Development of Value Added Products from Cotton Stalk By Products

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OUTLINE

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Introduction

- 2-3 tonnes of cotton stalk is generated per hectare of land [*R.M.Gurgar, 2007*]. Available is 350,000 hectares farmed.
- Cotton stalk is a great raw material for manufacturing bio-composite products [*Tao Lin, 2011*].
- Use of cotton stalks will help in achieving SDG 15.
- Zimbabwe's forest and woodland resources are under increasing threat. The current systems do not encourage investments in forest and woodlands.
- Deforestation rate is pegged at 326,000 hectares of forest per year *[FAO FORESTRY PAPER 163 ,2010]*.

Fig 1 – Cotton Farming areas in Zimbabwe *[W. Mubvekeri,2014]*

Aim and Objectives

Aim: To study value added products that can be obtained from cotton stalk by product

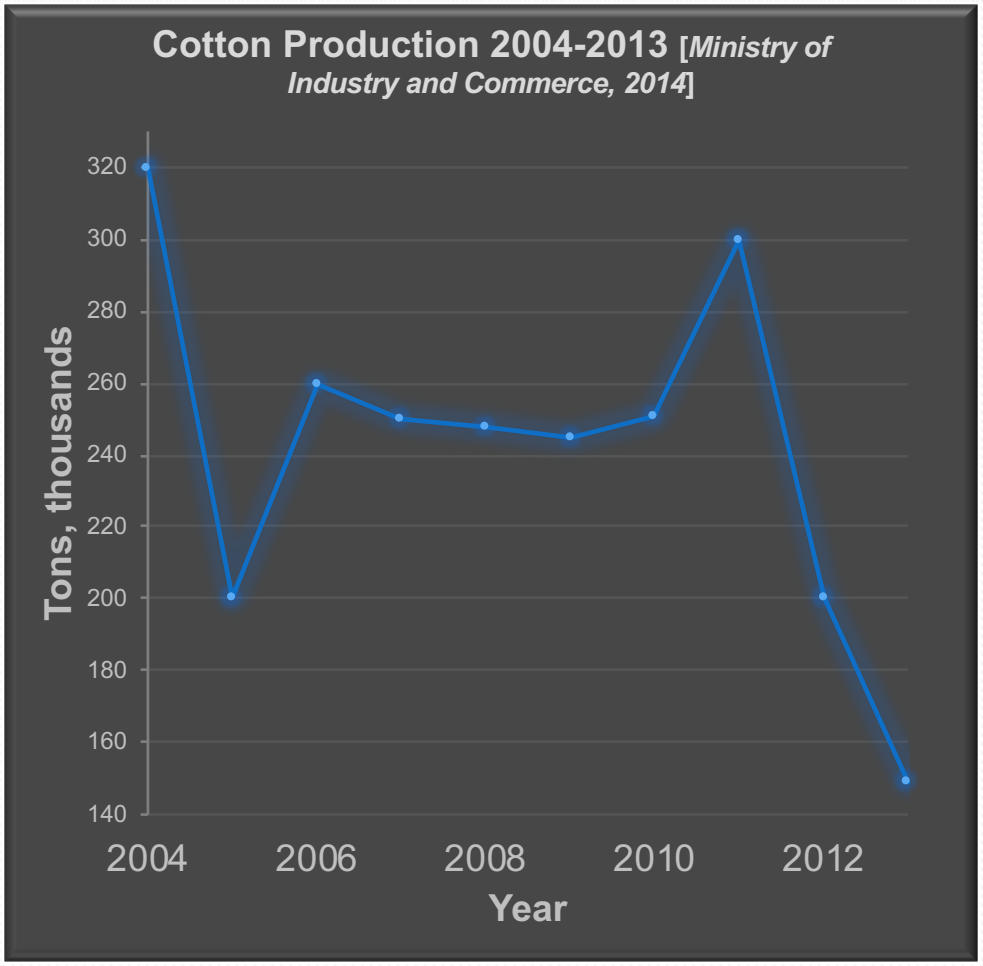
Specific Objectives

i. To study the use of cotton stalks in preparation of microcrystalline cellulose
ii. To study the use of cotton stalk in production of edible mushrooms
iii. Development of fibreboards from cotton stalks
iv. Development of paper and pulp from cotton stalks

Literature Review

Cotton In Zimbabwe

- In 2012 AMA set price of 0.36 to 0.45 cents. Yet farmers expected 0.45 cents minimum. Gvt intervened and gazetted statutory instrument 106A of 2012 making it controlled product.
- As price of cotton started to decline, most farmers abandoned the crop for more lucrative crops such as tobacco.



Pollution levels due to burning of cotton stalks

Green House Gas	Emission Factor ($g.kg^{-1}$)	Total Emission (Mn MT)	Total Emission (Mn Mt Co_2e)
NO_x	2.68	0.00265	0.7898
CH_4	2.7	0.0027	0.0675

Table 2 – Emission of greenhouse gas per million tonnes of cotton stalks burned in field [*Mseva, 2011*]

Cotton Stalk

Table 1 – Properties of cotton stalks compared to hardwood [*Solution for Making Good Cotton Stalk Pellets, 2012*]

Property	Cotton Stalk	Hardwoods
Hemicellulose (%)	30.00 - 31.50	19.0 - 30.6
Cellulose (%)	45.00 - 47.80	40.0 – 50.0
Lignin (%)	20.00 - 21.20	30.0 -35.0

- Cotton stalks consist of a fibrous outer bark which is 20% by weight and an inner pith [*Narendra R,July 2009*].

