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Success Stories of ICAR-CTRI Technologies

भा कृ अनु प – केन्द्रीय तम्बाकू अनुसंधान संस्थान
ICAR - CENTRAL TOBACCO RESEARCH INSTITUTE
(ICAR-NATIONAL INSTITUTE FOR RESEARCH ON COMMERCIAL AGRICULTURE)
(An ISO 9001 : 2015 Certified Institute)
RAJAHMUNDRY - 533 105, ANDHRA PRADESH, INDIA

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Success Stories of ICAR-CTRI Technologies

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Preface

The ICAR-Central Tobacco Research Institute (CTRI) was established in 1947, which coincided with the year of India's independence. The Institute was brought under the aegis of the Indian Council of Agricultural Research (ICAR) in the year 1965. Since its origin, the Institute has been leading national tobacco research and has made a spectacular contribution to the growth and development of tobacco science in India. Through its long journey of 75 years, the Institute has evolved into a tobacco research network system with six research stations, two KVKs and All-India Network Project on Tobacco catering to the research needs of varied tobaccos, imparting training, skill development, and capacity building in farming and other allied activities to enhance socioeconomic status of the farming community.

The Institute has developed and disseminated many improved varieties and agro technologies over the years, which has led to an incredible improvement in productivity, quality, exports, and welfare of the farming community. The Institute has brought several prestigious awards, recognitions, patents, and copyrights. This booklet titled **"Success Stories of ICAR-CTRI Technologies"** is being published at a juncture when the Institute is celebrating its Platinum Jubilee. The impressive past of the Institute, its research achievements technological development, dissemination in the farmers' field and the impact created are briefed in this booklet. Accordingly, the institute needs to showcase its Success Stories of important technologies and the impact created on the farmers and other stakeholders in the tobacco sector.

The Institute is grateful to the present and past DGs, DDGs (CS), and ADGs (CC) of ICAR for their intellectual inputs and support rendered for tobacco research in the country over the years. This document reflects and embodies the untiring efforts and invaluable contributions of scientists, and technical, administrative, and supporting staff towards the development and dissemination of varieties, technologies, and techniques which is highly praiseworthy and acknowledged with thanks. Finally, I compliment the authors for their sincere efforts in bringing out the publication.

Date: 10.12.2023

(M. SHESHU MADHAV)
DIRECTOR

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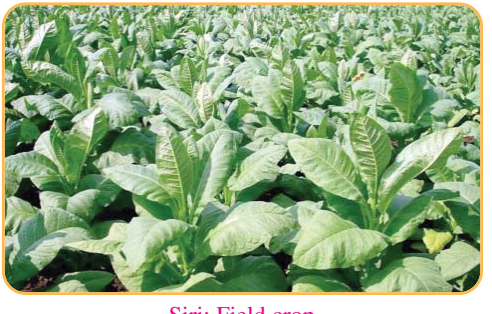
Legacy of Impactful FCV Tobacco Varieties in Rainfed Region of Andhra Pradesh

FCV tobacco is an important cash crop cultivated in Andhra Pradesh. Since the introduction of tobacco in rain fed region, ICAR-CTRI is continuously providing impactful tobacco varieties having higher productivity and tolerance to biotic and abiotic stresses. The varieties such as Hema and VT 1158 were popular during 1990s, which were replaced by Siri that ruled for more than a decade. Recently, ICAR-CTRI Sreshta which has the productivity potential of Siri and TMV resistance from VT 1158, becoming more popular. The farmers of this region are reaping the benefit of impactful tobacco varieties released by the Institute with enhanced productivity, quality and augmented farmers' income.

The Flue Cured Virginia (FCV) tobacco grown in rain fed regions of Andhra Pradesh, has its place in the international market as a cost-effective neutral filler. Since, the introduction of tobacco in this region, varieties released by the Institute are in practice by the farmers. The varieties Hema and VT-1158 released during 1987 and 1992, respectively, were extensively cultivated. Later with consistent effort to increase the productivity and enhance the farmer's net returns, a high yielding FCV cultivar, Siri was developed through pedigree method. It is a high yielding and superior in quality, having a yield potential of 2900 kg/ha. It is a medium to light cast variety with open plant habit. Cured leaves are deep lemon to orange in colour with open graininess. The cured leaf of Siri variety has desirable quality characters viz., nicotine (2.42 %), reducing sugars (17.1%), EMC (12.74%) and filling value (3.06cc/g). The cured leaf yield potential of Siri is about 50% and 100% higher than VT 1158 and Hema, ruling cultivars at the time of its release, respectively.



Siri: Field crop

In the first year of release itself, it was readily accepted by the farmers in rainfed region of Andhra Pradesh. It quickly replaced the old cultivars and occupied major area within 5 years. This phenomenal coverage evidently signifies the suitability and adoptability of Siri variety to biophysical environment of these areas and its acceptability and popularity among the farmers and traders.

As the variety Siri is susceptible to TMV and early maturing, there was a need to develop a variety which is high yielding, resistant to TMV and medium in maturity for this region. In order to overcome these problems, a variety CTRI Sreshta was developed through hybridization followed by pedigree selection from a cross between Siri which is high yielding and VT 1158, a TMV resistant variety. CTRI Sreshta has higher yield potential in Southern regions of Andhra Pradesh possessing TMV resistance. This variety was found to withstand heavy rainfall during grand growth period with even maturity, good quality leaves and longer colour retention. The variety CTRI – Sreshta showed consistently superior performance with 20% higher yield over the control, Siri. Leaf, the economic plant part of tobacco is relatively long, broad with good puckering and acute to acuminate tip. Leaf is light green cast in nature, sessile with medium auricle development. It produces a total of 22-27 curable economic leaves. The cured leaf is lemon yellow to orange in colour, medium bodied and oily with good ripeness characteristics. The quality characteristics i.e. nicotine (2.37-2.62 %), reducing sugars (12.56-18.26 %), chlorides (0.21-0.43 %) are in the acceptable range.

CTRI Sreshta

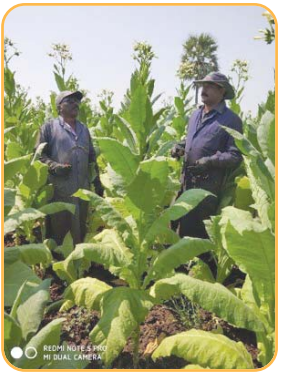
Impact

FCV tobacco growing farmers in rain fed region of Andhra Pradesh are reaping the benefits of this technology. CTRI Sreshta replaced ~15%, 25% and 40% of Siri area during 2020-21, 2021-22 and 2022-23, respectively. It gave around 20% higher yield than previously grown Siri variety under farmers' condition. The crop loss to farmers during heavy rains is being reduced due to cultivation of CTRI Shresta. The productivity of tobacco in this region has increased by 183 kg/ha and the farmers realized an additional income of Rs. 40,000/ha. This variety enables the beneficiary farmers to grow tobacco without infestation of TMV virus and produce higher and good quality tobacco leaf. CTRI Sreshta has huge advantage in terms of overcoming the TMV problem in tobacco production, besides having potential to enhance the farmers' income. The variety has relatively long harvest intervals and thus offers the farmers flexibility in timing of the harvesting depending on the weather situation.

Tobacco Seed Production and Supply System – A Three Decade Success Tale

Production and supply of tobacco seed is a successful system under ICAR-CTRI Revolving Fund Scheme. Since last three decades this scheme catering to the needs of tobacco farmers. Recently, the development and implementation of Tobacco Seed Portal made the system very efficient and transparent to supply quality seed to the farmers.

