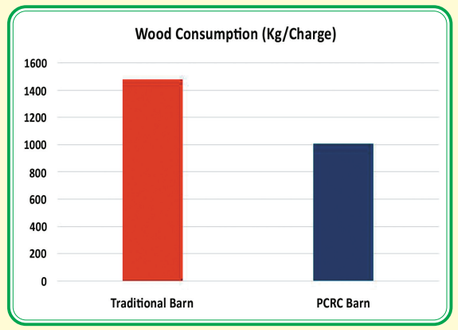
Parameter	PCRCB	Traditional
Nicotine (%)	2.46	2.59
Reducing Sugars(%)	15.14	16.02
Chlorides (%)	0.32	0.38
Starch (%)	1.19	1.10
Rutin (mg/g)	9.30	8.60
Chlorogenic acid (mg/g)	18.5	18.0

	Wood Consumption (kg / kg cured leaf)	Fuel wood Saving (%)	Wood excessively consumed by Traditional Barn (%)
PCRC Barn	3.13 - 3.99	22 - 29	28 - 46
Traditional Barn	4.39 - 5.66		

kg cured leaf was 3.13-3.99 kg with poly carbonate roof barn against 4.39- 5.66 kg in traditional barn. About 22-29% wood was saved due to harnessing the solar energy by the polycarbonate roof chamber compared to traditional barn. Percent excess wood consumed by the traditional barn was 28.0 - 46.0 %.



Economics: A total quantity of 4500 kg wood is saved per barn per year resulting in a net profit of Rs. 4750/- per barn by the polycarbonate roof chamber. Approximately 0.25 million tonnes of wood can be saved annually, more over the technology is environmental friendly and helps in reducing the deforestation.



Agribiomass briquettes as a supplement to solar energy: Large quantities of agro biomass residues are inefficiently burnt causing extensive pollution to the environment. These agro residues can be converted to efficient green fuel by means of biomass briquettes / pellets. The major residues are rice husk, pigeon pea husk, chickpea husk, cotton stalks, groundnut shells, sawdust, coir pith, and coffee husk etc. Biomass briquetting is the densification of loose biomass material to produce compact solid composites of different sizes with the application of pressure. ICAR-CTRI established a biomass briquetting facility for preparation of biomass briquettes of 60 mm diameter. To prepare Agri. Biomass briquettes locally available crop residues/agri-biomass *viz.*, chickpea husk and pigeon pea husk, were sun dried, powdered and mixed with sawdust in the ratio of 30:70, and briquettes were prepared using briquette making machine and were evaluated as a supplement to solar energy to cure FCV tobacco. Agribiomasses like maize rinds were used directly in the initial stages of curing (Yellowing and color fixing) where the temperature requirements were low (90-120^{0}F). Agri-biomass briquettes prepared with chickpea husk, pigeon pea husk and saw dust combination were used for curing in lamina drying and midrib drying where the temperature requirement is between 120-160^{0}F. Polycarbonate roof chamber along with agri-biomasses were evaluated as a against wood exclusively as a fuel. About 25% of fuel requirement is met with maize rinds and 74.5% is with briquettes. For every 1 kg cured leaf 1 kg maize rinds and 3 kg briquettes were consumed. Fuel (briquettes +Maize rinds) consumption per one kg cured leaf was 4.00 kg with poly carbonate roof against 5.60 kg in traditional barn. About 25% of fuel was saved due to PCRC barn and percent excess fuel consumed by traditional barn is 33%. Agribiomasses and their briquettes along with polycarbonate roof chamber can substitute the wood for curing the FCV tobacco.

Fuel Consumption (kg / charge)

PCRC barn			Traditional Barn	Fuel saving (%)
Maize rinds	Briquettes	Total	Wood	
271	795	1066	1423	24.9

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Poly Carbonate Roof Chamber:

A fuel saving intervention in FCV tobacco curing through Harnessing Solar energy



Project
Development and Evaluation of Solar Thermal Energy based FCV tobacco curing systems
(Sponsored by: Tobacco Board, Guntur)

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Indian Tobacco: Tobacco, the golden leaf is one among the leading commercial crops in India with a cultivated area of 0.47 million ha, producing 800 million kg annually. India is the third largest producer of tobacco after China and Brazil. Indian tobacco has an edge in the international market in view of its low production cost and offers the customers 'value for money' because of the availability of varied



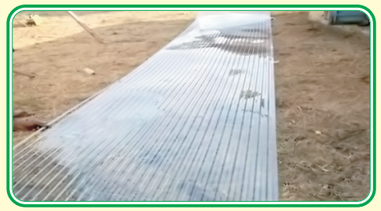
tobacco leaf styles. Tobacco made a significant contribution of Rs. 28,277 crores to Indian economy in terms of excise revenue (Rs. 22,737 crore) and export earnings (Rs. 5,540 crore), and provides livelihood security to 45.7 million people around 70 percent of whom are in agriculture sector. Of the total tobacco production, the Flue-cured Virginia (FCV) tobacco is grown in 1.5 lakh hectares and accounts for about 30% (240 m kg) of total tobacco production. FCV tobacco, used for manufacturing cigarettes, is predominantly grown in the states of Andhra Pradesh and Karnataka under distinct soil domains.

