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# Tobacco Curing and Fuel Efficiency in Karnataka, India

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## Abstract

The state of Karnataka in India produces some of the best Flue Cured Virginia Tobacco in the world, 75 percent of which is cured with fuelwood and another 20 percent with coffee husks. This paper examines the economic feasibility of reducing the use of fuelwood in curing tobacco leaves. The study finds that there are few alternatives to the dominant use of fuelwood in tobacco curing in Karnataka in the medium term. While farmers incur some 10 percent higher costs, on average, from using fuelwood relative to coffee husks, they prefer fuelwood because it is available, easy to store and requires no modifications in traditional barns. However, some scope exists for increasing fuel efficiency by using improved technologies such as Venturi furnaces and barn insulation. In addition to energy savings, the two technologies also bring down the cost of curing tobacco, making the net present value of installing fuel-efficient technologies positive in most cases. Tobacco curing in Karnataka requires nearly 700,000 tons of fuelwood every year. If all fuelwood-using tobacco farmers adopted the two fuel-saving technologies, 12 percent less fuelwood would be used on aggregate. Field data shows that a very small percentage of the wood used for curing is collected from forest depots with the rest coming from private plantations and, possibly, natural forests. Thus, fuelwood plantations, which are very profitable, could be encouraged, particularly on wastelands. The study also recommends that extension services should provide better information to farmers on coffee-husk use and fuel-efficient technologies to promote their adoption.

**Key Words:** *Tobacco curing; Alternatives; Biomass; Feasibility; Accounting*

# Tobacco Curing and Fuel Efficiency in Karnataka, India

## 1. Introduction

Both the consumption and production of tobacco can impose a heavy burden on society and the environment. Apart from the well-known negative effects of tobacco consumption on health, the large scale use of fuelwood for tobacco curing can also result in environmental degradation. Globally, several studies have linked tobacco cultivation and curing to environmental degradation, particularly deforestation (Mkanta and Chimtembo 2002; Fraser 1986; Geist 1999). This is particularly acute in the case of developing countries.

According to Geist (1999), the share of tobacco curing in national deforestation is approximately 5 percent in the tobacco-growing developing countries. In Tanzania, for instance, some 32 percent of the total value of forest products used by villagers is attributed to fuelwood used for tobacco curing although the actual earnings from tobacco are 15 percent lower than the value of forest resources used for curing tobacco (Mkanta and Chimtembo 2002). Estimates on fuelwood use in tobacco curing in Tanzania further suggest that some 0.6 ha of woodland is required for every hectare of land under tobacco cultivation (Siddiqui and Rajabu 1995). In some countries, such as China and Pakistan, the share of tobacco curing in total deforestation is as high as 17 percent and 19 percent respectively (Geist 1999). John and Vaite (2002) suggest that 30 percent of deforestation in Bangladesh may be related to tobacco manufacturing. In the case of India, too, the worry exists that tobacco production and curing is resulting in an increasing 'wood deficit or prospective wood deficit' (Frazer 1986). According to an estimate offered by John and Vaite (2002), 300,000-350,000 tons of firewood are used every year to cure tobacco leaves in Karnataka, India.

Despite concerns regarding fuelwood use in tobacco curing, few studies to date have studied the feasibility of alternatives for its use. The study by Dasgupta et al. (1991), which compared the fuel cost from rice-husk use with that from firewood use, found that the average fuel cost per unit of cured tobacco leaves can decrease by as much as 23 percent if coffee husks replace firewood in traditional burners. The potential for using surplus biomass from available resources to cure tobacco in India remains largely unexploited though there is evidence that proper use of biomass results in less air pollution than fuelwood. Greenhouse gas emissions, in particular, appear to be higher for fuelwood use than for agricultural residue burning (MNCE 2001). Fuel-efficient technologies for tobacco curing are another area that has received little attention from researchers. The present study therefore addresses itself to the perceived lacunae in research in this area via the following three questions: a) Are there alternatives to fuelwood-based tobacco curing and what are the costs of using the alternate fuels? b) Are fuel-efficient technologies profitable to farmers? c) What are some longer-term challenges to deforestation and food security that may result from tobacco farming? The study area for this paper is the state of Karnataka in India, which produces some of the best quality Flue Cured Virginia (FCV) tobacco in the world (Chojar 2002).

## 2. Tobacco and its Curing in India

India produced some 725 million kg of tobacco in 2009-10, its share of global tobacco production being approximately 9 percent (MoC, 2011). The major tobacco producing states of India are Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Bihar and Tamil Nadu, with Andhra Pradesh, Gujarat and Karnataka responsible for 80 percent of India's tobacco production and the land extent devoted to the crop. In 2009-10, tobacco production constituted around 10 percent of the national government's exchequer through excise revenues and 4 percent of India's earnings from the export of agricultural and allied products. In addition to FCV or cigarette tobacco, India also produces Bidi tobacco, which is considered the poor person's tobacco.

Different methods are adopted for tobacco curing, which is the process employed to dry tobacco leaves.<sup>1</sup> FCV tobacco is cured in barns by hanging the leaves from poles inside the barn with the leaves left to dry for 2-3 days and heat generated according to the different stages of the drying process. After drying, farmers grade the leaves according to texture and color and pack them into bundles. How much fuel is used in the curing process depends on the type of barn and technology used.<sup>2</sup> The barn used for curing generally has the floor of the barn fitted with cylindrical flue pipes with a furnace attached to the opening of the pipe, which forms the combustion chamber that extends through the walls of the barn. Heat is generated by lighting the furnace with a fuel source outside the barn, which spreads through the pipes into the barn.

Biomass fuel for curing tobacco includes wood and non-wood biomass. While wood biomass refers to fuelwood, wood chips, twigs of trees, etc., non-wood biomass includes mainly agricultural residue such as dead leaves, nut shells, cereal straw, grain husks and seed hulls. In India, fuelwood and coal are the fuel sources that farmers have traditionally used to flue cure FCV tobacco.<sup>3</sup> However, in the last few years, farmers have resorted to other non-wood biomass such as coffee husk, coffee root, coconut husk/fronds/shells, maize pods, paddy husk, groundnut shells, cashew kernels, orange tree roots and wood chips also to flue cure tobacco. The use of such agricultural residue entails a saving in terms of wood bio-mass.

