Technical Bulletin 01 / 2025

# Redefining Research: Transformation from CTRI to NIRCA

ICAR - NATIONAL INSTITUTE FOR RESEARCH ON COMMERCIAL AGRICULTURE
(FORMERLY ICAR-CENTRAL TOBACCO RESEARCH INSTITUTE)
RAJAHMUNDRY - 533 105, ANDHRA PRADESH, INDIA

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# Redefining Research: Transformation from CTRI to NIRCA

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# Preface

Transformation is crucial for agricultural research institutions to remain effective and relevant amidst the changing perspectives and priorities of the nation, particularly on agricultural development. The ICAR-Central Tobacco Research Institute, established in 1947, has focused exclusively on commodity-centric research related to tobacco for more than seven decades. The institute has a strong track record of generating new knowledge and developing technologies that benefit the farming community, it now faces a challenging situation due to ongoing uncertainties and the increasing social stigma associated with tobacco, which is stuck in a complex dilemma, balancing the livelihood security of those involved in tobacco production, against serious health and environmental concerns.

Considering this situation, the Indian Council of Agricultural Research has established an expert committee, led by **Dr. H.S. Gupta,** to firmly re-name and expand the mandate of the Institute. This committee has conducted a series of meetings to thoroughly examine the institute's historical context and evaluate the current state of the tobacco sector at both global and national levels. The Institute is grateful to ICAR for constituting Expert Committee on rechristening and broadening the mandate by including chilli, turmeric, castor, and ashwagandha crops, and preparing the vision, mission, and future research roadmap to explore new horizons and opportunities. The Director extend his gratitude to Dr. Himanshu Pathak, Secretary (DARE) and Director General, ICAR and Dr. T.R. Sharma, Deputy Director General (CS), ICAR, New Delhi, for the invaluable guidance and instrumental in helping to accomplish this task on time. The Director and his team in the PME Cell at the institute worked with dedication and commitment in drafting and preparing the technical bulletin, and they deserve special recognition for their efforts.

It is believed that the institute, now with a new name-**ICAR-NIRCA (ICAR-National Institute for Research on Commercial Agriculture)** with a broader mandate, will conscientiously pursue its mission to excel in research, explore new opportunities, and unlock its full potential in commercial agriculture under the umbrella of ICAR. Finally, I compliment the authors for their sincere efforts in bringing out this publication embodying all relevant information regarding ICAR-CTRI and high-value commercial crops, and future direction for research to harness the untapped potential in commercial agriculture. With a strong commitment to achieve its stated Vision, and Mission, the Director, and all the staff of the institute are delighted to present this technical bulletin.

**(M. SHESHU MADHAV)**
DIRECTOR

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# I. Introduction

## Background on CTRI and NIRCA

Tobacco, often referred to as the "golden leaf," is a significant commercial crop in India. Recognizing its importance to the national economy, the Government of India established the Indian Central Tobacco Committee (ICTC) in 1945 to oversee tobacco cultivation, focusing on its technical and economic aspects. In 1947, the ICTC founded the Central Tobacco Research Institute (CTRI) in Rajahmundry, Andhra Pradesh, to conduct comprehensive research on various tobacco types grown in India. The CTRI operated under the ICTC in Madras (now Chennai) until 1965, after which it came under the Indian Council of Agricultural Research (ICAR), New Delhi. Since its inception, the CTRI has significantly contributed to the tobacco sector by developing improved varieties and agro-technologies to enhance production efficiency.

On June 8, 2020, ICAR formed an expert committee to review the CTRI, assessing its historical background, achievements, and relevance to current agricultural priorities. After thorough evaluation and discussion, the committee recommended changing the institute's name to **ICAR-National Institute for Research on Commercial Agriculture (NIRCA)** and broadening its mandate. This transformation was formally approved by the Council (vide the order **No.F.No.CS/12/3/2019-IA.III(e.no.52491)** on January 8, 2025.

# II. The Legacy of CTRI

## 2.1. Historical background of CTRI

The *Imperial Agricultural Research Institute*, established in 1903, conducted botanical and genetic studies on tobacco. It later opened a *Cigarette Tobacco Research Station* in *Guntur* in 1936. With the introduction of excise duty on tobacco in 1943-44, it became a vital source of revenue. Acknowledging tobacco's significance to the national economy, the Government of India founded the *Indian Central Tobacco Committee* (ICTC) in 1945 to oversee tobacco cultivation, particularly its technical and economic aspects. The ICTC established the *Central Tobacco Research Institute (CTRI) in 1947* for research on various tobacco types, which came under the *Indian Council of Agricultural Research (ICAR)* in 1965.

Headquartered in Rajahmundry, Andhra Pradesh, ICAR-CTRI has four research divisions: Crop Improvement, Crop Production, Crop Protection, and Crop Chemistry & Soil Science. It also operates six research stations in Guntur (1936), Kandukur (1977),

Jeelugumilli (1987 Andhra Pradesh), Vedasandur (1948, Tamil Nadu), Hunsur (1957, Karnataka), and Dinhata (1952, West Bengal) to address the research needs of farmers growing different tobacco types in various agro-climatic zones. Additionally, ICAR-CTRI coordinates the *All India Network Project on Tobacco* (AINPT), established in 1970, and manages two Krishi Vignana Kendras (KVKs) in Kalavacharla (1983) and Kandukur (2012), Andhra Pradesh.

## 2.2. Key contributions to tobacco research

### Varieties released

- Since its inception, the ICAR-CTRI released 107 tobacco varieties/hybrids having high yield potential and resistance to abiotic and biotic stresses.
- The released varieties have the potential of 3,300 kg in FCV tobacco and 4,500 kg in non-FCV tobacco.

Kanchan

Siri

Kamatchi

A 119

Torsa

### Seed supply

- ICAR-CTRI has been supplying quality seed of all the popular tobacco varieties to the farmers in different agro-climatic zones of the country.

- Presently, the Institute is supplying more than 9.0 tons of pure seed annually for all types of tobacco grown in the country to meet > 90% seed requirement of the farmers.

**Agro-technologies developed**

- Site specific nursery technologies, climate resilient production technologies viz., drought management measures in SLS and KLS, drip irrigation in NLS, INM for different tobaccos, integrated management of Orobanche, crop intensification and diversification modules were developed.
- Labour saving mechanization in tobacco production and alternate sources of energy were advocated to the farmers.
- Physico chemical and biological properties of tobacco growing soils were analysed for balanced nutrition. Phytochemicals extraction from tobacco and tobacco waste and seed oil for human consumption were studied.
- Effective IPM modules with low volume pesticides, neem based compounds, NPV which are environment safe and with minimum CPAs were advocated in different tobacco regions.
- Integrated *fusarium wilt* management measures were recommended to Karnataka Light Soils. The technologies developed are widely adopted by the tobacco farming community

Tray seedligs

Water harvesting

Life saving irrigation

Alternative crops

IPM

**Technology outreach activities**

- Since its inception, the ICAR-CTRI has been providing in-season contingency advisories to the farming community and contributing to the capacity building of all the stakeholders including farmers, manufacturers, traders and Tobacco Board staff.
- Capacity building programmes are being conducted to make the farmers understand the latest technical know-how for enhancing the productivity and quality and to reduce the pesticide residues and NTRMs.
- Important technology dissemination activities include OFTs, FLDs and capacity building programmes, diagnostic visits, field days and kisanmelas. Every year the institute organizes 55-60 programmes for the benefit of the farmers.