Raising uniform crop is essential to obtain higher yields and superior quality tobacco. Use of pure seed of recommended varieties ensures uniform healthy crop leading to higher quantity and quality. Tobacco seed is very light and there are about 10,000 seeds per gram. Hence, farmers tend to use larger quantity of seed for the nursery than actually required. This is also another reason for seed contamination in tobacco. Further, due to varied cultural practices like topping, farmers don't produce their own seed and they resort to procure seedlings. Keeping this in view, Central Tobacco Research Institute (CTRI), Rajahmundry has started producing and distributing the pure seed of approved tobacco varieties to the farmers. In view of the purity and quality of the seed produced by the institute, the demand for tobacco seed supplied by CTRI has steadily increased over the years. In view of the popularity and efficiency of the seed production programme of CTRI, the Indian Council of Agricultural Research, in 1990, has sanctioned a "Revolving Fund Scheme" (RF Scheme) to CTRI with the objective of supplying pure seed and healthy seedlings of approved tobacco varieties to growers to improve the yield and quality of flue-cured tobacco. Initially, it was confined to FCV tobacco and in later stages Non- FCV tobacco type, Lanka was also included in the RF scheme.



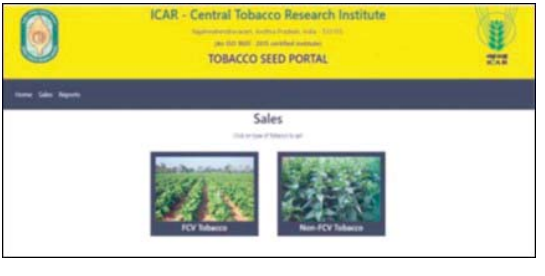
CTRI adopts a novel methodology for the production of huge quantity of pure seed. Every year, Seed Production Section raises tobacco nursery in an area of 2 ha and supplies the healthy seedlings @ 30,000/ha to 100-120 seed plot growers of East Godavari, West Godavari district and parts of Prakasam district of Andhra Pradesh.

Further, seedlings are also supplied for gap fillings, if necessary, in order to optimize the plant stand for achieving higher seed yields. During the process the seed-plots are planted directly under the supervision of the Seed Production Unit (SPU) staff. Adequate isolation distance (3.0 m) is maintained while planting seed plots. The plots are regularly monitored by the scientific personnel and rogued to remove the off-types at different growth stages to avoid varietal contamination.

Progressive farmers are chosen to raise the seed plots to maintain the seed purity. The farmers are provided the quality seedlings from CTRI, interim advisories and monetary incentive. The leaves are harvested by farmers and seed by SPU staff of CTRI. The harvested seeds are thoroughly dried to maintain seed moisture level below 4.0% and treated with insecticide. Further, germination, viability and moisture tests are conducted at regular intervals and the seed lots confirming the prescribed seed standards are supplied to the farmers. ICAR-CTRI has created the Seed Production Section for efficient execution of the RF scheme. Under regular supervision of the Director, CTRI and Officer-in-Charge of the Section, as per the advisory of Seed Production Advisory Committee (SPAC), a dedicated team of scientific / technical staff are working for the production and supply of pure seed to the farmer.

Tobacco Seed Portal: A new mechanism for efficient and transparent seed supply

The manual seed supply is laborious, time consuming, requiring more human resources and only a limited number of farmers per day are covered. Apart from this, tracing and retrieval of the specified records of the farmer and monitoring the instantaneous day wise/variety wise/region wise seed



supply is very difficult which is very much essential in planning the further seed supply in that current season. In order to overcome these difficulties, an efficient online digital seed distribution system **'Tobacco Seed Portal'** was developed and executed successfully in the year 2022. Using this software, seed of six FCV and one Non-FCV tobacco varieties could be distributed to around 24,000 FCV farmers and 120 Non-FCV tobacco farmers in a short span of 15 days. It also has the user interface to view the cultivation/production practices of the popular released varieties.

The specified software surpassed the bottlenecks in the manual process of seed distribution and enabled to retrieve the data in real time. The generated reports also helped in the monitoring, development and evaluation of crop strategies.

Impact

Year wise revenue generation under RF scheme

Flue Cured Virginia (FCV) tobacco is a regulated crop, cultivated by registered growers in Andhra Pradesh and Karnataka. ICAR-CTRI is supplying seed of released varieties to all the FCV tobacco growers through Revolving Fund (RF) scheme. Usually, around 9000-12000 kg of FCV tobacco seed and 200-300 kg of Lanka tobacco seed (Non-FCV) are produced and distributed to the tobacco growers in Andhra Pradesh. Farmers could get the good quality seed in time at subsidized rates and this seed portal has ensured more transparency in whole seed supply chain. In any given season, more than 90% of the FCV and lanka tobacco crop area is planted with the tobacco seed supplied by ICAR-CTRI through seed portal. Since RF scheme inception, revenue was generated to the tune of Rs. 60 lakhs per annum and in the last decade it is elevated to more than Rs. 80 lakh per annum. The seed sale receipts reached to a maximum of around Rs. 1.8 crores during 2023-24 season. As mentioned earlier, in a move to higher transparency and traceability, recently seed is being distributed through dedicated Seed portal. The unique service under RF scheme, production and timely supply of FCV and lanka tobacco seed to the farmers in all these years reaped the fruits in terms of quality tobacco produce, enhanced exports and thereby higher net returns to the farmers and traders.

Poly Tray Seedling Production – Boon to Tobacco Farming

Poly tray seedlings are cost effective, free from soil borne diseases, ensure uniformity in crop growth, and cent percent establishment in main field, improves the resource use efficiency, increase the yield by 10-25% and adopted by 90% of tobacco farmers.

Tobacco seeds being very small (0.75x 0.53 mm) with thick seed-coat (approximately 11,000 – 12,000 seeds/ gram of tobacco seed), nursery raising and transplanting is inevitable in tobacco production. Conventional nursery raising on raised seed beds is costly and requires good amount of natural resources. Application of water and weeding are labour intensive and due to its seasonality, shortage of labour is also one of the major constraints, in addition to preclude transplantation shock and disease problems. In this context, a tray nursery technique has been developed and standardized to produce healthy tobacco seedlings to overcome. The technique is simple and entails sowing tiny tobacco seeds on coconut coir pith compost and transferring the young seedlings of about 20-25 days to poly-trays for raising them on the growth media with standard nutrient and watering schedules. The tray nursery seedlings take about 60-65 days from sowing to transplanting. Tray nursery seedlings offer the unique advantage of ensuring crop uniformity with minimum gap fillings and consequently increased cured leaf yield and quality as against the seedlings grown under conventional raised soil-bed nursery.

In tray seedling production unlike in conventional method, seedlings are raised on composted coir pith medium in mother trays for about 25-30 days under protected conditions with recommended protocols. Seedlings are ready for transplanting in the trays by 20-25 days. The trays are to be filled with fortified coir pith tightly in the cells by periodical pressing in trays of 70/98 cells. Before filling the coirpith is to be moistened by applying required quantity of water so that filling made is easy.

After filling the trays with fortified coir pith, seedlings of 20-25 days are planted in the trays by making a suitable hole using a nail or small stick.

After planting, the media around the seedling is to be pressed. After resetting, the trays are to be kept in shade for 3-4 days. After that the trays are to be shifted to the raised beds in shade net (50%) using recommended procedure.

Thus healthy seedlings are ready after 60-65 days. At this stage when pulled seedlings come out easily from the tray because the coir pith is covered by the root mass. Clipping can be done if the field conditions are not ready for planting.

