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Business perspective and entrepreneurship opportunities in cotton stalk by product based industry in India

V. G. ARUDE*

ICAR-Central Institute for Research on Cotton Technology, Mumbai-400 019
**Email: arudevg@gmail.com*

ABSTRACT : Annually around 30 million tonnes of cotton stalk is generated in India. Very limited value addition is done to cotton stalk. Most of the cotton stalk produced is treated as waste, though about 5-6 per cent being used for commercial purposes and around 15-20 per cent is used as fuel by rural masses and remaining bulk of cotton stalk is burnt off in the field after leading to severe environmental pollution. Cotton stalk is comparable to most common species of hardwood in respect of fibrous structure and chemical composition. Cotton stalk contains 60 per cent hello cellulose, 27 per cent lignin and 6 per cent ash. The calorific value of cotton stalk is about 4000 kcal/kg. The present paper discusses various techno-economically viable technologies developed and commercialized through value addition to cotton by-products by ICAR-Central institute for Research on Cotton Technology (CIRCOT), Mumbai. As cellulose and lignin content is more in cotton stalk, it can be used for making particle boards, further it can be used for manufacture of briquettes and pellets as renewable source of energy and power generation as it has good calorific value. Cotton stalk can be converted to bio- enriched compost and can be used to cultivate edible mushroom. These technologies has created additional source of income to farmers, source of renewable energy, entrepreneurship opportunities for promotion of rural based industries and employment generation for rural youths in cotton growing areas. Further these technologies helped to convert waste to wealth and helped in protecting environment. Further it needs to be strengthened and promoted so that more number of farmers are benefitted. The economic business opportunities can be realised by establishing cotton by-product based industries to move towards sustainable development

Key words: Biomass industry, cotton stalk, entrepreneurship, value addition,

Cotton is grown in about 100 countries and traded in around 150 countries worldwide Cotton is an important commercial crop of India and has emerged as the largest producer in the world with its production touching 6.2 million tonnes in 2020-2021 (USDA, 2020). Cotton is cultivated mainly for its fibre which is the most important commercial product apart from the cottonseed and cotton stalks as its valuable by-products. Around 11 million tonnes of cottonseed and about 30 million tonnes of cotton stalk is generated in India every year (Arude *et al.,* 2018). Linter, hull and meal are the important by-products obtained after extracting oil from the cottonseed which are used for preparation of value added products.

In India very limited value addition is done to cotton stalk. Most of the cotton stalk produced is treated as waste, though about 5-6 per cent being used for commercial purposes and around 15-20 per cent is used as fuel by rural masses and remaining bulk of cotton stalk is burnt off in the field after leading to severe environmental pollution (Arude *et al.,* 2018).

Cotton by-products based industries are underdeveloped in India owing to several impediments, including, lack of logistics for supply of cotton stalk, lack of availability of equipment for uprooting and chipping, lack of awareness and information among the farmers about value added technologies, inadequate government policies to support the development of cotton by-product industries etc.

Cotton stalk is comparable to the most common species of hardwood in respect of fibrous structure and chemical composition. Cotton

Fig. 1: Cotton Stalk

Fig. 2: Domestic Fuel

Fig. 3: Burning in the field

stalk contains 60 per cent hello cellulose, 27 per cent lignin and 6 per cent ash. The calorific value of cotton stalk is about 4000 kcal/kg (Arude *et al.*, 2018). ICAR-Central institute for Research on Cotton Technology (CIRCOT), Mumbai has developed techno-economically viabletechnologies and commercialized various technologies for value addition to cotton by-products. As cellulose and lignin content is more in cotton stalk, it can be used for making particle boards. The cotton stalk can be used for manufacture of briquettes and pellets as renewable source of energy and power generation as it has good calorific value. Cotton stalk can be converted to bio- enriched compost and can be used to cultivate edible mushroom (Arude 2020).

The economic business opportunities can be realised by establishing cotton by-product based industries to move towards sustainable development and also to create entrepreneurship and generate employment in rural areas in cotton sector.

