

6 Application

6.1 Introduction

Why make use of mixed cropping or integrated systems such as alley cropping? Mixed cropping (e.g. a grass/legume sward) is already an established practice in fodder production. Leguminous crops are included for the addition of nitrogen, which also improves nutritional value and intake. The advantages include improved yield per unit surface area, improved quality, improved combined use of resources (light, water, nutrition, space), improved stability of yields and intake and animal production (Van den Berg, 1987).

The effectiveness of a mixed cropping system may be evaluated by calculating the Land Equivalent Ratio (LER). LER refers to the ratio of the *area* under sole cropping to the area under intercropping, at the same level of management, that gives an equal amount of yield. The sum of the fractions of the yields of the intercrops relative to the sole crops provides a measure of the overall effectiveness of the mixed system – where $LER=1$, there is no advantage to intercropping over sole cropping; and where $LER<1$, more land is needed to produce a given yield by each component as an intercrop. As indicated by Ong (1996), the choice of the denominator or sole treatment of each crop should be the *optimal* treatment for the site. However, LER has also been calculated using only yields obtained from the crops involved (Rowland, 1975, as cited by Rowland, 1993), which is the method that will be used to calculate the LER's of the alley cropping trial at Hatfield (Table 1). No pure stand of leucaena was harvested, thus previous experimental results obtained on the same site were used (Lindeque, 1997). These yields were calculated as the total seasonal yield obtained in an unpruned leucaena stand. It is not the most satisfactory manner by which to calculate LER, but at least provides a reference point.

The alleycrop LER for the S2 treatment was calculated as 3.109, and the LER for the S3 treatment as 19.574. It is clear that the alley crop system was more productive than a tree monocrop, although sorghum would be produced more productively in a monocrop.

Table 1 LER's of alley cropping trial, 1997/1998 season (6m treatment)

Crop yields (forage)			
Crop	Pure stand (t/ha)	In alley (t/ha)	LER (Components)
S2			
Fodder Sorghum	34.334	20.784	0.605
Leucaena	2.875	7.198	2.504
S3			
Fodder Sorghum	34.334	23.48	0.684
Leucaena	2.875	16.015	18.89

6.2 Application of alley cropping with leucaena

The use of hedges in alley cropping can aid in protecting crops from roaming wildlife, domestic animals and people. Hedgerows define borders, provide privacy and act as small windbreaks. They may be planted and managed for fuel wood, fodder production, or to provide green manure or mulch. The hedges should be widely spaced in order to avoid a negative impact on associated crops, when trees are grown to large sizes. Living fence posts can be used in the same manner as above; the trees planted further apart and managed less intensively (e.g. cut less often). The trees can be used with other materials to form a barrier and are allowed to grow to larger sizes than hedges. Windbreaks are single or multiple rows of trees planted along windward field boundaries. The purpose is to slow wind speed and thus conserve soil moisture and prevent wind erosion and crop damage. Hedgerow intercropping is, however, management and labour intensive (Macklin, 1988; Prinsley, 1993).

6.2.1 Wood production

Approximately 2 billion people are dependant on fuel wood and charcoal for 90% of their energy requirements, another 1.5 billion for 50% of their requirements (Gutteridge & Shelton, 1994). Approximately 90% of the wood used in Africa, is for the purpose of fuel, with the remainder being used for construction or other purposes (Cook & Grut, 1989). The problem is that the demand is much higher than the production capacity. This has led to massive deforestation, increased water and wind erosion and the depressed productivity of agricultural land. In 1994, 4 % of the rural community in South Africa had access to electricity, while \pm 40 % of the

population was still dependent on wood for their energy requirements. Approximately 11 million t wood are being used annually in South Africa, as fuel wood (Cooper & Fakir, 1994; Gandar, 1994, as cited by Shackleton, 1994).

