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Economic Feasibility of Alternative Biomass energy sources to Fuel wood in flue curing of Virginia Tobacco: an Accounting Exercise for a Tobacco growing region in India

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Abstract

This paper discusses the economic feasibility of using alternative biomass sources as against fuel wood in curing of Flue Cured Virginia (FCV) tobacco leaves in India. The paper is based on an empirical study carried out in a tobacco growing region in India. At the field level it is observed that tobacco growers are experimenting with biomass/agricultural waste viz. coffee husk, paddy husk, coffee roots, coconut husk/halves, coconut fronds, maize pods, cashew kernels, briquettes made of agricultural waste and coffee husk as alternative sources to fuel wood and coal, which are traditional sources used in curing of FCV (cigarette) tobacco. The study finds that there are huge variations among farmers in quantity of fuel used for curing a unit of tobacco and this is where a policy intervention is desirable for arranging organized market for quality fuel and creating awareness on use of fuel efficiency technologies. There could be savings in fuel use by increasing fuel efficiency with the application of improved technologies viz. venturi furnace and insulation of barns. The study reveals that tobacco curing in Karnataka requires around 690840 tons of fuel wood every year amounting to 5593.88 ha of wood land including private plantations. The field level data shows that 5.5% of the wood used for curing by tobacco farmers is collected from Forest depot. Accordingly that would mean that 37996 tons of fuel wood comes from forest every year for curing of tobacco in Karnataka considering an average of 123.5 tons per hectare. This translates into degradation of forest land to an extent of 308 Ha per season (covering normal stock of wood) due to tobacco curing alone. Moreover, these figures do not include illegal cuttings from forest. Karnataka light soil region where tobacco is grown is identified as bio-surplus region with an estimated availability of about 1,27,769 ha of waste land. To decrease the pressure on forest for fuel wood it is suggested to raise energy plantationsrestricted to waste land only. The higher average cost for fuel wood as compared to coffee husk, coconut waste and briquettes indicate that there is scope for and, benefit in shifting from fuel wood to other biomass sources. The use of alternatives can be promoted through institutional intervention such as creating awareness, establishment of briquette making units, improving marketing channel and transport and, infrastructure for bulk storage of energy sources.

Key Words: *Tobacco curing, alternatives, biomass, feasibility, accounting*

1. Introduction

Tobacco is considered as “merit bad” due to its addictive value and harmful substances contained in it causing diseases. The consumption and production of tobacco imposes heavy burden on the economy, society and the environment. Its consumption is one of the main causes of cancer and cardiovascular diseases. Its production leads to health hazards known widely as ‘green symptoms’ in the literature and its processing is associated with respiratory illnesses the causative factor to be studied further. It’s curing results in large scale use of fuel wood causing environmental degradation. The Framework Convention on Tobacco Control (FCTC) initiated by WHO and effective since 2005 calls participating countries (India is a member of FCTC) to diversify crops (Article 17) and take measures to combat social and ecological losses (Article 18) due to tobacco use and cultivation.

The environmental concerns due to tobacco curing exist from large scale use of fuel wood in flue curing of Virginia tobacco. Although the concerns are expressed on various platforms, there is very little research evidence in India to show that tobacco cultivation and processing lead directly or indirectly to deforestation. Globally there are studies which link tobacco cultivation and curing to environmental degradation, particularly deforestation (Mkanta and Chimtembo 2002, Fraser 1986, Geist 1999). Mkanta and Chimtembo (2002) found that in Tanzania the value of fuel-wood used for tobacco curing was 32% of the total value of forest products used by villagers accounting for about 2,15,000 cubic meters (93478 tons) of fuel-wood use annually. These estimates have been worked out by conducting a household survey in tobacco cultivated region and on the basis of data gathered from Forest department. The Natural Resource Accounting (NRA) method is employed to estimate the quantity and value of fuel wood used for tobacco curing wherein the quantity of forest product i.e. the fuel wood used for tobacco curing is proxied by the income from tobacco as it is observed that tobacco cultivation interferes with the growth of the forest. This study found that the monetary value of earnings from tobacco was 15% less than the value of forest resources used for curing tobacco.

On the basis of wood consumption data, population statistics and forest density figures a study by Fraser (1986) concludes that “high proportion of the tobacco growing areas in developing countries lie within parts of world identified by the FAO as being in wood deficit or prospective wood deficit situation”. India is one of the countries identified as deficit in fuel-wood supply. Geist (1999) presents deforestation due to tobacco curing to be higher in developing countries accounting for about 5% of national deforestation amounting to 1,96,400 ha annually in tobacco growing developing countries (see Table 1). The percentage of farmers not owning plantations (globally) was taken as the proportion of tobacco produce using wood collected from native forests.

There is absolute dearth of studies on the use of biomass for agricultural processing. Available literature indicates that non-woody biomass can be used extensively in curing of the produce in bio surplus areas by modifying the burner resulting in energy saving. Using the tube-in-basket burner as against traditional burners a study carried out in Andhra Pradesh (Dasgupta et al 1991) reveals that the average fuel cost per unit of cured tobacco leaves is lesser by 23% using rice husk as compared to fuel wood. Estimates on fuel wood use in tobacco curing for Tanzania indicate an average ratio of 14.2:1 (fuel wood: tobacco cured) by weight translated into 0.6 ha of woodland for one ha land under tobacco cultivation (Siddiqui and Rajabu 1995).

Biomass is one of the largest renewable energy sources the use of which is likely to increase in India as well globally. There is potential for surplus biomass from the available resources in India (see Table 2). Scientific use of biomass results in lesser air pollution and therefore more desirable than fuel wood. The green house gas emissions appear to be higher for fuel wood use than other biomass sources originating from agricultural residue as revealed from Table 3. Estimates of biomass energy source according to sector wise usage are not available as its consumption varies according to local availability and requirement and particularly because it is not transacted on the market. In this context the study on finding viable alternative energy sources as substitute or to complement fuel wood consumption in tobacco curing assumes importance.

The main objective of this research work is to document and account for the use of alternative energy sources in curing of tobacco and, study the economic feasibility of adopting these sources in the background of their availability and farm household characteristics. This study is a simple accounting exercise making an attempt to present the extent of fuel wood use in curing of tobacco, use of bio-mass based fuel as alternative to fuel wood, the source of their procurement, the costs of curing with alternate sources and technology and understand the factors promoting the use of alternatives. The use of alternatives is discussed in the background of their sustainability and the role of institutions and industry in promoting their use.

