ICAR-National Agricultural Higher Education Project

Project Report (up to Decmber 31, 2023)

Component 1b: Centres for Advanced Agricultural Science and Technology (CAAST)

<Name of the AU> Kerala Agricultural University

<Project Title> **Knowledge and Skill Development in Coconut Based Secondary Agriculture**

KAU - CAAST Team with Honorable National Director, Honorable AHEPC members and National Coordinators

Kerala Agricultural University

KAU P.O., Thrissur, Keraka -680654

Executive summary

Name of the AU: Kerala Agricultural University

Project Title: Knowledge and Skill Development in Coconut Based Secondary Agriculture NAHEP- CAAST project

Executive Summary:

The CAAST (Centres of Advanced Agricultural Science and Technology) project on **"Knowledge and Skill Development in Coconut Based Secondary Agriculture",** was sanctioned to Kerala Agricultural University in 2019-20 under the competitive grant programme of Indian Council of Agricultural Research (ICAR) through its prestigious World Bank aided National Higher Education Project (NAHEP) with a financial outlay of Rs. 18.7322 crore. The major area covered under the project include faculty and PG research focused on developing scientific protocols for "Whole Palm Utilisation" in coconut by value addition and processing and entrepreneurial and training activities for students and Farmer Producer Organisations (FPOs). The activities are carried out by a multidisciplinary team under the leadership of Coconut Mission, KAU at seven selected centres *viz*., Coconut Mission (CM) at College of Agriculture, Padannakkad; Agri Business Incubator (ABI), Vellnikkara; Dept. of Extension & Dept, of Economics at College of Agriculture, Vellanikkara (COAV); Instructional Farm(IF), Vellanikkara; College of Forestry(COF), Vellanikkara ; Regional Agricultural Research Station(RARS), Pilicode; Kelappaji College of Agriculture Engineering and Technology (KCAET), Tavanur / Agriculture Research Station (ARS), Mannuthy and Coconut Research Station (CRS), Balaramapuram .

In these 7 centres, 19 state-of-the-art facilities have been established for research, training and incubation of entrepreneurs. A total of 27 PG and Ph D students and around 30 faculty members are doing research directly under the project and around 200 PG students have benefitted with the research facilities developed in various campuses. The extension activities conducted through workshops, training programmes, and participation in national and state-level exhibitions helped to foster institution-industry linkages. Conducted 64 webinars and 47 EDP trainings on food processing and entrepreneurship development at ABI and 30 workshops/ seminars/hands on training on commercial production of value added products of coconut at other centres. Coconut Wood Technology Development Centre (CWTDC) established at CoF made significant strides in developing technologies for making construction materials, furniture, handicrafts, high-value products, charcoal, chemicals etc from coconut wood which otherwise goes as a waste material and training more than 60 wood technicians . Under Coconut Mission 30 pollination workers were trained and hybrid seed production is being carried out in farmer participatory

mode. Also 3 new coconut hybrids are in pipeline which are suitable as the raw material for product diversification. Over 19 Memorandums of Understanding (MoUs) were signed, supporting more than 9 coconut based startups and along with state Govt officials, are a part of Taskforce team for coconut shell based activated charcoal. As part of capacity building programme, 3 certificate /diploma/PG diploma courses were initiated. Mechanisation in coconut sector was carried out to address the labour deficit by designing and fabricating gender friendly, cost effective machines. Also green initiative like biomass utilisation by briquetting as well as by using microbes (both bacteria and fungi) isolated from various sources like decayed coconut fronds, coconut biomass and coir pith to make a consortium for fast composting of the coconut biomass was also taken up as student and faculty research programme.

Inorder to bridge the performance gaps and boost solutions-focused approach and to evaluate current status of Farmer Producer Companies (FPCs) a survey was conducted and analysed the primary data collected from 144 FPOs throughout Kerala which later extended at national level with data from 487 FPCs, 657 members, and 177 non-members across five regions. The initiative helped to chart an empowering path forward for the FPCs which will help in drafting suitable policy changes. As part of market research and analysis, price forecasting of coconut and coconut products like copra and coconut oil and the price analysis of coconut and coconut products were carried out. Five forecasts each for 3 market prices of coconut, 5 market prices of copra and 3 market prices of coconut oil were done using CNN-LSTM model (a combined model of 11 price series from January 2008). Thus, this project has positively impacted students, researchers in the theme area, entrepreneurs and farmer as well as FPCs covering coconut cultivation, value addition and marketing aspects.

Introduction

The coconut palm (*Cocos nucifera* L.) is well known as the "Tree of Life" due to its unique advantages. It is grown on more than 11 million hectares of land with the global production estimated at 62.5 million tonnes nuts. India, Indonesia, Philippines, Brazil, Sri Lanka, and Vietnam are the largest producers of coconut. India stands first in productivity (8323 nuts/ha), second in production (15730 million nuts) and third in area under coconut. In India, more than 1.9 million ha area is under coconut palm cultivation mainly spread in southern states. The crop contributes more than Rs. 8000 crores annually to the GDP and earns valuable foreign exchange to the extent of Rs. 2000 crores by way of export of coconut products. The contribution of the crop to the vegetable oil pool in the country is about 5 per cent and the crop sustains 10 million people of the country through cultivation, processing, marketing and trade related activities. Under these circumstances, the crop holds much value in the Indian economy.

The crop also ranks second in the Gross Value Output (GVO) in Kerala. Kerala has the largest area under cultivation of coconut at 7.7 lakh ha and has the number one position in production among the Indian states. It is grown throughout the state of Kerala, particularly in homesteads and is one of the most popular plantation crop among the middle and low-income famers. Around 42 lakh households in the state are engaged in coconut cultivation. In Kerala it is used mainly for culinary purpose (30%) and for copra 70% (i.e., 85% for oil & 15% for ball copra). Further, the mindset of the traditional coconut grower is attuned to processing for copra and coconut oil that their thoughts do not go out of this oil circle. But coconut is not just an oilseed crop. Exploiting the potentials of this crop to enable production of value added products will help in protecting the farmers from the annually recurring price fall during the peak production months. It is in this context the CAAST project entitled "Knowledge and Skill Development on Coconut Based Secondary Agriculture" (CAAST-KAU) was envisaged under the NAHEP programme with the following objectives.

- **Capacity Building among Students for Entrepreneurship Development**: Promoting the entrepreneurial capabilities of the students, farmers and FPOs in agriculture and allied sectors in the theme area of coconut value addition and to develop them into job providers rather than job seekers
- **Facilitating establishment of coconut based industrial units by tie up with farmer collectives (*Farmer Producer Organisations /private sector/ public sector)*:** Facilitating rural based enterprises through provisioning of all technical support services and to take up research to fill up the gaps in technology, skill upgradation, and industrial collaboration. The existing pilot plants will act as training cum demonstration centers of the technologies developed
- **Promoting industry–research linkage for addressing the research gaps *(Faculty / postgraduate / doctoral research programmes)***: Support faculty and PG researchers for solving of problems of industrial units that are related to technological, marketing, financial and management aspects.

- **Market Research and Analysis**: Market Intelligence studies to have regular monitoring of the marketing system among the farmers and dissemination of price movements and provide policy prescriptions to the government for effective pro farmer interventions

Launched on 2nd September, 2019 -World Coconut Day- the project could support KAU to develop into a multidisciplinary center for teaching, research, and extension. The activities are carried out by a multidisciplinary team under the leadership of Coconut Mission, KAU at seven selected centres *viz*., Coconut Mission (CM) at College of Agriculture, Padannakkad; Agri Business Incubator (ABI), Vellnikkara; Dept. of Extension & Dept, of Economics at College of Agriculture, Vellanikkara (COAV); Instructional Farm(IF), Vellanikkara; College of Forestry(COF), Vellanikkara ; Regional Agricultural Research Station(RARS), Pilicode; Kelappaji College of Agriculture Engineering and Technology (KCAET), Tavanur / Agriculture Research Station (ARS), Mannuthy and Coconut Research Station (CRS), Balaramapuram.