In recent years, several techniques for improving fuel efficiency have been promoted, one among which is the installation of the Venturi furnace<sup>4</sup>. However, to date, only a few farmers have adopted this technology. Most farmers in contrast have barns with traditional furnaces, which have small air vents, thus resulting in incomplete burning of fuel and carrying the possibility of high charcoal formation. In a Venturi furnace, in contrast, there is little deposition of filth inside the flue pipe as there is provision for fly ash to collect in an ash pit. Another fuel-efficient technique used is insulation. Roofs are insulated with thermacole or straw from crops such as paddy, maize and sugarcane to retain the heat. Tobacco farmers can adopt both modern technologies simultaneously.

The Tobacco Board under the Ministry of Commerce regulates the production and marketing of FCV tobacco in India, its regulation motivated by the need to ensure the suitability of land, agro-climatic zones, appropriate rotation of crops, quality of leaves and fair prices (Tobacco Board, 2011).<sup>5</sup> The Tobacco Board also requires FCV tobacco, which is graded according to the quality of leaves, to be compulsorily auctioned at auction platforms established by the Board in tobacco-producing areas.<sup>6</sup> According to the Tobacco Board, the auctioning system has streamlined the trading system, increased competition and ensured transparency and fair prices to farmers (2011).

### **3. Study Area, Sampling Design and Data**

Karnataka produces some of the best FCV tobacco in the world. In recent years, demand for FCV has been high leading to an increase in production. Correspondingly, the area under Bidi tobacco has decreased though it keeps fluctuating according to domestic demand. FCV tobacco is grown as a kharif (rainy -season) crop during the months of May-September in the Hassan and Mysore districts (see Fig 5),<sup>7</sup> the two districts together contributing around 97 percent of the total tobacco production in the state and accounting for about 5 percent of the world's traded high-quality tobacco.

In Karnataka, tobacco curing is a brisk agricultural operation carried out during the months of September and

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<sup>1</sup> While Bidi tobacco and chewing tobacco are dried naturally under the sun in the open fields and, thus, do not require any fuel, burley tobacco is air cured while cigar tobacco is cured in the shade.

<sup>2</sup> The barns describe structures which are generally built of mud/cement with tiled/thatched/zinc or cement roofs and located either adjacent to the residential building of the farmer or in the field itself.

<sup>3</sup> In Karnataka, the use of coal for tobacco curing has stopped due to the high costs of transport.

<sup>4</sup> This is a modified or improved version of the traditional furnace which is designed in such a way as to allow for air circulation and proper filtering of ash beneath the furnace. In a Venturi furnace, the cast iron dome is replaced by a brick wall below the furnace.

<sup>5</sup> The Board requires all FCV tobacco growers and barn owners to register with the Tobacco Board in each state and to obtain a license for growing tobacco. Every year the Board fixes the crop size under FCV taking into consideration national and international demand with crops grown over and above the notified quantity treated as unauthorized for which a penalty is imposed.

<sup>6</sup> The Board requires those manufacturers of cigarettes, tobacco exporters and dealers to register for each of the auction floors where they intend to participate as buyers. In addition, the Ministry of Commerce notifies potential buyers well in advance the minimum support prices for basic grades, which facilitates the initiation of bids as well the purchase of left-over stock.

<sup>7</sup> Tobacco cultivation is found extensively in Hunsur, Periyapattana, K.R. Nagar and H.D. Kote blocks of the Mysore district. In the district of Hassan, it is grown mainly in the Arakalgudu and Holenarasipura blocks.

October in FCV-tobacco-growing villages the curing barns<sup>8</sup>. These tobacco growers mainly use firewood and coffee husk for curing tobacco. While fuelwood use is higher relative to coffee husks in villages closer to forested areas, in villages in the Mysore district, which are closer to coffee-growing regions, coffee husk use is more popular.

In order to understand how farmers cure their tobacco, we carried out a sample survey of 610 tobacco-growing households or 1.5 percent of the registered FCV tobacco growers in Karnataka. Since there are 10 registered tobacco auction platforms in Karnataka (all located in the Mysore district), with 40,585 registered farmers in the year 2008-09,<sup>9</sup> the study adopted the systematic stratified random sampling method in choosing tobacco farm households for the field survey (see Table 1). We first identified six blocks<sup>10</sup> in the Hassan and Mysore districts that had more than 1 percent of the registered tobacco growers (as a percentage of the total growers in the region).<sup>11</sup> We then identified 20 tobacco-growing villages that had the largest percentage of tobacco farmers per block and used the auction platform list of tobacco growers available from the Tobacco Board of India to choose households per village. The households were identified using the circular systematic random sampling method so as to cover households from all the localities within a village. The number of households surveyed in each village was a proportion of the number of tobacco growers in each village to the total number of tobacco growers in the 20 villages selected for the study. We note that our analysis of curing costs includes only 600 farmers out of the 610 farmers in the sample as the remaining farmers did not have their own barn to cure tobacco.

Following the pilot survey, we administered structured schedules that included questions on land holdings, ownership of barns, area under tobacco and other crops, cost of curing tobacco (input cost, labor cost, transportation cost), type of energy source used for curing, type of improved technology adopted for curing, quantity of tobacco cured, sources for collecting the energy source, reasons for using specific energy source, etc. In addition, discussions were held with local biomass suppliers at the village level, with secondary information collected from the Tobacco Board, Forest Department, and Central Tobacco Research Institute.

Table 2 presents summary statistics on the farmers surveyed. The average tobacco farmer (household head) is 48 years old, has a family of 5.8 members and has had 4 years of schooling although around 50 percent of the growers are illiterate. Own farm agriculture is the main source of livelihood for almost all tobacco growers. The average size of cultivated land holdings per farmer is 1.56 hectare, with tobacco constituting 92 percent of the cultivated land. On average, farmers grow 1338 kg of tobacco per hectare, their earnings ranging from INR 60 to INR 180 per kg of cured tobacco. Although a majority of the FCV tobacco growers (i.e., 83 percent) own marginal and small land holdings, less than 1 percent are below the poverty line, the average income of households in our sample being INR 2.4 lakhs per year (or INR 20,000 per month),<sup>12</sup> with almost all farmer earning more than INR one lakh per year.

