a very young stage. The IITA recommendations for control of Leucaena as a weed are spraying with Atrazine at 3.0 kg/ha and ploughing the seeds below 11 cms. Both these control measures make Leucaena alley cropping feasible under zero tillage and conventional tillage. Alley cropping may prove a labour intensive system, although in village situations, adequate family labour is usually available.

Leucaena, if chosen to be used in alley cropping, should not be used in areas where the soil pH is low as it is sensitive to low pH.

Crops under alleys should be rotated in susbequent seasons to reduce build up of pests and diseases and to change the pattern of nutrient uptake and recycling.

DISCUSSION

Alley cropping is a modified version of the bush-fallow system. It retains many of the desirable characteristics of the bush-fallow system in restoration of physical and chemical soil properties and soil conservation. It also provides useful by-products in mulching material, livestock fodder, firewood, staking and possibly building materials. The biggest advantage alley cropping has over traditional systems is, it allows the fallow phase and the cropping phase to take place on the same piece of land at the same time. This enables the farmer to crop a piece of land for a longer period without returning land to fallow.

Like the traditional system it requires no imputs of agrochemicals yet leaves options open for low inputs to increase yield where desired. As such it should get a favourable consideration in Papua New Guinea, as in many other tropical countries where farmers are unable to afford modern agricultural inputs.

Table 1 Dry matter (prunings) and nutrient yields in young tops of four wood species with five prunings in a year (1985).

Species	Dry matter prunings (t/ha/year)	Nutrient yield (kg/ha/year)				
		N	P	K	Ca	Mg
Acio barterii	3.0	40.5	3.6	20.4	14.7	5.4
Alchornea cordifolia	4.0	84.8	6.4	48.0	41.6	8.0
Gliricidia sepium	5.5	169.4	11.0	149.1	66.0	17.6
Leucaena leucocephala	7.4	247.2	19.9	185.0	98.4	16.3

Source: IITA (1986)