Objective 1: Capacity Building among Students for Entrepreneurship Development

In the 7 centres of implementation of the project, 19 state-of-the-art facilities have been established for research, training and incubation of entrepreneurs. The extension activities conducted through workshops, training programmes, and participation in national and state-level exhibitions helped to foster institution-industry linkages. Conducted 64 webinars and 47 EDP trainings on food processing and entrepreneurship development at ABI and 30 workshops/ seminars/hands on training on commercial production of value added products of coconut at other centres. The development and upgradation of the Coconut Wood Technology Demonstration Centre (CWTDC) is one of the prominent initiative providing a suitable platform for knowledge dissemination and practical training in the wood processing and value-addition of the coconut palm wood, an underutilized and plentiful resource. At CWTDC training was imparted to more than 60 wood technicians and under Coconut Mission 30 pollination workers were trained and hybrid seed production is being carried out in farmer participatory mode. Over 19 Memorandums of Understanding (MoUs) were signed, supporting more than 9 coconut based startups and along with state Govt officials, are a part of Taskforce team for coconut shell based activated charcoal. As part of capacity building programme, 3 certificate /diploma/PG diploma courses were initiated.

Objective 2: Facilitating establishment of coconut based industrial units by tie up with farmer collectives (*Farmer Producer Organisations /private sector/ public sector*):

Neera and neera based technologies

Neera, the plant sap extracted from the inflorescence of coconut has immense potential as a premium health drink, the popularization of which will boost the remuneration to farmers. Though there were several FPCs in Kerala who ventured into commercialisation of neera, due to huge initial investments incurred by them and poor acceptability in market due to adoption of improper technology, the units are in the verge of closure. Coconut Mission, KAU had developed methods for the extraction of neera and standardized the technology for arresting the fermentation of the sap and its preservation (patented). The quality analysis conducted using advanced equipment like ICP-OES procured under the project revealed

that it is rich in sugars, protein, minerals [N, P, K, Mg and micronutrients Zn, Fe and Cu and has a high potassium (K) and low sodium (Na) content], antioxidants, water soluble vitamins (especially B complex and C) and phenols. Under the project, an automated demonstration unit was established with low cost machinery for processing with increased efficiency as required in a commercial neera processing plant. Also technologies for various products from neera such as palm sugar, palm jaggery , sweetballs, sipups, neera halwa etc were developed and transfer of technology was approved for commercialisation. Workshops and seminars were conducted in association with Coconut Development Board inorder to empower the FPCs to revive the processing units and the facility is being used for training the FPCs who are interested to adopt the technology.

Agri Business Incubation and entrepreneurship development

Agri Business Incubator has enhanced its entrepreneurship ecosystem for coconut-based startups with the intervention of the project. An integral mechanical coconut processing line has been established and around 17 food processing equipment have been fabricated at ABI for primary and secondary processing of coconut. Process protocols for defatted coconut meal (DFC) based Ready-To-Cook Pasta, Coconut milk-based flavoured RTS & vacuum impregnated coconut kernel were developed under the project. The optimal process parameters for the spray drying of toddy powder considering the quality attributes were found. Development and evaluation of spray dried coconut water, Spray Dried Coconut Sap (Neera) Powder was done using the help from the project. The project aided us in establishing novel food processing machineries like pulsed light technology. This enabled us to conduct research on comparative evaluation of retort pouch packaging and pulsed light technology for preservation of Coconut Neera. Further, the established facility and other infrastructure has facilitated the creation of a post-graduate diploma in 'Food Industry Management and Quality Control'. Besides, the centre has conducted a one-week national-level PG/PhD workshop and a Faculty Development Programme for various faculties and scientists across the country with the funding of the scheme. The centre has also conducted hands-on trainings and workshops to enhance the robotics and artificial intelligence in the coconut production sector. In this regard, around five workshops have been conducted for 'IOT Robotics and Drone in Agriculture'.

Coconut wood based technologies

The CAAST project centre at the Department of Forest Products & Utilization, College of Forestry has made significant contributions towards the advancement of research and outreach activities in the field of coconut wood processing and value addition through the project. The mature coconut palm wood is attractive and durable with minimum volumetric shrinkage. Timber is graded as hard, intermediate, or soft corresponding to high, medium, and low densities. The price of the coconut wood, is almost half the price of conventional wood making and is a cost-effective substitute for traditional structural materials. Under the prevailing burgeoning demand supply gap for timber in the domestic market, the expansion of coconut palm wood utilization as a cheap and useful raw material for various wood based industries has immense scope. Though bestowed with huge possibilities, the wide utilization of coconut palm wood is chiefly restricted due to certain limiting factors. In the traditional carpenter's point of view, the high fibrous nature of wood makes it a species difficult to work when compared to the conventional timber species. However, with proper optimization of processing techniques along with advanced tools and

machineries the coconut wood working can be modified greatly to the extent of using it as a better raw material for the manufacture of various value-added products. Another impediment in the line of coconut palm wood utilization is the lack of processing units and trained manpower. It was a felt need that with effective research, awareness, and product promotion strategies, production of quality furniture and other high value products using coconut palm wood could be achieved. Furthermore, through the effective utilization of its unique features, this indigenous resource has huge potential to be brought forth as prime material at the domestic as well as international markets.

The CWTDC is playing a significant role in industry tie up in the wood processing and value-addition of the coconut palm wood. The centre established collaboration with organizations such as the Kerala Artisan's Development Corporation (KADCO), Govt. ITI SCDD, Nadathara, Thrissur, Coconut Development Board (CDB), Kochi, and Kodungallur Coconut Producer Company Limited (KCPCL), Perinjanam, Thrissur and support the startups and ventures like Golden Kerapalm Pvt. Ltd., KODOCO Toys Pvt. Ltd., and Cocobricks, Pvt. Ltd. which are making significant contributions to sustainable growth and innovation in coconut palm wood utilisation.

Coconut kernel based product development and technology transfer

Development of technologies for value addition of coconut kernel and standardization of value-added products based on coconut kernel are being carried out at CRS and RARS. Technology for around 35 different products from coconut kernel, coconut milk, coconut water and Virgin coconut oil are statndardised and 22 of them are commercialised from these centres with the assistance from Self Help Group of women. Training and transfer of developed technologies to the interested entrepreneurs, handholding of small scale entrepreneurs for product development and other related activities, conducting research on the quality aspects of the developed products are being continued.

Profile Analysis of Farmer Producer Companies in Kerala and India :

Was carried out to address limitations of traditional cooperatives and Farmer Producer Companies (FPCs) in India and to empower smallholder farmers by providing access to economies of sale and markets. The pan India network project with multiple ICAR institutes and SAU partners, led by Kerala Agricultural University, delved into the performance and impact of FPCs in India. It employed diverse data collection methods and advanced analytical tools, to study FPC efficiency, impact on farmer well-being, regional variations, performance bottlenecks, and overall effectiveness. Recognizing the importance of FPCs beyond just profit, this study analyzes their features and performance to optimize their operations and maximize their impact on the agricultural sector. It employed diverse data collection methods and advanced analytical tools, to study FPC efficiency, impact on farmer well-being, regional variations, performance bottlenecks, and overall effectiveness. Data from 487 FPCs, 657 members, and 177 non-members across five regions, was analysed. While Farmer Producer Companies (FPCs) are crucial for India's agricultural development, performance varies across regions. Existing policies helped their formation, but targeted support is needed to improve efficiency and address diverse regional needs.

The study recommends optimizing FPC size, tailoring policies to different FPC stages, revising the Companies Act for stronger governance, and leveraging network connections and digital solutions like

e-markets to navigate the market confidently and sustainably. Female representation and empowerment within FPCs are observed crucial for the overall success and inclusivity. Skewed gender representation in FPC Board of Directors calls for structural reforms in FPC governance boards with 33 per cent reservation for women representatives. Women exclusive FPCs, quotas and incentives can boost female leadership, but qualified women and active participation are key.

Financial needs and challenges of FPCs vary depending on their region, crop type, size, and stage of development, but relying on limited grants and loans hampers growth. FinTech partnerships, streamlining of collateral loans and innovative financing like mezzanine loans, credit insurance, convergent funding can unlock efficiency, risk reduction, and even e-commerce.

