

## 28. BARRIERS TO USING AGRICULTURAL RESIDUES AS A BRIQUETTING FEEDSTOCK

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### 28.1. Introduction

Agricultural residues are defined as a biomass by-product from the agricultural system, and include straws, husks, shells, and stalks. These residues can be divided into two groups: crop residues, which remain in the field after harvest, for example, cotton stalk, and agricultural residues which are the by-products of the industrial processing of crops, for example, rice husk.

Agricultural residues appear an attractive feedstock since they are considered a waste material and therefore can have no intrinsic value. When they are dry the heat of combustion is similar to wood. Table 1 shows the energy potential from the major crops. Rice and wheat straws are the most important, contributing 43% of all agricultural residues. Asia has a very high potential, 45% of the total. Although the global potential is very high, the part that is recoverable is much lower, varying between 5 and 20% of the total, about  $4.4 \times 10^{18}$ J, which is = 1.5% of world energy demand.

*Table 1. Energy potential in  $10^{15}$ J of residues (straw, stalk, shells) of the main agricultural crops for 1983 in 1000 t*

Product	Africa	Asia	Latin America	North America	Europe	USSR	Oceania	World
Straw	913	12205	1543	5263	4464	1649	457	26882
Legumes	50	304	223	468	42	64	6	1157
Root & tube crops	353	960	160	97	386	307	10	2259
Oil seed	106	962	192	368	265	322	14	2180
<b>Total</b>	<b>1422</b>	<b>14431</b>	<b>2118</b>	<b>6193</b>	<b>5157</b>	<b>2342</b>	<b>487</b>	<b>32478</b>

LHV's in MJ/kg given as: straw 12, legumes 6; roots and tubers 6, oil seed 12.

Source: Strehler and Stutzle (1987) in Biomass (D.O. Hall and P. Overend eds), Wiley & Sons.

This paper examines some of the barriers to operating a sustainable business an entrepreneur is likely to encounter when selecting a suitable agricultural residue to act as a feedstock for a briquetting plant. Correct residue selection is a key factor in ensuring profitability since not only does the type of residue influence the wear and tear on the press but residue costs can account for at least half of all inputs.

## **28.2. Availability of Agricultural Residues**

Continuous supply of feedstock is important to ensure that availability does not create a bottleneck and lead to a poor capacity utilisation factor. Credit agencies may require statistical data on the feedstock. However, it is difficult to give a precise figure for the quantity of residues available. There is little incentive for government officials to monitor the production since residues are not subjected to tax and many are not usually traded as part of the monetarised economy. Estimating the physical amounts generated is not easy. Measurements are not usually made at the point of production but rely on the use of ratios of residue produced to crop yield. Individual crop ratios are highly variable and depend upon a number of factors, including crop variety, agricultural practices (which includes variations in harvesting techniques, for example, in how much straw is removed with the grain) and site conditions, so they need to be used with caution and should be determined on a country by country basis. For example, Bhattacharya and Shrestha (1990) report in a survey of crop residues in Thailand, finding 200 different types of rice being grown and the varieties vary with the season. The range in paddy straw ratio was 1:1.388 to 1:2.131 which could lead to significantly different results if only one value was used to estimate the potential. For the entrepreneur this could lead to equipment standing idle or having to pay a higher price for residues due to shortfalls in supply.

The calculated figure for residues produced represents a maximum and the amounts actually available are in reality lower since not all residues are technically recoverable or economic to collect, there are a number of competing uses and there are losses for example, due to pests and in handling during collection, storage and transport. There is also a fraction which, for environmental reasons, such as protection against erosion and maintaining soil fertility, it is not advisable to remove. These additional constraints are now considered in detail.

## **28.3. Socio-Economic Constraints**

Residues have many uses in the villages of developing countries, both agricultural and non-agricultural, which would be potentially threatened if residues were diverted to use as a briquetting feedstock. The uses are as fertilizer, fodder, fuel, fibre and feedstock for chemicals (sometimes known as the "5Fs" - see Fig.1). Many of the uses are site specific and are difficult to identify from aggregated statistics. Residues are used in rural industries as well as for domestic and farm uses. Table 2 shows some examples from Nepal.