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Business model for supply chain of cotton stalk for industrial applications : Lack of viable logistic model for supply of chipped cotton stalks to the industries is a cause for non- utilization of cotton stalks for industrial applications. Traditional method of uprooting cotton stalks with a traditional tool (*Chimta)* is very tedious and labour intensive process. Hence, it was not viable for supply of cotton stalks for any industrial uses. Therefore viable logistics model have been developed for supply of cotton stalks for pelleting, briquetting and power generation industries.

The viable supply chain model comprises

Fig. 4. Cotton stalk

Fig. 5. Cotton stalk chipper

of uprooting of cotton stalk by tractor operated V-type up-rooter, followed by sun drying, shredding by a tractor operated shredder and transportation of chipped cotton stalk with truck/tractor to briquetting and pelleting plant within the radius of 50 km. Chipped cotton stalk fetches price of Rs. 2500-3000 per tonne at factory gate. Additional remuneration of Rs. 1500-2000 per tonne to the cotton farmers, thus contributing to doubling famer's income (Arude *et al.,* 2018).

This cotton stalk supply chain model has been demonstrated to farmers and stakeholders, pelleting, and briquetting and power generation industry in Vidharbha region of Maharashtra. It resulted in creation of employment and entrepreneurship opportunities for rural youth in cotton growing regions. Around 50 briquetting and pelleting plants based on cotton stalks have been established in and around Nagpur.

Entrepreneurship opportunities to manufacture cotton stalk based briquettes and pellets Briquetting and pelleting technologies are well developed and widely used commercially in developed countries. But lack of knowledge of technology and technical constraints was the causes for less adoption of this technology in India. The calorific value of cotton stalk is about 4000 kcal/kg hence it can be used for manufacture of briquettes and pellets which can be used as a renewable source of energy. To address these issues extensive research work was done to develop process protocol and value added products *viz.*, briquettes and premium grade pellets from cotton stalk. Briquettes and pellets are prepared by densification at high temperature and pressure.

Briquettes find its application as an alternate fuel to coal and LPG in boilers in the sugar, paper, rubber, chemical and food processing industry. Briquettes also find application in power generation plant in place of coal. Besides this briquettes can be used in forging, furnaces and brick kiln and gasification. Cotton stalk briquettes can be used an alternate to wood for burning dead bodies which would help to reduce dependence on wood for cremation purpose. For establishment of briquetting plant with a capacity of 20 tons/day, an investment of Rs. 25 lakh is required for machinery. The return on investment in briquetting plant of capacity 20 tonnes/day is around 40 per cent and payback period is around 2 years (Patil *et al.,* 2019).

Pellets are being used in cooking stoves as fuel for preparation of snacks and cooking of meals, especially in roadside *dabhas,* restaurants, etc. The utilization of pellets for cooking saves over 50 per cent costs on fuel as compared to LPG gas price. Pelleting plant of capacity 3 tons/day can beestablished with an investment of Rs. 15 lakhs for machinery. The return on investment in pelleting plant of 3 tonnes/day is around 25 per cent and payback period is around 3 years (Patil *et al.*, 2019).

Fig. 6. Cotton Stalk briquettes

Fig.7. Cotton stalk pellets

Cotton farmers also get benefitted by Rs 1500-2000/- per tonne by selling of cotton stalks produced in their field.The utilization of cotton stalks based briquettes and pellets is a step towards doubling the farmer's income (Sundarmoorthy *et al.*, 2019). The manufacturing of briquettes and pellets from cotton stalk biomass has created entrepreneurship opportunities for promotion of rural based industries and employment generation to rural youths in cotton growing region.

Business opportunities in biomass briquette based cremations: Burning the dead human bodies in the open air and on a pyre made of wood is an ancient rite and commonly followed practice in Hinduism. Traditionally cremation is mainly performed by using fire wood. Cremation of a single person requires about 300 kg of fire wood which is equivalent of two fully grown trees that takes at least 15 years to grow. Electrical and diesel based crematoriums are also being used as an alternative to fire wood based cremations. The closed chamber design of these crematoriums does not allow performing traditional rituals like *mukhagni, kapalkriya* which are culturally considered essential for liberation of souls as per *Hindu Shastra*. Since the last rites of a loved one are understandably a very sentimental issue, these non-traditional electrical and diesel cremations are not much accepted by the society at large.