The results reveal valuable insights that point to a clear path forward for FPCs in the country. In India's evolving agricultural landscape, FPCs act as catalysts for shared prosperity, fuelled by data insights and partnerships, promising thriving livelihoods and empowered smallholder farmers for a sustainable future. Thus, with the right fit and support, FPCs can flourish, fostering shared success for all.

Objective 3: Promoting industry–research linkage for addressing the research gaps *(Faculty / postgraduate / doctoral research programmes)*

The implementation of the project has a significant impact on the enhancement of research outcomes, industrial linkage and equipping the stakeholders with relevant skills. The project tremendously improved the research and training environment in Kerala Agricultural University for the scientists, PG students and PhD scholars engaged in coconut research. The state-of the art facilities created under the project include establishment of novel food processing machineries for coconut processing and value addition, development of various coconut wood processing technologies, coconut biomass utilization by briquetting / microbial composting, coconut hybridisation and hybrid seed production for ensuring raw material availability for the coconut industry and mechanization in coconut production sector. Under the project, renovation of the available infrastructure in various centres and fabrication of primary and secondary processing machineries for production of value-added coconut products were carried out. All these resulted in an increased enthusiasm among students and faculty for taking up advanced research programmes to address the need of the coconut farmers, entrepreneurs and industry. As a result total 27 PG and Ph D students (Annexure 1) and around 30 faculty members are doing research directly under the project and around 200 PG students have benefitted with the research facilities developed in various campuses.

A state-of-art facility for ‘food processing and quality control’ has been established with high-end food processing and quality control machineries at ABI. Non-thermal processing equipment like pulsed electric field system, cold plasma system, ozone generation system, etc. are a few to name. This facility would pave a way to enhance the research outcomes in this sector while uplifting the research potential of PG and PhD students.

The strides made by CWTDC in the area of utilising coconut wood by kiln drying schedule preparation, chemical preservation, design and development of value-added products like knock-down furniture,

handicrafts, and wall panelling and flooring tiles, wood composites showcase a commendable commitment to innovation and ecological sustainability.

The briquetting unit established under Coconut Mission opened up a new are for research and green initiative in utilising the huge biomass produced by the palm which otherwise goes as a waste. High-lignin and complex phenolic contents make coconut biowaste very recalcitrant to natural decomposition resulting in huge accumulation of the residues in rural and urban areas causing environmental pollution and a source of human health hazard by becoming breeding sites for disease-causing mosquitoes and flies. Leaf fronds, inflorescence portion, mature nut husk and shell are the common wastes of the coconut palms. In addition, coir-pith, which is a waste produced from coir industries is also available. Consumption of tender coconut water has started yielding large volumes of coconut husks as wastes that are beginning to become an environmental and health issue. A great deal of coconut waste is generated when diseased, insect damaged or senescent palms are uprooted. All these biomass residues from coconut palm have a good potential to be recycled as soil amendment to aid agriculture and environment. An initiative is made under the CAAST project with objective of isolating microbial strains and developing microbial consortia for faster degradation of waste from coconut, to develop fuel briquettes, briquettes impregnated with fertilisers as a slow release mechanism in soil for cultivation of crops, shredded waste used as substrate for mushroom cultivation, animal feed etc.

Mechanization is the solution to bring down the cost of cultivation in Kerala. However, to make this happen, trained manpower is to be created to cater to the mechanization needs of the State. At ARS, the project envisages development of coconut-based technologies for aiding enterprise development. Capacity building programmes were carried out in operation and maintenance of various farm machineries, especially those related to coconut such as basin digger, palm climber, tractor, power tiller, sprayers, graders, driers, drones, for various stakeholders such as women, youth, FPO members and farmers. Hands on training were provided to empower them in the use of agricultural machinery. They were given insights into turning the knowledge obtained into self-employment ventures and enterprises. Different models of coconut graders have been fabricated. The design and development of coconut timber borer and autonomous vehicle for field operations in coconut gardens is also being carried out.

Objective 4: Market Research and Analysis:

Under this the main activity was price forecasting of coconut and coconut products like copra and coconut oil. For coconut, copra and oil three markets were selected and the monthly price data used was from January 2000 to December 2020. Five price forecasts were made for periods from (i) October 2019 to September 2020 (ii) January 2021 to December 2021 (iii) April 2022 to March 2023 (iv) January 2023 to December 2023 and (v) January 2024 to December 2014. During validation, among the various models tried, the Hybrid Deep Learning Model of Convolutional Neural Network - Long Short Term Memory Networks (CNN-LSTM) was found to be the best as the Mean Absolute Percentage Errors (MAPE) values were found to be least. Based on this, upto 4th forecast, a combined model of 11 price series was made from January 2008 consisting of three price series of coconut, three price series of coconut oil, three price

series of milling copra, one price series of Rasi Copra, and one price series of Ball Copra. The final CNN-LSTM model has two price series of coconut, four price series of coconut oil and five price series of copra. Validation was also done using the forecasted and actual prices and the forecast errors were found to be less than 10 percent in most of the cases. As the outcome of this activity, best forecasting model for forecasting the prices of coconut, copra and coconut oil was developed, which can be used for further price forecasting. Based on the price forecasts, draft policy for coconut and coconut products as well as markets were developed.

Another activity of the project was the price analysis of coconut and coconut products were done using the TCSI analysis which identified the trend, cyclical, seasonal and irregular variations. The intra-annual and inter-annual monthly price volatility were measured using the Parkinson's measure and intra annual standard deviation of changes in log prices. The price volatility in annual prices was also assessed using the Coppock's Instability Index. The findings of these analyses provided a deep understanding on behaviour of coconut, coconut oil and copra prices and also gave inputs on policies to control price volatility. Apart from this, the trade performance of coconut and coconut products in India was also studied which gave an understanding on export performance of coconut and coconut products and thus provided inputs to improve export performance. The market structure analysis of coconut in Kerala, the value chain analysis of coconut and the edible oil sector's performance were all the other activities that were carried out in the project.

Social Security and Environmental Security under the project:

The project enhances stakeholder resilience so that the vulnerable and marginalized groups such as the physically challenged, students of SC/ST and minority groups, women, small and marginal holding farmers stand to benefit through its social safeguard mission under the Equity Action Plan component (EAP). 16 trainings conducted on these aspects benefitted 1811 Students (85.22% Female/ 20.53% SC/7.12% ST), 193 Faculty (17.04% Female/ 4.3% SC/ 1.07% ST) and resulted in increase in PG placement rate by 24%. These activities resulted in improvement of two-way communication mechanisms and inclusion of resilience building in the socio-economic planning process. Incinerators and waste management systems formed the integral components of the Environmental Sustainable Plan (ESP). Also, green protocols are strictly followed in the implementation of the project.

The environment safeguard aspects acquired increased importance after the implementation of the NAHEP project in KAU. Through the project, environment friendly and renewable technologies could be successfully demonstrated in various campuses of the University. Waste management techniques such as biogas technology, EM composting, vermicomposting etc. for handling farm, kitchen and food wastes and incinerators for handling dry wastes are now in place in all campuses. Solar based gasifier was developed for dry waste management. Planting of fruit trees, bamboo etc. have been carried out by involving the students of the University to inculcate the importance of environment protection. Roof top rain water harvesting, water harvesting using percolation ponds, farm ponds etc. was demonstrated. Water conservation methods such as drip irrigation have been demonstrated in 3 ha leading to a savings to the tune of approx. 1450000 litres of water. Foot operated taps were installed in project centres to

demonstrate water saving technology. 60% water savings observed with savings of approx. 250 to 270 L of water per tap per hour. Solar power generation is being done at all campuses with more than 80 kW solar power being generated per day in the various project centres. Solar street lights installed in various campuses (15 numbers). The project centres now use energy efficient LED lights and BLDC fans. Fire extinguishers have installed in the labs and offices of different project centres to ensure safety from fire hazards. Display boards and safety signages were also installed at all centres, as directed by the NAHEP. Lab safety equipment including exhaust hoods, first aid boxes, safety gear etc. were provided in various laboratories and for the workers.