Competing uses do not exclude these residues from use as a briquetting feedstock and an entrepreneur may feel that market forces should be allowed to operate. However, government policy may influence credit agencies on what feedstock they are prepared to release funds for. On the other hand replacement of residues as a household fuel by a higher quality fuel (for example, kerosene) could have significant impact on indoor air quality by reducing the level of particulates emissions which would reduce the incidence of lung and eye diseases in women and

children. Fuel switching may be a policy governments are keen to promote, thereby releasing potential briquetting feedstock material.

Crop residues are generally scattered and would require considerable effort to collect. Unless farmers are all compensated for their efforts they will place a low priority on collection especially since this activity would compete with other post-harvest activities. Mechanisation would improve the efficiency of collection but, in addition to the technical constraints discussed below, mechanisation, if available, would add to the farmer's costs. Agro-processing residues do not suffer from this collection problem since they are generated at a central location. Annexation of a briquetting plant to an agro-processing industry with a residue disposal problem, for example rice mills, has a significant advantage for cost savings.

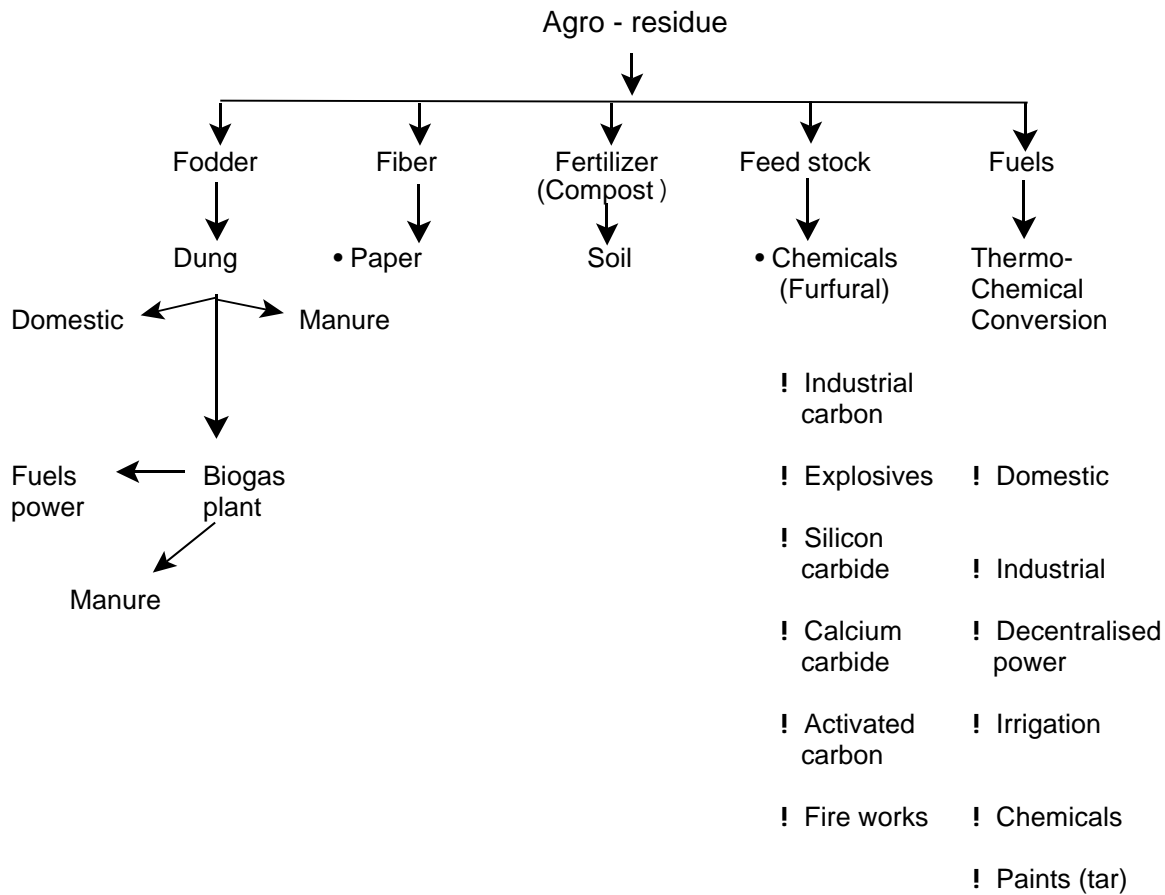


Fig.1 The "5 F's" of agricultural residue utilization.

The entrepreneur's investment and operating costs will need to be recouped. This means that briquettes will have to be traded within the monetarised fuel economy. Many entrepreneurs have been attracted to briquetting because the size of the household fuel market is potentially enormous. Every household needs a daily supply of energy to meet its cooking requirements. In developing countries most people still use fuelwood or charcoal. The gap between supply and demand is well publicized and entrepreneurs have hoped to bridge that gap with briquettes. However, rural people, who make up the majority of the population, do not consider they have a problem and still obtain what they perceive to be sufficient fuel for free. Rural people are therefore unlikely to buy a low grade fuel such as briquettes. Working on an incorrect assessment of the market has led many entrepreneurs to overestimate the size of their potential market and miscalculate the likely return on their investments. Entrepreneurs are also not competing on a level playing field since many governments continue to distort fuel prices and briquettes still have to compete against subsidised fuels.

*Table 2. Use of agricultural and forestry residues in Nepal.*

Crop residue	Use