In order to provide an eco-friendly solution and to allow and to perform traditional Hindu rituals during cremations, ICAR-CIRCOT, have developed briquette based eco-friendly, efficient andrapid burning green crematorium as an alternative to traditional fire wood based cremation. Briquettes made from agricultural biomass like cotton stalk, sugarcane bagasse, groundnut & castor seed shells, rice husk and paddy straw etc. can be used as greener and renewable alternative for fire wood in cremation.

The ICAR-CIRCOT Green Crematorium consists of a compact trapezoidal shaped cage and a forced draft aeration system for supply of air for rapid initiation of fire and for enhanced combustion process. The forced air required for combustion during cremation process is supplied through single phase electric fan to an aeration chamber, which distributes air at the bottom and two-sides of cage through manifold pipes and subsequently to individual pipes having holes. By making the air available at the location where the briquettes are burned, the proportion of CO being generated is considerably lowered leading to significant reduction in pollution during cremation process. This crematorium also can be used without forced draft aeration system and fire wood can also be used in place of briquettes.

ICAR-CIRCOT Green crematorium has

Fig. 8: ICAR-CIRCOT Green Crematorium

many advantages over the traditional fire wood cremation. It requires only 200 kg of biomass briquettes as against 300 kg of fire wood in traditional cremations. Traditional fire wood cremation requires around 5 lit of kerosene. However, ICAR- CIRCOT crematorium does not require kerosene. The cost of cremation with ICAR- CIRCOT Crematorium comes to Rs. 2500/- as against Rs. 5500 for traditional cremation. Around 55 per cent of cost saving per cremation can be attained making it economical and ecofriendly (Patil *et al.*, 2019).

Nagpur Municipal Corporation in state of Maharashtra has already installed ICAR-CIRCOT Green Crematorium at Ambazari ghat and many cremations have been done effectively using briquettes made from cotton stalk and other agro-residues. The Institute has given non-exclusive license for manufacturing of green crematorium to a Nagpur based entrepreneur. Many more such kind of enterprises can be established for manufacturing of green crematorium.

In India about 75 lakh cremations take place annually. Saving per cremation using ICAR-CIRCOT green cremation in comparison with cremation using firewood is Rs 3000/-, resulting in annual saving of Rs 2250 crores. Saving of 300 kg fire wood per cremation will save 22.5 lakh tonnes offire wood *i.e.* 150 lakh trees per annum. The demand for 15 lakh tonnes of briquettes for cremation will create opportunities for establishment of around 300 additional briquetting plants (20 tonnes/day capacity) which in turn would result in additional employment opportunities to thousands of peoples in India. Thus the use of biomass briquettes for cremations has tremendous potential for creation of rural based industries and employment generation.

On farm entrepreneurship through production of bio-enriched compost : Bio-enriched compost can be made out of cotton stalk using microbial consortia. An accelerated process has been developed by ICAR-CIRCOT for composting cotton stalk. Duration of composting is 45 days for wet and 60 days for dry cotton stalks. Yield of compost is 800 kg/tonne of cotton stalk. Accelerated process of composting saves 15 to 30 days of composting over farm yard manure (FYM). Bio-enriched compost made out of cotton stalks has higher NPK content (1.43: 0.78:0.82) as compared to FYM (0.5:0.2:0.5). It results in saving of Rs. 9000/ha by replacing FYM (12 tonne) with cotton stalk compost (5 tonne). It can be used for soil health enrichment as a substitute to chemical fertilizers. This technology is demonstrated through hands on

Fig. 9. Compost from cotton stalk

training to farmers of Wardha, Nagpur and Amaravati District of Maharashtra and of Sirsa of Haryana and many famers has adopted it. Rural enterprises for production of compost from cotton stalk can be established at farm level in rural areas (Mageshwaran *et al.*, 2017).