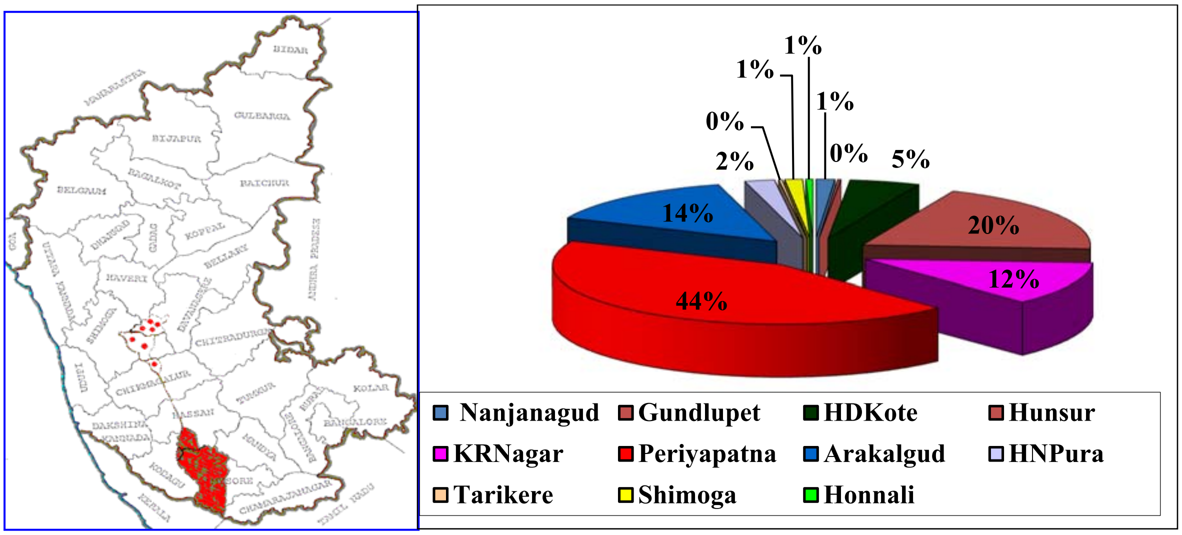
2. Tobacco Crop and its significance in the region

Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Bihar, Tamil Nadu are the major tobacco producing states in India. Around 80 per cent of India's production and area under tobacco is in Andhra Pradesh, Gujarat and Karnataka. Farmers are growing tobacco for several years and are acquainted with cultivation practices. Tobacco has been contributing significantly to the total agricultural income of the farmers in the region. The immediate and tangible benefits that accrue from tobacco cultivation, manufacture and, marketing act as incentives for farmers to grow tobacco and for the government to encourage tobacco cultivation and manufacture. It has high net returns per unit of cultivation as compared to other crops. Fairly encouraging domestic and international demand for tobacco and tobacco products can be considered as yet another reason for treating tobacco as a commercial crop. The net returns from tobacco on an average are

6-7 times higher than other crops like groundnut, cotton, black gram in Karnataka, Gujarat and Andhra Pradesh. This is the reason why farmers go in for tobacco cultivation. But, these net returns do not take into account the health and social costs associated with tobacco production and cultivation. Moreover, the returns are higher only due to higher prices facilitated by organized auction market and institutional support.

On the other hand, its economic value (contribution to the exchequer and economy) is also eulogized. Farmers do not realize that the man days required for tobacco are 3-5 times more than other crops and cost of cultivation is also very high. If the market fails or if the state withdraws its infrastructural support, then tobacco farmers are severely hit and suffer total loss.

Fig 1 FCV Tobacco area in Karnataka Light Soil



Map not to scale- Source –CTRI, Hunsur

Karnataka produces both FCV (cigarette) and bidi tobacco. In 2008 the area authorized for cultivation of FCV tobacco in Karnataka light soil region was 78475.60 hectares. The production was 114 million kg. The FCV tobacco produced in Karnataka is internationally demanded due to its light flavour. FCV tobacco is a five months crop. It is grown as kharif crop in Karnataka during the months of May-September. In Karnataka, Hassan and Mysore are the two main districts growing FCV tobacco (see Fig 1 above). In Mysore district tobacco crop occupies around 22% of the cultivable area whereas in Hassan district it is only 2% of the net sown area. Together they contribute for around 97% of the total tobacco production in the State producing world quality cigarette tobacco worth about Rs. 300-350 crores.

3. Tobacco Curing Process in India

Tobacco curing is a process of drying tobacco leaves by generating heat at the opening of a furnace attached to the pipes fixed in drying units. These units known as barns are set up in different sizes of 13x13x13 ft (single barn); 16x 16x16 ft (duplex barn) and 24x16x13 ft (triplex barn) with a capacity to cure 250-400 kg, 600 -800 kg and 1200 kg respectively. There are around 56,514 registered barns in Karnataka light soil region. Flue Cured Virginia (FCV) tobacco commonly known as cigarette tobacco is cured in barns by hanging the leaves to the poles inside the barn. The curing process helps to remove the moisture content from the leaves. The leaves are left for drying for two-three days and heat is generated according to the stages of drying. After drying the leaves are graded according the texture and colour and packed into bundles ready for auctioning. Bidi tobacco is sun cured and left in the open field for natural drying. Tobacco used for other purposes is either fire cured or air cured. In India conventionally FCV tobacco is flue cured by burning traditional sources such as fuel wood and coal. In the last few years farmers have been using bio-sources/ agricultural wastes viz. coffee husk, coffee root, coconut husk/fronds/shells, maize pods, paddy husk, groundnut shells, cashew kernels, roots of orange tree, wood chips, etc., to cure tobacco. In Karnataka the use of coal for tobacco curing has stopped due to high costs of transport from Singareni coal mines in Andhra Pradesh. Earlier the Tobacco Board provided subsidy on transport of coal with the help of Tobacco Industry, but withdrew the facility later as a result of which none of the farmers in Karnataka are using coal for curing.

4. Terminologies

4.1 Biomass fuels: The organic fuels from biological origin used for generating energy are referred to as biomass fuels in this study. Biomass fuels include woody and non-woody biomass. Woody biomass includes fuel wood, wood chips, twigs of tree, etc. Non-woody biomass include mainly agricultural residues such as dead leaves, shells of nuts, straw of cereals, husk of grains and hull of seeds.

4.2 Biomass energy refers to energy derived from the direct combustion of biomass fuels.

4.3 Barn: Barn is a structure built with mud/cement with tiled/thatched/zinc or cement roof constructed by the tobacco grower in his field to cure tobacco leaves. The floor is fitted with cylindrical flue pipes with a furnace attached to the opening of the pipe. This is the combustion chamber extending through the walls of the barn. Heat is generated in the barn by lighting the furnace with fuel source outside the barn. The heat spreads through the pipes in to the barn. The poles are tied to the walls in rows to enable hanging of raw leaves for curing.