The inclusion of alley cropping principles in rural community gardens, can help alleviate this problem. Fuel wood and/or kindling can be produced throughout the year, ensuring a steady supply. Unpruned tree rows could be harvested to provide logs that would be suitable for fuel wood, while hedgerows could be harvested to provide kindling. Pruning to single stemmed trees could yield a useable pole for fencemaking or construction purposes, but could also be harvested for fuel wood.

6.2.2 Fodder production

Fodder banks refer to intensive plantings of trees spaced to maximise leaf production and provide a source of "cut and carry" fodder (Macklin, 1988). This could also be applicable to alley cropping systems. In Tanzania it was found that 2 kg/day fresh leucaena leaves may result in a notable improvement in the body condition of animals. Under grazing and zero-grazing systems, supplementation with leucaena resulted in an average daily live weight gain (DLWG) of 52.8 g/day after 28 days, and 53.47 g/day after 48 days (N'Jai, 1995).

The use of the leaves as fodder in such a "cut and carry" system holds the disadvantage that soil nutrients may be depleted, as the nutrients taken up by the plant are not circulated. It is also not a well known concept in certain parts of the world. In Australia, only $\pm 2\%$ of farmers who practise agroforestry do so for fodder. This increases to 4% in the drier zones (Prinsley, 1993). It is, however, of interest to note that mechanisation of harvesting and feeding of coppice growth of *Albizia* species in the USA has improved the feasibility of such zero-grazing systems (Rethman, personal communication)¹.

6.2.3 Mulch/Green manure

Low water availability has been known to adversely affect N fixation (Tewari, 1995). Apart from possibly increasing soil fertility, the addition of mulch could actually reduce the loss of moisture by preventing evaporation from the surface. Other

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favourable effects mentioned by Arnon (1992) include the reduction of run-off and erosion, reduction of salinity and improvement of soil temperature by changing the radiant energy balance of the system (mulched soil are usually warmer and cooler than bare soil, depending on the situation, because of the insulating effect).

Problems associated with mulched soils were also mentioned, including sanitary problems due to the harbouring of disease, pathogens and pests.

6.2.4 Weed control

The presence of mulch has been reported to suppress weed growth (Lal, 1975, cited by Kintomo, Agboola & Mutsaers, 1995). Weed suppression may, however, be influenced by morphology of the leaves used for mulch. The leaves of leucaena are bipinnate (small leaflets) and will almost immediately fall from the rachis when drying starts and be easily blown away. Unless the mulch layer is laid relatively thick, the effect might, therefore, be lost.

6.2.5 Windbreaks

The principle effect of windbreaks is to reduce wind velocity and turbulence. When used in wide alleys, single stemmed trees could act as windbreaks (Arnon, 1992). In semi arid and dry temperate areas, planting of 5% of the land to shelter could reduce windspeed by 30-50% and soil losses by up to 80% (Bird, Bicknell, Bulman, Burke, Leys, Parker, Van der Sommern & Voller, 1993).

To aid farmers in the decision making process, an agroforestry computer simulation model - "Farmtree" - is available, that estimates the likely costs, effects on agriculture, tree growth, timber value, directs effects on farm income and nett rate of return. It uses the input details of site, layout, species, intended harvest age and proposed management (Farmtree, undated). The model does not, however, have an adequate data base for tree and plant interactions.

6.3 Conclusion

All of the above mentioned points fit neatly into two well known concepts, which may aid in the adoption of the technology (Arnon, 1982), viz. "LISA" and organic farming.

- *LISA (Low Input Sustainable Agriculture)*

This technology seeks to minimise the use of external production inputs, such as purchased fertilisers and pesticides, wherever feasible and practicable, to lower production costs, to avoid pollution of surface and groundwater, to reduce pesticide residues in food, to reduce a farmer's overall risk, to increase both short- and long term farm profitability. Arnon (1992) noted that the slogan "low input agriculture " is misleading and counterproductive because it diverts attention from the really important goal of increasing the farmers' awareness that further deterioration of the natural resource base must also be prevented.