Developing cottage industry for cultivation of Oyster mushroom using cotton stalk : ICAR-CIRCOT has established the suitability of cotton stalks for production potential (growth performance and yield) of oyster mushroom and developed the protocol for cultivation of oyster mushroom. Oyster mushroom (*Pleurotus florida* and *Pleurotus ostreatus*) can be cultivated on hot water treated cotton stalks of 3-4 cm length. The mushroom can be cultivated by hanging bag technique (Satankar *et al.*, 2018). About 300 gm of fresh oyster mushroom could be harvested from one kg of dry cotton stalks. The cropping period for cultivation of oyster mushroom in cotton stalks is 30 days. An average of two harvests can be done per crop. The average cost of production of one kg of fresh oyster mushroom is Rs. 50/- The selling price of fresh oyster mushroom in the market ranges from Rs. 80 to 150/-. Thus, a farmer can earn a minimum of Rs. 30/kg of oyster mushroom produced. On an average, a famer can generate a minimum additional income of Rs. 6,000/acre by cultivation of oyster mushroom in cotton stalks generated from an acre of land. Oyster mushroom cultivation using cotton stalk can be established as cottage industries in rural areas.

Fig.10. Oyster mushroom cultivation on cotton stalk

Fig.11. Harvested fresh mushroom

Business opportunities in production of particle board, composites and activated carbon ICAR-CIRCOT has developed technologies for preparation of particle boards, composites and activated carbon from cotton stalk. One tonne/day capacity pilot plant for preparation of particle boards from cotton stalks has been established at Ginning Training Centre of ICAR-CIRCOT, Nagpur with the financial assistance from Common Fund for Commodities (CFC), Netherlands. The quality of the particle boards from cotton stalk is comparable to that of particle boards made from wood. These particle boards find applications in interior decoration, wall panelling, false ceiling, portioning, table tops etc. Cotton stalk has cellulosic materials which is useful as reinforcement for polymer composites. Cotton stalk/epoxy composites has better mechanical and good thermal resistance properties and hence can be used in thermal resistance roofing panels in construction fields and automotive sector. The cotton stalk based activated carbon has higher micro-porosity and meso-porosity and surface area around 1000 m^2/g. It can be used for the various applications such as air filtration, water purification, medical application and dye adsorption from textile effluents. Face masks using activated carbon

made form cotton stalk has been developed for the traffic police. Business models needs to be established and promoted for production of particle boards and composites from cotton stalk.

Business perspective in cotton by-product based industry: The biomass briquette and pellet industry has gained a rapid momentum over the past decade. The USA and most of European countries are the largest markets for biomass pellets. In Europe, pellets are mainly used for the production of electricity and residential heating. United Sates of America and Sweden procure about 4 and 13 per cent of their energy, respectively, from biomass and Sweden is implementing initiatives to phase out nuclear plants, reduce fossil-fuel energy utilization and enhance the use of bioenergy. Though, briquetting technologies are well developed and widely used commercially in developed countries, it is yet to receive a strong foothold in many developing countries because of the technical constraints involved and the lack of knowledge to adapt the technology to suit local conditions. Overcoming many operational problems associated with this technology are crucial factors in determining its commercial success.