**ICTs in Tobacco Farming**

- ICTs enable transmission of accurate information at right time and right place for improving the FCV tobacco production efficiency and produce quality and thereby augmenting farmers' income.
- The ICAR-CTRI developed ICTs such as mobile apps, decision support systems, e-portals, expert systems and whatsapp groups which were proven to be effective in terms of disseminating precise, reliable, timely and updated information.

## III. The Role of Agriculture in Economic Development

### 3.1. Overview of agricultural significance

India's agriculture is a cornerstone of its economy and society, significantly impacting the lives of millions. Key points highlighting its importance include:

Agriculture Contribute approximately 18% to India's GDP, making it a vital sector for the economy. It employs over 50% of the workforce, providing livelihoods for a substantial part of the population. Agriculture ensures food security by producing a variety of crops, including staples like rice, wheat, and pulses. The sector is the backbone of rural India, driving development and infrastructure in these areas. India is a major exporter of agricultural products such as spices, tea, coffee, and fruits, vital for foreign exchange earnings. Agriculture is deeply woven into Indian culture, influencing festivals, cuisine, and daily life. The sector faces challenges like climate change, water scarcity, and the need for sustainable farming practices.

### 3.2. Importance of research in commercial agriculture

To maintain and strengthen India's position in high-value commercial crops in the World and take advantage of the growing export demand by improving the competitiveness (cost and quality) and branding capabilities of the high-value crops through focused research-for-development (R4D) backup assumes greater significance. Accordingly, the research framework of the institute under the broadened mandate is built based on all possible avenues and opportunities for agro-processing, value addition, and improving farm profitability and farmers' income. Further, the ICAR-National Institute for Research on Commercial Agriculture (ICAR-NIRCA) is focusing on myriad activities of commercial crops towards accelerating agricultural exports through strengthening the value chain systems. Thus, the ICAR-NIRCA plays a pivotal role in advancing commercial agriculture in the vision of a "VIKASIT BHARAT-2047" (Developed India). The institute's contributions are multifaceted, ensuring innovation, sustainability, and economic growth in agriculture. The role of the institute is defined below:

**1. Research and Development (R&D)**

- **Crop Improvement:** To develop high-yielding, stress-tolerant, and disease-resistant crop varieties tailored for commercial farming.
- **Technology Development:** Advanced techniques like precision farming, genome editing, genomics and climate-smart agriculture are promoted to enhance productivity and quality in commercial crops.
- **Post-harvest processing and value Addition:** Research on agro-processing and value addition technologies helps improve product diversification, enhancing shelf-life, quality, and marketability of commercial agricultural products.

**2. Sustainability and Climate Resilience**

- Refining climate-resilient technologies to mitigate the impact of climate change on commercial agriculture.
- Promoting practices like integrated farming systems, organic farming, and conservation agriculture.

### 3. Capacity Building and Training

- Organize training programs for farmers, entrepreneurs, and agribusiness professionals to adopt advanced agricultural practices.
- Krishi Vigyan Kendras (KVKs) to provide grassroots-level support for technology dissemination and skill development.

### 4. Market Linkages and Commercialization

- Establishing an ABI (agri-business centre) will facilitate the agribusiness incubatees, and promote, and support agri-startups and entrepreneurship development in agriculture.
- Encourages public-private partnerships (PPPs) to support research and development and enhance market access for farmers.

### 5. Product Diversification and Export Promotion

- Promotes Product diversification into secondary agriculture products in high-value crops mainly focusing on export markets.
- Supports export-oriented agriculture by ensuring quality parameters, grading systems, and product compliance with international standards.

### 6. Policy Support and Collaboration

- Provides scientific inputs for policymaking to foster an enabling environment for commercial agriculture.
- Collaborates with international institutions for the exchange of agro-technology and expertise.

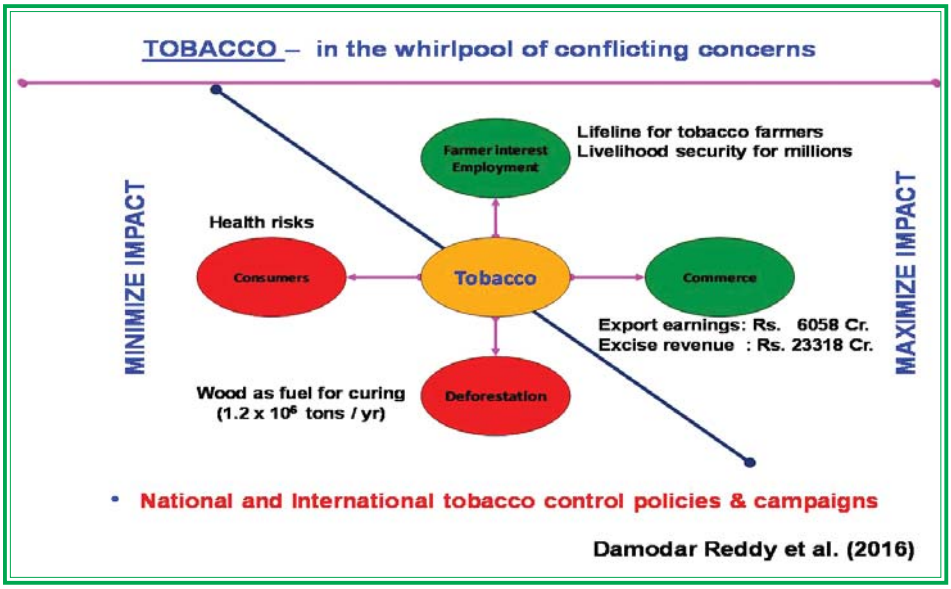
### 7. Digital Agriculture

- Develops and promotes digital tools and platforms like mobile apps and online advisory services for farmers.
- Encourages the use of AI, IoT, and block chain for precision agriculture and traceability in the supply chain studies in commercial crops.

## IV. Challenges during Transformation

### 4.1. Barriers encountered during the transition

The tobacco sector today is in the whirlpool of diametrically opposite and conflicting concerns: the income and livelihood security of those involved in tobacco production, processing, and marketing, versus the serious health risks for consumers. Additionally, deforestation is a growing issue due to the substantial wood used for flue-curing FCV tobacco. National and international tobacco control policies, rising health consciousness, increased public awareness of tobacco-related health hazards, and the stigma surrounding tobacco and its researchers are also emerging challenges for the industry.




**Adverse Effects of Tobacco on Public health and Environment**

Notwithstanding its socio-economic benefits in terms of employment generation and livelihood security and contribution to national economy, tobacco is associated with a stigma. Public perception about the tobacco is generally negative and growing with time. This is due to the fact that tobacco production and consumption causes adverse socio-environmental impacts in terms of public health risks and curing-induced deforestation and air pollution. Eye brows are often raised questioning the rationality of continuing tobacco cultivation.