- *Organic farming*

Organic farming is not exactly a new approach, having been actively propagated since the 1940's and experiencing a revival the past few years. The system ascribes most of the ills of modern agriculture to the use of "artificial" chemicals, such as soluble fertilisers, insecticides, fungicides, herbicides and others. It is claimed that the chemicals destroyed soil fertility, by replacing organic manure and poisoning the soil organisms. This, in turn, caused an increase in the incidence of plant diseases and thereby adversely affected the health of humans and domestic plants using the contaminated and diseased plants for food. Although the amounts of organic food produced still constitute only a fraction of total food production, the numbers of organic farmers are increasing, mainly as a result of the increase of consumers' interest in environmental problems, improved quality of life and health-giving food (Arnon, 1992).

However positive the results obtained and possibilities of leucaena, some concern exists about the status of leucaena as a weed in South Africa, as it has reached invader status in some countries. The plant is perceived as a "noxious" weed by many, so much so that some authors believe the "conservation of environment" vs. "agricultural production" debate to be swinging towards conservation (Partridge,

2000), therefore discouraging the production of leucaena. In South Africa, amendments to the Conservation of Agricultural Resources Act (Act 43 of 1983) have been proposed by the National Department of Agriculture, that will regulate the use of potential invading plant species. According to these proposed regulations leucaena will be classified a Category 2 invader (plants that are useful for commercial plant production purposes but are proven plant invaders under uncontrolled conditions outside demarcation areas). Plantings thereof should be confined to demarcated areas, where controlled conditions of cultivation and care prevail. Plants or products derived from the plants must serve beneficial purposes including uses for own consumption, esthetic value, ornamentation, building material, animal fodder and fuel. Precautionary measures should be taken to reduce the spread of seed or any other propagating material outside the demarcated areas. An additional condition stipulates that the trees shall not be planted within 30 m from the outside boundaries of the flood areas of perennial watercourses and wetlands. The regulations have not yet been promulgated, but are expected to be finalised during the course of 2001.

Leucaena is widespread in sub-tropical areas of South Africa, but invasion has been prevented by management strategies such as pinching off the flowers in order to prevent the production of seed (personal observation, Northern Province) and utilisation by grazing animals. At this stage it would seem as if leucaena has only been invasive in disturbed coastal urban areas and lowveld areas with high rainfall (>900 mm per year) (Underwood, 1986 and Fenn, 1987, as cited by Pauw, 1994).

Pauw (1994) provided a summary of factors regulating the spread of leucaena, including:

- Altitudes higher than 500 m
- Rainfall of less than 900 mm per year
- Frost
- Well established vegetation and associated competition
- Acidic soils

Useful guidelines regarding the control of leucaena have been published by the Tropical Grassland Society of Australia (Partridge, 2000):

- Only plant leucaena if you need it and are prepared to manage it
- Do not plant leucaena near streams or major waterways. Maintain a dense grass buffer between the leucaena and the high water mark of the river bank.
- Control unwanted seedlings that establish outside camp fence or in areas where cattle do not normally have access.
- Plant leucaena in a carefully fenced paddock, at least 10 m away from external fence lines.
- Do not allow ripe seed to drop to the ground.
- Graze or cut leucaena to keep it within reach of animals.
- Graze leucaena in summer so as to minimise flowering and seed set.
- Do not plant leucaena in pure stands without grass (this system will be more to erosion).
- Assist your local government identify any stands of escaped leucaena so that action can be taken to control it.

Although results obtained from alley cropping differ widely, and have been mainly obtained in tropical areas receiving a higher rainfall, the system offers the potential of increased productivity to developing agriculture. Results from various locations differ, as many of the interactions with environmental factors are not yet fully understood. Each system should be evaluated on its own merits, taking into account the locality-specific conditions. Adaptations should be made along the way, streamlining the management of the system in order to obtain the goal of increased and sustained production.

6.4 References

ARNON, I., 1992. Agriculture in dry lands - Principles and practice. Elsevier, Amsterdam.