Front line demonstrations and training programmes were conducted to farmers and stake holders at different locations. In collaboration with Tobacco Board, sensitization programmes were conducted through Field Friends programme.

Impact

More than 80% farmers in Northern Light soils of Andhra Pradesh and 90% farmers in Karnataka Light Soils adopted the tray seedling technology. This technology gave 100% establishment in the main field, uniform crop growth due to less gap fillings (<1%), no transplantation shock, facilitates uniform field operations *viz.,* topping and harvesting, less weed problem and enhanced water and fertilizer use efficiency, less pest and disease incidence. Tray seedlings enhanced the FCV tobacco yield by 10-25% depending on the growing conditions. The net profit realized in raising the tray seedlings is Rs. 22,000/- per 1 lakh seedlings apart from considerable saving in irrigation water, fertilizers and pesticides.

Micro-sprinkler Irrigation in Nursery: A Successful Method for Enhanced Resource Use Efficiency

The technique of micro sprinkler irrigation watering system in seedbeds enhanced water and nutrient use efficiency in addition to huge reduction in labor cost. This technique is widely followed by tobacco farmers in Andhra Pradesh and Karnataka.

Conventional tobacco nurseries are raised on raised soil beds. Soil texture is sandy or sandy loams. Five to six irrigations are given per day using water cans. Water and nutrient efficiency is very low as soils are light textured. Experiments were conducted on micro-sprinklers and fertigation in tobacco nurseries to reduce the labour cost and improve water and nutrient use efficiency.

Field experiment was executed at SPO Nursery block of ICAR-CTRI in 2008-09 to study the effect of different levels of fertigation on tobacco seedling production. Geometry of micro-sprinklers, uniformity, coverage, growth of seedlings, number of transplantable seedlings and labour requirement under micro-sprinklers were studied and compared with control (water applying with rose cans). Each of the lateral and micro sprinklers were placed in between beds of 1 m width and 4 sprinklers were required for irrigating two beds of 1 m width and 10 m length. The optimum spacing between laterals was found to be 2.5 m and the spacing between micro sprinklers was 2.5 m under the operating pressure of 1.25 to 1.5 kg/cm^2. Root

volume, weight and height of the seedlings and transplantable seedlings were higher in case of seed beds irrigated by micro-sprinklers when compared to rose cans. Fertigation in tobacco nursery through micro-sprinklers improved number of transplantable seedlings and saved the fertilizers to an extent of 20% compared to conventional fertilizer application. Growth of seedlings under micro-sprinkler was rapid and seedlings were ready for transplanting in 45 days against 60 days in conventional water application.

Front line demonstrations and training programmes were conducted to farmers and stake holders at different locations. In collaboration with Tobacco Board, sensitization programmes were conducted through Field Friends programme

Impact

It is widely followed by tobacco farmers in Andhra Pradesh and Karnataka. Irrigating the tobacco seed beds using micro-sprinklers reduced the labour cost by Rs.1,45,000/ha. Micro-sprinkler irrigation technique developed by ICAR-CTRI saved 24% and 35% of irrigation water at nursery bed level and at total system level, respectively in comparison to rose can water system.

Sustainable FCV Tobacco Cultivation through Integrated Nutrient Management

To produce quality FCV tobacco, the soils require an integrated nutrient management approach. Due to the shortage of FYM, farmers experimented with different organic sources from 1997 to 2008 in vertisols and alfisols to find the solution. In Andhra Pradesh, the farmers of the Northern Light Soil (NLS) region are adopting a popular agro-technology that involves using *in situ* green manuring with sunhemp. Integrated Nutrient Management technology has become popular due to the scarcity of FYM and recommended by the institute, being adopted by more than 80% of farmers in the NLS region. In Vertisols, farmers are practicing green leaf manuring to improve soil health and sustainable tobacco production.

The production of quality FCV tobacco in major growing soils is a challenging task due to its low organic carbon and residual nitrogen content. However, an integrated nutrient management approach that involves the conjunctive use of organic manures and fertilizer N with P and K has proven to be effective in improving the productivity, yield, and quality of tobacco. While farm yard manure (FYM) was once commonly used as an organic source of nutrients for these soils, its availability has decreased due to the declining cattle population. In response, farmers have experimented with different organic sources from 1997 to 2008 in vertisols and alfisols, with the hope of finding sustainable alternatives to FYM.

Description of technology: The research conducted on the use of organic manures and nitrogen for tobacco production points towards some promising findings. Sunhemp in situ green manuring can be a viable organic manure alternative in certain soil types where FYM availability is low. Moreover, the study suggests that the application of 150 kg N/ha in a 25:75 ratio of organic and inorganic sources can improve productivity, quality, and economic returns of tobacco, while also enhancing

soil fertility. Green leaf manuring and calcium ammonium nitrate were used in this study, and green leaf manuring resulted in higher yields and a 25% reduction in TSNA compared to FYM and groundnut cake. These results were useful for farmers looking to improve their tobacco yield and quality while also maintaining soil fertility.

According to the research, the conjunctive application of 10 t/ha of FYM and 40 kg N/ha is the most optimal way to achieve higher yield and better grade index with acceptable chemical quality parameters and higher monetary returns under conserved soil moisture conditions in Vertisols of Andhra Pradesh. The study also confirmed that the application of 60 kg N/ha in 25:75 organic and inorganic proportions, either in the form of FYM or green leaf manuring *pillipesara* with ammonium sulphate, can significantly improve the productivity, quality, economic returns of tobacco, and soil fertility status in Vertisols.

Furthermore, it was found that sunnhemp *in situ* green manuring followed by tobacco with the application of 120 kg N/ha in 25: 75 organics: inorganic proportion will enhance higher cured leaf yield, grade index, and lower levels of TSNA, which are cancer-causing substances, in leaf. This indicates that farmers who grow tobacco in Vertisols were adopting effective strategies such as green manuring with pulses, either with*pillipesara* or green gram, to improve soil fertility and leaf quality.

Impact

In the NLS region of Andhra Pradesh, the use of agro-technology for farming has become extremely popular among farmers. Integrated Nutrient Management technology involves the use of *in situ* green manuring with sun hemp, which is being adopted by more than 80% of farmers in the region. Its popularity increased due tothe scarcity of FYM and the fact that it was recommended to farmers in 1997 and demonstrated at farms for the tobacco farming community. The Tobacco Board has also been actively promoting the use of this technology by providing seed to growers through State Agricultural Departments in respective tobacco-growing districts of Andhra Pradesh and Telangana to further enhance the adoption of this technology. This technology is part of the institute's package of practices for the NLS region. In Vertisols, farmers were advised by scientists of ICAR-CTRI and Tobacco Board field staff to use green leaf manures.

Introduction of Drip Fertigation – An Effective Tool for Efficient Fertilizer and Water Management

Drip fertigation helps in efficient and economic use of water and fertilizers. This technique has reduced cost of cultivation and enhanced crop productivity and leaf quality. It is adopted by more than 60% of farmers in NLS region of Andhra Pradesh and 70% of the farmers in Chewing tobacco growing regions of Tamil Nadu.

FCV tobacco is grown under irrigated (furrow irrigation) conditions in West Godavari and East Godavari districts of Andhra Pradesh and Khammam district of Telangana to an extent of 28,000 ha. Chewing tobacco is also grown in area of 10,000 ha in Tamil Nadu as these soils are light textured (sands and sandy loams), water and nutrient use efficiency are low with furrow irrigation. Irrigating the field crop with furrow irrigation will lead to leaching of nutrients from plant available root zone to unavailable deeper soil layers. Moreover, giving furrow irrigation is a labour intensive field operation and the labour supply is scarce now-a-days.