**Public Health Hazards:** Tobacco consumption, both as smoke and smoke products, is implicated as main cause for a number of diseases either directly or indirectly. It is linked to cardiovascular diseases, cancers, COPD etc. Tobacco consumers are also reported to become more vulnerable to many infectious diseases.

**Environmental Hazards:** Wood is the major source of fuel for curing FCV tobacco. To cure one kg of FCV tobacco ~ 5 kg wood fuel is consumed. Annually, 1.2 million metric tons wood is being utilized for curing resulting in deforestation, a serious environmental issue. Burning of wood fuel during tobacco curing process also results in emission of gases that cause environmental pollution. Added to this, tobacco smoking also contributes to air pollution. Spitting habits associated with tobacco chewing makes environment dirty and unhygienic.

**Tobacco Control Policies and Anti-Tobacco Campaigns:** The stringent national and international tobacco control policies are put in place to reduce demand and supply of tobacco. The WHO-Framework Convention on Tobacco Control (FCTC) with overwhelming membership of 182 countries added a new dimension to the complex nature of the crop. It envisages non-price, price and tax measures to reduce the supply and demand for tobacco in the world. India, being a signatory to the FCTC, is under obligation to support the measures for reduction of supply and demand for tobacco. The WHO observes the 31$^{st}$ May every year as World No-Tobacco Day (WNTD) to enhance public awareness about tobacco-related health hazards and discourage all forms of tobacco consumption. The COTPA-2003 (Cigarettes and Other Tobacco Products Act) is an important law made by Govt. of India on prohibition of advertisement and regulation of trade and commerce, production, supply and distribution of tobacco.

**Ministries of Government of India – Conflict of Interest:** Tobacco sector is related to various ministries including (i) Commerce and Industry regulating FCV tobacco crop size, trade and exports, (ii) Health and Family Welfare dealing with tobacco control and managing health risks and (iii) Agriculture and Farmers Welfare providing research backup to tobacco production for the benefit of farmers. Interests of Commerce and Health Ministries are often conflicting, while the MoA & FW is sandwiched between them. Such conflicts of interests result in confusion and uncertainty in the tobacco sector, a cause of concern for CTRI.

## V. Rationale for NIRCA's Establishment

### 5.1. Factors necessitating the transition

The Central Tobacco Research Institute, established in 1947, has been in existence for more than seven decades pursuing commodity-centric research exclusively on tobacco. The institute has been spearheading national tobacco research in all its dimensions and made immense contributions to growth and development of tobacco sector in the country. Despite the excellent research progress in terms of developing a large number of improved varieties and a whole range of production and protection technologies for enhancing production efficiency and produce quality, the institute is facing an enigmatic situation because of continued uncertainties and stigma associated with its mandate crop.

Though tobacco is known for its potential to give relatively high returns to the farmers and generate huge revenue to the government, the public perception about the crop is generally negative and growing with time because of health risks and environmental issues associated with its production and consumption. In addition, the tobacco-control policies such as WHO-FCTC (2005), COTPA (2003) etc., and anti-tobacco campaigns have also contributed to prevailing uncertainty in the sector. Given this situation, the CTRI needs a paradigm shift in its research mandate from single cash crop-centric to that with focus on multiple high value commercial crops.

There has been a steady decline in tobacco consumption due to growing health consciousness among public on one hand, and the national and international tobacco control policies on the other. With the advent of Covid-19 pandemic, tobacco consumption is expected to decline further as tobacco consumers are generally reported to be more vulnerable to health risks in terms of infection, severity of symptoms and mortality. Accordingly, tobacco crop would experience a gradual phase out making the room for other commercial crops as components of the crop diversification being promoted by the Govt. of India. Crop diversification, value addition and export promotion are some key areas that help augment the farm returns. Crop diversification is generally considered as an overarching gateway for sustaining farm production and farmers' income. Therefore, it is crucial for the CTRI to adopt a multi-commodity research mandate, prompting a reevaluation of its priorities in light of the tobacco sector's current crossroads.

### 5.2. Future needs in agriculture

With the growing population, rising incomes, and shifting consumer preferences, global demand for processed and value-added agricultural products is increasing. In India, however, there is currently limited value addition, processing, and product diversification in the high-volume commercial crops is happening. This situation presents a significant opportunity to enhance value-added products and meet the rising demand for diversified exports worldwide. Therefore, it is crucial to prioritize growth potential, incentivize processing and value addition, and encourage investments in research and technology to boost India's agricultural exports.

## VI. Transitioning to NIRCA

### 6.1. Key milestones achieved in this journey

ICAR constituted statutory review / advisory committees (RAC, QRT) also felt the need for changing the institute name and mandate to make the research road map of the institute more relevant and effective. This is amply evident from the committee recommendations made in the previous years. The relevant excerpts from the recommendations are furnished hereunder for ready reference.

| Review/Advisory Committee | Recommendation/suggestion |
|---|---|
| **RAC, 2012** | "The RAC recommended that a proposal may be sent to the council requesting for changing the name of the institute, broadening the mandate of the Institute and including crops like chilli, turmeric etc. in the mandate" |
| **RAC, 2013** | RAC decided to send a proposal to Council requesting for changing the name of the Institute, so as to broaden the institute mandate by including crops like chilli, turmeric etc. |
| **RAC, 2014** | Considering the large scale cultivation of chilli and turmeric in the state which have high potential for phyto-chemicals, and the fact that CTRI has the needed expertise to work on phyto-chemicals, and no other institution is devoted to this aspect, the institute mandate may suitably be expanded for inclusion of research on exploitation of phyto-chemicals from these two crops also. |

| | |
|---|---|
| **RAC, 2019** | "In connection with recent developments for rechristening Institute and broadening the mandate, RAC felt "Central Institute for Diversified Commercial Agriculture" is appropriate to take care of research needs of high value commercial crops having export potential. However, the mandate including crops needs to be discussedfurther". |
| **QRT, 2009-2015** | **Recommendation on Modification of CTRI Mandate:** To face any future problems, it is required that CTRI has to extend its research mandate to study commercial crops for equitable economic remuneration. The Institute will work on core tobacco crop and unresearched commercial crops like turmeric, chilli and ginger. |

The need for changing mandate of the CTRI is also reflected amply in the queries raised or directions made by many responsible official and private agencies/individuals including Parliament, Planning Commission / NITI Aayog, Ministry of Health and Family Welfare, Honorable Courts, Ministry of Agriculture and Farmers Welfare, Voluntary Organisations etc. for discouraging tobacco. The underlying intent of all these directions/queries has been in the nature of discouraging tobacco and to promote crop diversification as alternative viable option in tobacco growing areas.