Rice husk	Briquetting industry; boiler and furnace fuel; rice husk cement industry
Sawdust	As a fuel in cooking stoves; briquetting industry
Wood	Cooking purposes; construction materials
Rice straw	Cattle feed; fuel; compost; paper industry
Wheat straw	Cattle feed; fuel; compost; paper industry
Maize straw	Cattle feed; fuel; compost; briquetting
Pigeon peastalks	Cooking purposes; construction materials
Dung (cow & buffalo)	As fuel for cooking; compost; biogas production

Source: Shree Krishna Adhikary (1990) "Current status and future prospects of rice husk and other biomass gasification technologies in Nepal" in Agricultural Residues as an Energy Source, ESCAP Seminar.

## **28.4. Technical Constraints**

There are two specific areas where technical constraints hinder the exploitation of agricultural residues as a briquetting feedstock. The first is for those field residues which have no competing uses, collection would at present rely on hand gathering since mechanised methods either do not exist or are not available at a size appropriate to fields in developing countries.

## **28.5. Financial Constraints**

It is difficult to give general advice on the financial performance of briquetting plants since the data is highly site specific. The handling, transport and storage costs are high and can form a significant part of the fuel production costs. In India, a recent study by TERI (1995) shows that transport and residue costs can make up more than 50% of total costs. However, an earlier study in Malaysia identified cost of energy, availability of labour and a steady supply of raw materials as most significant influences on manufacturing cost.

Where possible a residue should be selected which requires minimal pre-treatment, for example, paddy husk requires no drying. Storage of seasonally produced residues will be required for continuous use throughout the year to maximise the capacity utilisation factor or a mixture of feedstocks can be used but it is important to check if any variations in briquette composition affects quality and match users specifications. Continuity of supply to a user is essential if briquettes are to compete with other fuels such as fuel wood or coal.

Entrepreneurs should not assume that agricultural processing residues will have no cost. Evidence from Thailand shows that in a relatively short period of time that there has been a significant alteration in the use of rice husks, from a waste with a disposal problem to a valuable raw material, for example for firing bricks. Rice husk is now becoming increasingly difficult to obtain without a long term supply contract. This has been shadowed by a price increase. In 1988, a survey showed a maximum price of 200 baht/tonne, and by 1991, the price had reached 300 baht/tonne during the milling season and 600 baht/tonne in the off-season.