Drip irrigation not only enables the efficient use of every drop of applied water but also leads to enhanced crop growth and yield by maintaining uniform soil moisture regime in the crop root zone. Drip fertigation, ensures the efficient use of nutrients, fertilizer conservation, environmental protection. Micro-irrigation and fertigation is one of the approaches of the precision farming. Hence field experiments were conducted in FCV and chewing tobaccos with the objective of nutrient and water use efficiency.

Field experiments were conducted at CTRI Research Stations at Jeelugumilli and Vedasandur during 2008-2014. In FCV tobacco, drip irrigation with Recommended Dose of Fertilizer (RDF) recorded increased green leaf yield by 16%, cured leaf yield by 18% and grade index by 15% per hectare when compared to furrow irrigation with RDF. Drip fertigation with 100% RDF proved its superiority over drip irrigation with RDF and furrow irrigation with RDF. Drip fertigation with RDF recorded increased green leaf yield by 27%, cured leaf yield by 12% and grade index yield 11% when compared to drip irrigation with RDF. When compared to furrow irrigation with RDF, the green leaf yield increased by 47%, cured leaf yield by 32 % and grade index by 28% per hectare. Drip fertigation with 80% RDF recorded yields comparable to drip fertigation with 100% RDF and significantly higher than drip irrigation with RDF and furrow irrigation with RDF there by saving fertilizers to an extent of 20%. Field experiments conducted on chewing

tobacco at CTRI Research Station Vedasandur, revealed that water saving of > 50 % could be achieved through drip irrigation as compared to conventional furrow irrigation.

In another field experiment conducted in FCV tobacco at CTRI RS, Jeelugumilli, drip fertigation accrued additional profit of ₹ 25,285, benefit: cost ratio of 1.82, WUE of 11.74 kg of cured leaf/ ha-mm of water as compared to 5.77 kg of cured leaf/ha-mm in furrow irrigation with soil application of fertilizers. Only 57.2% of total quantity of furrow irrigation is required for drip fertigation and there is 203.5% increase in WUE with drip irrigation as compared to furrow irrigation.

Drip fertigation in FCV tobacco

Furrow irrigation in FCV tobacco

Drip fertigation in chewing tobacco

Impact

The drip fertigation was sent to Tobacco Board for its dissemination to farming community. The additional profit accrued due to drip fertigation plot is Rs 25,285/- per ha with a B: C ratio of 1.823 and with 57.2% of total furrow irrigation water requirement thus showing 42.8% saving in irrigation requirement. The technology is adopted by >60% farms in irrigated alfisols of Andhra Pradesh in view of its impact on crop growth, yield, leaf quality and mainly the labour saving. Drip fertigation is also adopted by 70% of the chewing tobacco farmers, as the chewing tobacco areas have failure of monsoon, the farmers adopt this technology for higher yield and farm net returns.

Drought Management Strategies for Yield Loss Minimization

FCV tobacco is grown under Karnataka Light Soils, Southern Light Soil and Southern Black Soils in rainfed conditions. These regions often experiences lower and unsustainable production due to erratic and unpredictable rainfall, cyclic/periodical droughts. To address this problem, dense planting a resilient technology advocated as contingent measure in FCV tobacco cultivation under rainfed areas under delayed monsoon situation to minimize yield loss.

In Karnataka, FCVtobacco being a rainfed production system during *kharif* season in the transitional zone, the annual leaf production and cured leaf quality parameters are largely determined by the amount of rainfall received during crop season. Tobacco crop often experiences lower and unsustainable production due to erratic and unpredictable rainfall, cyclic/ periodical droughts. With this background field experiments as well as large scale location trials were conducted in dry and semi dry zone of FCV tobacco growing areas in light soils of Karnataka and in Southern Light Soils of Andhra Pradesh during 2014 to 2018 crop seasons and to ascertain comparative benefits of various contingency measures/drought mitigation techniques that can be introduced to optimize the productivity and quality of FCV tobacco.

Increasing the plant density by reducing intra and inter row spacing could be a potential crop management strategies for increasing and optimizing tobacco leaf productivity especially in perpetually drought affected, low rainfall, poor and marginal soils of tobacco growing areas of KLS. The technology involves changing the planting pattern from 100 x 55 cm to 90 x 50 cm to accommodate 23% higher population per unit area (22, 222 plants /ha). The high density planting technique evaluated with row spacing of 90 cm and 50 cm spacing between the two plants in the row and increasing the plant density to 22,222 plants/ha revealed that the overall cured leaf productivity could be enhanced to an extent of 11.9-12.4% from the recommended population of 18,181 plants/ha with 100 x 55 cm.

In KLS, achieving initial plant vigour helps in quick and faster growth of plants that can effectively withstand droughts. The application of CN fertilizer as a starter dose at 25 kg/ha improved cured leaf productivity and top grade equivalent by 10% and by 8-9% respectively across the locations and seasons. The technology involves the application of one bag of 25 kg calcium nitrate fertilizer (15.5% N & 19.0% Calcium) while planting tobacco seedlings in individual planting hole.

Foliar feeding of N and K nutrients appears to be the ideal option for maintaining the desired N and K nutrient levels in the tobacco plant for overcoming the mid-season drought and realizing optimum productivity and quality of the crop. The water soluble foliar grade fertilizers like potassium nitrate (13:00:45) were dissolved in water at the rate of 2.5 % (250g in 10 lit of water) and sprayed on the crop twice at crop growth stages during 45 and 55 days after planting. The studies have proved that foliar nutrition of N and K nutrients improved the cured leaf productivity by 9.3 to 9.5% and bright

High density planting in KLS

CN application

Potassium Nitrate application

grade productivity by 13.4 -15.8% compared to the control apart from significant improvement in leaf K content by 14.1% -15.9% as higher leaf K enhanced drought mechanism and also was preferred for better curing and quality leaf production in FCV tobacco.

High density planting in SLS

Demonstration

Under rain fed alfisols of Andhra Pradesh, enhancing plant population by reducing plant to plant spacing from 65 cm to 32.5 cm could minimize the yield loss by 410 kg/ha without affecting the leaf quality. This strategy is tested on farmer's fields (On-farm testing) and found that increasing the plant population (dense planting) minimized the cured leaf yield loss to an extent of 11-26% under low productivity areas of SLS domain and or situations when planting is delayed due to late onset of monsoon.

Impact: The high density planting, Starter dose of calcium application technology is being recommended and popularized especially in the perpetually drought affected and low rainfall areas with poor/low soil fertility status of Hunsur and KR Nagra Taluks of Mysore District in an extent of 10,000 ha. Foliar nutrition of FCV tobacco was found to be very beneficial in increasing the productivity and enhancing higher bright grade out turn of tobacco crop and found very cost effective with ICBR ratio of 1:6.51. Dense planting, a resilient technology was advocated as contingent measure in FCV tobacco cultivation under rainfed areas of southern Andhra Pradesh under delayed monsoon situation.

Unique operation of Topping and Sucker Control for attaining Enhanced Leaf Quality and Productivity of Tobacco

Topping and sucker control is an important unique cultural practice in FCV tobacco, which improves substantial yield (20 to 25%) and quality. The recommendation of time of topping and chemical means of sucker control helped the farmers to increase yield by increasing the leaf area and thickness and quality by maintaining the optimum sugar-nicotine ratio in FCV tobacco. This technique is practiced by almost all the farmers of the NLS region.