As shown in Table 3, a majority of farmers (70 percent) cure their tobacco using fuelwood as the single source of energy followed by the coffee husk, which is used by some 16 percent of farmers. Fuelwood is used for curing 75 percent of tobacco while the coffee husk is used for curing 20 percent of tobacco. Although other sources of fuel such as maize pods, paddy husk, coconut husk and fronds, cashew kernels, orange tree stems/roots, and tobacco stem/roots are used by a few farmers, they together cure only 5 percent of the tobacco produced. Eighty-six percent of the growers with a barn facility use a single source of fuel while the remaining use mixed sources. One reason why farmers prefer fuelwood could be that fuelwood is available locally to 57 percent of the users while coffee husk is accessible to 36 percent of the users in the local market.

Only 5.5 percent of the fuelwood used in curing is purchased directly from the Forest Depot as reported by farmers. Though urged by the Tobacco Board and Central Tobacco Research Institute (CTRI), tobacco growers are not inclined to develop their own fuel plantations as the earnings from tobacco crops are higher than those from wood plantations<sup>13</sup>. Farmers in nearby villages, however, operate fuelwood plantations of Acacia, Eucalyptus and

<sup>8</sup> These units, which are known as barns, are set up in different sizes of 13x13x13 feet (single barn), 16x16x16 feet (duplex barn) and 24x16x13 feet (triplex barn) with a capacity to cure 250-400 kg, 600-800 kg and 1200 kg respectively.

<sup>9</sup> This accounted for about 50 percent of licensed FCV tobacco growers in India.

<sup>10</sup> A block is a below-district-level unit of planning and administration.

<sup>11</sup> The other five districts, viz. Shimoga, Coorg, Chamrajnagar, Davangere and Chikmagalur together, have only 1.66 percent of the registered tobacco farmers. Therefore, we have not included these districts in the study.

<sup>12</sup> USD 426 per month.

<sup>13</sup> Personal discussions with tobacco growers, officials of Tobacco Board and Director, Central Tobacco Research Institute (CTRI), Hunsur.

Casuarinas which, on average, produce 124 tons of wood per hectare<sup>14</sup> enabling large tobacco farmers to purchase the required quantity of fuelwood from either the forest department or the neighboring villages well in advance. In addition, many dealers regularly supply local markets with a variety of biomass for curing purposes. Although private suppliers identify nearby plantations as the main source of the firewood used for curing, the cleaners and drivers of supply vehicles suggested that illegal cuttings from the forest are often mixed into such loads.

**4. Research Methods**

This study seeks to estimate the gains and losses to farmers from using different energy sources to cure tobacco in Karnataka and to determine alternate fuels and technologies that would make curing more energy efficient and less dependent on fuelwood, some of which at least is sourced from natural forests. The study therefore addresses itself to the following three research questions: a) Are there alternatives to fuelwood-based tobacco curing and what are the costs of using such alternate fuels? b) Are fuel-efficient technologies profitable to farmers? and c) What are the long-term impacts on deforestation and food security from the current dominant practices of tobacco farming?

In order to answer the first question on the costs of alternate fuels, we resort to simple cost accounting methods by estimating and comparing average curing costs associated with the two main fuel sources: fuelwood and coffee husks.

*Cost of curing fuel source ij/ kilogram of tobacco cured = (Cost of fuel + transport cost + labor cost to make the fuel ready for use + labor cost required for curing the tobacco leaves)/total kilograms of tobacco cured during one season.....(1)*

Where, *i* = fuelwood or coffee husks and *j* = traditional burners/Venturi furnace with or without insulated barns

Among the various technologies that are being promoted currently to improve fuel-use efficiency in tobacco curing are insulation of barns with paddy straws, thermacole or rock wool; installation of modified furnaces like the Venturi furnace; lowering of the height of the barn to reduce fuel use; the use of a turbo fan for the air vent; and the modification of the flue pipe. However, since the two dominant technologies in use are the Venturi furnace and barn insulation, we estimate curing costs for the traditional technologies and the new technologies. We calculate labor costs on the basis of actual payments made to labor on an hourly basis in the case of hired labor and use that wage to compute the equivalent labor cost in the case of family labor.

We focus next on the profitability to farmers of adopting fuel-saving technologies. Since the mid-70s, many tobacco farmers, generally marginal and small farmers with less than 2.5 ha of land, have received subsidies from the Tobacco Board for installing a Venturi furnace and insulating barns. Though this subsidy has since been discontinued, it is useful to ask how helpful the subsidy was in enabling farmers to adopt fuel-efficient technologies and whether they remain profitable without the subsidy. For this purpose, we undertake a cost-benefit analysis to the average farmer of installing a Venturi furnace or insulating a barn.

At the next stage, we examine the potential impacts of fuelwood use for tobacco curing on two fronts: firstly, the contributions of fuelwood use to deforestation and degradation and, secondly, the link between new fuelwood plantations and reduction in paddy production, which aggravates food security concerns. We scrutinize thus the opportunity costs of plantations and the significance of fuelwood use for tobacco curing from these different angles.

**5. Results and Discussion**

**5.1 Costs of Curing Tobacco**

As mentioned above, fuelwood is the main energy source used in curing tobacco, accounting for 75 percent of the tobacco produced in the sample region. Coffee husk comes next with 20 percent of the tobacco produced. Table 4 provides a breakdown of costs associated with fuelwood and coffee husk use based on equation (1). The average

<sup>14</sup> As reported by plantation owners and officials from the Forestry Dept. of the Agricultural University, Dharwad.

cost of curing using fuelwood in our sample is INR 23 per kg of tobacco cured while it is INR 21 per kg of tobacco cured for coffee husk, which makes fuelwood costlier than coffee husk by some 10 percent. Simple t-tests of mean differences show that these differences in average costs are statistically significant. Moreover, over 90 percent of the costs of curing tobacco are associated with fuel prices with little difference in labor costs across the two fuel uses. However, one significant cost that is not included in Table 4 is the cost of storage. Fuelwood is easier to store relative to coffee husk, the latter requiring both larger storage space and protection with tarpaulin sheets over the entire stock. Thus, the higher storage costs associated with coffee husks may make them relatively less appealing to tobacco farmers.