4.4 Venturi Furnace: It is a modified version of traditional furnace and is designed in such a way to allow for air circulation and proper filtering of ash beneath the furnace. The placement of a number of trays in slope position in the furnace helps in easy passing of fuel sources such as husk, cashew kernels, etc. In venturi furnace the cast iron dome is replaced by brick wall below the furnace. In conventional furnace, air vent is small, therefore burning of fuel is not complete and the possibility for charcoal formation is high. In venturi furnace there would be complete combustion of fuel through ample supply of air or oxygen. As the fly ash gets collected in ash pit there would not be any deposition of filth inside the flue pipe.

4.4 Insulated Barn: The roof of the barn is insulated with thermacole and straw of crops such as paddy, maize and sugarcane to restore heat produced in the barn.

5 Sampling Design

5.1 Study Area

Karnataka, which is one of the two main FCV tobacco-producing states in India, was taken up for empirical investigation. In Karnataka, Hassan and Mysore are the two main districts growing FCV tobacco with their respective share of 80% and 17% in total production. Both the districts are covered for the household survey. The other three districts viz. Shimoga, Coorg and Chamrajnagar together have only 1.66% of the registered tobacco farmers. Therefore these districts are left out from the study. There are 10 registered tobacco auction platforms where farmers sell their produce. All the ten platforms are located in Mysore district. The two districts covered under the study are located in southern part of Karnataka and are surrounded by natural forest.

Tobacco cultivation is specific to soil conditions. FCV tobacco can be grown only in light soils with sandy-loamy features. Tobacco cultivation is found extensively in Hunsur, Priyapattana, KRNagar and H.D.Kote taluks of Mysore district. In Hassan district it is grown mainly in Arakalgudu and Holenarasipura taluks. Total area under FCV tobacco in Karnataka during the year 2009 was 107,000 ha as against 90,000 ha in 2008 showing an increase of 19% within one year period. And there is a variation to the extent of 14.5% in area registered and actual area planted by farmers. The area planted in 2008 is 90000 ha as against the registered area of 78563.60 ha (see Table 5). Although cigarette tobacco is grown in neighbouring districts also the quantity and area is insignificant. Other crops grown in this area are paddy, ragi, jowar, maize, sunflower, peas, gram, sugarcane, fruits, etc.

5.2 Sampling Framework

The number of farmers registered for 2008-09 crop season was 40585 in Karnataka. This accounted for about 50% of licensed tobacco growers in India. The researcher has covered 1.5% of the registered FCV tobacco growers in Karnataka for the household survey. This amounts to 610 tobacco growing households. The details of sampling framework are presented in Table -6.

The study followed systematic stratified random sampling in choosing the units of field survey. Tobacco growing households are the basic units of the empirical study. All the blocks having more than 1% of registered tobacco growers (as percentage to total growers in the region) are included in the study. These six blocks fall in Mysore and Hassan district accounting for 97.2% of registered tobacco growers in the region. The number of villages covered for household survey is 20, allocated to selected six blocks of two districts in proportion to the percentage share of tobacco farmers per block to total tobacco farmers of the two districts. The first 20 villages with higher number of tobacco growers from the six blocks of two districts are included in the study. The number of households surveyed in each village is in proportion to the number of tobacco growers to the total tobacco growers of the selected 20 villages. The auction platform-wise list on tobacco growers available from the Tobacco Board of India is used for choosing the sample per village.

5.3 Data Collection

The information was gathered through administration of pilot tested structured schedules to 610 tobacco growing households.The household survey carried out in 2009 included questions on land holdings, ownership of barns, area under tobacco and other crops, cost of curing tobacco (input cost, labour cost, transportation cost), type of energy source used for curing, type of improved technology adopted for curing, quantity of tobacco cured, sources of collecting the energy source, reasons for using specific energy source, etc. In addition the information gathering was strengthened by farmers' testimonies and discussion held with local biomass suppliers at the village level, secondary information collected from Tobacco Board, Forest Department, and Central Tobacco Research Institute.

6. Methodology

6.1 Empirical context

Tobacco curing is a brisk agricultural operation carried out during September and October in FCV tobacco growing villages of Mysore and Hassan districts. The environmental concern being expressed from different corners and limited availability of wood from Forest Department has induced farmers in nearby non-tobacco region to take up plantations of Acacia, Eucalyptus and Casuarinas to supply wood for tobacco curing. The Tobacco Board, which is a Government of India Agency regulating tobacco cultivation and marketing, also encourages tobacco farmers to have their own plantations. But, tobacco growers have not shown good response to plantations as the earnings from tobacco crop are higher due to rising prices of tobacco and farmers do not want to divert land for plantations. Farmers get on an average of 50 tons of wood per acre (123.5 tons per hectare). Tobacco growers mainly use firewood and coffee husk for curing of tobacco. The use of fuel wood is reported by higher number households in K.M.Wadi village in Mysore district and Bettadpura in Hassan district, which are in midst of forest. The reporting is higher for coffee husk in Tammadhalli, Konasur, Amblare in Mysore districts. This is because these villages are nearer to coffee growing region. One can find trucks loaded with wood, coconut halves and strands on road side during tobacco curing season. The agents/dealers themselves visit the local market to sell the biomass for curing. So transportation cost is implicit in the cost of fuel source. Although maize is one of the main crops grown in Hassan and Mysore district the residue is wasted or not used commercially as there is no organized market to facilitate its supply to tobacco growing villages or to the briquette making units.

6.2 Identifying Feasible Alternative Biomass Energy Sources

The economic feasibility of using each biomass source is expressed in terms of comparative unit costs of curing calculated for different types of biomass energy sources in the background of their availability. Total costs taken for calculating unit costs include input cost, labour cost and transportation cost clubbed according to the type of energy source used for curing. The proposition for alternative biomass energy sources is briefly discussed also in terms of negative externalities extended by fuel wood curing resulting in replacement of food crops, loss of fodder to animals and loss of soil moisture.

The estimates of fuel wood use in tobacco curing and the extent of annual degradation of forest land due to tobacco curing for Karnataka state are worked out using ratio of fuel wood use to quantity of tobacco cured during the reference period (2009). The information on the source of fuel collected from farmers gives an account of the quantity of fuel wood coming from forest area and private plantations. The quantity of fuel wood collected from forest depot and used for curing is considered to be the wood coming from forest area. The average costs discussed in section 7.3 worked out for each bio-mass energy source considering input, labour and transport costs present a picture of economic feasibility of different alternatives. These need to be justified, propagated or overlooked depending upon other economic factors like availability, storage, transportation, etc.