Tobacco is a flowering plant with a central, terminal meristem, which suppresses the growth of axillary buds (suckers) by hormonal action until the meristem begins to produce flowers. Removal of the terminal inflorescence and the uppermost leaves with the accompanying stalk is referred as topping. This practice breaks apical dominance and the axillary buds become active and put forth shoots known as suckers. Topping and sucker control is an important cultural practice in FCV tobacco grown under irrigated conditions to improve yield about 20-25% and quality substantially.

Topping increases the area of the leaves and slows leaf senescence in the whole plant. The increase in dry weight of plant parts that remain after topping is attributable in part to the larger leaf area and extended leaf area duration and slowing of the rate of decline of net photosynthesis with age. Most of the dry weight increase is in the leaves and is proportionately larger than the increase in their area, so specific leaf weight increases and the plant produces a larger proportion of heavy leaf grades. Not only the topped plants are heavier, but also have an increased starch content which increases by reducing the sugar content. Topping also increases nicotine content, the increase is associated with delayed senescence of leaves, increase in root volume and mass, and enhancing the activities of enzymes involved in nicotine biosynthesis in roots. The nicotine content of cured leaf is usually increased more than that of reducing sugars and consequently, the ratio of sugar to nicotine is decreased. Tobacco produced from topped plants has a decreased filling value, and more total particulate matter in the smoke stream. However, it has an increased content of flavour precursors, which improve smoking quality.

Time of topping has a pronounced influence on the yield and chemical composition of cured leaves. Topping at the button stage increases yield and body of the leaf if suckers are controlled effectively. The beneficial effects of topping decrease as the time of topping is delayed. In addition, delayed topping decreases the nicotine content of leaves.The height of the topping affects the proportion of lugs, cutters, leaves and tips. If plants are topped low, mainly lugs and leaf grades are obtained, higher topping produces lugs, cutters, leaf, and tips, and no topping results mainly in lugs and cutters. Therefore topping can be used to modify the tobacco according to the requirements of the market.

FCV tobacco is grown with conserved moisture on heavy black soils and under irrigated conditions on light soils, and as a rain-fed crop on southern light soils of Andhra Pradesh in *rabi* season and on light soils of Karnataka in the *kharif* season. Presently, cultivated tobacco varieties produce 24-30 leaves and reach to flower bud initiation stage. Tobacco grown under irrigated conditions should be topped at the flower bud initiation stage by leaving 22-24 leaves on the plant to realize maximum yields with desirable leaf quality. Judicious topping is recommended depending on the crop growth, climatic conditions, and dose of nitrogen fertilizers applied in black soils and southern light soils of Andhra Pradesh.

Immediately after topping sucker growth is very vigorous and has the largest influence on yield, quality, and chemical composition. Suckers can be controlled manually or by chemical means. Manual sucker control i.e. hand removal of suckers is seldom practicable until the suckers are at least 5 cm long, by which time they have already offset some of the beneficial effects of topping. In addition, it is tedious, time-consuming and requires more labour. Extensive research efforts were made at CTRI to find out the chemical means of sucker control which include basic research on natural plant hormones and biochemicals, field trials with plant oils like Neem oil and edible oil emulsions in addition to different chemical formulations. Among the different chemicals tested, fatty alcohol, 1- Decanol ($C_{10}H_{22}O$), acts as an effective sucker control agent. It must be applied in 3-4 leaf axils from the top using drop bottle so that it will rundown on the stalk upto bottom leaf axils. It kills small suckers by burning when they come into contact. It does not leave any residues. From the experiments, it was found that the suckericide formulation with a C_8 to C_{10} fatty alcohol-based active ingredient and an emulsifier will control the suckers effectively. This suckericide formulation was extensively tested in field trials of FCV and burley burly tobacco for control of suckers.

Application of suckericide at a concentration of 4% effectively controls the suckers in FCV tobacco.

Impact

The recommended practice of topping and effective control of suckers in FCV tobacco developed by CTRI, Rajahmundry is very effective. This suckericide formulation (fatty alcohol, 1 decanol) was extensively tested in field trials in FCV, burley and chewing tobaccos for control of suckers. Application of suckericide at a concentration of 4% effectively controls the suckers in FCV tobacco. At present due to the release of high-yielding varieties and increased crop duration, the sucker pressure is more. Therefore, the application of contact-type suckericide twice during the crop growing season i.e. immediately after topping and three weeks after the first application will effectively control the suckers. This practice is followed by all the FCV tobacco farmers of in the NLS region and burley tobacco.

Topping

Suckericide application and control of suckers

Eco friendly Management Strategies for Tobacco Caterpillar

Tobacco caterpillar *Spodoptera litura* infests nursery and planted crop and causes 25-30% damage to the crop and total crop loss during outbreaks. Sole reliance on insecticides leads to non-target effects and pesticide residues in the cured tobacco leaf. Non-pesticidal management of pests not only saves crop from pest damage, but also safeguards the beneficial insects in the environment. The eco-friendly management effectively prevent caterpillar damage without non target effects on natural enemies, soil and ecosystem as a whole.

Tobacco crop is regularly infested by tobacco caterpillar *Spodoptera litura* in nursery and planted crop. They cause 25-30% damage to the crop and upto 80-100% damage during outbreaks. Caterpillar management with insecticides has associated costs of pesticide residues in the cured leaf and also in the environment. Non-pesticidal management safeguards the beneficial insects in the environment while protecting crop from pest damage. Botanical and microbial biopesticides *viz*., Neem Seed Kernel Extract (NSKE), *Bacillus thuringiensis* (Bt), Nuclear Polyhedrosis Virus (NPV) were proven to efficiently suppress insect pest population in various crops. Trap crops are another ecofriendly habitat management approach to divert pest build up from the crop to the trap crop. Integration of all these approaches with the economic threshold level based application of novel insecticides with low active ingredients can be effective for pest management, besides being ecofriendly.

Extract of neem seed kernels has antifeedant and toxic properties, which prevents feeding damage and also annihilates the pest population. *Bacillus thuringiensis* (Bt) biopesticides are eco-friendly due to their selectivity and specificity. Nuclear Polyhedrosis Viruses (NPV) are obligate pathogens with rod-shaped nucleocapsids containing double stranded circular DNA with high virulence, relatively narrow host range, non-toxicity to vertebrates place. Initially NPV inoculum was procured from IARI, New Delhi. Alternately local strains of NPV were collected from the NPV infected *Spodoptera* larvae occurring in tobacco fields. Mature larvae were subjected to NPV infection through infectious castor leaves. The larvae with pink coloured ventral surfaces were crushed and saved for NPV crude extraction. Integration of all these approaches could be a promising alternative to the sole reliance on insecticides in the management of *Spodoptera litura*.

Castor, an ovipositional trap crop for *Spodoptera* was sown two weeks before sowing tobacco around the nursery. Neem seed kernels were ground to paste with 150 ml of soap solution and 200 litres of water, kept overnight and sprayed in the morning in nursery till 40 DAP. *Spodoptera litura* Sl NPV was applied to 3-4 weeks nursery and on mature crop @ 250 larval equivalents (LE)/ ha mixed with 250 g starch during the evening hours. Farmers realized that NPV was as effective as insecticides with 100% mortality of larvae within 72 hours. Further, adding 0.25% tannic acid or boric acid as adjuvants to NPV increased the efficacy. NPV Extractor machine was also developed and patented for hassle free production of 15-20 litres of viral solution within one hour. About 600 diseased larvae would be placed in the NPV extractor for 20 minutes to get the crude extract of NPV with one semi-skilled labourer compared to three labourers for manual grinding process. The NPV extractor was used to produce 100 litres of NPV solution per day, which is sufficient to treat 100 hectares of tobacco field on a commercial scale.