Competent Authority at the Indian Council of Agricultural Research, New Delhi constituted an expert committee under the Chairmanship of **Dr. H.S. Gupta** to make suggestions on re-christening and broadening the mandate of ICAR-Central Tobacco Research Institute, Rajahmundry vide Office Order No F.No.CS.12/3/2019-IA-III dated June 08, 2020. The expert committee is truly multifaceted as its other distinguished members represent diverse perspective and expertise in agricultural research and development. In accordance with the terms-of-reference, the committee, through a series of virtual meetings and interactions, had reviewed the institute's historical background covering genesis, growth, achievements and impact, examined the present scenario of tobacco at global and national level, uncertainties in tobacco sector and future prospects in the context of emerging Tobacco New Normal, and assessed the

need for changing the name of the institute and scope for broadening its mandate. After critical examination of facts and intense deliberations on the whole issue and taking into account the present scenario, emerging priorities and future prospects of commercial facets of agriculture in India and commensurate with changing needs and emerging priorities, the committee unanimously recommends changing the name to **National Institute for Research on Commercial Agriculture (ICAR-NIRCA).**

## VII. Engaging Stakeholders

### 7.1. Perspectives from researchers, farmers, and policymakers

- Enables Institute to remain relevant in the milieu of changing needs, priorities and policies. It paves the way for shifting research focus to agribusiness, in tune with the emerging commercial facets of agriculture.
- Helps in overcoming the stigma/social disgrace associated with tobacco and attracts resources (scientists, budget support etc) for research on high value crops within the broad framework of commercial agriculture.
- Opens new opportunities for attracting research funding from external sources.
- Research stations in districts with declining tobacco acreage (Guntur and Dindigul) will have better connectivity with Chilli, Turmeric and Ashwagandga farmers under broadened mandate.
- Strengthens functional integration of KVKs with Institute and thus effectiveness of outreach programmes.
- Provides more comprehensive research backup for selected high value crops and cropping systems to enhance and sustain farm profitability and farmers' income and country's export earnings by becoming centre of excellence for research on Commercial Agriculture.

## 7.2. Collaborations and partnerships established

### A. Tobacco

**Collaborations/ Linkages with government institutes and departments**

- Tobacco Board, Guntur for On Farm Trials, Frontline Demonstrations, Field Friends, Training programmes and Diagnostic visits
- Bureau of Indian Standards, New Delhi for Development of Indian standards for tobacco and tobacco products and Study of GAP for FCV tobacco and Bidi tobacco
- National Bureau of Plant Genetic Resources, New Delhi for National Active Germplasm Site (NAGS). Import of tobacco germplasm and maintenance
- Protection of Plant Varieties and Farmers Rights Authority, New Delhi for DUS characterization and registration of FCV and bidi tobacco varieties
- Indian Meteorology Department, Pune for Maintenance of meteorological observatories at different Stations
- ICMR-National Institute of Nutrition, Hyderabad for Pre-clinical efficacy and safety evaluation of Refined tobacco seed oil
- ICAR-Central Institute of Agriculture Engineering, Bhopal for Inter-institutional project on mechanization
- State Department of Agriculture for Development of technologies related to different tobacco types and technology dissemination

**Collaborative contract research with private firm's**

- M/s Alliance One Industries India Pvt. Ltd., Guntur for Evaluation of imported burley varieties and hybrids for their sustainability under Indian condition to enhance the yield and quality
- M/s FMC India Pvt. Ltd, Maharastra for evaluation of Sulfentrazone and Sulfentrazone + Clomazone herbicides
- M/s Syngenta Pvt Ltd, Pune, Maharashtra for evaluation of bioefficacy of new generation insecticides
- M/s. ITC Ltd., Guntur, Andhra Pradesh for research on Rhizomicrobiome, Orobanche resistant tobacco and wilt resistant tobacco cultivars

- M/s. Godfrey. Phillips India Ltd., Guntur, Andhra Pradesh for breeding for water stress tolerance in burley tobacco
- M/s. Krishna Agro Bio Products Pvt. Ltd., Hyderabad, Telangana for evaluation of "Nano Biotech Capsules" in FCV tobacco
- M/s. Gujarat Boron Derivatives Pvt. Ltd., Baroda, Gujarat for evaluation of Boron fortified Potassium Scheonite in FCV tobacco

**Collaboration in Public Private Partnership mode**

- Synthesis and evaluation of specialty chemicals tailored for diverse uses in tobacco cultivation with M R Biochem Pvt. Ltd, Hyderabad, Telangana
- Designing, evaluation, facilitation and promotion of LPG as fuel for curing FCV tobacco green leaf with IOCL, TAPSO, Moosapet, Hyderabad & Eminent gas tech. pvt ltd Thane, Maharashtra

AINPT linkages - Gujarat Agricultural University, Anand; University of Agriculture Sciences, Dharwad; University of Agriculture and Horticultural Sciences, Shimoga and Chandra Shekhar Azad University of Agriculture and Technology, Kanpur

**B. Chilli, Turmeric, Ashwagandha and Castor**

**Linkages through All India Coordinated Research Projects**

- ICAR-Indian Institute of Vegetable Research, Varanasi on chilli lines for value addition
- ICAR-Indian Institute of Spices Research, Kozhikode, Kerala for turmeric Phytochemicals and High value compounds of turmeric
- ICAR-Indian Institute of Oilseed Research, Hyderabad on Rabi castor crop in SLS, Andhra Pradesh
- ICAR- National Bureau of Agricultural Insect Resources, Bengaluru for Coordinated trials on biological control
- ICAR-Indian Agriculture Research Institute, New Delhi for Coordinated trials on Nematodes

**Linkages for Collaborative research**

- Evaluation of Sustainable waste utilization of chilli pedicel in quest of nutraceutical based project with IARI (funding from Council of Scientific and Industrial Research, New Delhi)

- Quantification of five marker compounds in the germplasm accessions of Ashwagandha with CSIR- Indian Institute of Chemical Technology, Hyderabad

**Collaboration in Public-Private Partnership**

- Public Private Partnership for developing nutraceutical food supplements in Turmeric and Ashwagandha with M/s Kalaga Herbal Research Labs Private Limited, Hyderabad

**Linkages for post graduate and doctoral research**

Konda lakshman Telangana Horticulture university; Acharya N G Ranga Agricultural University, Guntur; Uttar Banga Krishi Vishwavidyalaya, West Bengal; Dr. Y.S.R. Horticultural University, Venkataramannagudem; Tamil Nadu Agricultural University, Coimbatore; Yogi Vemana University, Kadapa; Adikavi Nannaya University, Rajahmundry; Siksha 'O' Anusandhan, Bhubaneswar; Mangalayatan University Jabalpur, Madhya Pradesh and Vignan University, Guntur

**Linkages for Commercialization**

- Bale Pressing Tool with M/s RJ Technoquips, Hunsur, Mysore, Karnataka
- Hand Held Battery Operated Topping Tool with SS enterprises Pvt Ltd, Gollaprolu, Andhra Pradesh
- Poly Tray Medium Pressing Tool with M/s Veerabhadra Rao, Anakapalli, Andhra Pradesh