Table 4 also shows that the costs of curing are lower when farmers use alternate technologies, with the average costs of fuelwood-based curing with insulated barns at INR 21 per kg of tobacco cured and at INR 20 per kg for Venturi furnaces. These costs are significantly lower by (9 percent and 12 percent respectively) when compared to curing costs using traditional technologies. Similarly, on average, the costs of coffee-husk-based curing with insulated barns is 18 percent less and with Venturi furnaces 21 percent less than the cost of curing tobacco using traditional technologies.

Figure 6 plots unit costs against the amount of tobacco cured. According to the Figure, there are economies of scale because the costs of curing for both fuel types decrease with larger amounts of tobacco. For large farms (using more than 4000 kg of tobacco), the costs of curing are lower by 82 percent when the farmers use fuelwood and by 120 percent when they use coffee husks relative to costs incurred by small farms (using less than 1000 kg on average). These economies of scale emerge because a minimum amount of fuel is required to generate heat in the barn no matter how much tobacco is cured. Thus, owners of small farms are at a disadvantage.

Since farmers continue to use fuelwood though coffee husk is less expensive than fuel wood, as shown above, Figure 7 identifies why farmers prefer fuelwood to alternate sources. Among the reasons, which appear to be mainly technical, are (i) the requirement of barn modification for the use of alternative fuels; (ii) damage to curing pipes when using alternative fuels; and (iii) the non-availability of alternate fuels in required quantities. We also surmise that easier storage facilities for fuelwood in comparison with other alternatives may determine farmers' choice of fuelwood despite higher costs.

## 5.2 Energy Efficiency in Tobacco Curing

In Karnataka, approximately 8 and 6 kg of fuelwood and coffee husk respectively are required, on average, for curing 1 kg of tobacco. The survey data however indicates that there is significant variation in fuel use among farmers, ranging between (-) 95 percent and 302 percent from the average. This variation is attributable to the use of moist biomass, errors in human activity, use of improved technologies, and scale economies.<sup>15</sup> The curing process requires a continuous supply of the fuel source into the furnace to maintain the required level of heat in the initial stages and for regulating the heat in the final stages. The known tendency of farmers to take a break sometimes from work, which in turn interrupts the steady supply of fuel to the furnace, leads to a reduction in the temperature inside the barn requiring additional fuel to maintain heat at high levels.

Despite such behavioral lapses on the part of farmers, energy efficiency can still be achieved if farmers adopt the available improved technologies. In our sample, some 18 percent of barn owners had insulated barns while 7.3 percent used a Venturi furnace. An additional 5 percent approximately of farmers used both barn insulation and a Venturi furnace. Because of the Tobacco Board's historical subsidies to low-income groups, farmers who use improved technologies tend to be the small and marginal farmers, 73 percent of whom operate with insulated barns and 78 percent with Venturi furnaces. Table 4 indicates that, on average, efficiency improves with the use of barn insulation and the Venturi Furnace. The insulation of barns reduces the use of fuelwood by 10 percent and coffee husk use by 17 percent. Similarly, adopting a Venturi furnace reduces the use of fuelwood by 7 percent and coffee husk by 21 percent for every kg of cured leaf. Thus, both technologies offer better fuel savings if coffee husks are used instead of fuelwood.

<sup>15</sup> Some curing takes place at the end of the monsoon season when it is still raining, which makes it likely that some farmers use moist sources.

Figure 8 provides further evidence of economies of scale in fuel use according to which large farmers<sup>16</sup> (who cure more than 4000 kg of tobacco), on average, use 57 percent and 48 percent less fuelwood and coffee husks relative to farmers who cure less than 1000 kg of tobacco. As previously noted, this is because farmers who cure larger quantities benefit from loading leaves to the maximum capacity of their barns.

### 5.3 Is it Profitable to Farmers to Use New Technologies?

Table 5 presents the cost-benefit analysis for installing the Venturi furnace and the insulation of barn (without a subsidy) for tobacco curing for an average small farmer and a large/medium farmer. As the Table shows, the total average cost of installing the two technologies, viz. insulation of barn and the Venturi furnace, is INR 10,018, which cost remains the same for all farmers. The total maintenance cost if both technologies are used is INR 4,333 per annum. The benefits are the annual fuel savings (and the resulting expected cash flows) from adopting these two technologies minus the maintenance costs, which equal INR 26,000 and 70,000 respectively per year for fuelwood and coffee husks for a small farmer. However, in the case of large farmers using fuelwood and coffee husk, the saving comes to INR 77,000 and 140,000 respectively per year.

For the average small farmer, the Net Present Value (NPV) of insulating a barn plus adding a Venturi furnace comes to INR 15,978 and 59,559, respectively, using fuelwood and coffee husk. For the average large farmer, the NPV of insulating a barn with a Venturi furnace is INR 67,232 and 129,988, respectively, for fuelwood and coffee husk. The NPV is calculated over a period of 10 years with a 12 percent interest rate, which is what farmers would need to pay for obtaining a commercial loan.

We also estimate the NPV from technology adoption separately for the two technologies. While the NPV from insulating barns (without subsidy) is negative (-80) for small farmers using fuelwood, it is positive for all coffee husk users and large farmers who use fuelwood. If we include the average subsidy previously received by small farmers, then the NPV for small farmer fuelwood users, which includes the subsidy, becomes positive (INR 1406). On the other hand, the net present value of installing a Venturi furnace is positive for all farmers for both fuels. This suggests that a subsidy is required for small farmers to adopt barn insulation while the use of technology among large farmers can be encouraged through awareness, education and training. Overall, the NPV of installing these two new technologies is positive and strong even without a subsidy except for small farmers who own insulated barns and use fuelwood for curing.