Alternately, *Bacillus thuringiensis* @ 1 kg/ 1125 l water managed the larvae effectively. *Spodoptera litura* pheromone traps installed 3 weeks after planting @ 4-5/ acre monitors the spodoptera moth population and when the population crossed ETL of 5 % infestation or 5 moths per trap per night, baits or pesticides could be utilized. Insecticide baits were prepared with 100 g of emamectin benzoate or 200 ml of novaluron mixed in 5 litres of water, along with 2.5 kg jaggery and 10 kg rice bran. The bait mixture was applied in the terminal bud of the tobacco plants which offers maximum protection to the tobacco leaves from late instar larvae, which are sturdy and escape other modes of treatments. Application of the insecticide pyridalyl with novel mode of action @ 10 ml/10 litres showed least seedling and foliar damage and saved 20 % yield from pest damage.

This integrated *Spodoptera litura* management approach efficiently managed tobacco caterpillar and subsequently increased healthy transplantable seedlings by 54 %. The technology helped in minimizing the pesticide residues in the cured leaf.

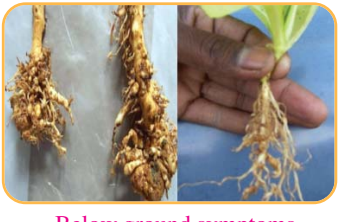
Impact: The eco-friendly integrated pest management was adopted by about 70% of NLS and SLS farmers in AP for the efficient management of tobacco caterpillar. This approach was superior to other management strategies, not only in terms of pest suppression, but also as an ecologically sustainable solution. The predator population was higher in this integrated module fields in comparison to the sole chemical management, indicating scope for natural pest suppression.

Bio-rationale Root Knot Nematode Management in FCV Tobacco

Integrated management technologies against root knot nematodes in FCV tobacco in KLS are recommended to the farming community as eco-friendly and cost-effective technology. This is widely adopted in almost 10,000 hectares of FCV tobacco in KLS region. The farmers are also realizing additional revenue by saving minimum of 8-9% avoidable yield loss due to root knot nematodes.

FCV tobacco is an important commercial crop grown under rain-fed conditions in Southern Transitional Zone of Karnataka. Among several biotic stresses, root knot nematode, *Meloidogyne incognita* infestation is a major limitation for the production and productivity of FCV tobacco causing significant yield reduction in both nursery and main field crop to the tune of 59.4% and 52.9%, respectively. Losses caused by this nematode are very high, especially when they interact with other soil borne disease causing pathogens. Both fumigant and non-fumigant nematicides have been successfully used against this nematode. However, their use is often discouraged due to prohibitive cost and the residues they leave in both soil and water environment. Hence, concerted efforts were made in this direction to evolve cost effective and eco-friendly technologies to combat this menace. Planting root knot free and healthy transplantable seedlings in time is a pre requisite.

Rim firing symptom



Below ground symptoms

Application of nematode egg parasitic fungi, *Paecilomyces lilacinus* ($2x10^6$ spores/g) or *Pochonia chlamydosporia* (10^8 spores) enriched vermicompost / FYM in solarized soil or integration of *Paecilomyces lilacinus* (20g) with poultry manure @ 200 g/m^2 against root knot nematodes in nursery.

For bio-rational management of root knot nematodes and associated disease complex in FCV tobacco under field conditions, antagonistic organisms are to be easily delivered into the main field. The methodology

developed for effective delivery of nematode antagonists into field involves, fortifying tray media (well decomposed coir pith) with *Trichoderma viride* + *Paecilomyces lilacinus*, both @ 50g / 1.2 kg media for raising antagonistic organisms enriched tray seedlings.

In field, *rabi* crops taken after *kharif* tobacco play a major role in nematode population fluctuations and in nematode infection in subsequent FCV tobacco crop. Some *rabi* crops like field bean and cowpea are found highly susceptible to root knot nematodes and increase the root knot nematode population in soil. Studies made in this direction helped to identify radish and sunhemp as suitable preceding *rabi* crop for reducing root knot disease incidence in subsequent *kharif* tobacco.

For the management of root knot nematode in FCV tobacco nursery, the technology involving application of egg parasitic fungi, *Pochonia chlamydosporia* (10^8 spores) @ 100g/m^2 or *Paecilomyces lilacinus* (10^8 spores) @ 100g/m^2 in integration with soil solarisation for significant increase in root knot free and total healthy transplants count to the tune of 58.6 and 60% respectively is recommended. Both *Paecilomyceslilacinus and Pochonia chlamydosporia* are added to the nursery bedsand covered with transparent LDPE (50G) sheets for six weeks period. Similarly, technology for integration of poultry manurewith the promising bio-agent, *Paecilomyces lilacinus* against nematodes in nursery involves, application of *Paecilomyces lilacinus*(20g) + poultry manure @ 200g/m^2on tobacco nursery beds and periodical watering to facilitate decomposition and for release of toxic compounds such as NH_3 and H_2S.

For cost effective delivery of bio-agents under field conditions, the developed methodology involves, fortifying well decomposed coirpith with

Planting of bioagent enrichedtray seedlings

Bio agent treated bed

Untreated bed

Rabi radish

Rabi sun-hemp

Trichodermaviride @ 50g + nematode egg parasitic fungi, *Paecilomyces lilacinus*@ 50g/1.2 kg media, covered with polythene sheet and kept incubated under shade for a week period to raise FCV tobacco seedlings. Planting such enriched tray seedlings caused 12.2% increase in cured leaf yield and 50.5% reduction in root knot nematode incidence in field.

Similarly under field conditions, *rabi* radish and *rabi* sunhemp as preceding crop reduced the root knot nematode population to the tune of 42.8% and 38.6% respectively and also reduced the root knot index (RKI) in subsequent *kharif* FCV tobacco to 1.8 and 2.0 respectively as compared to RKI of 3.3 in *kharif* tobacco grown in fallow plot. ICBR of taking up radish and sunhemp as preceding *rabi* crop to FCV tobacco was 2.53 and 2.35 respectively. Hence radish and sun-hemp were recommended as *rabi* crops after tobacco to effectively manage the root knot nematode and also to increase the farm returns in the tobacco based cropping system.

Impact

Integrated management technologies against root knot nematodes in FCV tobacco in KLS are recommended to the farming community from ICAR-CTRI, RS, Hunsur. These eco-friendly and cost-effective technologies, are being widely adopted in almost 10,000 hectares of FCV tobacco in Hunsur, HD Kote, Periyapatna, KR Nagar and Ramnathapura regions, where root knot nematodes are serious menace. The antagonistic organisms recommended are supplied by Tobacco Board to the farmers along with enriched coco peat media and trays for raising root knot free healthy seedlings to ensure timely planting.

On farm demonstration of preparing bio-agent enriched coco-peat for raising tray seedlings

The technology adoption rate ranges from 20-25% of area, where root knot nematode is a serious problem in FCV tobacco grown in Karnataka.This integrated nematode management technology adoption helped the KLS farmers in minimizing the pesticidal residue levels in their final produce. In addition to above, farmers are also realizing additional revenue of **eight crore rupees** by saving minimum of **8-9%** avoidable yield loss due to root knot nematodes. In collaboration with Tobacco Board the technologies are being disseminated through field level training programmes conducted across the FCV tobacco growing areas in Karnataka.

Farmer Centric Mobile APPs for FCV and Non FCV tobacco Cultivation

Mobile apps are gateways to human knowledge, a bilingual (Telugu and English) Android based static mobile apps were developed for FCV and non-FCV tobacco cultivation to impart technical information aspects related to all tobacco types and their Good Agricultural Practices. It enables the farmers to retrieve information instantaneously and receive agro-advisories timely.