**General linkages**

- Association for Innovation Development of Entrepreneurship in Agriculture (a-IDEA), of ICAR-NAARM, for Collaboration to strengthen agri-preneurship
- NGO Grameen Foundation Indian Pvt ltd, New Delhi, for Women Entrepreneurship Development towards self as a part of grow project
- District Project Monitoring Unit (East Godavari) Andhra Pradesh Community Managed Natural Farming and quality evaluation and co-branding packing and marketing of Farm produce of Natural Farming & Conducting collaborative trials/ demonstrations on Natural Farming at KVK, Kalavacharla and
- Braintree Consulting & Business Services LLP, Hyderabad for Collaboration to strengthen agri-preneurship

## VIII. Success Stories Under NIRCA

### 8.1. Detailed exploration of successful projects and initiatives

**Commercial Crop Improvement**

**Tobacco**

- Six tobacco varieties were released in 2024 *viz.,* two FCV varieties CTRI-Naveena (3300 kg/ha) and CTRI Shreshta (2400 kg/ha), TMV resistant were released and notified through CVRC, one Burley tobacco Vijetha (YB-22) 2900 kg/ha having resistance to TMV; one chewing tobacco Yasini (BSR-1), (3700 kg/ha) having tolerance to black shank; one Jati tobacco DJ-1, (1600 kg/ha) and early maturing and one bidi tobacco Nandyala Pogaku-2, (2300 kg/ha) variety with low smoke tar constituents

CTRI Sreshta

CTRI Naveena


Vijetha

Nandyala Pogaku-2


Yasini


DJ-1

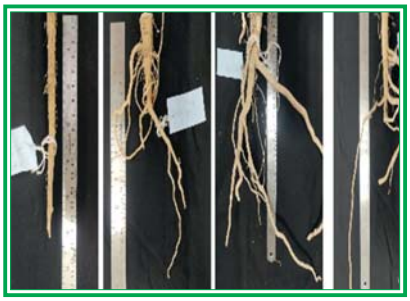
- Two high yielding lines viz., FCH-2, FCV tobacco line having yield potential of 3000 kg/ha, NBD-316, a Bidi tobacco line high yielding potential of 3785 kg/ha identified for Karnataka Light Soils (KLS)
- Identified a novel resistant source for *Orobanche* infestation from wild species i.e. *N.umbratical-nesophila*
- The DUS guidelines developed by ICAR-CTRI for FCV and bidi varieties were notified by Protection of Plant Varieties and Farmers Rights Authority, New Delhi and ICAR-NIRCA is identified as DUS Testing Centre for registration of FCV tobacco varieties
- A total of ~19,000 kg pure seed of cultivated tobacco varieties were produced and supplied to tobacco farmers and realized an amount of about Rs. 2.48 crores
- To reduce the levels of Tobacco Specific Nitrosamines (TSNA) in burley, *CYP82E4 (N-demethylase)* a member of CYP gene family involved in the conversion of nicotine to nor nicotine was targeted through gene editing utilising the CRISPR tools. Four constructs (having gRNAs designed from conserved region of 3 CYP82E genes as well as specific regions) were developed
- Key genes (five: DXS, DXR, SPS-1, SPS-2 and IspH-1) involved in Solanesol biosynthesis pathway were identified through expression analysis. These five genes are proposed for editing to improve the Solanesol yields

**Chilli**

- For widening nutraceutical potential of chilli, 3 variable lines (Dinhata Local 1, Jum Chilli Local 340-8, Dinhata Local 6) for black color (anthocyanin rich) were identified
- Five orange colored lines were identified and the total carotenoid content was ranged from 247 µg $g^{-1}$(DIN 320-4)to 397 µg $g^{-1}$ in Kakchai (KC)
- The total flavonoids content (3422 mg 100 g-1) and having highest capsaicin content (18949 µg g-1) i.e. Tamenlong King Chilli line found highest in Tamenlong King Chilli

**Ashwagandha-Genetic improvement for bioactive compounds**

- By collaborating with various research organization a total 400 Ashwagandha germplasm lines were acquired and evaluated for morphological characters, development of corset is in the progress



Ashwagandha Root

Ashwagandha Seed

**Crop Production Management in Commercial Agriculture**

**Agronomy and Soil science**

**Tobacco**

- Estimation of greenhouse gases and emissions from tobacco based cropping systems

- Identified new and effective weedicide i.e. application of Sulfentrazone @ 0.25 kg a.i/ha at 3 days before transplanting has better weed control in FCV tobacco at both Northern Light Soils of Andhra Pradesh and Karnataka Light Soils

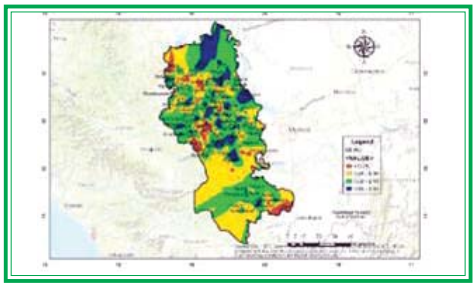
Control

Herbicide applied plot

- Best intercropping systems i.e. Tobacco + black gram (2:1) which have higher tobacco equivalent yield (TEY 1256 kg/ha), compared to sole crop of tobacco was identified for Karnataka light soils

Tobacco + Black gram

- The soil fertility status of entire KLS of FCV tobacco was assessed through spatial thematic maps of major, secondary and micronutrients



Soil fertility Map of KLS

- Boronated potassium schoenite (BPS) was identified as an alternate source of potassium, and the BPS can also potentially supply other nutrients namely Mg, S and B and hence contributing to balanced fertilization
- Designed and recommended customized fertilizers (having recommended doses of NPK in a pre-mix) along with secondary and micronutrient products which significantly increased cured leaf yield by 15 per cent compared to the straight fertilizers

Straight fertilizers application

Customised fertilizers application

**Chilli**

- Identified a module for effective weed control in chilli which includes i) intercultural operation with power weeder ii) pre emergence application of pendimethalin (30 EC) 0.7 kg a.i. /ha + iii) post emergence application of Quizalofop-ethyl 5% EC @0.06 kg a.i./ha

**Turmeric**

- Turmeric + Blackgram (*Kharif*) - Tobacco (*Rabi*)-Ground nut relay has given higher net returns. However, Korra- tobacco cropping system is the best and fetched significantly higher net returns than any other cropping systems

Turmeric + Blackgram (*Kharif*) - Tobacco (*Rabi*)-Ground nut

- Optimized the right time of sowing and spacing for achieving highest rhizome yield (17.5 t/ha) of Megha-1 variety in *Terai* region of West Bengal

**Ashwagandha**

- Intercropping Ashwagandha with annual moringa increased the dry root yield by 7 % than with castor, tobacco, chilli and aggregatum onion

- Optimized the manurial requirements for higher root yield of Ashwagandha (Sheep manure 2 tons +Azotobacter10 kg/ha +PSB application10 kg/ha)

## Tobacco

- A New nematicide i.e., Fluopyrum 400 SC @ 0.05% was identified for control of root knot disease incidence and recommended for KLS
- Identified effective insecticide (Deltamethrin 25 WP) for important post-harvest pest (cigarette beetle) in Tobacco