Rationale: Post-harvest drying of tobacco leaves is done through a process of flue curing in a specially constructed structures called 'Barns' under controlled conditions by regulating the temperature and humidity to obtain desired leaf quality. There are about 95 thousand flue curing barns possessed by 88 thousand registered FCV tobacco growers in the country. At present, firewood is the predominantly used source of energy to fuel the flue-curing barns, with agro-biomass residues like coffee husks making small contribution to total energy requirement. Some conservative estimates on wood fuel requirement suggest that on an average 5 kg wood is needed for each kg of cured leaf. Assuming that 80% FCV tobacco produced is cured using wood as source of energy, the quantity of wood consumed annually for tobacco curing comes to 1.0 million tons. The fuel use efficiency in traditional curing barns is also often very low, contributing to large requirement of fuel wood. Such large scale use of wood fuel for tobacco curing can result in deforestation and represents a serious environmental issue. This situation highlights the need for exploring alternative green energy sources on one hand, and integrated and efficient use of all available fuels on the other.

Solar Energy for Curing: Exploiting solar energy use for tobacco curing is one of the options available to reduce dependency on fuel wood. Fortunately the FCV tobacco growing regions are under high solar radiation during the months coinciding with the tobacco curing periods. Besides being renewable, the solar energy also represents environmental friendly energy source and thus, the potential for its use to provide some of the heat requirement for tobacco curing appears bright. To fulfil the desired objectives ICAR-CTRI, Rajhamundry and Tobacco Board, Guntur are implementing a collaborative project "Development and Evaluation of Solar Thermal Energy based FCV tobacco curing systems" with the objectives

- To evaluate the suitable interventions for harnessing the solar energy for curing
- To develop a integrated barn with duel fuel system (Solar Energy + Agri biomass Energy/Electrical energy/ Water heating system) for curing FCV tobacco

Technology : A poly carbonate roof chamber as a solar energy collector was evaluated for three consecutive years (2016-2019) at CTRI Research farm Katheru to evaluate its efficacy in harnessing the solar energy as a supplement to wood fuel for curing the FCV tobacco at CTRI Research farm Katheru. Designed a roof top chamber of 2 ft height with polycarbonate sheet (1.2 mm thick) mounted on a iron frame over the existing curing barn (24'x16'x10.6') roof (PCRC) with metal sheet over the barn as an solar radiation absorber. A provision for air circulation was made through a duct from the barn top. The tin sheet surface of the barn was painted with black colour for increasing the absorption efficiency of solar radiation. Curing



Polycarbonate sheet



Iron frame

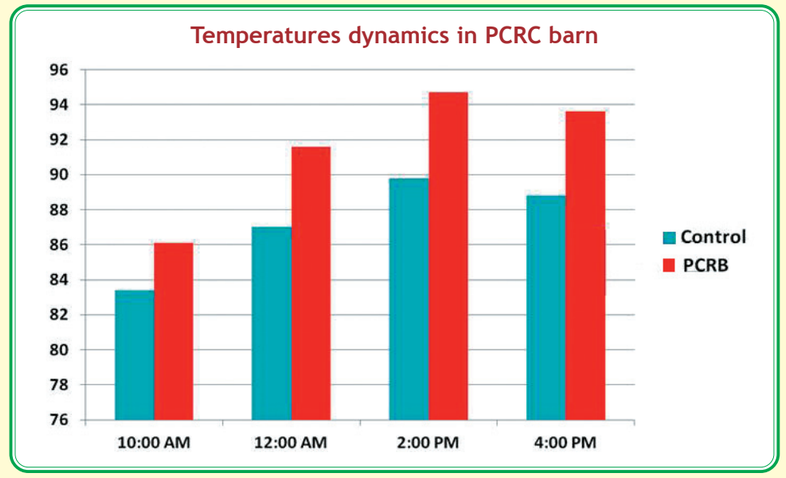


Duct for air circulation



Poly carbonate roof chamber

barn with PCRC was compared with traditional curing barn with wood exclusively as a fuel for curing FCV tobacco. Observations on temperature changes in the barns, polycarbonate chamber and Tin sheet over the barn, leaf temperature variations while curing, wood consumed, saving in wood fuel, chemical and biochemical quality



parameters in cured leaf, etc. were recorded. Fixing PCRC on the barn resulted in a temperature rise of 6^0F inside the barn due to trapping the solar radiation through green house effect. A consistent raise in temperature was recorded in upper tiers inside poly carbonate roof barn compared to traditional barn. The temperatures of Tin sheet on the top of curing barn ranged from 117-125^{0}F in the traditional barn and in PCRC barn 134-155^{0}F because of which the leaf temperatures inside the PCRC barn were high (96-131^{0}F) during the curing process compared to traditional barn (90-127^{0}F) which hastened the curing process there by reduced the wood fuel consumption. Physical and chemical (nicotine, reducing sugars, chlorides) and biochemical (starch, rutin and chlorogenic acid) parameters in cured leaf remained unchanged due to the polycarbonate roof chamber over the barn. Wood consumption per one

