Fodder trees as a renewable energy source for biomass gasification

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INTRODUCTION

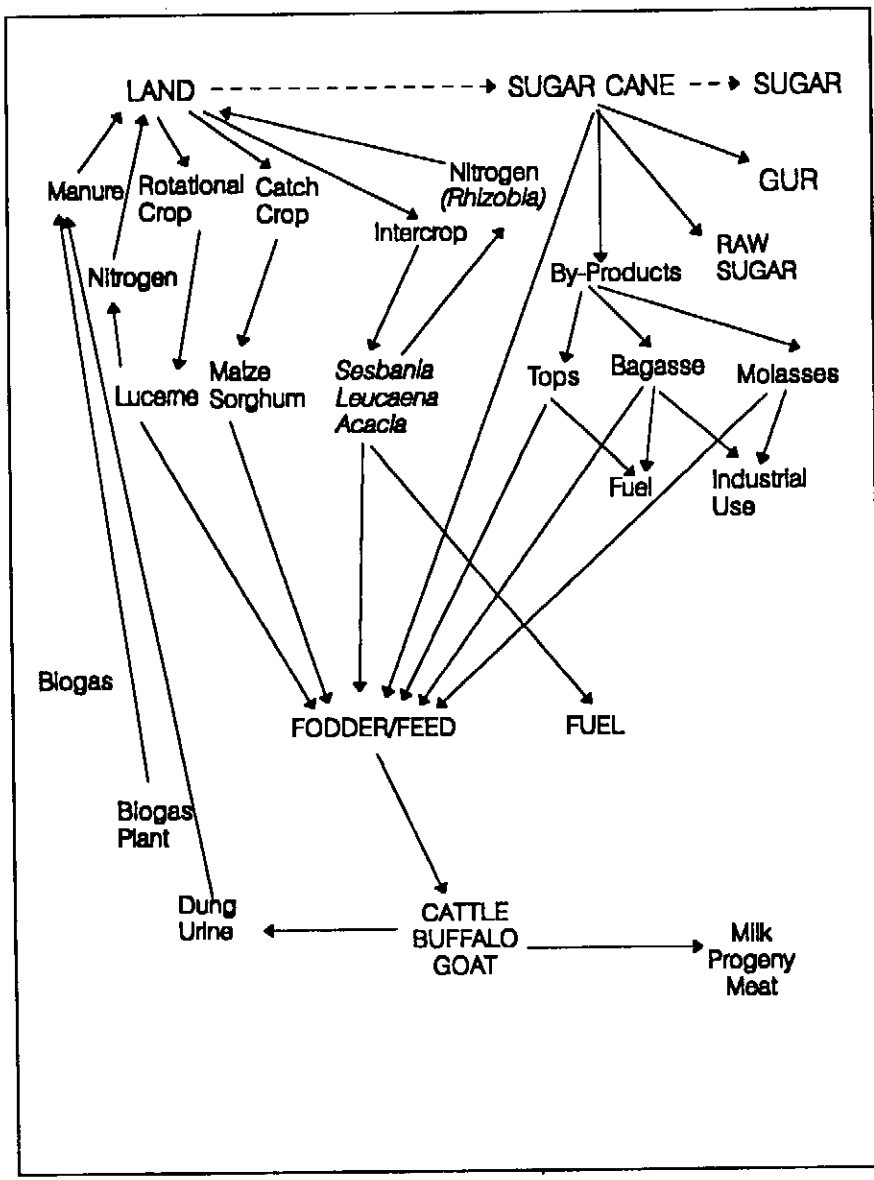
In countries like India with rising energy requirements and dependence on imports of fossil fuel, considerable stress is being placed on developing renewable energy sources. There have been a series of workshops and seminars in India on this issue and three major aspects are generally discussed (Chandrashekar & Bowander, 1982):

1. Which are the major renewable sources of energy relevant to India?
2. Which of these are now ready for adoption?
3. What new resources can be developed or what available technology can be modified to realize these resources?

It has been realised that, unlike conventional fossil fuel, the renewable or non-conventional energy resources cannot be put to use directly (except when they are used as fuel for household use). They need transformation into a suitable form of energy or the equipment needs to be changed to make use of them.

The National Commission for Agriculture, appointed in the 1980's to look into agricultural production as well as related aspects like availability of fuel and requirement for energy, had already pointed out the need to take up an intensive programme of augmenting renewable energy resources like biomass. The Government of India subsequently established a Department of Non-conventional Energy Sources (DNES) and also Energy Development Agencies in each state. These organisations identify suitable approaches for different states and promote research and development activities to enable the proper utilisation of renewable energy sources.

FIGURE 1. **Integration of sugar and milk production for optimizing land use.**



Biogas use is one such renewable energy resource which integrates well with livestock production and which is of importance to the BAIF programme, in view of the fact that cattle development activity is our major area of involvement. Figure 1 shows how well the biogas system has integrated into the total farming system in the sugarcane growing regions of South Gujarat, western Maharashtra and Karnataka, the three main areas where BAIF is involved. Similar integration has developed with other crop production systems like fruit and food crops.

BIOMASS PRODUCTION IN BAIF'S DEVELOPMENT PROGRAMMES

Rural energy demand patterns indicate that the requirement for cooking and heating account for 80% of the total need and that firewood and crop residues emerge as the main sources of fuel. The second major requirement is for agriculture operations, i.e., for irrigation, and draught power (Gujral and Vasudevan, 1982).