We may also examine the profitability of new technologies to farmers by estimating how long it takes for them to break even, which can be done by linking the technologies with the benefits that accrue due to fuel saving. The results indicate that farmers using fuelwood need to cure at least 1,100 kg of tobacco while coffee husk users have to cure at least 665 kg of tobacco in order to break even, thus recovering the investment made on fuel-saving technologies such as barn insulation and Venturi furnace. Small and large farmers using fuelwood and coffee husk annually however cure more tobacco than the quantity mentioned above. While large farmers require just 2 (with coffee husk) and 3 years (with fuelwood), respectively, to recover the cost incurred by installing the two technologies, small farmers curing with coffee husk and fuelwood require 4 and 7 years respectively. With the life-span of barn insulation at 10 years and that of Venturi furnaces much longer, the technologies seem therefore a worthwhile investment. Though in the case of barn insulation paddy straw needs to be replaced every 2-3 years, as straw is sometimes available as a waste product at low cost or no cost, there is no major expenditure required.

The question then is what constrains farmers from installing Venturi furnaces and insulating their barns if there are cost savings and the investment in technology can be recovered within a few years. Farmers cite the limited subsidy, lack of awareness about fuel efficiency, non-availability of technical guidance, and poor marketing of products at the village level as the main factors determining non-adoption. Many farmers furthermore expect the government to give them a subsidy in future and do not wish to incur 100 percent of the expenses.

<sup>16</sup> While the terms, large and medium farmers, refer to those holding >10 acres and <=10 acres, respectively, "small and marginal farmers" refer to those holding <= 5 acres and <= 2.5 acres respectively though marginal is clubbed with small farmers and medium clubbed with large farmers for the purposes of this study.

## 5.4 Aggregate Wood Use due to Tobacco Curing in Karnataka

Our data suggests that an average of 8 kg of fuelwood is required to cure one kg of dry tobacco. In the 2008-09 period, the recorded production of tobacco in Karnataka was 114,000 tons and, based on our field results, we assume that 75 percent of this tobacco was cured using fuelwood. Thus, approximately, 86,000 tons of tobacco was cured with fuelwood. Based on the reported usage of fuelwood per quantity of tobacco cured (8 kg), the share of fuelwood in all fuels used for curing tobacco (which is 75 percent), and the quantity of tobacco produced in the state for 2008-09 period (which is 114,000 tons and 75% of this constitutes 86,000 tons), we can surmise that FCV tobacco curing in Karnataka requires around 690,840 tons of fuelwood per year.

Given the use of nearly 700,000 tons of fuelwood for tobacco curing per year, and given the field-level data that shows that only 5.5 percent of the wood used for curing by tobacco farmers is collected from Forest Depots, we estimate that about 38,000 tons of fuelwood comes directly from forests every year.<sup>17</sup> This figure does not include illegal cuttings from forest areas and the purchase of forest wood from private vendors.

Further, our findings on fuel efficiency suggest that if all fuelwood users in our sample (70 percent) became more efficient, then the estimated annual saving in fuelwood per farmer would be 2.88 tons for those adopting both the Venturi furnace and the barn insulation solution. Aggregating these numbers to 70 percent of all FCV tobacco farmers in Karnataka (2009), we estimate that the adoption of the two technologies by all farmers who are fuelwood users would reduce fuelwood use by 12 percent annually, i.e., around 84,000 tons of fuel wood.

The Forest Department of Karnataka is legally empowered to sell fuelwood through its forest depots on the assumption that mature stands are harvested and that afforestation programs are simultaneously in place to increase forest cover. However, the Forest Survey of India (2009-10) report shows a 10 percent decline in forest cover in Karnataka between the years 2005 and 2009 (MEF, 2009). We need therefore to better understand the root cause of this documented decline and to investigate whether it is indeed linked to tobacco curing and if so to what extent.

## 5.5 Are Forest Plantations a Threat to Food Security?

To what extent are fuelwood plantations for tobacco curing a threat to food security? We explore this question by examining the growth of plantations. Both field visits and tracking of the fuelwood supply to the tobacco-growing villages indicated that the supply of fuelwood other than that from the Forest Department comes mainly from the villages of Malavalli block in the Mandya district and T. Narasipura block in the Mysore district. This has had a demonstration effect on nearby villages of Mysore and Tumkur districts.<sup>18</sup>

In order to understand the economic rationale behind farmer preference for growing tree crops, we estimated 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 124 tons per ha. Thus, we may surmise that on an average 8.5 tons of paddy (the main crop in the region) are foregone to produce 35 tons of fuelwood per hectare per year in villages where paddy is replaced by plantations.

The average price of wood cuttings varies from INR 1,650 per ton in the off season to INR 3,250 per ton during the peak season, fetching farmers on average INR 2450 per ton or INR 74,571 per hectare per year after subtracting labor costs of INR 11179. Paddy, which is one of the main food crops replaced by tobacco, yields on average 8.5 tons per ha, the average price of which in the year 2008-09 was INR 9250 per ton. After deducting INR 19,656 towards the costs of production, labor and transportation, we estimate the returns from paddy to be INR 58,969 per hectare, which proves forest plantations to be more profitable than paddy by approximately 21 percent. While forest plantations are more risky than paddy, the significantly higher returns suggest that there will continue to be some substitution of paddy with plantations.

<sup>17</sup> According to reports from local farmers who own wood plantation, the average yield of wood cuttings (Eucalyptus, Casuarinas, etc.) per hectare of land is 124 tons harvested in three and a half years. Thus, given the use of nearly 700,000 tons of fuelwood for tobacco curing per year, we estimate that approximately 5,594 hectares of woodland is required to grow this fuelwood.

<sup>18</sup> For example, Harish (2006) shows that land under miscellaneous tree crops increased while cultivable wasteland and growth in total cropped area declined for the Mandya district during the period 1990-91 to 2003-04. Since the plantations are relatively new, there are no district- or state-level data to compare with earlier scenarios. The plantations are neither included in forestry nor in horticulture crops, contributing to the lack of information at the state level.