ICAR-Central Tobacco Research Institute established in 1947 has done yeomen service to farming community through technology backstopping on myriad aspects of tobacco cultivation. Availability of latest technology in crop cultivation is essential in reaching the goal of doubling the farmer's income as envisaged by Government of India. Latest technology needs to be disseminated in a way that it reaches the doorstep of farmers rapidly and can be accessed instantly even in their fields. Currently, with the availability of ICT tools viz., mobile app and e-portals, technology can be transferred more effectively with text, pictures, interactive software's for instant crop advisories etc. right into the hands of farmers. Such applications are more effective in case of tobacco crop as majority of the tobacco farmers are well educated and progressive than other crop farmers. Hence, technology dissemination strategies through mobile phone will go a long way in transmitting latest agro-techniques and contingency measures, if any, to the tobacco farmers at a faster rate and instantly. It is against this backdrop, ICAR-CTRI developed the android based mobile application on "Good Agricultural Practices" for both FCV and Non-FCV tobacco cultivation for the benefit of the farmers.

Android Based Static Mobile App was developed on "Good Agricultural Practices of FCV tobacco" for global accessing of the information through smart phones in English and Telugu language and it was installed in Google play store with URL as https:// play.google.com/ store/apps/details?id=com.icar.

ctri&hl=en. This app contains the entire information on package of practices on nursery, field crop and post-harvest management. In 'Field crop' module, information on 'Planting, Cultural operations, Irrigation and Fertilization' was provided based on soil type *viz*., Northern Light Soils (NLS), Southern Light Soils (SLS), Black soils and Karnataka Light Soils (SLS). In addition to this, information on Insect Pest Management, Disease Management, Nutrient Management, Weed Management, Topping and Sucker Control, Harvesting and Orobanche Management measures was also provided.

The Non-FCV Mobile app was developed in Android studio environment using Java and XML languages. The content management of this software consists of complete information about 11 Non-FCV tobacco types. Various frames of this app consists of information about the areas where these tobaccos are cultivated in India, Research Infrastructure, Varieties released, Good Agricultural Practices encompassing the soil & climate, nursery management, field crop management and Post-Harvest Management practices. This App acts as a decision tool by providing comprehensive solutions to the farmers for taking decisions in right time to optimize the resources, hastening the production cycle which helps in achieving the higher productivity thereby the farm income. This app was hosted in Google Play Store with URL https:/ /play.google.com/store/apps/details7id=com. nonfcv.mapplication.

Key Features

Information is supported by good quality photographs which facilitates the user for easy understanding and accessing; is embedded with Decision Support and Expert Systems for easy retrieval; is an icon based user-friendly menu driven application for easy and instant accessing of the FCV and Non-FCV tobacco information.

Impact

The FCV app was installed in 1500+ devices while the Non-FCV app was installed in 50+ devices. Copyrights for both the apps were obtained from Copyright Office, Government of India.

The information disseminated through mobile application facilitates the farmers to decide what and when to plan, how to cultivate, when and how to harvest, what post-harvest management practices to follow and other important information on package of practices on FCV tobacco. Quick and instant mobile accessing assists the tobacco farmers in semantic management of crop for achieving higher yields with desired quality. All FCV tobacco farmers are using this app in their smart phones as it is easy to access and understand the information in local language.

Leaf Quality Analysis: Institute Service Function for Quality Compliance and Tobacco Trade and Industry

Tobacco leaves have many chemical constituents, but only a few impact quality. In the past, chemical quality analysis was practiced manually and was time consuming. Hence, the institute adopted advance techniques and instrumentation to analyze nicotine, reducing sugars, and chlorides, simultaneously. ICAR-CTRI monitors tobacco growing areas and receives leaf samples from the Tobacco Board. Additionally, the Leaf Quality Analysis Laboratory analyzes 4000 samples every year. Over the last 15 years, the institute generated a revenue of Rs. 76, 47, 959/-. Thus, it is worth mentioning that ICAR-CTRI is the only authorized Leaf-Quality Lab providing service function for tobacco leaf analysis for trade, industry to meet the leaf quality compliance and standards of international market.

In the late 1970s, the analysis of chemical quality parameters was titrimetric and completely manual, which resulted in limited output despite high manpower utilization. To overcome this problem and increase productivity, a continuous flow analytical instrument, Auto-Analyser AA II, was purchased from Technicon, Germany. In 2001, the latest version of the instrument, AA III, was purchased from Bran+ Lubbe. The Auto-Analyser successfully resolved the problem by analyzing three parameters, namely: nicotine, reducing sugars, and chlorides simultaneously, with a capacity of 60 samples per hour, providing the need-based output with a standard method (Harvey, W. R., et al., 1969).

The process of leaf quality assessment

The concentrations of nicotine, reducing sugars, and chlorides in the extracts are determined colorimetrically using Auto-Analyzer AAIII (Bran+Luebbe, Germany) as per the procedure outlined by Harvey et al., 1969. In brief, nicotine in the extract is determined by developing color using cyanogen bromide and buffered aniline solution and measured at 460 nm where the concentration of reducing sugars is quantified by using alkaline potassium ferricyanide (K_3 [Fe $(CN)_6$] and sodium chloride at 420 nm. The

leaf chloride is quantified by using a colour reagent comprising mercuric thiocyanate ($Hg(SCN)_2$) and ferric nitrate ($Fe(NO)_3\ 9H_2O$) at 480 nm. The flow process is fixed using a standard flow rate for each of the parameters.The contents of nicotine, reducing sugars, and chlorides present in the tobacco-cured leaf samples are quantified, calculated, and expressed in percentages. The process of assessing the chemical quality of tobacco leaves has undergone a significant transformation over the years. With the introduction of Auto-Analyzer AAIII from Bran+Luebbe, Germany, the analysis of nicotine, reducing sugars, and chlorides has become more efficient and productive. The colorimetric analysis method using standard flow rates for each parameter has enabled the quantification and calculation of the chemical constituents accurately, expressed as a percentage. This has been a great success story in the tobacco industry, paving the way for quality assessment and regulation that benefits farmers, traders, and consumers. The Leaf Chemical Quality Analysis Laboratory of the division of Post Harvest and Value Addition of ICAR-CTRI is the only authorized leaf quality lab for tobacco in the country, and its annual revenue of around Rs. 6 lakhs earned from paid samples has been a significant contribution to the Institute's success. The chemical quality report generated by the lab has become mandatory for the export of tobacco in the international market, and the recommendations made based on the assessment of chemical quality through Good Agricultural Practices have helped obtain the best quality leaf.

Auto-Analyser(AA III, Bran+Lubbe, Germany)

Impact

It's important to understand that the quality of tobacco is heavily influenced by three key parameters. As a result, it is crucial to provide a chemical quality report when exporting tobacco to the international market. To ensure that the chemical quality of tobacco is up to par, the Tobacco Board, in collaboration with ICAR-CTRI, monitors the tobacco-growing areas in Andhra Pradesh and Karnataka. Accordingly, the Institute receives around 200-300 seasonal samples from the Tobacco Board each year. It's worth noting that trading companies also seek the quality reports of the institute. Additionally, the Institute analyzes approximately 4000 samples pertaining to all research projects of the main institute and its research stations for chemical quality every year. Over the past 15 years, the paid samples analyzed were 4005, and they generated an impressive amount of Rs. 76,47, 959/- as revenue for the Institute. Based on the assessment of chemical quality, the Institute provides region-wise recommendations through GAPs (Good Agricultural Practices) to obtain the best quality tobacco leaf to meet the trade and industry requirements. Thus, it is worth mentioning that ICAR-CTRI is the only authorized Leaf Quality Lab for tobacco in the country, and its rigorous assessments ensure that the tobacco produced in India is of better quality.