7. Results and Discussion

7.1 Tobacco Growers' Profile

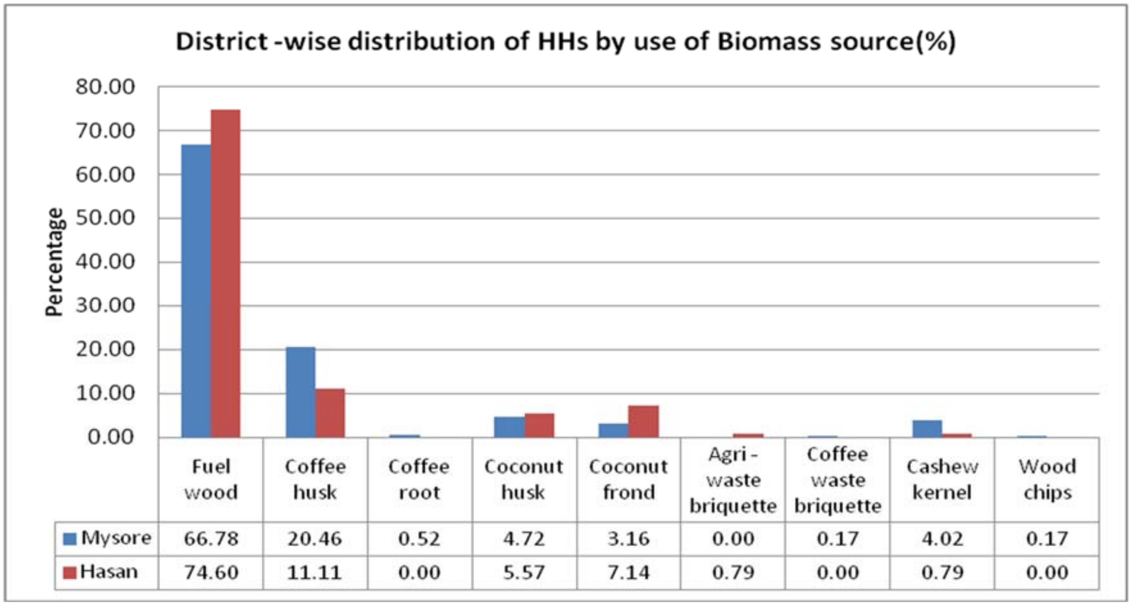
Own farm agriculture is the main source of livelihood to 92% of the tobacco growers. Around 50% of the growers are illiterate (see Table 7). Although majority of the FCV tobacco growers (83%) in the sample own marginal/small holdings less than 1% of them are below poverty line (as per official cut off point considered under Public Distribution System (PDS) for rural areas in Karnataka) with reported income of less than Rs. 12,000 p.a. Ninety three percent earn more than rupees one lakh p.a. (see Table 8). This is because the earnings from tobacco far exceed other crops ranging between Rs. 60 to Rs. 180 per kg of cured tobacco. The average price for 2009 crop was Rs. 112 per kg of cured tobacco. The main crops grown by farmers are tobacco, paddy, millet and maize. Sugarcane, Hurali (a local pulse), bengalgram, groundnut and vegetables are also grown in small quantity. Total area under tobacco crop constitutes 92% of the cultivated land reported by farmers.

7.2 Use of Bio-mass Energy Sources in curing of Tobacco

7.2.1 Types and sources of procurement

Fuel wood is the main energy source used for curing as around 70% reported the use of this as a single source (see Table 9). Fuel wood continues to be a major energy source because of its easy availability and perceived lower costs (as farmers do not realize labour cost, which is incurred on cutting the logs in to small pieces after buying the wood). Farmers also feel that there is less damage to curing pipes with the use of fuel wood the authenticity of which needs to be studied further. Non- woody bio-mass sources used by farmers for curing the tobacco include coffee husk, coconut husk, coconut fronds, cashew kernels, briquettes, coffee roots and wood chips. Around 13% of the growers using coffee husk or other alternative fuel earlier to year 2008 have shifted back to fuel wood and 7% of the growers using fuel wood earlier are not using it now. Other sources that are being experimented and used by farmers in the region include maize pods, paddy husk, orange tree stems/roots, and tobacco stem/roots. As given in Table 9, eighty six percent of the growers with barn facility have used a single source either fuel wood or alternative for curing tobacco. The remaining 14% have used mixed sources. The use of fuel wood including mixed sources accounts to be around 71%. Coffee husk is used by 17% (including mixed sources) of the curers and the remaining 12% use coconut husk/fronds, cashew kernel and coffee root. Coffee briquettes were used by farmers earlier when the Tobacco Board gave subsidy on purchase of briquettes to curers. The briquettes made of coffee husk or agricultural wastes are easier to use and produce less smoke. If left unused on the ground the husk/waste may generate methane. If they are used as fuel in the barn the left out ash may be used as organic manure in the field. The estimates of energy use in tobacco curing in Karnataka as furnished in Table 10, indicate an average ratio of 8.08:1 for fuel wood and 5.91:1 for coffee husk measured by weight.

Fig -2 District –wise distribution of HHs by use of biomass source (%)

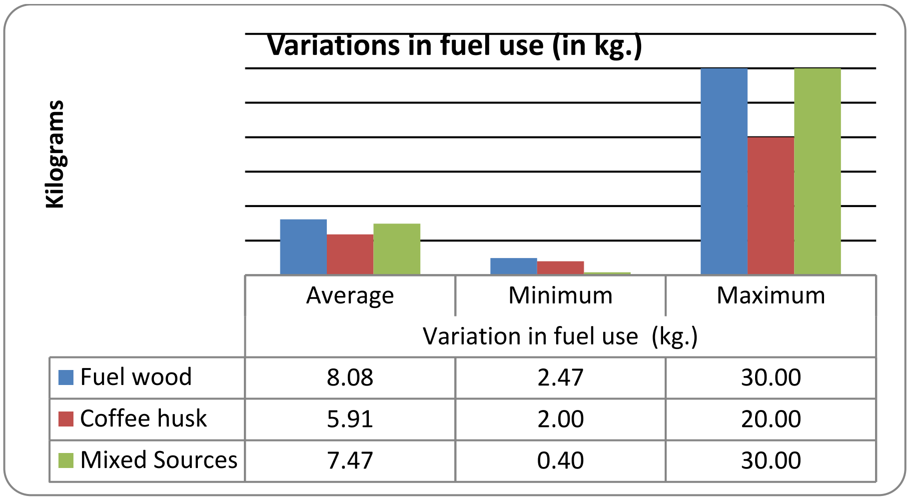


The local or the nearby market is the main source reported for collecting fuel source. Fuel wood is available locally to 57% of the users and coffee husk is available to 36% of the users. Only one farmer in the sample had fuel wood supply from his field. The trees that existed in the field for long have been used for curing. None of the tobacco growers in the study area have separate plantations raised for fuel wood supply. Around 30% of the farmers using coconut waste as single and mixed source have collected the produce from their field. The average requirement of coconut waste from husk and fronds for curing is respectively 3:1 and 5:1 by weight. Although, Mysore and Hassan districts are endowed with coffee production in the neighbouring districts, the use of coffee husk as percent to all sources is higher in Mysore (20%) as compared to the use in Hassan (11%).