Credit institutions, such as agricultural development banks, are not familiar with briquetting technology which makes them reluctant to lend money for investment in the technology, IREDA in India is an exception which has done much to promote the technology.

## **28.6. Manpower Constraints**

Collection of field residues competes with post-harvest processing and farmers will be reluctant to be diverted from their traditional tasks unless well compensated which will add to an entrepreneurs' costs. This reduces the attractiveness of unutilized crop residues.

In many developing countries there is a shortage of skilled manpower trained in the operation and maintenance of briquetting. The lack of after sales service by manufacturers and supplies of imported technologies have been the reasons why a number of briquetting plants have failed.

There is also a shortage of research and development personnel who can adapt the technologies to match local resources and needs, for example, tractors and bailers appropriately sized for small fields. This hampers the exploitation of unutilized crop residues.

## **28.7. Institutional Constraints**

Entrepreneurs should appreciate that there is not as yet a fully indigenous briquetting technology in many countries. This means that the technology does not as yet, except in a few isolated examples, function completely satisfactorily since it has not been optimized for local conditions of feedstock type and quantity availability. One of the objectives of the Biomass Densification Research Project (BDRP) undertaken by the University of Twente in collaboration with IIT, Delhi, has been to develop a technology which is more suitable for use in the South and South East Asian region. Reported elsewhere in this workshop are the technical findings of the research which should help in the spread of a more appropriate technology. This workshop has been convened to communicate the research findings and to promote an exchange of information between briquetting entrepreneurs, manufacturers of equipment, research institutes, government agencies and other relevant agencies. This type of communication has in the past been weak and has hindered the development and dissemination of the technology.

A lack of an indigenous briquetting press manufacturer also means that the commissioning, maintenance, spare parts and back-up facilities, infrastructure is weak and has been heavily reliant on imported technology and expertise. This can lead to significant costs incurred by the entrepreneur and has been a major cause of failure of projects in the past.

Entrepreneurs have not always adopted modern business approaches to establish and manage a briquetting plant. Briquettes are a new product and the market does not perceive the advantages of briquettes over fuelwood. Marketing strategies are lacking. This was specifically identified in the Philippines as a barrier to further dissemination.

## **28.8. Environmental Constraints**

These may not be as great a barrier as might at first be envisaged. Not all residues make good fertilizers and farmers already actively select those residues best suited to this purpose. The response of crops to organic manures is extremely varied, some crops show dramatic increase while others show little effect. What is apparent is that the effect on the crop depends upon the type of soil and the preparation and method of application of the compost. Probably of much greater significance is the effect of residue removal on erosion both from the wind and water. Some residues make reasonable substitutes for fuelwood and are utilized as such. Traditional farmers also remove field residues for a number of sound agricultural reasons; different composting abilities, disease prevention; ease of planting succeeding crops.

Any environmental problems should be identified by environmental impact assessments required by financing institutions. The most significant environmental problem in the briquetting plant is likely to be dust and fumes which can be overcome by suitable extraction equipment. This should be constructed in such a way so as not to cause a nuisance to people living in the vicinity of the plant. Preventative action naturally adds to costs.

## **28.9. Conclusions**

There have been some bad experiences with briquetting in the past. Many entrepreneurs envisaged a quick and large profit from turning a "free" waste into a product to meet fuel shortages. Entrepreneurs have underestimated what appears to be a simple operation. There have been problems with the technology being inappropriate for local conditions. BDRP has gone a long way to addressing these and good solutions have been identified. However, what is most important is for entrepreneurs to understand the market they are trying to serve.

## **28.10. References**

- !     Bhattacharya, S. C. and Shrestha, R. M. (1990), Biocoal Technology and Economics, RERIC, Bangkok Thailand ISBN 974-8201-414.
- !     TERI (1995), Guidelines for the appraisal of investment plans for briquetting plants and study of social acceptability of briquettes as a fuel, Report prepared for BDRP II.