Agroforestry as a potential alternative to sugarcane in marginal areas of Mauritius for economic and environmental sustainability and energy

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Introduction

- The price of sugar exported to the EU will fall by more than 36% in the coming years.
- Price of petroleum products is continuing its ascent
- For Mauritius exports to be competitive, the sugar industry has to re-engineer itself
- The Government of Mauritius, in consultation with stakeholders, has come up with several plans (SSSP and the MAAS).
- Many marginal lands in Mauritius (land of mountain slopes, on rocky substrata, areas of excessive rainfall or very dry zones, will no longer be profitable for sugar production.

Introduction contd.

- Many of these marginal lands are owned by small sugarcane planters.
- About 6,000 ha of land has been categorised as being difficult areas for sugarcane (MSIRI has identified about 12,341 ha).
- Taking the above scenario into account, alternative and/or innovative land use measures, especially on marginal lands, must be considered.
- These measures should be acceptable to the planters as well as it should sustainable and environmentally-friendly.

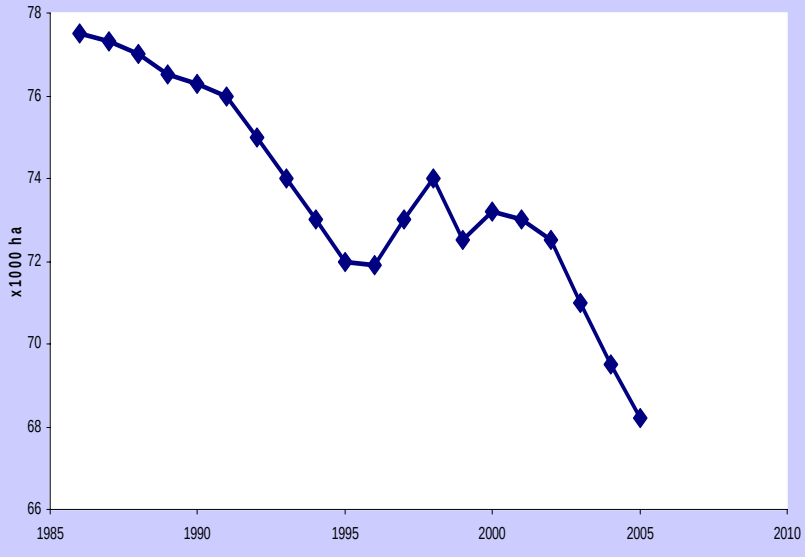

Fig. 1. Change in land area of sugarcane harvested

Agroforestry

- Agroforestry is one such land use which offers a promising alternative.
- Just like sugarcane, Agroforestry is multifunctional, environmentally sustainable, and requires minimum cultural operations.

Agroforestry

- Agroforestry is a collective name of land use systems in which woody perennials (trees, shrubs, etc.) are grown in association with herbaceous plants (e.g. crops, pastures, etc.) and/or livestock in a spatial arrangements, a rotation, or both in which there are both ecological and economic interactions between the tree and the non-tree components of the system.

Agroforestry systems

- Silvicultural (trees with crops)
- Silvopastoral (trees with pastures and livestock)
- Entomoagroforestry (trees with insects such as honey bees, silkworm)
- Aqua-agroforestry (trees with aquatic organisms such as fish, crustaceans).

Components of agroforestry systems

- Trees
- Shrubs
- Crops
- Pastures
- Animals (insects, livestock, fish and other aquatic organisms)
- Environmental factors (soil, land form, climate)

Agroforestry as a practical management land management option

- Type of land : the range of practices allow agroforestry to be applied over a wide variety of environmental conditions, e.g. wetlands, dry lands, rocky, slopy lands
- Extent of land : most agroforestry practices are not land intensive.
- Supply of inputs : agroforestry does not require inputs that are costly or in short supply. It is a relatively inexpensive form of land development.
- Technology ; the technology employed is generally known and familiar to farmers.

Agroforestry is therefore widely applicable as a practical land management option.

Benefits of agroforestry

- On soil : increases soil organic matter through carbon fixation in photosynthesis and transfer via litter and root decay
- Nitrogen fixation by leguminous and non-leguminous trees
- Nutrient uptake : taking up nutrients released by rock weathering in deeper layers and recycling it to the surface
- Atmospheric input by trapping rainfall, dust and nutrients.
- Exudation of growth promoting substances
- Prevention of soil erosion and loss of organic matter and nutrients

Benefits of agroforestry contd.

- Nutrient retrieval
- Reduction in rate of decomposition of matter by shading
- Improvement of soil physical properties, e.g. structure, porosity, WHC, breaking up of indurated layers
- Modification of soil temperature extremes
- Reduction of soil acidity through addition of plant litter
- Reduction of salinity or sodicity
- Production of a range of plant litter of different quality
- Timing of nutrient release

Adverse effects of trees on soil

- Loss of organic matter and nutrients in tree harvest.
- Nutrient competition between trees and crops.
- Moisture competition between trees and crops.
- Production of substances which inhibit germination or growth (allelochemicals).
- Acidification of soil by some tree species.