7.2.2 Variations in Fuel use

Farmers use biomass in a crude form. There is variation in size, moisture content and quality of biomass source used in curing. As a result there is wastage in curing process resulting in variation in fuel consumption. In addition, barn structure also adds to variation in fuel requirement. The average use of fuel per kg of cured tobacco is 8.08 kg for fuel wood and 5.91 kg for coffee husk. These are the main sources used for curing. The variation in fuel use for all biomass sources used in the sample is noted to be varying from (-) 95% to 302% from the average (see Fig-3). The two main reasons for variations in fuel consumption excluding a few extreme cases are, economies of scale for large farmers and use of moist bio-mass and errors in human activity. The curing requires continuous supply of fuel source in the furnace to maintain the heat in the initial stages and regulating heat in the final stages to control over burning. Farmers have to sit before the furnace continuously for three days to ensure uninterrupted supply. The negligence on the part of farmers leads to improper curing and variation in fuel use. The adoption of insulation of barns and venturi furnace also reduces the use of fuel wood by 0.50-1 kg and coffee husk by more than 1 kg for every kg of cured leaf.

Fig- 3 Variations in fuel use (in kg)



7.2.3 Estimates of deforestation due to tobacco curing in Karnataka [2008-09]

According to the study the quantity of fuel wood used for curing tobacco in the sample in 2008-09 season is 7108.93 tons. This amounts to an average of 8.08 kg of fuel wood required to cure one kg of dry tobacco. In 2008-09 the recorded production was 114 million Kg. Table 10 shows that 75% of the tobacco is cured by using fuel wood, which amounts to 85.5 million kg cured by fuel wood. Based on this reported usage of fuel wood per quantity of tobacco cured in the sample region along with the share of fuel wood to total curing and the quantity of tobacco produced in the state for 2008-09, we can generalise that FCV tobacco curing in Karnataka requires around 690840 tons of fuel wood every year. According to the reports from local farmers who own wood plantation an average yield of wood cuttings per hectare of land is 123.5 tons harvested in three and half years. The harvesting is done in each of the plot bearing matured cuttings. Total amount of fuel wood used annually for curing tobacco amounts to 5593.88 ha of wood land (app.) including private plantations. The field level data shows that 5.5% of the wood used for curing by tobacco farmers is collected from Forest depot. Accordingly that would mean that out of 690840 tons, 37996 tons (app.) of fuel wood comes from forest every year for curing of tobacco in Karnataka considering an average of 123.5 tons per hectare. This translates into degradation of forest land to an extent of 308 Ha per season due to tobacco curing alone.

7.2.4 Reasons for using the energy sources

The question on the type of energy source used earlier and reasons for using it generated relevant information that could be linked to promote alternative sources in future. Earlier coffee husk was being used by 13% of the barn owners (who are not using it now) and 8.5% had used coffee husk briquettes. The withdrawal of subsidy by the Tobacco Board on briquettes is the main reason for shifting of farmers to other sources as reported by 40% of those who shifted from alternative sources to fuel wood.

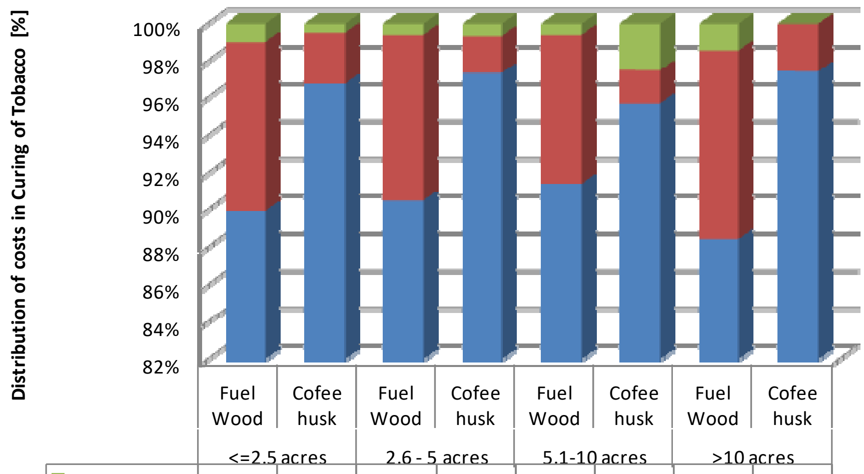
The high cost of input due to withdrawal of subsidy on the source, use of alternative requiring modification of barn, non-availability of required quantity and frequent damage to curing pipes are the main reasons for not using energy source other than fuel wood (see Table-12). Moreover it is easier to store fuel wood than any other alternative. Coffee husk requires larger space and protection with tarpaulin sheets over the entire stock. And specifically 72% of the tobacco growers in the sample region opine that use of alternative biomass energy source other than fuel wood requires modification in the existing barn i.e. the structure of furnace. The traditional furnace used by 93% of the curers is convenient for burning fuel wood.

7.3 Cost of Curing tobacco

7.3.1. Average Cost

The alternative biomass sources which had negative cost values earlier are now fetching Rs. 3000-3500 per ton. A few years back they had to be disposed off at a cost from the backyard of the coffee processors. And to save themselves from these costs coffee processors gave it freely to tobacco farmers. Currently almost all the biomass sources have value and are a source of livelihood to many. The comparison of cost of curing across different alternatives as shown in Table 10 indicates that fuel wood is costlier among all the sources except agro-waste briquette and wood chips, which are un-common sources of fuel used in curing (see Table- 9). The average cost is calculated by adding input cost, transportation cost and the cost of labour included in making the source ready for usage as well the cost of labour required for curing the tobacco leaves (see figure -4). The average cost of curing is highest at Rs. 22.88 with fuel wood use and lowest at Rs.11.79 with the use of briquettes, showing a reduction to the extent of 49% in the average cost. The use of alternative sources such as coffee husk reduces the cost by 9%, coconut husk by 17% and coconut fronds and cashew kernels by 21%. Although labour and transport cost in the use of fuel wood accounts for 10% of the total cost as against 3% in the use of coffee husk, farmers do not realize that fuel wood is costlier. This is because the input cost of fuel wood is lesser and can go down if it is collected in off season. Coffee briquettes are less costly than all other fuel sources and emit less carbon during burning.