Extraction of of Cotton Stalks

- Cotton stalks were collected from Umguza regions in Zimbabwe after harvest and transported in polypropylene sacks. Then left in the sun for a number of days for shedding of leaves.
- Water retting was carried out for 3 weeks.
- The water used had an initial pH of 7.40, conductivity of 204 µS(micro Siemens) and Total Dissolved Solids (TDS) of 102ppm

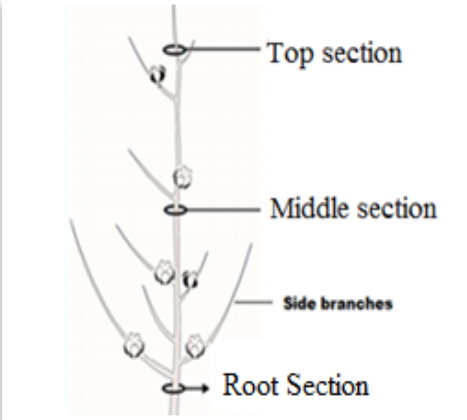

Transportation


Retting

Extraction and segmentation of fibres

Decortication

Shive



Segmentation

- Fibres were collected from three sections of the cotton stalk the top section, middle section and root section of the stalk [N.Nkomo et al 2016].
- Only stalks exceeding 1 metre were used and divided into 3 equal sections.
- Scutching separating fibres from the shive.
- Heckling pulling the fibres through several different sized combs.

Preparation of microcrystalline cellulose

- Microcrystalline cellulose (MCC) has been widely used especially in food, cosmetics and medical industries as a water retainer, a suspension stabilizer, a flow characteristics controller in the systems used for final products, and as a reinforcing agent for final products such as medical tablets.
- MCC is normally obtained at an industrial scale through hydrolysis of wood. MCC has been prepared from coconut shells , sugar cane bagasse, ramie, wheat and rice straws, jute, flax fibres and flax straw and soya bean husk.

Microcrystallie Cellulose

Production of Edible Mushrooms

- Mushrooms are the fleshy sporophotrd of fungi known to grow in nature on decaying cellulosic materials, dead wood, soil and manure pits.
- Mushrooms, a macro fungi with a distinctive fruiting body, is a unique biota which assembles its food by secreting degrading enzymes. It decomposes the complex organic material on which it grows to generate simpler compounds for its nutrition.
- Cultivation of oyster mushrooms on various crop residues is well known and it has been shown that pleurotus spp can be successfully grown on rice straw, wheat straw, cotton stalks and other cellulosic materials [Z.Bano 1962]

Procedure for preparing cotton stalk substrate for mushroom production

- Chipping of the cotton stalks
- Overnight soaking and boiling of the cotton stalks
- Cooling of the stalks after boiling
- Mushroom spawn is introduced into the cotton stalk polypropylene bags
- Holes are punched into the bag and it is hanged on the wall.

Stages of mushroom growth

- Mushrooms produced from cotton stalk substrate take approximately 25 days to mature and be ready for harvesting.
- Temp must be maintained at 25-30Deg Celsius with relative humidity of 55-80%.

Stage	Time (Days)
Spawn layer	1
Mycelium growth	15-20
Pin heads	20-24
Fruiting bodies	24
Harvesting stage	25 - 30

Mushroom Yield

- Mushrooms yields up to 600g per kg and on supplementation with Bengal flour @ 3%, as much as 1000g of fleshy fruiting bodies can be harvested per kg of cotton stalks.

Development of paper and Pulp

- Forests are shrinking day by day and contrary to this the demand for raw materials for paper production is increasing.
- Pulps produced from cotton stalks could be an alternative rea material for the paper and pulp industry [M.Akgul, 2009].
- The cotton stalks are put into a rotary digester and temperature raised. The cooking material can then be refined in a disc refiner in two passes, and then thoroughly washed in mechanical washers and beaten in a valley beater to obtain pulp of desired freeness.
- Screening is then don to remove uncooked cotton stalk chips and fibre bundles [A.J.Shaikh, 2003].

Conclusion

Value addition to the cotton farming process.

Study can reduce pollution from burning these cotton stalks as waste

Cotton stalks can be used for growing edible mushrooms adding value to the cotton farming process.

Potential end uses for composite boards for furniture applications. More research into natural resins with cotton stalk fibres.

Use of Cotton stalks in the paper and pulp industry

References

1. FAO FORESTRY PAPER 163. (2010) Global Forest Resources Assessment 2010 Main report, http://www.fao.org/docrep/013/i1757e/i1757e.pdf.
2. Ministry of Industry and Commerce, (2014), Zimbabwe Cotton to Clothing strategy 2014-2019.
3. Mseva, (2011), Eastern African Cotton, Textile & Apparel value Chain conference, General Agronomy and Extension Practices for Cotton Production; Case Study of Zimbabwe.
4. Narendra R, Y. Y. (2009, July). Properties and potential applications of natural cellulose fibres from the bark of cotton stalks. *Bioresource Technology, 100*(14), 3563-3569. Retrieved from http://www.sciencedirect.com/science/article/pii/S0960852409002168
5. Nkomo, N.Z, L.C Nkiwane, D.Njuguna, E.N.Oyondi (2016). Extraction and characterisation of the mechanical properties of cotton stalk bast fibres (pp. 10-16). Nairobi: Proceedings of the 2016 Annual Conference on Sustainable Research and Innovation: JKUAT.
6. R.M.Gurgar, A.J Shaikh, R.H.Balasubramanya and S.Srenivasan, (December 22, 2007), Composite boards from cotton stalks, Central Institute for Research on Cotton Research, Regional Station Coimbatore
7. Tao Lin, Z. W. (2011, November). Cotton Fiber-Reinforced Polypropylene Composites. Retrieved from http://www.scientific.net/AMM.138-139.581

"Why destroy when you can create?"

Thank you….

End .....