The production of FCV tobacco in Karnataka has increased by 32 percent between the 2007-08 and 2009-10 periods. In the long run, if fuelwood plantations continue to increase to meet this demand, there may be a threat to food security due to the replacement of food crops by plantations, the loss of fodder for animals, and the loss of soil moisture due to the increase in water-exhausting species such as Eucalyptus (Shiva and Bandyopadhyay 1983; Chandrashekhar et al., 1987). Ramachandra et al. (2003) have estimated that some 127,769 hectares of waste land in Karnataka could be used for energy plantations. This wasteland could serve as an alternate source of land for fuelwood plantations. However, we would still need to understand both the feasibility and economic drivers that would allow these wastelands to be used for energy production.

## **6. Conclusions and Policy Recommendations**

In Karnataka, fuelwood and coffee husks are the main biomass sources used by farmers in tobacco curing, with 75 percent of FCV tobacco cured using fuelwood and another 20 percent cured using coffee husks. Our study raises questions about the energy efficiency of the fuels currently in use, the feasibility of alternate technologies to increase energy efficiency and the adverse impacts of the current fuels on forest cover and food security. The results of the study indicate that there are few alternatives to the dominant use of fuelwood in tobacco curing in Karnataka in the medium term. While farmers incur some 10 percent higher costs, on average, from using fuel wood relative to coffee husks, farmers prefer fuelwood because it is easily available and easier to store and does not require any modification in traditionally-used technologies.

Our study finds that there is ample scope for improving the way fuel is used in tobacco curing. Firstly, fuel efficient technologies, both barn insulation and the Venturi furnaces, are available and accessible to large and small farmers. Secondly, the net present value of adopting fuel-saving technologies is positive in most cases, except in the case of small farmers using fuelwood, who would require a subsidy to insulate their barns. The results indicate that while large farmers benefit from economies of scale and can recoup any investments made in fuel-efficient technologies within 2-3 years, small farmers require a little over twice that amount of time.

With regard to firewood use, our estimations suggest that adopting a fuel-efficient Venturi furnace and barn insulation would reduce the overall annual fuelwood use for tobacco curing in Karnataka by 12 percent. Since, at present, fuel-efficient technologies are not being adopted by farmers to the extent that they can be, the Tobacco Board could play a bigger role in promoting coffee husk use and energy-saving technologies. For instance, the Board could prompt farmers to buy dry wood in summer if they are offered credit facilities to purchase their required firewood needs on credit. Since many farmers also appeared unaware of and uninformed about fuel savings from the new technologies, the Board could better organize the market and extension services in order to increase awareness on and the willingness to adopt available technologies.

The data also show plantations to be increasingly emerging as a major source of fuelwood. While this development is, on the one hand, welcome because it reduces pressure on natural forests and carries carbon-sequestration benefits, it is important, on the other hand, to track the growth of plantations to ensure that this growth is not at the expense of paddy cultivation and food security. Our study recommends the promotion of plantations on waste lands in order to minimize perceived disadvantages having to do with possible encroachments on paddy lands.

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## Tables

**Table 1: Sampling Frame**

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
<b>Total</b>		<b>20</b>	<b>(No. = 39,457) 100.00</b>	<b>610</b>

**Table 2: Socio Economic Indicators of Tobacco Growers (n=610)**

Indicator	Score
Own farm agriculture (%)	91.64
Head of Household -Reported Illiterate (%)	47.70
Average years of schooling (no.)	4
Average land holding (ha)	1.56
Average household size (no.)	5.8
Average annual income (Rs.)	2,39,877
Percentage of households below poverty line	<1%
Average amount of tobacco cured by a farmer (kg)	1960

**Table 3: Household Use of Alternate Fuel for Tobacco Curing (n=600)**

Indicator	Percent of HHs
Fuelwood	69.55
Coffee husk	15.51
Coffee root	0.16
Coconut husk	0.32
Coconut frond	0.16
Coffee waste briquette	0.16
Cashew kernel	0.48
Wood chips	0.16
Agro-briquette*	
Total [single source]	86.50
Total [mixed source]	13.50
Total Sample	100.00
*Included in mix source	

**Table 4: Fuel Use and Costs with Alternative Sources and Technologies (n=600)**

Energy Source	Traditional curing		Barn Insulation		Venturi Furnace	
	Average curing cost (Rs.)	Average Fuel use (Kg.)	Average curing cost (Rs.)	Average Fuel use (Kg.)	Average curing cost (Rs.)	Average Fuel use (Kg.)
<b>Fuelwood</b>	(n= 464)		(n= 78)		(n= 39)	
		8.08		7.28		7.51
Total Fuelwood Cost	22.88	8.08	20.72	7.28	20.10	7.51
- Fuel	20.74 (90.41%)		18.82 (90.70%)		18.52 (91.10%)	
- Transport	2.03 (8.85%)		1.70 (8.19%)		1.60 (7.87%)	
- Labor for curing	0.17 (0.74%)		0.23 (1.11%)		0.21 (1.03%)	
<b>Coffee husk</b>	(n= 123)		(n= 16)		(n= 5)	
		5.91		4.92		4.64
Total Coffee husk Cost	20.77		17.11		16.49	
- Fuel	19.93 (97.26%)		17.80 (97.96%)		16.78 (97.84%)	
- Transport	0.47 (22.94%)		0.27 (1.49%)		0.33 (0.02%)	
- Labor for curing	0.09 (0.44%)		0.10 (0.55%)		0.04 (0.23%)	

(Figures in parenthesis indicate percentages)