Cigarette beetle

- A new locally systemic suckericide (SUCKERSTOP™ was synthesized with Public Private Partnership mode and recommended its application @ 20 to 25 ml per litre before bud initiation/emergence (around 95% in controlling the growth of suckers) in FCV and Burley tobacco for effective sucker control


## Chilli

- Integrated management of chilli black thrips revealed that chemical pesticides (spinetoram; *cyantraniliprole*) are comparatively more effective than botanical (neem cake powder & neem oil) and microbial pesticides (*Lecanicillium lecanii* & *Beauveria bassiana*) applied alone, where the thrips population was reduced by 62.8% over untreated control

## FARM MECHANIZATION

### Tobacco

- Refinement of Tobacco Leaves Stringing machine" was done with CIAE, Coimbatore and demonstrated at CTRI RS, Kandukur

- Tobacco transplanter was developed in collaboration with CIAE, Coimbatore and evaluated, refinement to suit different soils is in the progress

### Post-Harvest Produce Management

- Usage of solar thermal energy and other energy sources were explored to reduce the dependency on wood fuel. Solar energy interventions reduced the wood consumption up to ~ 33%. Their integration with biomass energy/ Electrical energy/ Gas has potential up to 54% of saving wood fuel used for curing

## Ashwagandha

- Characterization of Ashwagandha accessions (100) for five biomolecules was taken up with CSIR-IICT. The result indicated that Withanolide -A contribute largely to the total content of Withanolides. Among 100 accessions, GP17 showed highest Withanolide content (1.7%)

## Value added products

- Curcumin based milk/ beverage mix was developed from Turmeric and Ashwagandha. 87.5% respondents scored high under sensory evaluation. FSSAI certification was obtained


- Green chilli flakes, green chilli sauce, Turmeric chips are developed

**Extension and Market Intelligence**

- Econometric analysis of four decades export data of tobacco revealed crop compliance & maintaining quality and exploring to new export destiny markets are the strategies for sustaining the exports
- AI based machine learning software was developed with 20 years of datasets for forecasting of Chilli prices
- To promote value chain models in FPOs few strategies were identified:
    - Introducing high yielding varieties with high curcumin content
    - Mechanization for processing
    - Providing market linkages
    - Information about credit support, etc.

**Information, Communication and Publicity Services**

- A Tobacco Seed Portal was developed by the ICAR - CTRI to enable the seed supply of all tobacco types across the different tobacco growing regions of the country. The software facilitated the digital payment very easily resulting in seamless hassle-free seed supply to farmers. Specific provision was also made to monitor the seed sales in real-time environment with URL *tobaccoseed.in/seeds/realtimedata.php*


- Developed Mobile App on Good Agricultural Practices for NON - FCV tobacco and hosted in Google Play store
- Develop Mobile App "CROP SURAKSHA" on IPM of 15 crops and hosted in Google Play store

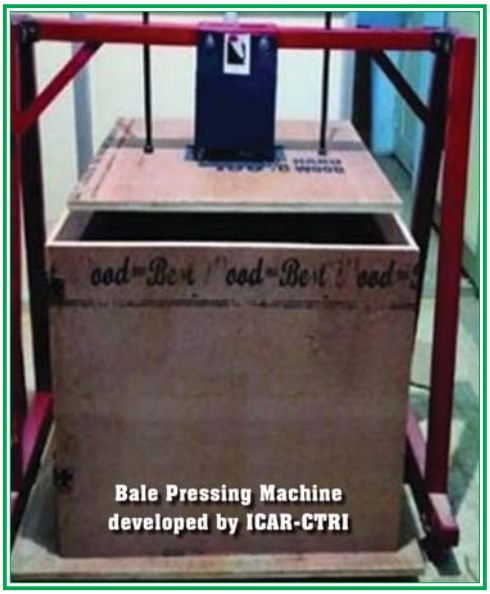
## 8.2. Impact on agricultural practices and commercialization

- Adoption of technologies developed by the institute

| Variety/ Technology | Number (percentage) of farmers utilizing new method/technology out of total trained |
|---|---|
| 1. Micro sprinklers | 90% |
| 2. Tray seedling | 90% |
| 3. Drip irrigation | 70% |
| 4. CTRI Shresta variety | 90% |
| 5. CTRI Naveena variety | 20% |

**Commercialization**

Three technologies viz., 1. Tobacco Bale Pressing Unit, 2. Poly Tray Medium Pressing Tool and 3.Hand-held Battery operated Topping Tool developed for labour saving & drudgery reduction were commercialized through licensing with private firms for the benefit of the tobacco farming community.




Tobacco Bale Pressing Unit

# IX. Innovations and Best Practices

## 9.1. Emerging methodologies and frameworks in research

### Tobacco

- Whole Genome re-sequencing of core collection to develop the SNP makers to use in breeding
- Genome editing based varietal development for reducing carcinogenic compounds, high yields, resistance to biotic stresses and leaf quality
- Transcriptome and metabolome studies for understanding the Tobacco- orbanche interactions
- Leaf quality index –A first-of-its kind quality-based index (nicotine, reducing sugars and chlorides) was developed for monitoring leaf quality spatially and temporally
- Synthesiszing and evaluating the novel chemicals for sucker control
- To reduce the residues- standardized estimation of chlorantraniliprole (Insecticide) in tobacco leaf and soil
- Standardizing the elctric and LPG based curing tobacco leaf to reduce the wood consumption and without stringing cost than conventional barn
- Novel method of estimation of Nicotine
- Exploring the use of tobacco seed oil for human consumption

### Ashwagandha

- Standardized the methodology for estimation of bioactive compounds in ashwagandha

### Turmeric

- Standardized the methodology for estimation of bioactive compound curcumin in turmeric

### Chilli

- A LC-MS/MS Method was developed for quantification of Capsanthin in Chilli
- Drying both green & red chilli drier was standardized

**Castor**

- Developed GC-Mass spectrometer-based estimation protocol for *Ricinoleic acid* in castor oil was completed and initiated the synthetic route for designing 2-Octanol/ 2-Octanone

## 9.2. Research framework of ICAR-NIRCA

### 1. Commercial Crop Improvement

- Characterization and enhancement of tobacco genetic resources
- Breeding of tobacco varieties with agronomically superior traits including climate resilience, resistance to biotic and abiotic stresses
- Biotechnology for tobacco improvement
- Breeding for enhancement of biochemical compounds in commercial crops

### 2. Crop Production Management in Commercial Agriculture

- Development of agro technologies for commercial crops
- Optimization of resource use (soil, water, nutrient) for production efficiency and produce quality
- Identification of innovative intensive and diversified cropping systems for enhanced productivity and farm income
- Development of effective techniques for biotic stress management in high value commercial crops

### 3. Post-Harvest Produce Management

- Assessment of Phyto-chemical profiles in chilli, turmeric, ashwagandha and castor
- Development of efficient protocols for post-harvest processing and storage of high value commercial crops
- Value addition in chilli, turmeric, ashwagandha and castor through product diversification
- Farm Mechanization and Energy Conservation