1. Key activities carried out under the project during the entire period

1.1. Interventions carried out by AU which helped to improved research effectiveness

Please provide the details about the interventions carried out to support inter-disciplinary advanced centers for innovative teaching, research, extension, and capacity building in the specialized area for holistic development and integrating agricultural education with employment and entrepreneurship for PG students. Please write one paragraph for each interventions and/or activities.

Key interventions	***Remarks/Photographs***
Focused interventions to uphold the value addition prospects of coconut inflorescence sap. a) In-depth research in nutritional and therapeutic characterisation of coconut inflorescence sap and its value-added products : The nutritional characterisation of coconut inflorescence sap, sugar, jaggery and syrup were carried out. The therapeutic value of sap and its products were analyzed via in vitro antioxidant and antidiabetic assays. A detailed analysis on the sap metabolites had been done. The research findings are in pipeline for publication. *b)* Novel product development : Understanding the alpha amylase inhibition potency and antioxidant capacity of coconut inflorescence sap and its products, novel products were formulized by substituting sugar with neera syrup. Products viz., pudding, cookies, halwa and spreads were optimized c) Optimization of commercially scalable technologies: Production technologies were validated and are ready to be to transferred to the FPOs	  
Community based intervention programs – supplementation of nutri-snack	With the facilities available at the CAAST centre of the campus, an extruded snack was optimized and supplemented through the ICAR TSP scheme to the PVTGs 'Korgas' tribal community of the Kasaragod district with an aim to enhance the nutritional status of the preschoolers of the community
Utilization of facility for delivering advanced training programs in secondary agriculture	An ice cream processing plant with 100 LPH is established as part of the project, is converted to an incubation facility using which advanced training programs in new technologies being delivered to the prospective entrepreneurs
Development of state of art value addition unit and development of innovative products from coconut kernel	Development of products such as coconut chips , vinegar, VCO based mouth wash, body lotion, instant curry paste etc, as a model exemplifying

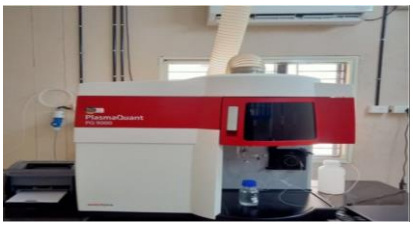
	the scope of value addition in doubling farmers income
Green initiative by establishing a briquetting unit and microbial consortium for biomass composting	Two lignin decomposing fungi and five cellulose and lignin degrading bacteria were isolated and characterized. Fugal isolates could compost the coir pith and wood waste in 90 days of time indicated by CN ratio, bulk density and microbial activity. Volatile profile of decomposed wood waste revealed characteristic compounds facilitated by fungus. Cellulose and lignin degrading bacterial isolates were made into a consortium for faster degradation of coconut waste.
Research for ensuring raw material availability for coconut value addition industry through crop improvement: a) Characterisation and evaluation of promising hybrid combinations of coconut b) Large scale multiplication of coconut hybrids in farmer participatory mode by artificial pollination c) Understanding the genetic basis of stress tolerance in coconut	
Creation of a mechanical processing line for coconut primary and secondary processing. Machineries like solar-cum-gasifier, coconut splitter, coconut dehusker, coconut milk extractor, coconut desheller, microfilter, clarifier, testa remover, coconut slicer, VCO expeller, centrifugal separator, refractance window dryer, heat pump dryer, pasteuriser system, microwave digestion system, ultrasound processing system, etc. have been fabricated for coconut processing	• The facility is utilized for conducting hands-on training on coconut processing for food entrepreneurs and startups (Annexure 2). • The facility is provided for incubation supports and research needs – optimisation of retorting conditions for flavoured coconut skim milk based RTS, fresh grated coconut, etc.
Creation of a state-of-art facility for food processing and quality control Machineries like walk-in cool chamber, rotary oven, centrifuge, shredder, fibre extraction system, vacuum drier, pulveriser for briquetting, CNC lathe machine and non-thermal processing machineries like cold plasma, ozone processing system, pulsed electric field system, have been procured.	• Facility enhanced the research in the area of coconut processing and value addition utilizing the high-end equipment (Annexure 3). • Extended technical supports to six coconut entrepreneurs. • 10 technologies developed in coconut value addition and 6 process technologies transferred.

	• Signed around 13 MoUs with coconut based food industries and research institutes • Facility favoured the joint-research program with international universities (Monash university), workshop and FDP programs with the participation of international resource persons.
Certificate Training Programs on Processing & Production of Value-Added Products from Coconut wood The signing of Memoranda of Understanding (MoUs) with various wood-based industries, academic institutions, and entrepreneurs reflects a collaborative approach, fostering partnerships that can contribute to the growth and development of the coconut wood industry	
Academic collaborations : enriching the learning experience and expanding the reach of the training programme.	
Mechanisation in coconut sector : a) For various stakeholders such as women, youth, FPO members and farmers, hands on trainings were provided to empower them in the use of agricultural machinery	Conducted 8 trainings with a total of 183 participants
b) For students from four ITIs and three VHSEs, 11 capacity development programmes were conducted (276 participants).	12 youth of ITI Perumatty (out of 22), who attended the training obtained campus placements in various agro machinery companies
New Courses started: a) two year diploma programme in Agricultural Mechanization at ARS Mannuthy **b)** PG Diploma in	
Development of machinery for aiding coconut cultivation – coconut graders, coconut timber borer, coconut timber boring cum facing machine, remote	

controlled soil tilling machine, shredder, solar coconut tunnel drier, mechanical coconut climber	
Profile Analysis of Farmer Producer Companies in India a) Analyzed FPC efficiency, impact on farmer well-being, regional variations, performance bottlenecks, and overall effectiveness. Data from 487 FPCs, 657 members, and 177 non-members across five regions were collected. Conducted 7 workshops and Focus group discussions in all the 5 region	   
b) A national workshop was conducted at KAU, Vellanikkara on 01-02, December 2023 inorder to finalise the conclusions and suggestions of FPO analysis	  Report presented in workshop

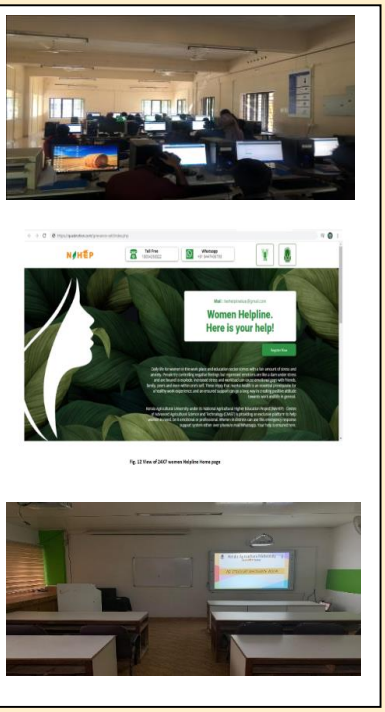
1.2. How the facilitative units helped to enhance learning outcomes

Please provide the details of the facilitative units which helped in enhancing learning outcomes of the students and/or faculties. Please note that we may not need to mention all facilitative units created in the AU here, but focus on those which are open for the students/faculties and other stakeholders.