Fig -4 Distribution of costs in curing Tobacco according to land holdings and source of energy [%]



	<=2.5 acres		2.6 - 5 acres		5.1-10 acres		>10 acres	
	Fuel Wood	Cofee husk	Fuel Wood	Cofee husk	Fuel Wood	Cofee husk	Fuel Wood	Cofee husk
Transport cost	0.96	0.47	0.58	0.65	0.58	2.56	1.42	0
Labour cost	9.10	2.76	8.9	2	7.96	1.84	10.13	2.56
Input cost	89.94	96.77	90.52	97.35	91.46	98.13	88.45	97.44

The share of labour cost in the total cost is higher for fuel wood as compared to coffee husk, which is the other main fuel source used by farmers (see figure 4). But, farmers find fuel wood cheaper as the amount paid for purchase is lower compared to coffee husk. They do not realise that they are bearing the cost of labour as they themselves cut the wood in to small pieces for more than a week. The easy availability and easy storage for fuel wood add to the demand. In the case of coffee husk, briquettes, coconut fronds, etc., the material is directly put in to the furnace unlike fuel wood, which requires further cutting of the log into small pieces. Transport cost is not explicit in most of the cases as it is generally included in the input cost by the agents supplying the biomass.

7.3.2 Variations in fuel cost

In absolute terms there is no significant variation observed within minimum and maximum costs between different sources used for curing. But, there is large variation from the average in the use of same source between households. Fuel cost for all sources taken together varies from (-) 92% to 251% from the average. The variation is higher in the use of coffee husk varying at (-) 83% to 276%. The variation in fuel cost could be due to purchase of biomass in curing season vs. off season. And the curing process takes place at the end of monsoon season when it is still raining. It is likely that some farmers use moist source, which could increase the requirement of fuel source and there by the cost of curing. The application of improved technology like installation of venturi furnace and insulation of barns also has some impact on usage and cost of the fuel as there is saving in fuel use due to higher fuel efficiency. The tobacco growers who have space for storing the material, purchase biomass in summer at lower prices when there is no immediate demand for fuel source.

7.3.3 Technology Improvement and Fuel Efficiency

Farmers insulate the roof of barns with thermocole and paddy straws to increase the heat restoration capacity and to sustain the temperature for long. And 18% of the barn owners have insulated their barns to increase fuel efficiency. In addition 7.3% of the farmers have fixed venturi furnace to barn to improve the burning capacity. The share of farmers using both insulation of barns and venturi furnace is 4.6%. It is found that 73% of the farmers having insulation to their barns are marginal and small farmers. Similarly, 78% of those reporting installation of venturi furnace are marginal and small farmers. Generally subsidy on improved technology is given to low income groups and this could be the reason explaining the adoption of improved technology by these groups.

The results from the field (see Table 10 and 11) indicate that there is a decline in the average fuel use and therefore the average fuel cost due to modification of barns with insulation and venturi furnace. There is a reduction in the average use of all fuel sources to an extent of 10% and average cost by 11% on account of insulated barn. Similarly modification of barn with venturi furnace has resulted in reduction of average fuel use by 7% and average cost by 13%. The insulation of barn has reduced the use of fuel wood by 10 % and average cost by 9 %. The reductions are higher for coffee husk at 17% in average quantity used and 18% in average cost. The average quantity of fuel in curing with venturi furnace decreased by 10% in the case of fuel wood and 21% in the case of coffee husk. Subsequently the average fuel cost per unit of tobacco decreased by 12.15% for fuel wood and 20.61% for coffee husk.

The tobacco farmers receive subsidy for installing venturi furnace and insulation of barns. The average cost of insulating a barn is Rs. 5425 and may require an additional spending of Rs. 2856 p.a. on maintenance. Similarly, the average cost of installing a venturi furnace is Rs. 4593. The additional costs on maintenance of the furnace could be around Rs. 1477. However, in both the cases the percentage of farmers reporting additional costs is less than 25%. Farmers can save 0.5 to 1 kg of fuel wood and more than one kg of coffee husk per kg of cured tobacco, if they adopt insulation of barns and venturi furnace.

If we assume that if all users were going through the most economical use of fuel by installing venturi furnace or insulation of barns, then the estimated annual saving in fuel wood including private land could be 48,735 tons or 394.6 ha of wood land with the use of venturi furnace and, 68,400 tons or 553.85 ha of wood land with the adoption of insulation of barns. If we consider only the fuel wood coming from forest depot, then the saving on account of fuel efficiency due to venturi furnace and insulation of barns would be 22 to 30 hectares of forest land resulting in 7 to 10% saving of wood procured from forest annually in Karnataka.

7.3.4 Opportunity cost of Land under Plantations to land deprived for paddy cultivation [A generalization from a case study outside the sample region]

The field visits and tracking of fuel wood supply to tobacco growing villages revealed that the supply of fuel wood other than Forest Department comes mainly from the villages of Malavalli block in Mandya district and its adjacent villages of T.Narasipura block in Mysore district. In the past 6-7 years farmers in Nuggalikoppalu, Gullaghatta, Maganhalli, etc., in Mandya district have taken up plantation of Eucalyptus and Casuarinas and few other species for the main purpose of supplying fuel wood to tobacco curing in the neighbouring Mysore and Hasan districts. This has demonstration effect in nearby villages of Mysore district wherein farmers have taken up plantation.

Farmers do not need permit from Forest Department to transport and sell fuel wood cuttings from their farm within 100 kms in Mandya district. This relaxation has led to illegal cuttings in villages adjacent to forest area and, villagers reported that such incidence has happened in the past. The fuel wood from forest area is mixed with cuttings from private plantation. The other negative impact of these plantations is that they are being raised in wet land and beds and bunds of dry tanks in the village replacing food crops. Tobacco has replaced paddy and millet to some extent. Those not growing tobacco are supporting tobacco cultivation by supplying fuel wood to tobacco curing at the cost of food crops. Since the plantations have been taken up in the recent years there is no data to compare with earlier scenario as well to discuss the current status of private plantations. These are neither included in forestry nor in horticulture crops.

Based on villagers' testimony and discussion with farmers raising plantations in above stated villages of Mandya and Mysore district we worked out the opportunity cost of raising plantations. According to farmers the plantations are ready for harvest after an average period of 3.5 years with an average yield of 123.5 tons per ha during this period. The average price varies from Rs. 1650 in off season to Rs. 3250 in season fetching farmers around Rs. 2500 per ton. Paddy, which is one of the main food crops replaced by tobacco yields on an average 85 quintals per ha. The average price in 2008-09 was Rs.925 per quintal. After deducting for Rs.19656 towards the cost of production, labour and transportation the returns from paddy amounted to Rs.58969 per Ha. The calculations on similar lines reveal that earnings from plantations amount to Rs.74571 per Ha per annum. There is a net difference in earnings amounting to Rs.15602 on account of plantations. The opportunity cost could vary significantly over the seasons if we take into account the fluctuations of fuel wood prices over season and off season. In off season the net difference in earnings from plantation could be negative. So farmers have to be careful before planting as large scale plantation may reduce the prices on account of excess supply. We can generalize that on an average 8.5 tons of paddy are foregone to produce 35.28 tons of fuel wood per hectare per annum in villages where paddy is replaced by plantations. Although farmers get higher returns from plantations, there is a threat to food security in the long run due replacement of food crops by plantations and loss of fodder to animals and loss of soil moisture due to water exhaustive species like Eucalyptus.