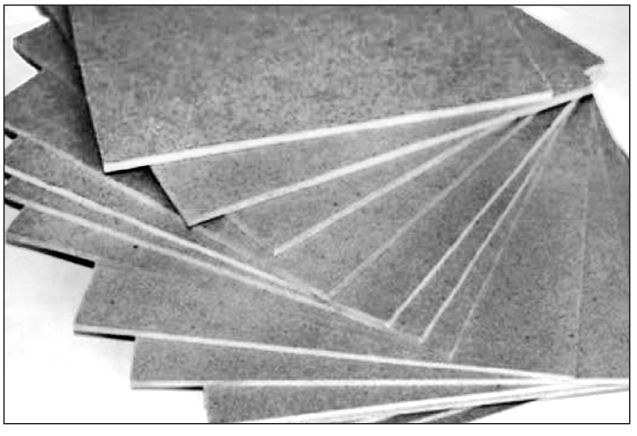

Fig.12. Cotton stalk particle boards

Fig.13. Cotton stalk composite trays for nursery

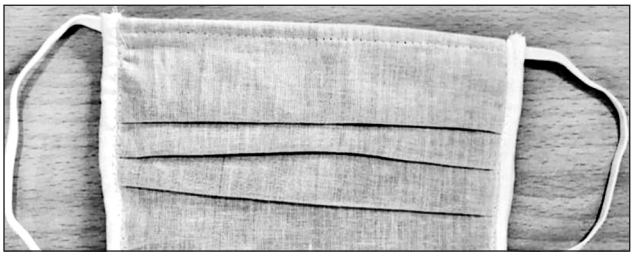

Fig. 14. Face masks of activated carbon from cotton stalk

In India, the briquette and pellet industry is gaining momentum in last few years. Over 250 small and large size pelleting plants are being operational in India. The growing number of entrepreneurs in the state of Maharashtra in India, it is evident that biomass briquetting and pelleting industry has emerged as a promising option for the new entrepreneurs and other users of biomass in India. It requires low investment and can generate employment among the rural masses leading to improvement in social as well as economic life of rural people.

The utilization of cotton stalks and other agro-residues based briquettes and pellets is a step towards doubling the farmer's income. Further this business model needs to be strengthened so that more number of entrepreneurs will be benefitted. There is huge potential to establish profitable processing businesses in India based on cotton by-products, such as briquettes and pellets as successful business models exist in our country. This business models would contribute to increased income opportunities for farmers and entrepreneurs, especially in rural areas, and to amore in cotton sector overall. Strategies to enhance farmer's income and create entrepreneurship and business opportunities in cotton sector must therefore include increased value addition to cotton by-products.

CONCLUSIONS

Techno-economically viable technologies developed and commercialized by ICAR-CIRCOT through value addition to cotton stalk by-products has great potential to create entrepreneurship and employment opportunities in the rural areas and contribute to doubling farmers income. These ttechnologies helped to convert waste to wealth, generate renewable energy, and improve soil health and to protect environment. Entrepreneurship and employment opportunities are created for rural youths for supply of cotton stalk as a raw material for industrial application, establishment of briquetting and pelleting industry, compost making and cultivation of mushroom and manufacturing of crematorium for rural youths. Successful business models based on technologies are demonstrated to stakeholders at national level and through United Nations Conference on Trade and Development (UNCTAD), Geneva in African countries like Uganda, Tanzania, Zimbabwe and Zambia.

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REFERENCE

Arude, V. G, Patil, P. G. and Deshmukh P. S. 2018. Value Addition to Cotton Stalks. *Shetkari.*

Arude, V. G., Shukla, S. K. and Patil, P. G. 2018. Value addition to cotton stalk. Book of paper, National seminar (Hindi), Advanced processing technology of natural fibres and their value added products, pp. 54-60.

Arude, V. G. 2020. Business perspective and entrepreneurship opportunities in cotton stalk by- product based industry in India. Invited paper, National Symposium on *'Cotton Production Technologies in next decade: Problems & Perspectives'* organized by CRDA, OUAT, Bhubaneshwar.

Mageshwaran, V., Satankar, V. and Hasan, H. 2017. Compost production and Oyster mushroom cultivation - A potential entrepreneurship for cotton growing farmers. *Internat. J. Forestry Crop Impr.* **8** : 149-56.

Patil, P. G, Arude, V. G., Shukla, S. K. and Deshmukh, P. S. 2019. *Kapus Parhati Pasun Briquette and Pellet Nirmittee. Agrovon Marathi Daily Magazine, Sakal,* Issue July, p.: 2.

Patil, P. G., Arude, V. G., Shukla, S. K., Sundarmoorthy, C., Mageshwaran, V., Raja, A. S. M. and Patil, D. U. 2019. ICAR-CIRCOT Green Crematorium. Leaflet, ICAR-CIRCOT, Mumbai. pp. : 1-2.

Satankar, V., Mageshwaran, V., Jagajanantha, P. and Khan, K. A. 2018. Oyster mushroom- A viable indigenous food source for rural masses. International Journal of Agricultural Engineering, 11 (Sp. Issue), 173-178, DOI: 10.15740/HAS/IJAE/11.

Sundarmoorthy, C., Arude, V. G., Shukla, S. K., Bharimalla, A. K., Deshmukh, P. S., and Mageshwaran, V. 2019. ICAR-CIRCOT Value addition technologies on cotton by- products for Eastern and Southern Africa, Training Manual, ICAR-CIRCOT, Mumbai, pp. : 1-28.

USDA. 2020. Cotton Product Update, United States Department of Agriculture (USDA), May 2020.

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