Facilitative unit	Activity/achievement	Remarks/Photographs
Neera processing, product development and quality assessment unit	Development of Neera , a health drink from coconut inflorescence sap and various products from it along with nutrition and biochemical analysis to enable them to be classified as nutraceuticals so that the farmers get a premium price in the market	 CAAST lab for PG research work  ICP- OES for quality analysis
Coconut kernel based value addition units at two districts (Kasaragod and Thiruvannathapuram)	Serve as a model training unit for entrepreneurs and farmers As study unit for PG students and provide internship opportunities for students from various faculties	 

Coconut biomass utilization unit – physical and microbial (waste to wealth)	Established a briquetting unit with prospecting of coconut biomass waste for diverse agricultural application such as fuel briquettes for industry, fertilizer impregnated briquettes as a slow release mechanism in soil, crushed biomass as mushroom growth substrate and as compost by decomposition using microbial consortium	   
Renovation of KAU ABI laboratory for extensive research and training facility	For hosting high-end food processing machineries and for setting up incubation facility	 inaugurated by Adv. Sunil Kumar, Hon'ble Minster of Agriculture, Govt. of Kerala on 25/01/2021
State-of-art facility for food processing and quality control	a) Procured high-end non-thermal processing machineries for food processing like cold plasma, ozone processing system, pulsed electric field system, 3D food printer, etc. b) Procured non-invasive and precision quality analysis and control equipment like acoustic resonance system, machine vision system, NIR spectroscopy, etc.	a) Facility favoured the joint-research program with international universities. (*Mr. Gaurav, Ph D Scholar from Monash university*) b) Three post-graduate and one PhD students utilizing these and four process technologies developed
Mechanical processing line for coconut primary and secondary processing	a) Fabricated 17 equipment for primary and secondary processing of coconut, like solar-cum-gasifier, coconut splitter, coconut dehusker, coconut milk extractor, coconut	a) Research on coconut value addition has been conducted with the facility and research publications have been accomplished. Incubation and

	desheller, microfilter, clarifier, testa remover, coconut slicer, VCO expeller, centrifugal separator, refractance window dryer, heat pump dryer, pasteuriser system, microwave digestion system, ultrasound processing system, etc.	technical support have been extended with the created facilities for startups. A few of the coconut-based startups that received the supports are M/s. Nata Nutrico, M/s. Cocobricks and M/s. Kodoth India.
Coconut Wood Technology Demonstration Centre (CWTDC)	procured advanced machineries like wood seasoning plant (kiln), Vacuum Pressure Chemical Treatment Plant (CTP), wood finishing tools, Portable Sawmill (Wood Mizer) etc. This enhances the capabilities and efficiency in coconut wood processing by modernization and upgradation of effective wood processing techniques resulting in product diversity, sustainability, and market competitiveness. The Universal Testing Machine (UTM) helped to focus on quality control and ensuring the structural integrity of coconut wood products to meet the industry standards**.**	  Seasoning kiln portable sawmill  UTM
Farm machinery development workshop	Small machinery are being designed and developed in the centre for supply to the public on demand. Creating trained manpower for repair, servicing and maintenance of farm machinery	skill enhancement of more than 150 stakeholders

Common Facilities: • Language Labs • PG Resource room • Girls' restroom • Labor Restroom • Women Helpline Portal • Amenities for physically and socially vulnerable groups	• Helped in communication skills and self confidence • Helped with online classes during COVID 19 and	

1.3. Out-of-box initiatives undertaken by the AU

Please provide the details on out-of-box initiatives undertaken by the AU in one-two paragraph.

Out-of-box initiative	Activity/achievement	Remarks/Photographs
Coconut Biomass utilisation	High energy calorific value briquettes were made out of coconut biowaste which could serve as alternate for firewood / as fertilizer impregnated slow release briquette which provide balanced nutrition to different crops thereby avoiding nonjudicoius use of urea and other commercial fertilizers	

Entrepreneurship Development Program (EDP) under NAHEP CAAST jointly with other government schemes like PMFME ODOP	Conducted EDP training programs for district level trainers representing Malappuram, Calicut and Kannur districts on Coconut processing	 Participants of EDP training
Process technology development for innovative ready-to-use coconut products	Formulated process technologies for neera, toddy and, matured and tender coconut water powders using spray drying.	The innovative product like toddy powder is developed as food ingredient beneficial for the bakery and breakfast food sector, where fresh toddy is not available and addition of its flavour is integral (appam)
Green technology for sustainable food processing	a) Fabricated a solar-cum-gasifier dryer that uses coconut shell and husk produced as waste products in the coconut processing line as fuel source for drying. b) Fabricated solar-panel based solar dryers in view of using renewable energy source in the sustainable food processing.	 solar-cum-gasifier dryer
Project designing, technology transfer, and training support at CWTDC : In collaboration with Kerala Artisan's Development Corporation (KADCO, Govt of Kerala) and Coconut Development Board, Kochi (CDB)	To commercialize products through a Public-Private Partnership for year-round production of coconut wood products.	• Signify a collaborative, market-oriented, and sustainable approach to industry development • Establish the CWTDC as a key player in the coconut wood sector.

1.4. Collaborations with industry and other HEIs for bringing relevancy

Please provide the details on relevant collaboration with industry for bringing relevancy and improving research effectiveness in the AU in one-two paragraph.

Collaborations	Activity/achievement/purpose	Remarks/Photographs

Agri Business Incubator : International collaboration	With Australian universities like Monash University, Melbourne University and RMIT University to streamline the novel, innovative and sustainable food processing researches. Dr Sudheer, K.P, Co-PI has undergone training program at Monash University and has involved in the mainstream food research, and published a part of his work in a reputed journal with impact factor of >5 (Foods, MDPI publisher).	• An Indo-Australian research project under VAJRA scheme has been submitted for the research and development in food processing sector. • The next Indo-Australian project (SPARC) focusing on uplifting of food byproducts utilizing non-thermal technologies is in the pipeline. • A Faculty development program and a PG/PhD student workshop has been organized utilizing the collaboration involving the research persons from various National and International institutes.
Collaboration with startups	• Incubation support to M/s. Golden Kerapalm for coconut wood utilization into carvings furniture. • Incubation support to M/s. Kodoth India for coconut wood utilization into toys. • Technical support to M/s. Zaphon Repurpose for production of straw from fallen coconut leaves. • Technical and incubation support to M/s. Aadrics Coconut Products for production of drinks from waste/ byproducts from VCO industry. • Support to M/s. NAVA Design & Innovation Pvt. Ltd. for mechanization of coconut sap tapping. • Technical supports to M/s Nata Nutrico Coconut Food Products for quality evaluation of nata de coco products.	• M/s Fuselage Innovations was honored by the Ministry of Civil Aviation for their recognition in drone technology. • Mr. Saji Varghese (M/s. Zebronics) has won prize in National-level Agri India Hackathon 2020 organized by IARI, Pusa during 1-3/08/2020, for straw made from coconut leaf (annexure 6).
Collaborations with start ups and entrepreneurs for coconut kernel	• M/s Yedible food products, Manjeri, • M/s Moms tesori Malappuram	•

based product development, training, technology transfer and support	• M/s First bee Malappuram • M/s Kera King Kondotty • M/s Angha coconut products, Payyanur, • M/s Organic Malabari, Ernakulam	
MOU between Dept of Forest Products & Utilization, CoF and Government ITI (SCDD), Nadathara,	For training and technical support in the coconut wood industry - a multifaceted effort aimed at enhancing skills, promoting safety, and ensuring the efficient utilization of resources.	Professional development of students and the advancement of the coconut wood industry
MoU between the Dept of Forest Products & Utilization, CoF and Golden KeraPalm, Pvt. Ltd.	Provide support in the areas of technology transfer, product development, market expansion, and any other mutually agreed-upon areas	 GOLDEN KERAPALM
Ready to transfer technologies (approved by KAU)	processing of coconut palm wood for increased durability Products neera, (patented) , Kerachakkara (Palm jaggery from neera), Palm sugar, Kera chakkara sweetballs, neera cookies (fibre enriched)	

2. Achievements made through CAAST under NAHEP

2.1. Output-outcome monitoring

S. N.	Particulars	September'2019 to Dec'2023	
		Target	Achievement
1.	% increase in number of technologies commercialized	50 %	67%
2.	% increase in faculty research effectiveness	15%	17%
3.	Number of direct beneficiaries of the project	600 Nos	1600 Nos
4.	Number of female beneficiaries	400 Nos	847 nos
5.	% increase in JRF / SRF / ARS	50%	71 %
6.	% increase in number of students who were admitted in foreign universities	-	-
7.	% increase in PG student placements	10%	16 %
8.	Number of industry- sponsored projects and positions in cutting-edge areas of agri-science	4 nos	5 Nos
9.	Number of faculty training programmes (national) undertaken by AU	5	5
10.	Number of faculty training programmes (international) undertaken by AU	7	6
11.	Number of student training programmes (national) undertaken by AU	12	18
12.	Number of student training programmes (international) undertaken by AU	Nil	Nil