BIRD, P. R., BICKNELL, D., BULMAN, P. A., BURKE, S. J. A., LEYS, J. F., PARKER, J. N., VAN DER SOMMERN, F. J. & VOLLER., 1993. The role of shelter in Australia for protecting soils, plants and livestock. In: The role of trees in sustainable agriculture. Edited by R. T. Prinsley & J. Allnut. Kluwer Academic Publishers, Dordrecht/Boston/London.

COOK, C. C. & GRUT, M., 1989. Agroforestry in Sub-Saharan Africa. A farmer's perspective. World Bank Technical Paper No 112. The World Bank, Washington DC.

COOPER, D. & FAKIR, S., 1994. Commercial farming and wood resources in South Africa: potential sources for poor communities. Plant for Life/Biomass Initiative Conference, Pretoria.

FARMTREE, undated. A computer model to help estimate the profitability of agroforestry, undated, Dept Agriculture/Conservation & Environment, Melbourne, Victoria.

GUTTERIDGE, R. C. & SHELTON, H. M., 1994. The role of forage tree legumes in cropping and grazing systems. In: Forage tree legumes in tropical agriculture. Edited by R.C. Gutteridge & H. M. Shelton. Commonwealth Agricultural Bureaux International.

KINTOMO, A. A., AGBOOLA, A. A. & MUTSAERS, H. J. W., 1995. Weed control effects of mulch from prunings of *Leucaena leucocophala* and *Senna siamea*. *Nitrogen Fixing Tree Research Reports* 13:75-78.

LINDEQUE, J.P., 1997. Groei, ontwikkeling en voedingswaarde van *Chamaecytisus palmensis* en *Leucaena leucocephala* onder marginale somerreënvaltoestande. M. Sc. Agric dissertation. University of Pretoria, Pretoria.

MACKLIN, B., 1988. An overview of agroforestry systems: A classification developed for extension training. In: *Agroforestry land use systems*. Special Publication of the Nitrogen Fixing Tree Association, Hawaii.

N'JAI, O., 1995. Comparison of groundnut hay, sesame seed cake, *Leucaena leucocephala* and *Gliricidia sepium* as protein sources for rams. In: Nitrogen fixing trees for fodder production. Edited by J. N. Daniel & J. M. Roshetkoe. Winrock International Washington, DC.

ONG, C.K., 1996. A framework for quantifying the various effects of tree-crop interactions. In: *Tree-Crop Interactions – A Physiological Approach*. Edited by C.K.Ong & P. Huxley. ICRAF, Nairobi.

PARTRIDGE, I., 2000. Freedom of information. *Tropical Grasslands Society News & Views* 16(3):1

PAUW, E., 1994. Evaluation of *Leucaena leucocephala* (Lam.) de Wit. M. Sc. Dissertation, University of Fort Hare, Fort Hare.

PRINSLEY, R. T., 1993. The role of trees in sustainable agriculture - an overview. In: *The role of trees in sustainable agriculture*. Edited by R. T. Prinsley & J. Allnut. Kluwer Academic Publishers Dordrecht/Boston/London.

ROWLAND, J. R. J., 1993. Grain Legumes. In: *Dryland Farming in Africa*. Edited by J.R.J. Rowland. Macmillan Press Ltd., London.

SHACKLETON, C. M., 1994. Sustainable veld management and its role in social forestry and energy planning. Plant for Life/Biomass Initiative Conference, Pretoria.

SOUTH AFRICA, 2000. Regulations: Proposed Amendment to the Conservation of Agricultural Resources Act (Act 43 of 1983). National Department of Agriculture, Pretoria.

TEWARI, D. N., 1995. Nitrogen fixing tree species research. In: Nitrogen fixing trees for fodder production. Edited by J.N. Daniel & J.M. Roshetkoe. Winrock International, Washington, DC.

VAN DEN BERG, M., 1987. Wisselwerking tussen *Trifolium vesiculosum* Savi en *Lolium multiflorum* Lam. by gemengde verbouing. M. Sc. Agric dissertation, University of Pretoria, Pretoria.