8. Conclusions and Policy Insights

The empirical evidence indicates that although opportunities exist for large scale use of non-woody biomass as source of fuel in curing of FCV tobacco, fuel wood continues to be a major energy source (70%) because of its easy availability and perceived lower costs (as farmers do not realize labour cost, which is incurred on cutting the logs in to small pieces after buying the wood). Farmers also feel that there is less damage to curing pipes with the use of fuel wood the authenticity of which needs to be studied further. We should realize that fuel wood is the traditional source and there is absence of concrete efforts in promoting the use of alternatives. Tobacco growers themselves have been experimenting on curing with different locally available sources in their barns, which are largely fitted with traditional furnace. The share of coffee husk in curing, which was reported to be around 29% a few years back has come down to 16%. It appears that the tobacco industry instead of promoting non-woody bio-mass is promoting private plantations, which replace food crops, reduce fodder availability and result in depletion of soil moisture. From this study we can roughly estimate that tobacco curing results in an annual degradation of 308 Ha of forest land, which is around one percent of the total forest area of Karnataka. This does not include fuel wood supply from private land and illegal supply from forest. Since farmers are largely using fuel wood we need to economize their use by promoting fuel efficiency technologies. It is found from the field that mainly the farmers who have received subsidy have adopted fuel efficiency technology like venturi furnace and insulation of barns. As the study shows that fuel efficiency technologies like adoption of insulation of barns and venturi furnace reduce the use of fuel wood by 0.50-1 kg and coffee husk by more than 1 kg for every kg of cured leaf, Tobacco Board, which is regulating agency for FCV tobacco crop, should insist that farmers should adopt these technologies in their barn. This could result in an estimated annual saving in fuel wood including private land to an extent of 48,735 tons or 394.6 ha of wood land with the use of venturi furnace and, 68,400 tons or 553.85 ha of wood land with the adoption of insulation of barns. If we consider only the fuel wood coming from forest depot, then the saving on account of fuel efficiency due to venturi furnace and insulation of barns would be 22 to 30 hectares of forest land resulting in 7 to 10% saving in current supply of wood coming annually from forests of Karnataka for tobacco curing.

Although tobacco cultivation it-self is not desirable considering health impact of its consumption and socio-environmental concerns of its cultivation, it could take some more years to ban it totally unless we identify alternative livelihoods to farmers. Until then in the light of increasing awareness on climate change and considering the availability of fuel efficiency technologies there is scope for promoting the use of biomass sources other than fuel wood through state intervention i.e. provision of subsidies, establishment of briquette making units, improving marketing channel, transport and infrastructure for bulk storage of energy sources like maize pods, coffee husk, briquettes, etc. The availability of woody biomass other than that from forest can also be increased by restricting energy plantations to waste land only. Karnataka light soil region where tobacco is grown as one of the main crops is identified as bio-surplus region by a study carried out by Ramachandra et al (2003), which also estimated the availability of about 1,27,769 ha of waste land in this region of Karnataka that could be used for energy plantations. Therefore there is scope for increasing the use of biomass as energy source in the State for agricultural processing in the near future. But, institutional intervention is necessary to promote establishment of agro-waste briquette making units for cluster of tobacco growing villages. Farmers are willing to use other sources for curing if the resources are available locally. It is easier to use coffee husk and briquettes as they can be put directly in to the furnace whereas farmers have to put in lot of labour to cut fuel wood logs in to small pieces to adjust to the size of furnace. The Tobacco Board can act as a link between coffee/agro waste briquette making units or coffee processors and farmers. Although many briquette making units exist in Mysore very near to tobacco growing region, the material is not available to tobacco farmers as it is supplied largely to Mangalore and Mumbai for hotel industry. De-routing it to tobacco villages would be an economical way than supplying it to places more than 600 kms away. The field results indicate that the marketing channels are not formalized or awareness is low for the use of maize pods, coconut halves, briquettes, etc. Agricultural waste briquettes are the best option as they are handy, easily transported and can be easily stored. Therefore, the Tobacco Board can help entrepreneurs to establish briquette making units in the region for promoting use of environment friendly energy sources using locally available biomass or enable supply of briquettes from the existing units. These units get subsidy on capital, bank interest, custom duties and excise from the government. The higher average cost for fuel wood as compared to coffee husk, coconut waste and briquettes indicates that there are prospects in shifting from fuel wood to other biomass sources.

There exists scope for taking up further research on developing area replacement index for ‘Tobacco vs. Food crops’ and ‘Plantations vs. food crops’. The use of fuel wood needs to be discouraged not just because of its environmental concern, but for the reason that it is grabbing away the land from food crops. The immediate impact of such shifting is not felt immediately, but can be a major problem in the future affecting food production. Action research on briquette making at local level and production function estimates for briquette making are relevant for further research. Such studies may be useful for policy and advocacy purposes to increase fuel efficiency, encourage alternative energy sources and thereby reduce the burden on the environment.

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Annex-I Tables

Table 1-Percentage of total annual deforestation related to the production and curing of tobacco in selected countries, 1990-95

Sl. No.	Country	Deforestation (%)
1.	South Korea	45.0
2.	Uruguay	40.6
3.	Bangladesh	30.6
4.	Malawi	26.1
5.	Jordan	25.2
6.	Pakistan	19.0
7.	Syria	18.2
8.	China	17.8
9.	Zimbabwe	15.9
Source: Geist, Helmut J. (1999), Global Assessment of deforestation related to tobacco farming, *Tobacco Control*, Vol. 8:18-28		

Table 2 Potential for surplus biomass in India (Million MT / Yr)

Source of Biomass	**Biomass Generated**	**Surplus Biomass**
Crop Residues / Agro Industrial Residues (excluding bagasse)	465	115-135
Forest Sources	35	25-35
Total (Million MT / Yr)	500	140-170

Source: Ministry of Non-Conventional Energy Sources (2001)

Table 3 Greenhouse Gas Emissions from Biomass (In Thousand Tons), 1995

Type of Fuel	**CO2**	**CO**	**CH4**	**TSP**	**SOX**	**NOX**
Fuel wood	17,713.1	10,118.3	99.9	120.6	6.9	22.2
Agro-residues	9,669.5	214.6	25.9	216.3	**37.1**	11.3
Animal Waste	60.2	-	-	-	-	-
Charcoal	2,118.6	173.1	6.4	**13.3**	0.5	2.8
Total	29,561.5	10,506.0	132.2	350.2	44.4	**36.2**

Source: Emmanuel T. Quejas

Table 4 District wise area in Karnataka Light Soil

District	Percent in Total
Mysore	80.37
Hassan	16.52
Kodagu	00.19
Chamraj Nagar	01.55
Shimoga	00.27
Chikkamagalur	00.20
Davanagere	00.90
Total	100.00