Observation

<<Please provide the explanation on the progress made against the output-outcome monitoring indicator and highlight the key initiatives which attributed to the overall outcome/potential impact of the project-Maximum 2-3 paragraphs>>

NAHEP has facilitated the establishment of state of art lab facilities and academic programs targeting vulnerable sections among students at Kerala Agricultural University. With the advanced facilities created under NAHEP- CAAST, PG/PhD students and faculty working even in the remote centres could pursue advanced research programmes like biotechnological interventions in coconut crop improvement, developing neutracutical products from neera and nutrional and biochemical profiling, environment friendly initiatives like coconut biomass utilization etc. Infrastructural amenities and other social safeguard measures expedited under the project in emerging areas has widened the learning and thinking processes of students as reflected in the recorded increase of JRF and SRF selections from 5 and 7 selections respectively in 2018-19 to 59 JRF and 38 SRF in 2019-20 and 66 JRF and 18 SRF in 2021-22. Remedial coaching classes organized under different departments in various campuses where NAHEP has been implemented is credited with this achievement. This provides a direct measure of academic quality and student competency improvement under the project.

Moreover the overall dominance of girl students in both JRF and SRF with 42 out of 59 and 27 out of 38 selections respectively accounting for 71 percent each of total selections vindicate the principles of social equity implemented under the NAHEP. It is also to be mentioned that the socially disadvantaged sections of students from SC and ST categories have found representation in these selections proportionate to intake. Capacity building programs organized for soft skill development of students through PG resource room, English labs and communicative English courses have improved the employability of students evident through better campus placements. Social safeguards for girl students in the form of 24X7 women helpline portal, toll free number and whattsapp platform that provide distress counselling, complaint resolutions and stress management has contributed to their confidence building and aided with stress free learning environment especially in the COVID 19 pandemic situation. The program has also contributed to labour productivity by ensuring the implementation of Labour Management Plans (LMP) through civil work contractors and timely monitoring. Health safeguard of farm labourers were ensured through the distribution of PPE kits and sanitizors. Though a minority, the often left out category of the physically challenged, could be integrated into the main stream through wheel chairs, ramps and other amenities under the project.

After the project implementation, the technologies transferred could be increased to 13 start ups. The project e could bring into limelight the potential of coconut as a lively hood provider through value addition. The project increased the visibility of technologies developed, by expanding the facilities to students from all different subject areas like food science and nutrition, food technology, forestry, plant breeding , biotechnology, extension, economics, agri engineering etc apart from farmers and entrepreneurs.

2.2 Knowledge Management Collaterals

I. Knowledge Collaterals	September 2019 to Dec'2023
1. Publications	around 135 (including brochures, leaflets, manuals, seminar proceedings etc)
2. Research Articles	59
3. Annual Reports	3 nos.
4. Books	9 +36 book chapters
5. Success Stories	6 nos.
6. Newsletter	2 nos.
7. Magazines	45 nos.
8. Blogs	Around 61 nos.
The details of the Knowledge Management Collaterals with detailed list of authors, title, publication period, URL links etc., given in Annexure 4.	

II. Mobile and Web Applications	September 2019 to Dec'2023
1. Mobile Applications Developed	NIL
2. Web Applications Developed	01
<Please provide the details of the applications (along with URL links) with List of documents, authors, publication period in Annexure4>	

III. Number of IPR (Intellectual Property Rights) Registered/Obtained	September 2019 to Dec'2023
1. Copyrights	NIL
2. Patents	NIL
3. Others	NIL

IV. Dissemination and Outreach	September 2019 to Dec'2023
1. No. of Posts on Social Media	>60 nos. (Facebook, YouTube and LinkedIn)
2. No. of Posts on Newspaper	~10 nos.+8 cof
3. No. of Posts on Magazines	47
4. No. of Unique Promotional or Outreach Collaterals	8 nos. (in form of brochures)
< details of the Knowledge Management Collaterals with List of documents, authors, publication period in Annexure4 >	

Capacity building programs to improve the research effectiveness

1. International trainings for students and faculties

Subject areas	*Host institutes, period of training*	*Output of the training*
Students		
	NIL	
Faculty		
Dr. Sudheer K.P.	• Monash University, Australia (2 months) • Melbourne University, Australia • RMIT University, Australia • The NAHEP-CAAST project functioned at KAU also enables international training of the faculty at Australia (for 2 months). This could facilitate the joint-research programmes of the international universities like Monash University, RMIT University, etc. with KAU and uplifting the present research interests in the food sector. A student from Monash University has visited the centre, 26tilized the facility at the centre for his research.	• International research collaborations with Monash University, Melbourne University and RMIT University. • Indo-Australian strategic fund has been proposed for Monash University under DST-Vajra project. • A PhD student from Monash University is involved in the research collaboration with KAU and utilizes high-end research facility developed under NAHEP-CAAST. • MOU signed for international collaboration with ICRISAT towards the establishment of World Vegetable Center. • Organised one-week national-level PG/PhD workshop and a Faculty Development Programme for various faculties and scientists across the country with the funding of the scheme including International and national resource persons.
Dr Binoo P Bonny	• Anglia Ruskin University, Cambridge, UK (Sept 25 – October 29, 2023)	• The program opened up exciting opportunities for self-directed learning and hands-on experience in higher education. It played a vital role in nurturing self-learning abilities and skills, particularly in emerging fields like lean thinking, circular economy, novel foods, remanufactured goods, resilient supply chain management, and the practical use of agricultural technology according to the affordance's theory.
Dr.Boby V Unnikrishnan Dr.Vaijayanthi P.V. Dr. Binitha N.K,	• International Rice Research Institute, Philippines one month	As part of training different facilities like international gene bank, grain quality centre, Zigler experimental station, genetic transformation lab, plant growth facilities, hybridisation unit, ware housing, phytotron, seed health unit, Rapid Generation advancement (RGA), pathology unit, breeding programmes, post-harvest straw handling, machine learning to monitor pests, drought experiments, greenhouse gas emission (GHG) measurements were visited. In addition, there was discussion with scientists working on various aspect. Correspondence with scientists for collaborative research is in progress.
Dr. Berin Pathrose	• Queensland, Brisbane, Australia	The visit was highly useful and understanding the best practices in designing and executing a

		fumigant toxicity bioassay, maintenance of insect cultures and in assessing the toxicity of fumigants. The exposure was also helpful in executing an experiment for evaluation of the toxicity of non-toxic gases such as CO_2 and N_2 in silos. The use of sensors in real-time monitoring of phosphine, CO_2 and N_2 in silos can be ideal tool for management of storage pests in modern silos.

2. National trainings for students and faculties

Subject areas	*Period of training, total beneficiaries*	*Output of the training*
Students		
Plywood manufacturing technology	One month training at the Sub Centre of Institute of Wood Science and Technology, Visakhapatnam. Total 3 beneficiaries	By providing a detailed account of hands-on training experience, convey a comprehensive understanding of your practical skills in this field. This can be beneficial when applying these skills in professional or research settings.
Advanced Social Science Research Approaches	At International Rice Research Institute (IRRI), SARC, Varanasi, UP, Under NAHEP-CAAST, KAU November 28th to December 27th, 2023 Total -6 beneficiaries	Gained in-depth knowledge about the various qualitative analyses, sampling methods, photovoice, and Nvivo software. Introduction to Kobo Toolbox in crafting questionnaires, sharing forms, collecting responses, and exporting data to Excel sheets. Basics of R and STATA in statistical analysis
Innovation and Entrepreneurship Development in Agriculture and Startup Ecosystem	at ICAR-NAARM, Hyderabad, November 20th -December 19th 2023 Total 4 beneficiaries	FPO registration rules under the companies act such as Producer certificate or VRO recognition certificate, MoA, AoA, Bank statements and other personal documents. Pecha Kucha method of presentation for effective communication, "Business Modelling and Networking – Business Model Canvas and Business Strategy Case study" Startup Ecosystem, Lean Startup, Team and Vision, Product Market Fit, Business Model Canvas and its different components, Market Strategy and Networking - New Market Development"
Crop improvement /biotechnology/ bioinformatics	*At IARI, New Delhi and IISR, Calicut 6students*	Got exposure in Various advanced technologies like CRISPER various tools in bioinformatics etc, metabolomics, transcriptomics and bioinformatics. The knowledge and skill acquired during the programme significantly increased my understanding of advanced techniques and methodologies.
< list of trainings in Annexure5>		