**Table 5: Cost Benefit Analyses of Improved Technologies (without subsidy)**

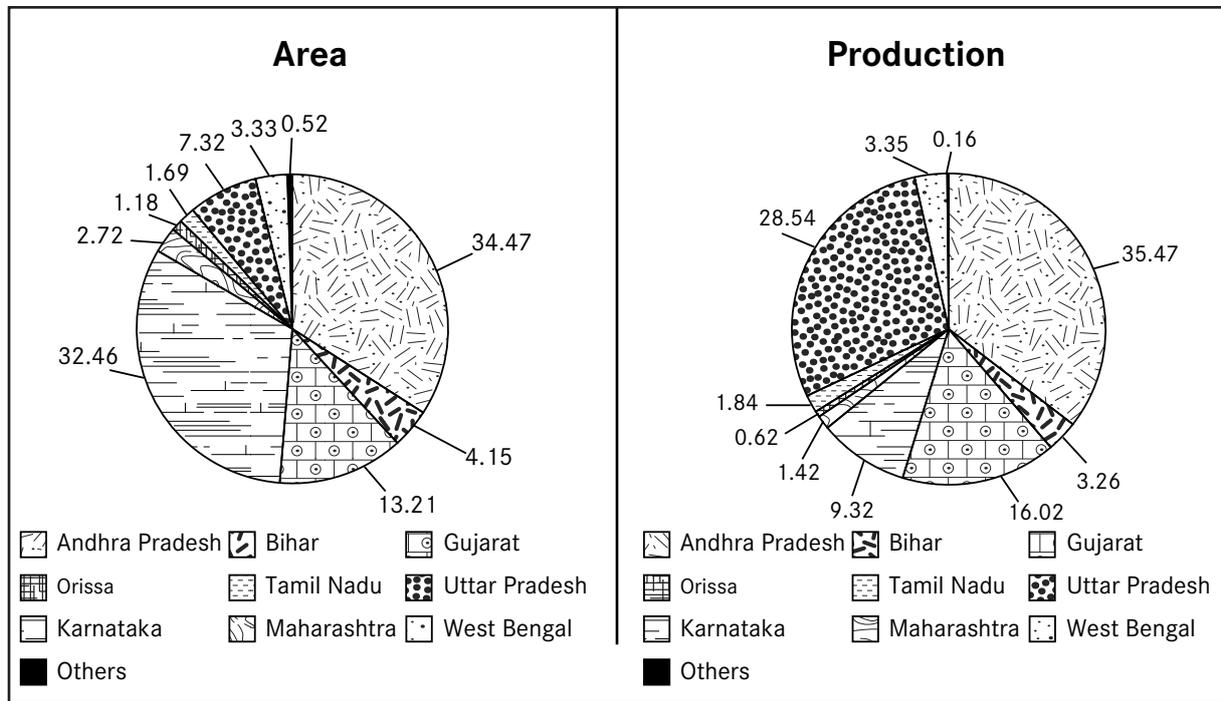
(in INR) [Rate of Interest-12 percent]

Details	Marginal & Small farmers		Medium & Large farmers	
	Fuelwood	Coffee husk	Fuelwood	Coffee husk
<b>Insulated barn &amp; Venturi furnace</b>				
Costs (initial cost of installation of insulation of barn and Venturi furnace)	10,018.00	10,018.00	10,018.00	10,018.00
Discounted Benefits from Fuel Savings (projected cash flows over 10 years accrued by deducting annual maintenance costs)	25,996.00	69,577.00	77,250.00	140,006.00
NPV	15,978.00	59,559.00	67,232.00	129,988.00
<b>Insulated barn</b>				
Costs (initial cost of installation of insulation of barn)	5,425.00	5,425.00	5,425.00	5,425.00
Discounted Benefits from Fuel Savings (projected cash flows over 10 years accrued by deducting annual maintenance costs)	5,345.00	27,940.00	27,098.00	60,502.00
NPV	-80.00*	22,515.00	21,673.00	55,077.00
<b>Venturi furnace</b>				
Costs (initial cost of installation of Venturi furnace)	4,593.00	4,593.00	4,593.00	4,593.00
Discounted Benefits from Fuel Savings (projected cash flows over 10 years accrued by deducting annual maintenance costs)	20,295.00	43,088.00	49,456.00	81,109.00
NPV	15,702.00	38,495.00	44,863.00	76,516.00

\*NPV with subsidy amounts to INR 1,406

## Figures

Figure 1 : State-wise Area and Production of Tobacco in India (2007-08)