Banana Fibre Extractor: An Instrument to Transform Waste to Wealth

Banana cultivation generates a significant amount of waste mainly from pseudo stems. Approximately 1000 million tones of banana pseudo stems are discarded as waste in India alone. In this context, theBanana Fibre Separator machine was developed to reduce drudgery by eliminating the scraping and combing actions involved in the manual process. This machine increased fibre production by 4-5 times and produces high-quality fibre and it is a cost-effective, user-friendly machine.

Banana is one of the important fruit crops of India and is grown in about 0.68 million hectares and area spread in ten states of the country influencing the economy of farmers. Banana is mainly cultivated for fruits and leaves. Other portions of the banana plant are dumped as waste causing environmental problems. Currently, about 1000 million tonnes of banana pseudo stems are dumped as waste at the farm level in India. The effective utilization of pseudo stems is a vital issue related to banana cultivation. Extraction of fibre and preparation of organic manure from banana pseudo stems are found to be highly useful and economical to farmers.

Fibre from bananas is of superior quality with the required strength, length, and colour. The length of fibre ranges from 3" to 5" depending upon the size of the sheath. Banana fibre is extensively used in the textile industry as a natural fibre. Banana fibre can also be used in the manufacturing of chemical-free tissue paper, currency paper, filter paper, decorative craft paper, paper bags, household articles, etc. Thus, the market

avenues are manifold for the banana fibre within and outside the country particularly with Japan, the Philippines, Korea, U.K., and Malaysia.

Due to very low fibre productivity and the involvement of drudgery in manual processes, the extraction of banana fibre has not received desired attention. The fibre constitutes about 3% of the total weight of the banana pseudo stem. To address these problems, Krishi Vigyan Kendra (KVK) of CTRI has developed a need-based user-friendly machine christened as Banana Fibre Extractor for the extraction of fibre from unutilized portions of bananas such as pseudo stems, peduncles, and petioles on a commercial basis. The machine works with the principle of beating and scraping the fibre simultaneously.

The Banana Fibre Extractor uses the impact force with the roller drumand scrapping action with the blunt blades mounted on it to separate the fibre from banana stem sheaths. Initially, each sheath is held firmly by the operator through the guiding rods and fed inch by inch into the roller drum. By scrapping action of the blades, the pith component of the sheath is removed, and fibre is extracted while driving back the sheath within a short time. It is a low-cost portable device measuring 4" x 3' x 2.5" weighing about 176 kg and works with a One HP single-phase electric motor. It produces an output of 15-20 kg dry fibre/8 hours. The production cost and product value are Rs.150-170/kg and Rs.200-250/kg, respectively. It costs about Rs.75,000 - 1,00,000/-.

Impact

It helps in reducing drudgery by eliminating the scraping and combing actions involved in the manual process. It increases fibre production by four to five times compared to the manual process. Four persons can extract 15-20 kg of fibre/ day as against 4 kg fibre by manual process. Thus, earning a net income of Rs.450/ per day per head. It is a user-friendly machine and cost-effective. It requires less maintenance cost, safe and easy to operate. It produces superior quality fibre with the required strength, length, softness, and colour. The number of Banana Fibre Extractor Machines sold is 86 and Royalty amount generated is Rs. 4,12,000/- over the years.



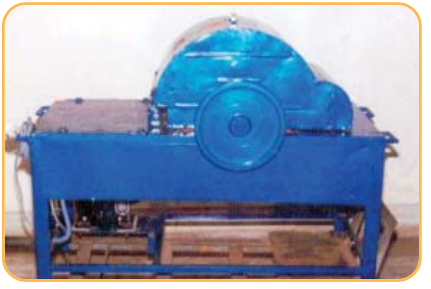
Extraction of banana fibre

Palmyrah Fibre Separator: A Drudgery Reducing Device

Palmyrah fiber separation is a tedious and cumbersome process, manually labour-intensive and low in productivity, causing ill-health to rural and tribal poor. Therefore, the Fibre Separator Machine was developed to extract fibres with an objective to reduce drudgery, and increase its production by many folds, and enhancing the earning capacity of the families. This machine is user-friendly, cost-effective, and produces high-quality fiber. It has won several awards, such as including the NRDC Republic Day Award in 1998 and the All-India Industrial Best Invention Award in 1999. The Patent Rights were granted with Patent Number - 227533, 2009.

The Palmyra fibre separation was a tedious and cumbersome process. Traditionally, a family comprising of 4 to 5 members can produce 5 to 6 kg of fiber/day by manual process. This involves high drudgery and low fiber productivity. High drudgery caused ill-health to rural and tribal poor. The bodies of the children got deformed at the chest and shoulders. The middle-aged men suffered from chest pains, arthritis, and respiratory disorders. Drudgery involvement and low fiber output were found to be the major problems. To address these problems, it was felt that the development of an efficient drudgery-reducing device is essential. In this backdrop, Krishi Vigyan Kendra (KVK) of CTRI has designed and developed a drudgery-reducing device for palmyra fiber separation christened as Palmyra Fibre Separator (PFS) for the extraction of fiber from petiole and leaf butts of palmyra on a commercialbasis.

Palmyra Fibre Separator Machine is a low-costportable device that works with one H.P.single-phase electric motor.The size of the machine is 4" x 3" x 3" weighing about 185 kg. The output was 50 – 60 kg, dry fibre/ 8 hours with a production cost of Rs. 25-30/kg, and a product value of Rs.50-80/kg. The net income obtained was Rs. 495/day. The cost of the machine is Rs.75,000/-



The Palmyrah Fibre Separator Machine uses the impact force with the drum and shear forcecum combing action with the nails mounted on it to separate the fiber from the fronds. Initially, each frond was held firmly by the operator under the guiding rod and fed inch by inch into the drum chamber. As the drum rotates in a downward direction towards the front, the nail-mounted wooden strips separate the fiber from the frond within a short time.

Feasibility analysis of mechanization

No. of fronds required per day	:	3000
No.of persons (workers)	:	2
Per day fiber production	:	60kg (dry wt.)
Raw material charges	:	Rs.750/ @ 250 per 1000 fronds
Electricity charges/day	:	Rs. 40/
Machine maintenance charges	:	Rs.20/.
Total expenditure per day	:	Rs.810/
Market price for 60kg fiber	:	Rs.1,800/- @ Rs.30/kg
Net income per day	:	Rs.990/- (two persons)

Impact

This machine reduces the drudgery to a greater extent by eliminating the beating and combing actions involved in the manual process. It increases fibre production by 10-fold compared to the manual process. A family can extract 50-60 kg of fiber/ day as against 5- 6 kg fiber by manual process. Thus, earning a net income of Rs.500/ per day per head. It is a user-friendly machine and cost-effective, requires less maintenance cost, safe and easy to operate. This machine gives superior quality fiber with the required strength, length, softness, and colour. The waste which comes as a byproduct during

the mechanical separation contains pithy material and fiber scrap which can be used as organic manure infarming.

Total Machines Supplied : Through KVK-87; Through DRDA-150; Others- 26

This invention received the

1. **NRDC Republic Day Award** in 1998
2. **All-India Industrial Best Invention Award** in 1999

The Patent Rights were granted with **Patent Number-227533**, 2009 by the Indian Patents Office, New Delhi.

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