2.2. Input and activity monitoring

	Capital	Revenue
Total funds sanctioned during 2019-2023 by PIU (INR Lakhs)	680.24	1292.98
Total funds received till December 31, 2023 (Cumulative) (INR Lakhs)	680.24	1192.98
Total expenditure up to December 31, 2023 (INR Lakhs)	**671.41182**	1091.07926

Input / Activity indicator	Sub- head / category	September 2019 to Dec'2023 Expenditure / input in INR lakhs		Activity elaboration
		Utilization	Planned	
Goods and equipment	Equipment, Plant & Machinery	**227.60369**	**227.60369**	Utilized completely
	Office equipment	**6.095**	**6.095**	Utilized completely
	Laboratory equipment	310.44987	313.00662	Balance 2.55675 not sufficient to purchase the required equipment
	Furniture & fixtures	16.11174	16.11174	Utilized completely
	Computers and Peripherals	13.36295	13.36295	Utilized completely
	Books and Journals	16.66	16.66	Utilized completely
Civil works	Minor repair and renovation work	81.12857	87.4	Balance Rs 6,27,143 completed all planned activities
Human capacity building	National level training	11.44686	11.45	Balance Rs 314 completed all planned activities
	International level training	25.06015	26.95	Balance Rs 1,88,985 completed all planned activities
	Short visit/ seminars	0.7254	0.93	Balance Rs20,460
	Meetings and workshops	12.2822	12.29	Balance Rs78
Consultancy	National level consultancies	0.9676	0.9676	Utilized completely
Recurrent cost / Miscellaneous	Travel	4.16898	12.38	Balance Rs 8,21,102
	Contractual services	261.11886	261.11886	Utilized completely
	Operational costs	742.86228	810.74354	Balance Rs67,88,126

Input / Activity indicator	Sub- head / category	September 2019 to Dec'2023 Expenditure / input in INR lakhs Utilization	Planned	Activity elaboration
	Institutional charges	32.44693	56.15	Balance Rs23,70307
Total		**1762.49108**	**1873.22**	Balance Rs 110,72892 to be refunded

Observation

<<Please provide the explanation on the progress made against the input and activity monitoring parameters>>

The capital amount was almost fully utilized completing all planned procurements except one and all the renovation works. Under revenue the balance amount is from the unutilized amount from consultancy which could not be utilized due to the COVID situation.

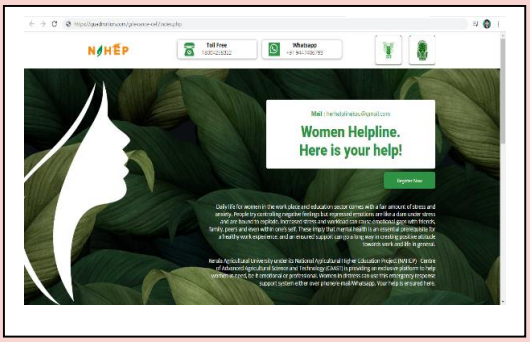
2.3. NAHEP outreach and other unique initiatives undertaken

Please provide the brief progress undertaken against the different categories placed below along with the suitable photographs/links/documents etc. Please note that only significant activities/initiatives are to be incorporated in this document.

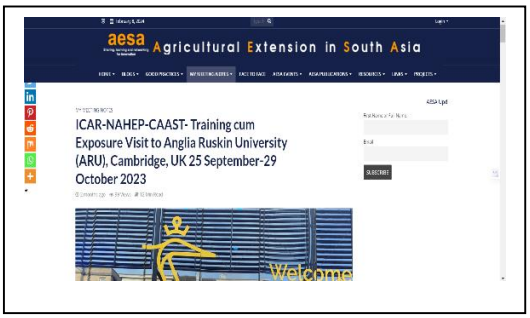
a) Knowledge management and outreach initiatives (development of collaterals, newsletter, social media outreach activities, creation of website, experiential learning workshop, exposure visits (provide the details of the documents/articles/reports/modules/social media outreach/ website creation/experiential learning workshop/exposure visits etc. developed under NAHEP along with the suitable photograph of the cover-page and web-link (if available) – brief summary, cover page,

S.N	Category of the collateral	Brief summary	Snapshot/cover page	Weblink (if any)
1	Technical bulletin	Technical bulletin for NAHEP-Centre for Advanced Agricultural Science & Technology (CAAST) project on 'Knowledge and skill development on coconut based secondary agriculture' by KAU Agri Business Incubator, Vellanikkara. The publication	Annexure 4	

		focuses the significance of coconut processing, the edible portions of coconut and coconut value addition that showcases the immense research and entrepreneurship opportunities.		
2	Technical bulletin	Publication on 'Prospects of Value Addition in Coconut' by KAU Agri Business Incubator. The publication overviews the prospect in value addition of coconut and different value added products from coconut.	Annexure 4	
	Handbook	Handbook on Coconut palm wood titled "The Coconut Palm Wood Handbook" by E.V. Anoop, M.C. Anish, R. Sujatha, Jobin Kuriakose and Pavin Praize Sunny	Annexure 4	
	Manual	Manual on portable sawmill operations and lumber production schedule for value added utilization of coconut Stem Wood by T.K Dhamodharan, E.V. Anoop, Vishnu R and Pavin Praize Sunny	Annexure 4	

24 x 7 - Women Helpline Portal		(http://she.kau.in)

b) Unique initiatives undertaken

Blog on international training attended for extension professionals		https://www.aesanetwork.org/icar-nahep-caast-training-cum-exposure-visit-to-anglia-ruskin-university-aru-cambridge-uk-25-september-29-october-2023/

1. Digital infrastructure

(development of digital/smart classroom, virtual reality facility, digital library system, other digital education and administrative infrastructure, Agri Diksha, AMS implementation etc.)

A smart training hall has been installed with audio/ visual aids and air conditioning facility for conducting hands-on training and awareness programs. The facility also has installed arrangements to conduct online sessions or virtual classes with international resource persons through online platforms like Zoom, google meet or Webex.

PG digital resource room with digital/smart interactive board facilitating online classes

2. Digital initiatives:

(organizing trainings through online, conducting online examinations, administering attendance, developing of web applications, e-learning modules etc.

S.N	Category of the collateral	Digital initiative	Practice before introduction of the initiative	Practice after introduction of the initiative
1	Web-based applications – Zoom/ webex	Purchase of licenses for Zoom to conduct online classes and attending meetings	Amidst the restrictions due to COVID19, online platforms were essential for organizing and conducting of scheme activities	Conducted more than 60 webinars and online workshops with various resource persons across the country. Some of the webinars are shown in Annexure 11.
	Organizing online trainings	Webex collaboration suit	Off line class room sessions	Mostly hybrid mode facilitating classes of experts from International learning Centers

Please provide up to 15 photographs with high quality (minimum 1-2MB) and label with suitable caption. Attach the photographs separately in the mail.