**4. Extension and Market Intelligence**

- Development of profitable value chains for commercial crops
- Creation and analysis of commodity specific database for policy inputs
- Development of market intelligence-based ICT models for efficient marketing and profit making
- Frontline extension for technology transfer, fostering linkages and capacity building for stakeholders

## 9.3. Lessons learned from the transition

- The Electronic Marketing System in Indian FCV Tobacco has imparted price stability, ensured fair, remunerative prices, and prompt payment to the tobacco growers in Andhra Pradesh and Karnataka, which need to be emulated in other commercial crops
- Grading systems like tobacco can be emulated for chilli and turmeric so as to market the produce based on these grading systems
- Development of customized fertilizers for balanced nutrition in commercial crops
- The soil fertility mapping status of different regions will address the nutritional needs of commercial crops and will improve the overall soil health
- FCV tobacco farming, regulated by policy-led crop size fixation, is more vibrant and operates in an organized environment. Similar kind of policy intervention to ensure better prices and augment farmers' income to protect farmer producers and consumers from violent price fluctuations
- App based identification of pests and diseases by the farming community
- Providing technology backup for the turmeric and spice board

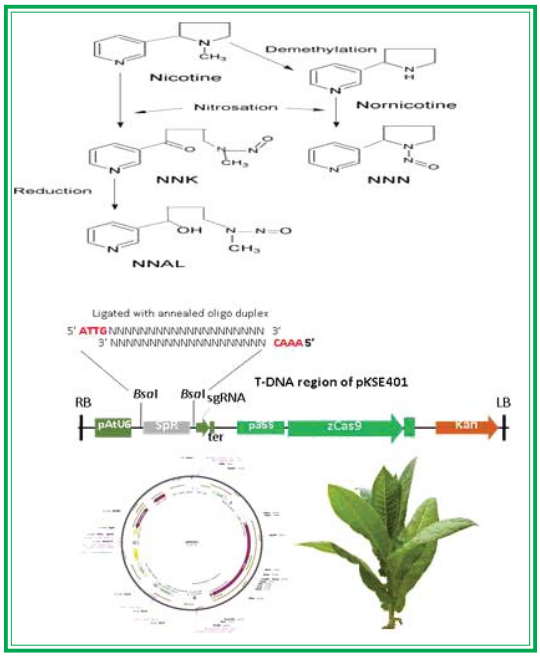
# X. Future Directions for Agricultural Research

## 10.1. Insights into the future landscape of agricultural research

India is one of the fastest-growing major economies, currently ranked as the world's sixth-largest economy and potential to achieve a **US $ 5 trillion** economy in a couple of years. In this context, agriculture and allied sectors will play a pivotal role by bringing a **1 trillion-dollar** economy. Therefore, harnessing the untapped potential of high-value commercial crops will be a viable option in the total agro-economic system. India, being the largest producer and exporter of several high-value commercial crops such as chilli, turmeric, castor, and ashwagandha, the export orientation of these crops on a global scale is very low, which needs to be accelerated to emerge India as the powerhouse of agri-exporter in the international market.

### Tobacco

- Development of FCV varieties with a yield potential of 4500 kg/ha with CS varieties integrating classical breeding & Molecular Breeding
- Extending Genome editing to other tobacco types, for therapeutic proteins




- Development of nutrient use efficient lines, Metagenome studies & reducing the carbon foot prints

- Intensification on redevelopment of labour saving interventions like (i) Suckericide applicators, (ii) customized inter-cultivation tools, (iii) Harvesting machines
- Validation of biodegradable mulches for soil water conservation
- Development of viable technology for cigarette beetle and *Orobanche* management
- Basic studies on understanding the interaction of *Fusarium wilt* with Black Shank
- Development of robust AI based Pest identification & interactive App and popularization of refined new technologies


- Bringing solution to replace complete wood with phase change materials, hot air pumps and gas based interventions
- Exploiting seed oil for industrial uses Polyurethane plastic making etc.

Gas based interventions for curing

## Chilli

- Standardization of suitable agronomic practices for specialized local land races for value addition
- Developing scientific grading/quality indices- Spice Board
- Mapping studies on GRL/MRL levels suited to different destiny countries
- Developing and use of farm/market level rapid testing tools for maximizing export
- Value added products development through Secondary processing & certification


## Turmeric

- Quality Seedling supply
- Exploring Secondary Agriculture technologies
- Curcumin based product development through linkages
- Collection of special type of turmeric

**Ashwagandha**

- Identification of Chemotypes suitable for different ailments
- Classical breeding to improve the bioactive compounds
- Market intelligence studies

Ashwagandha lines maintained at Vedasandur

**Castor**

- Standardization of low cost 2-octonol extraction technology from castor oil.
- Production of 2-octonol derivatives to reduce the imports of secondary products.

## 10.2. The role of NIRCA in Vikasit Bharat

**Chilli**

- India is the leader in chilli production (25.96 lakh tons) and has a share of 47% in the globe, but only 23% of produce (6.01 lakh tons) is being exported ( top ranker among species) and contributing to the foreign exchange of Rs. 12,492 Crores
- This implies export orientation of Indian chilies is very low and the majority of exports (81%) constitute un-processed, while China, exports 65% and Spain exports nearly 90% in processed form
- ICAR- NIRCA partnering with stakeholders evolving proper grading systems, and quality standards, of the destination markets which might eliminate the hindrances in the export market. GI tagging, and developing processed and value-added products in accordance with the specific requirements might boost the export earnining by another Rs. 6000 crores annually

**Turmeric**

- It is a golden spice, 82% of world production (10.74 lakh tons) is grown in the country, encompasses huge diversity (around 40 to 45 species), and has a great advantage in bringing innovations. Currently, turmeric export is 1.62 lakh tons contributing foreign exchange of Rs. 1,875 Crores, however, the processed share is only 0.49 lakh tons
- The global demand for Indian turmeric is increasing due to its superior quality, therapeutic value arising from curcumin content (which ranges from 3% to 12%,), and availability of different types (Alleppey, Nizamabad, Sangli, and Rajapuri) with a range of flavors and aromas, that meets the diverse needs of worldwide buyers
- India is a bulk producer, prices are more competitive than other countries which also gives the edge in capitalizing the market. The research at ICAR-NIRCA aimed at product diversification through value-addition using traditional knowledge and validation will boost the export revenue by Rs. 1000 crores annually from this golden spice

**Castor**

- India enjoys a virtual monopoly in castor production and exports in the world. The castor oil exports (6.46 lakh tons) contribute to foreign exchange of nearly Rs. 7805 Crores but import around 9, 000 crores of castor oil derivatives
- Castor oil derivatives have several industrial applications including paints, varnish, resins, plasticizers, and so on. There is a growing market for castor oil-derived products such as fatty alcohols ( 2-octanol), aldehydes, amyl cinamic aldehyde, gamma-ndecalactone, and ethyl methyl phenyl glycidate
- ICAR- NIRCA exploring the development of green chemistry-based protocols for the production of various derivatives to attain import substitution of these compounds and reduce the import bill by Rs. 9000 crores, which presently we are incurring on import of castor oil derivatives