Source: CMIE, 2010

Figure 2 : Tobacco Curing Barn



Source: CMDR survey 2009

**Figure 3: Conventional furnace versus Venturi furnace**



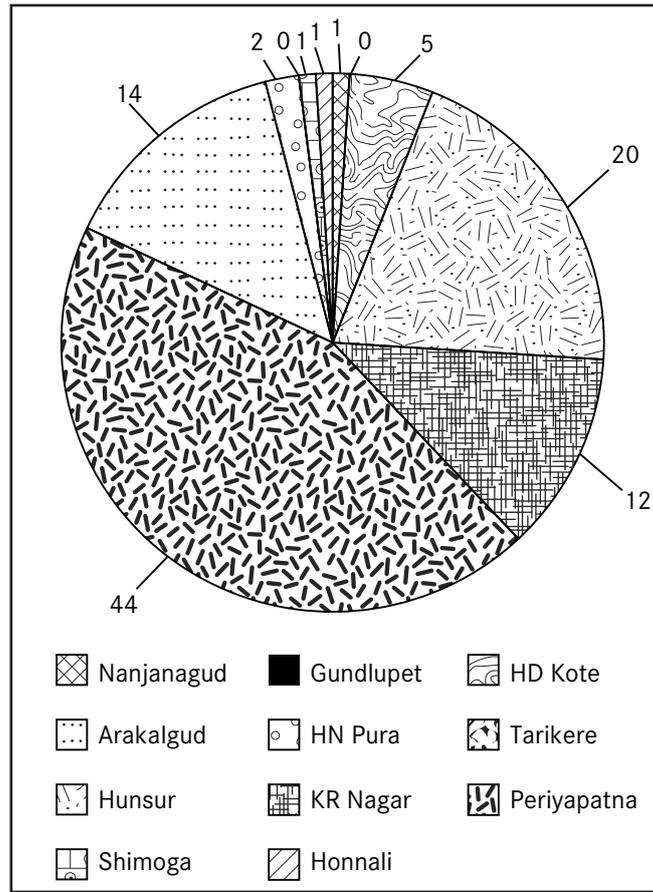
Source: CTRI, Hunsur

**Figure 4: Cured leaves (in Barn and carried for packing)**



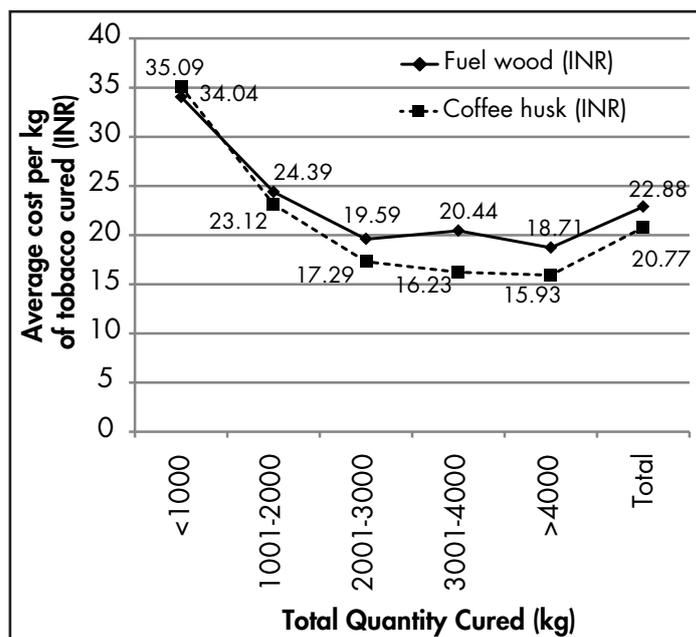
Source: CTRI, Hunsur and CMDR survey 2009

Figure 5: Block-Wise Area under FCV Tobacco in Mysore and Hassan District



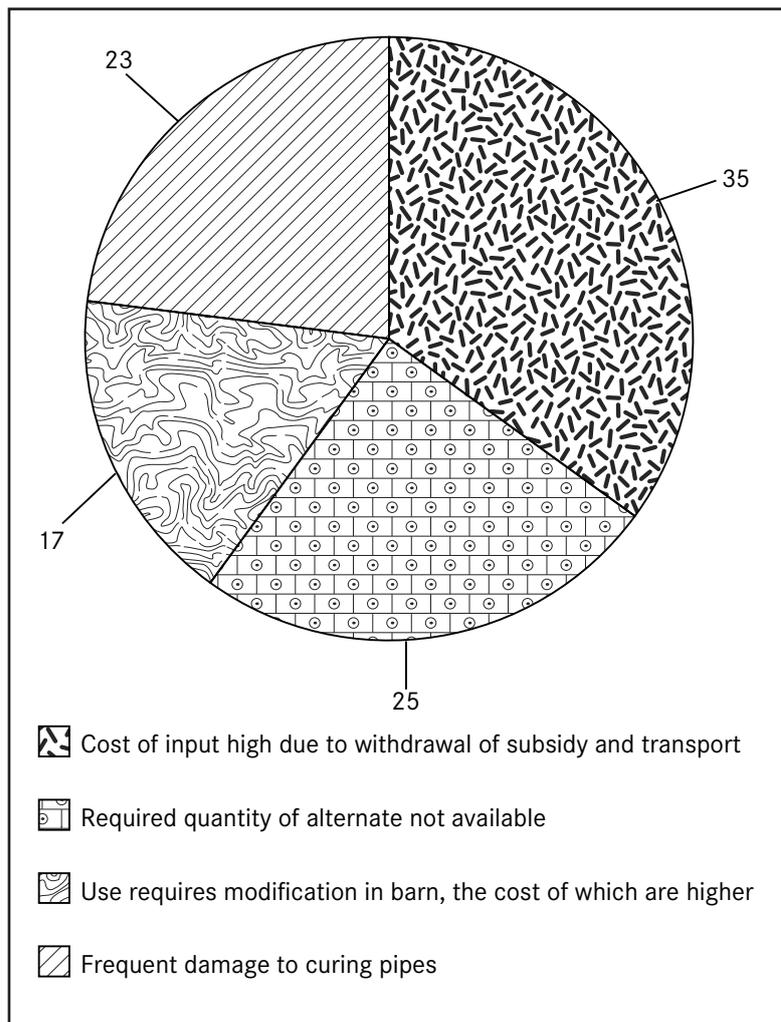
Source: CTRI, Hunsur

Figure 6: Cost of Curing by Quantity of Tobacco Cured

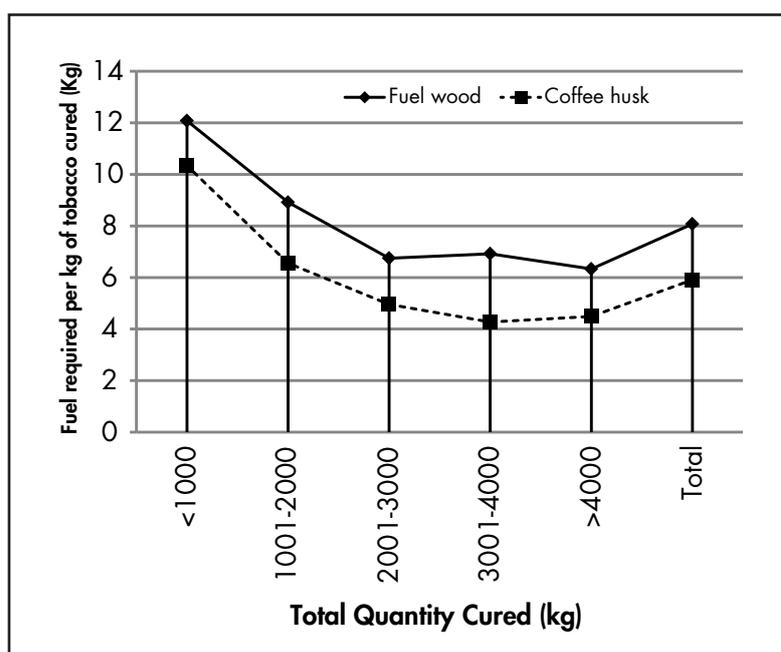


Source : CMDR Survey, 2009

**Figure 7: Reasons Stated by Farmers for not Using Alternatives to Fuelwood (% of respondents)**



**Figure 8: Fuel Use by Quantity of Tobacco Cured**







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