Soil characteristics under longterm *Leucaena leucocephala* (> 20 yrs) on UoM farm (Lalljee, 1996)

Characteristics	*L. leucocephala*	Open field
pH	6.84	5.04
Total N (%)	0.33	0.50
Av. P (%)	0.011	0.012
Av. K. (%)	0.037	0.021
Organic matter (%)	3.23	2.90
$NH4^+N$ (mg/kg)	1095	1048
NO_3N (mg/kg)	603	400

Soil properties beneath trees in northwest India (Aggarwal, 1980)

Av. soil nutrients	*Prosopis cineraria*	*P. juliflora*	Open field
N (kg/ha)	250	203	196
P (kg/ha)	22	10	8
K (kg/ha)	633	409	370

Soil properties beneath trees in a dry climate in Nigeria (Radwanski and Wicqens, 1981)

Soil property	*Azadirachta indica*	Bare fallow
pH	6.8	5.4
Organic C (%)	0.57	0.12
Total N (%)	0.047	0.013
P (mg/kg)	68	195
TEB (cM/kg)	2.40	0.39
CEC (cM/kg)	2.25	1.70
Base Saturation (%)	98	20

Other benefits

- In addition to the above positive effects on soil trees and shrubs offer other environmental advantages.
- Wind effects : act as windbreaks and therefore as antierosive agents
- Capture industrial aerosols and therefore purifies air and reduces air pollution
- Reduce compression and turbulence
- Rehumidify air streams
- Control air temperature by evaporative cooling.

Economic aspects

- Most of the trees chosen for agroforestry are multipurpose.
- They provide fodder for animals;
- Some can be exploited for medicinal and pesticidal properties, e.g. neem;
- Some serve as habitat for bees for production of honey, wax, propolis, royal jelly, etc. for silkworms.
- They are very efficient in biomass production, which can be transformed into energy.
- They fertilise the soil and therefore reduce the cost of fertiliser application.
- Biomass can be used as poultry litter, mushroom production.
- Some can be used as ornamentals, e.g. Christmas trees.

Yield of above ground biomass of some MPT (kg dry matter/ha/yr)

Trees	Biomass
Leucaena leucocephala	4,000-8,000
Acacia mangian	18,000
Albizia falcutana	11,300
Prosopis juliflora	30,000

Nitrogen fixed by trees and shrubs

Species	N fixed (kg N/ha/yr)
Acacia albida	20
A. mearnsii	200
Casuarina equsetifolia	60 – 110
Gliricidia sepium	13
Leucaena leucocephala	100 – 500
Prosopis glandulosa	40 – 80
P. tamarugo	200

Characteristics of trees to be considered suitable for agroforestry

- High biomass production
- High N fixation
- Well developed rooting system
- High nutrient content in biomass, including roots
- Fast or moderate decay of litter
- Absence of toxic substances in foliage or root exudates
- Cyclone resistant

Potential Agribusiness from Agroforestry

- Fuel Briquettes for Green Energy : Small planters could be grouped into cooperatives or associations to produce fuel briquettes which can be co-fired in bagasse as well as coal powered stations. There are various ways of producing these briquettes, e.g. production of charcoal and conversion to charcoal briquettes or production of waxed briquettes, or non-waxed briquettes.
- Pesticidal preparations : setting up of SMEs to extract pesticidal extracts from trees/shrubs/plants and prepare into commercial formulations
- Medicinal preparations : same as above.

Potential Agribusiness from Agroforestry

- Apiculture : SMEs or individuals for production of honey, propolis, royal jelly, wax.
- Food production : fruits, vegetables, poultry litter, mushroom substrates, etc.
- Ornamentals : decorative plants, Christmas trees for local tourist and domestic, as well as for the export market
- Construction industry : scaffolding, poles, etc.

The way forward

- To harness all these ideas into strategic and action plans the creation of **a Biomass Energy Group is proposed.**This Forum for Renewable Energy Development in Mauritius **(FREDM)** biomass energy group will *interalia* consider and bring forward proposals that will:-
- Create momentum in the development of a biomass industry that will (a) maximise the contribution that Agroforestry, including secondary sawmill products, energy crops, and other arable based agricultural materials can make towards the achievement of a renewable technology mix (b)identify the correct tree/crop species for the different climatic zones and soil types and (c) contribute to sustainable rural development.

International Implications

- The conversion of marginal lands under sugarcane to agroforestry will help improve the environment by increased in C sequestration, reduction in C emission, increase in Oxygen in the atmosphere.
- This will be in line with the Clean Development mechanism (CDM) of the Kyoto Protocol.
- Such land use conversions are eligible for carbon credits by the World Bank and the Carbon Finance Fund. Hence these funds can be used to create the enabling environment for SMEs in the sector of Agroforestry.

Conclusion

- Agroforestry is a potentially promising alternative land use system for sugarcane.
- It has economic advantages as well as environmental sustainability.
- It has a multifunctional role.
- It is a sector which will create opportunities for SMEs.
- There needs to be put in place an enabling environment for the same. The Faculty of Agriculture, University of Mauritius can lead such a programme in terms of consultancy, research, outreach, capacity building.