A variety of activities and approaches are under trial to augment biomass resources and their utilisation. They range from tree plantations to gathering and densification of tree leaves, aquatic weeds and agro-industrial waste. Development of equipment for their proper utilisation, which ranges from smokeless wood stoves to bricketing and gasification of wood, is also in progress.

In the BAIF development activities, the use of renewable energy sources is considered as having multiple objectives. Tree planting programmes, either on individual farms or on community land and degraded forest, is a useful source of employment, income, fuel and fodder, as well as for soil water conservation. In many remote areas, irrigation is hampered by a shortage of power and diesel. Some of these aspects are discussed by Rangnekar (1982) and Sohoni (1987).

From the farmers viewpoint, the major resources are land and animals (Rangnekar, 1982). The animals provide food and energy, as well as the draught power for agriculture operations, transport, etc. The land is the major source of food, feed and fuel. We have been exploring the possibilities of augmenting this resource to meet the requirements of the family. There is a sizable population in rural areas who have very

limited land or are landless. They have to depend upon bigger farmers or community resources to meet their energy requirement. For this purpose, a different approach of developing community lands and wasteland has been taken up, so that it serves as a source of employment and income, as well as for fuel and fodder (there by saving the drudgery of women and children gathering fire wood). There is also need to take cognizance of the farmer preference for multipurpose trees or a combination of species.

BIOMASS PRODUCTION TRIALS FOR SPECIES EVALUATION

In Gujarat and Maharashtra states, trials were organised to study biomass production from local and introduced species under a variety of soil moisture conditions. Species tested were *Acacia nilotica, Azadirachta indica, Albizia lebbeck, Prosopis juliflora, Leucaena leucocephala, Pithecololium dulcei, Casuarina equisetifolia* and *Eucalyptus* hybrid. These trials were organised on regional farms, as well as on farmers' fields. The results indicate that *A. indica, P. juliflora, A. nilotica* and *P. dulcei* amongst the local species, and *L. leucocephala* and *Eucalyptus* amongst the introduced species, were most promising (Mohatkar and Relwani, 1985).

L. leucocephala has attracted attention because of its adaptability to saline-alkali soils and brackish water, as well as for its multipurpose utility. The studies demonstrated the possibilities of developing plantations for fodder, fuel and timber in agro-forestry with food crops and, in silvipastoral systems with grasses. *P. juliflora* adapts well to saline-alkali soils but has no value for other purposes and experience in Gujarat indicates that it destroys grass cover. The suitability of various tree species for salt-affected soils has been well reviewed by Yadav (1989). *Leucaena* plantations in saline-alkali soils produced an average of 40-70 tonnes of green forage and 80-100 tonnes of wood. Some plots have shown higher productivity, yielding 175 tonnes of wood/ha with 10,000 plants/ha (Relwani *et al.*, 1985).

The planting of tree species like *L. leucocephala, Acacia*, etc., are part of integrated Tribal development programmes. In South Gujarat, where

the programme now involves more than 4000 families (over a period of 8-9 years of involvement), interesting combinations have emerged. These can best be described as fodder+fuel production, food crop+fodder+fuel production and fruit+fodder+fuel production. The programme involves the development of 1 hectare of land by each family, with rainwater harvest and lift irrigation by a group of families. Each family has to plant trees on 0.4 hectare with 1 x 1 m. spacing (4000 trees) and another 1500 plants along the bunds and in plots. These include some fruit trees, as well as fodder and fuel species.

GASIFIER SYSTEM TRIALS

One of the approaches being tried for the utilization of fuelwood is biomass gasification. As indicated earlier, gasifiers are being tried as a part of integrated projects which subsequently involved fruit planting, dairy cattle development, etc. Most of these projects are in remote, underdeveloped, tribal areas where the power supply is very irregular and timely supply of water for irrigating the crops becomes difficult. The alternative of using diesel engines often faces the difficulty unavailability of diesel oil. Moreover, it is difficult to operate submersible pumps with the diesel engines. The gasifier system is being tried in areas where tree planting is well established and uses small branches and twigs after the main trunk is cut for sale.

In the BAIF projects, the gasifier system is being tried in two ways: (i) using the gas directly to operate engines, and (ii) a gasifier with a generating set to produce electricity which can provide energy for a series of pumps. Reports by Sohoni (1987) may be referred to for details. Initial trials involved 5 engine pump-sets connected to five C-25 gasifier models. The pump sets were powered by 5 hp AND 8 hp engines. Each pump set-gasifier system is used by a group of families. One caretaker family is chosen by the group and trained in the operation and maintenance of the gasifier system and pumpset. Each family contributed about 30kg of wood to operate the gasifier system and this had to be supplemented with wood chips (available locally). After about two years, the plantations produced enough wood to meet the require-

ments. The wood requirement was about 3kg per hour and average diesel substitution rate of 50% was observed which was lower than expected. With experience and improvements in the working system, it was possible to get higher replacement rate for diesel. The wood consumption was found to increase to about 6 kg/hr with 60 to 70% replacement of diesel. Frequent cleaning of the unit, inconsistent flow rate of the gas and air and slow movement of wood were some of the problems which needed to be rectified. The operators had also to be trained to ensure use of dry wood (less than 20% moisture) cut to the right size.

At four locations, gasifier-generating set units have been tried with mixed results. These units, which have a capacity of 20-30 kW, need 14-15kg of wood per hour. They are placed on farms with large plantations located in remote areas of Maharashtra and Gujarat. One of the units has given good performance with a satisfactory diesel replacement rate of over 60%. The other two units initially showed low replacement rates (35%) which improved subsequently to about 60%.

Technically the systems seems to be feasible but the same problems are faced as stated earlier. The need for training is also critical.

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