**Ashwagandha**

- India is the top producer of Ashwagandha, predominantly grown in Madhya Pradesh and Rajasthan. Ashwagandha from the Neemuch market (Madhya Pradesh) exporting to international markets such as the Czech Republic, Canada, USA

- In recent years, there has been tremendous growth in the export of Ashwagandha. It is one of the most sought-after health supplements and is exported to over 60 countries
- The Ayurvedic industry in India has been growing at 17% CAGR. The size of the industry was $3 billion in 2014, it has grown to $24 billion in 2024
- ICAR- NIRCA, initiated the development of scientific and evidence-based products from Ashwagandha using diverse chemotypes suited to the different ailments, which will have great potential in the domestic as well as export markets and captalise the growing demand for ashwagandha across the globe

**Tobacco**

- It is an important cash crop grown only in 0.2 % of arable land and plays a significant role in socio-economics in the country by providing livelihood to the 45.7 million people and bringing Rs. 12,006 crores rupees annually from the exports
- Although India produces about 12 types of tobacco, the export earnings are mostly derived from FCV (Flue Cure Virginia) tobacco and burley tobacco
- There is a great demand for Indian tobacco in the international markets due to its diversified styles, qualities, price ranges and augment the tobacco export revenue by additional Rs. 6000 crores annually
- To accelerate the export proposition, ICAR-NIRCA has initiated working on strengthening stringent ESG (Environment, Sustainability, and Governance) norms and farm mechanization interventions

**Need of government support in strengthening ICAR-NIRCA**

- With the financial support for creating a drying facility for chill and turmeric with a hot air pump at research station Guntur for helping the farmers realize better prices(Ministry of A&FW- Division of Horticulture, Government of India)
- R&D support for developing rapid assessment tools for chilli quality assessment (Colour and pungency) for better marketability in both domestic and export segments (Ministry of Science & Technology, Government of India)
- R&D support for developing scientific grading scales and quality indices in dry chilli for meeting international standards and quality improvement (Spice Board, Ministry of Industry and Commerce, Government of India)
- Support for establishing a state-of-art valueadded development laboratory (Ministry of Food Processing Industries, Government of India)

- R&D support for developing protocols for castor oil derivatives (Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India)
- Support for market intelligence and research studies in Ashwagandha (Ministry of A&FW- Division of Agril. Marketing, and Division of Digital Agriculture)
- Support for research studies on sustainable tobacco production and labour-saving technologies/interventions(Tobacco Board, Department of Commerce, Ministry of Commerce and Industry, Government of India)
- Support for establishing agri-incubator enabling the start-up ecosystem in coastal Andhra Pradesh (NABARD/ Ministry of Science & Technology, GOI/ Ministry of Agriculture, GOI)

## XI. Conclusion

The establishment of a dedicated Institute on Commercial Agriculture (ICAR-NIRCA) can significantly benefit the diverse agricultural landscape in India. The intense focus on the market-driven research and commercialization of Indian agriculture would enhance productivity, quality, agro-processing, and value addition, product diversification, marketability in accordance with the growing demand (domestic and global) for processed and value-added products. This would be translated into augmented income and profitability for the different stakeholders involved in the commercial agriculture sector. The likely benefits accrued from this new institution are furnished below.

- **Market-Driven Research:** Aligning agricultural practices with market demands can help farmers grow high-value crops, improving their profitability
- **Value Addition:** Developing post-harvest technologies and promoting agro-industries can enhance value addition, enabling farmers to earn more from their produce
- **Access to Global Markets:** Research on export-oriented crops can help Indian farmers tap into international markets, increasing income opportunities
- **Reduced Post-Harvest Losses:** Innovations in storage and transportation can reduce wastage, ensuring more food reaches consumers
- **Research Opportunities:** Creating opportunities for agricultural scientists and students, which contribute to agricultural innovation
- **Integration with Agribusiness:** Facilitating collaborations between farmers and agribusiness firms can ensure steady supply chains and reduce inefficiencies

- **Evidence-Based Policies and Advisory Role:** Database and insights from the institution can help policymakers design better schemes and interventions for the commercial agricultural sector. Providing regular recommendations to governments and stakeholders on global agricultural trends and their implications for India
- **Increased GDP Contribution:** With enhanced productivity and profitability, agriculture's contribution to India's GDP can witness substantial growth
- **Export Growth:** Promoting research on commercial crops, processed and value-added products can boost agricultural exports

A commercial agriculture research institution in India has the potential to transform the agricultural sector into a more productive, sustainable, and profitable enterprise. By addressing key challenges and leveraging modern technology and market insights, such an institution can uplift farmers' livelihoods, ensure food security and contribute significantly to the nation's economic growth.

The definitive and unified Vision, Mission and Mandate of ICAR-NIRCA :

**Vision**

To emerge as the premier institute of excellence for research on Commercial Agriculture

**Mission**

To develop and provide science-technology-innovation-value chain based vibrant solutions for enhancing profitability, farm income, employment, nutrition and export, while ensuring sustainability of environment and agro-ecological assets

**Mandate**

- To conduct research on diverse aspects of commercial agriculture for enhancing farm income, employment, nutrition and export earnings, while ensuring sustainability of environment and agro-ecological assets
- To develop cost-cutting strategies, secondary agriculture technologies and diversified value chain models for increased profitability, competitiveness and sustainability

- To deliver front-line extension services for technology and market intelligence dissemination and organize trainings for stakeholders' capacity and competency building
- To collaborate, coordinate and liaison with producing processing, value addition, marketing and exporting agencies for achieving its vision

It is envisaged that the Institute will strive to achieve the above mandate by focusing its research efforts on Tobacco, Chilli, Turmeric, Castor, Ashwagandha etc.

**Five years targetsof ICAR-NIRCA**

**Targets of ICAR-NIRCA**

- Developing nutritionally rich, input responsive climate resilient high yielding varieties (HYV) with special emphasis on oilseeds and pulses using modern breeding tools including genome editing; and use of trait specific germplasm: Tobacco
  - Release or notification in CVRC for **varieties - 5**
  - Registration of varieties with PPV & FRA for **varieties - 10**
- Development of and use of modern biotechnological tools including genome editing
  - Identification of **new genes- 15**
- Modernizing seed systems for rapid dissemination of HYV seeds to farmers through public private peasant partnership
  - Production of **truthfully labelled seed** in tobacco -**150 quintals**
- GI tagging of crops
  - **GI tagging of Durgadachilli**
- Rapid diagnostic tools and AI based digital forewarning systems for management of emerging insect-pests and diseases
  - Development of AI based digital **diagnostic tools** and **mobile apps -3**
- Improved Technologies, product, processes, methodologies etc.
  - Certification of **various production and protection technologies/ methodologies/ products/ processes - 34**
- Commercialization activities
  - Commercialization and licensing of **technologies -6**
- Capacity Building & Human resource development
  - Conducting **trainings** to stake holders - **28**
- Publications (NAAS rating >6)
  - **Research papers - 67**


# NIRCA