Table 5 Block- wise no. of growers, barns and area registered during 2008-09 crop season

Taluk	Growers	Barns	Area Registered in Ha
District: Mysore			
H.D.Kote	1587	2157	3019.80
Nanaganagudu	408	685	959.00
Hunsur	10179	13726	19216.20
Periyapatna	16466	23571	32999.40
K.R.Nagar	4371	5852	8194.20
District: Chamarajanagar			
Gundlupet	85	146	204.40
District: Hassan			
Aluru	31	51	71.40
Arakalagudu	5270	6867	9613.80
Beluru	10	12	16.80
H.N.Pura	1584	2094	2931.60
Hassan	3	5	7.00
District: Coorg			
Somarapet	297	374	523.60
District: Shimoga			
Shimoga	29	70	98.00
Shikaripura	40	71	99.40
Hannali	196	376	526.40
Tarikeri	29	59	82.60
Total	**40585**	**56116**	**78563.60**

Table 6 Sampling Framework

District	Block	No of selected Villages	Tobacco growers (as % to total of two districts)	Sample size (No of HH)
Mysore				
	1.Periyapattana	8	41.73	254
	2. Hunsur	5	25.80	157
	3. K.R.Nagar	2	11.07	68
	4. H.D.Kote	1	4.02	25
Hassan				
	5.Arakalgudu	3	13.36	81
	6. H.N.Pura	1	4.02	25
Total		**20**	**(No=39,457) 100.00**	**610**

Table 7 Distribution of household head by main occupation and educational status

Occupation of Head of the Household	%	Sub - occupation	Educational Status of Head of the Household	%
1. Own farm agriculture	91.64 (559)	6.22% (38)	1. Illiterate	47.70
			2. Less than primary	11.31
2. Others	8.36 (51)	28.19% (172)	3. Primary	8.20
			4. <Graduation	27.87

Table 8: Distribution of Households by Economic status

Sl. No.	Land holdings (2.47 acres=1 Ha)	%	Income category (Rs.)	%
1.	<=2.5 acres	43.77	<=12000	0.66
2.	2.5 - 5 acres	39.34	12001-50000	3.11
3.	5-10 acres	14.26	50001-100000	3.61
4.	>10 acres	2.63	100001-300000	75.57
5.			>300000	17.05
6.	Total	100.00	Total	100.00

Table 9 Distribution of households by use of biomass source

Sl. No.	Sl. No.	Percent of HHs
1.	Fuel wood	69.16
2.	Coffee husk	15.83
3.	Coffee root	0.17
4.	Coconut husk	0.33
5.	Coconut frond	0.17
6.	Coffee waste briquette	0.17
7.	Cashew kernel	0.50
8.	Wood chips	0.17
9.	Agro-briquette*	
10.	Total [single source]	86.50
11.	Total [mixed source]	13.50
12.	Total Sample	100.00
	*Included in mix source	

Table 10 Average fuel use and costs of curing tobacco

Sl.No.	Source	Average cost of curing (Rs.)			Average fuel use (kg.)		
		Mysore	Hassan	Total	Mysore	Hassan	Total
1.	Fuel wood	22.93	22.61	22.88	7.91	8.93	8.08
2.	Coffee husk	20.88	19.91	20.77	5.95	5.58	5.91
3.	Coffee root	14.33	0.00	14.33	5.27	0.00	5.27
4.	Coconut husk	13.57	35.35	18.96	2.91	5.25	3.49
5.	Coconut frond	20.97	15.21	18.02	5.81	5.01	5.40
6.	Agro -waste briquette	0.00	32.00	32.00	0.00	6.67	6.67
7.	Coffee waste briquette	11.79	0.00	11.79	3.59	0.00	3.59
8.	Cashew kernel	17.81	30.00	18.02	4.30	6.67	4.34
9.	Wood chips	60.00	0.00	60.00	5.00	0.00	5.00
	Total	22.26	22.16	22.24	7.33	8.22	7.47

Table 11 Fuel use and Costs of curing tobacco with improved Technology

Sl.No.	Energy Source	Cost with Insulation of Barn		Cost with Venturi Furnace	
		Average cost (Rs.)	Average Fuel wood use (Kg.)	Average cost (Rs.)	Average Fuel wood use (Kg.)
1.	Fuel wood	20.72	7.28	20.10	7.51
2.	Coffee husk	17.11	4.92	16.49	4.64
3.	Coconut strand	17.00	5.33	-	-
4.	Coffee waste briquette	11.79	3.59	11.79	3.59
	Group Total	**19.84**	**6.72**	**19.35**	**6.98**

Table 12 Distribution of Households by reasons for not using sources other than fuel wood

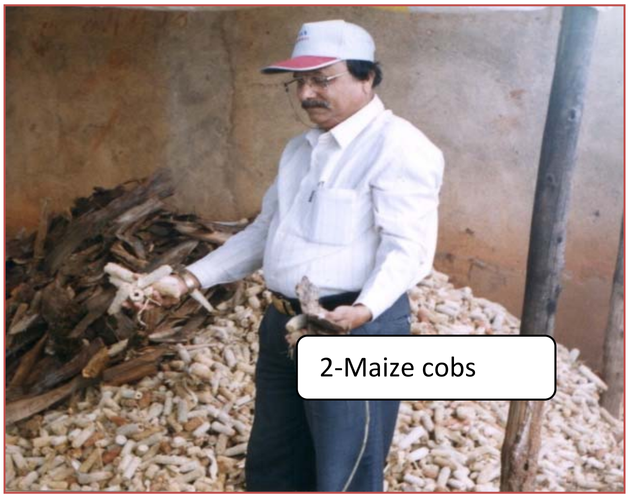
Sl.No	**Reasons**	**No. of HHS**	**%**
1.	Cost of input high due to withdrawal of subsidy and transport cost	148	35.49
2.	Require quantity not available	104	24.94
3.	Use requires modification in barn for which I cannot bear the cost	70	16.79
4.	Frequent damage to curing pipes	95	22.78
	Group Total	**417**	**100.00**

Annex-II Figures

Fig- A-1 Private plantations replacing Food crops in villages of neighbouring districts

Source: CMDR survey, 2009

Fig A-2 Bio-mass energy sources used in curing of tobacco (1-6)



Source: CTRI, Hunsur

Source: CTRI, Hunsur

Source: CMDR Survey

Fig- A-3 Conventional furnace vs. Venturi furnace

Source: CTRI, Hunsur

Fig- A- 4 Cured leaves (in Barn and carried for packing)

Source: CMDR survey, 2009 **Source: CTRI, Hunsur**

Fig-A-5 Tobacco curing barn

Source: CMDR survey 2009