Potential impact of the intervention:

Observation
<<Please provide the explanation on potential impact of the intervention in short and long term while illustrating the key initiative/activity. Also, relate how input turned into output→outcome→impact in brief sentence or graphical way. Consider one or two examples/cases etc, >> Agri Business Incubator is a potential centre of NAHEP-CAAST, KAU that hosts an entrepreneurial ecosystem for startups with cubicle facility provision on rent basis. Further, the ABI laboratory is a self-sufficient research support to the PG/PhD scholars of KAU and other universities and for the technology requirement of startups. With the intervention of the NAHEP-CAAST project at the centre, ABI laboratory has been renovated to occupy high-end hot extrusion, carbonation and bottling and dehydrated products processing lines. Also, the project support was utilized for creating a smart training hall with audio/ visual aids and air conditioning facility for conducting hands-on training and awareness programs. The facility also has installed arrangements to conduct online sessions or virtual classes with international resource persons through online platforms like Zoom, google meet or Webex. Further, hygienic food practices in the lab were ensured with the purchase of miscellaneous equipments. As an outcome to the research and infrastructure efforts put by the centre under the project, around 7 process technologies were developed exclusively for the processing, value addition and preservation of coconut based products, which involves the PG/PhD theses. The funding from the project was utilized for organizing FDP program, PG/PhD workshop and workshop on IOT and Robotics in Drone Technology (Annexure 12).
At the Coconut Wood Technology Centre at College of Forestry, Thrissur, CAAST Project helped to increase the efficiency of process of conversion, and processing of coconut lumber and could develop diverse value-added products from “waste” wood. Diversification of products like wood composites, furniture, handicrafts, wooden toys, kitchen utensils, flooring and wall panel production, bored coconut pillars, provide an opportunity to start micro, small, medium, and large enterprises in this sector. These initiatives will lead to fetch higher price by farmers for the coconut wood harvested from their farm. Additionally, this will create high employment opportunities in the carpentry sector using coconut wood replacing conventional timbers. Production and sale of the coconut wood-based products developed using CAAST facility generate additional income to the Institute. Moreover, consultancy service for various wood testing services using CAAST facilities also generate income. Production of wooden toys from coconut wood by KODOCO toys and export of treated coconut palm wood by Golden Kerapalm company are two out of box start up resulted from CAAST intervention. In addition to this, CAAST Project improved the research and academic outputs which is evident from increase in the students’ achievements like JRF/SRF awards, publications, and trainings
The Neera Processing unit and Briquetting unit under Coconut Mission, College of Agriculture, Padannakkad, Kasaragod developed under the CAAST project are two niche areas in coconut sector which were not utilized in its full potential before the implementation of the project. The project activities helped to bring out the health benefits of neera and

products from it like palm jaggery, palm sugar etc into limelight and the possibilities of exploiting the national and international market as neutraceuticals. There are several FPCs in coconut sector who have facilities suitable for neera processing but inactive due to financial crisis which can be revived by adopting the technology developed in this area. The utilization of huge biomass produced by the coconut tree such as dried fronds, spathe, husk from mature nut as well as from tender coconut industry, shell, coir pith, trunk of senile / diseased tree etc through briquetting / composting is an untapped and innovative idea which could be materialized with the implementation of the CAAST project. This out of box initiative under the project could address the environmental problems caused by this huge biomass which otherwise are either burnt or left in the field/ coconut processing centres. The advanced PG and faculty research in this area could be taken up and will be continued to convert these biomass residues to be recycled as soil amendments and as slow release mechanism to increase fertilizer use efficiency thus aid in agriculture or as fuel briquettes in boilers used in the coconut industry.

Challenges faced and lessons learned while implementing the project at AU:

Challenges	
1	The pandemic lock down related restrictions resulted in delayed supply of goods. Also post covid increase in the price structure has resulted in withdrawal of vendors from supplying equipment. Research activities were delayed as labs were closed and staff could not work continuously and difficulties in field activites. Also availability of reagents and services were delayed leading to delay in conducting experiments. Installation and maintenance of equipments were adversely affected at the time but which were cleared later.
2	COVID19 regulations minimized the opportunities for hands-on trainings to students and farmers, research activities and international trainings
3	Under operational coat permission needs to be given to carry out minor repair works with cost less than INR 2.0 lakhs (~ 2000 USD) such as making a platform for installation/ floor repair in a small room in the main lab etc or minor lab instruments (eg: a pH meter/ small weighing machines / stirrer/ spinwin /pressure washer/ a microwave oven etc) which is too small to be included in the capital head and following STEP procedure, but which are very essential for the installation of equipment/machinery or accessories required for the items procured under capital head. Considering all these under assets and classifying under capital item by the auditors cause great difficulty in utilizing the amount under operational cost for genuine requirements
4	For "consultancy" we were not familiar with the procedure. Initially the exact nature of appointing a consultant was not very clear for us resulting in selecting a large number of short areas which finally had to cancel due to COVID -19 situation at that time. Only one of the planned consultative workshops / consultancy programme scheduled was completed within the specified period, while all the remaining were either cancelled or had to be converted to online trainings. Many of the individual consultants who submitted applications and ToRs when contacted later were unable to revive the programme due to personnel reasons or other commitments.
5	Initially while preparing the DPR, it was understood that minor equipments and repair works (less than Rupees one - two Lakhs) need not be included in capital item as it will be difficult to monitor and follow the STEP procedure. However many such works were very essential for the effective working of the equipment/machinery procured, lab repair works, class room facility modifications etc.
6	Use of STEP software in procurement helped to keep track of the procurement activities and we got several trainings and help from PIU as this was a new procedure. However, some hitches are still to be resolved.
7	In the CAAST- KAU project, the transfer and change of Drawing and Disbursing Officer (DDO) and project centre from KCAET Tavanur to Agricultural Research Station Mannuthy as well as transfer orders of some of the CoPIs, etc caused much difficulty in implementation of various activities.
8	Due to constant change of the finance personnel concerned with the project fund handling, updating the finance section every time was required in the University about the project. This resulted in slowing the pace sometimes and difficulty in preparing the audit statements and reports.
9	In remote centres, non-availability / scarcity of technically trained contract staff to carry out the research work caused much struggle for the respective scientists to complete the research objectives.

10	At university level, the distance between different CAAST centers caused some difficulty in coordinating various activities
Lessons learned	
1	Measures to tackle the issues related to the unforeseen circumstances like the pandemic need to be taken well in advance
	Trainings and constant support from PIU helped in overcoming several procurement difficulties
2	At AU level, brief training needs to be given to selected higher officials in administrative and finical sections about the difference in financial rules while implementing the project, mode of implementation and the project monitoring methods. It needs to be emphasized that such trained persons as well as the project CoPIs are not transferred from the respective centres till the project is over, as insisted in the case of PI.
3	Similarly specific instructions to University administrations about international trainings and consultancy would have made the efforts of project team much easier to achieve the targets set in these areas as these were new items in an externally aided project compared to those implemented earlier
4	For "consultancy" also it would have been effective if a detailed a training as in the case of procurement was given
5	The PMTS software, OOF reports and scoring of the various activities created a healthy competition to strive hard by each University

3. Sustainability Plan

3.1. Sustainability plan of the AU

- *Does the AU have any sustainability plan for the interventions undertaken in NAHEP? (Yes / No)? (Yes / No)*
- *If yes, details thereof?*

1.	Continuing the advance research programmes initiated to address the gap in technology and commercialization with state support (STATE PLAN Projects have been sanctioned)
2	Seeking new projects by utilizing the facilities developed under NAHEP- CAAST Project
3	Continuing the research activities by utilizing the facilities of CAAST Project through PG .and PhD projects
4	Transfer of technology to industry: KAU ToT committee have approved several of the technologies developed for Transfer of Technology to interested stakeholders : Coconut chips, Coconut milk based ready to serve, Spray dried coconut toddy powder, Spray dried neera powder, Coconut palm jaggery (Kerachakkara), VCO based Face cream VCO based Mouth wash VCO based Hair cream Coconut wood preservation – inorganic treatment etc
5	Year-round training to various stakeholders
a	EDP trainings and incubation facilities with the advanced equipments procured and technology developed under the project to various stakeholders at ABI, Thrissur
b	Initiated the efforts to sign MoU with Industrial Training Institute ,Nadathara, Thrissur for giving training to students in carpentry works by using the facility of Coconut Wood Technology Demonstration Centre established in the College of Forestry under CAAST Project.
c	Collaboration with Coconut Development Board, Kochi for giving training to various stakeholders in processing and value-addition of coconut wood by using the facility of Coconut Wood Technology Demonstration Centre established in the College of Forestry under CAAST Project.
d	Collaboration with KADCO, Govt. of Kerala for giving training to various stakeholders in processing and value-addition of coconut wood by using the facility of Coconut Wood Technology Demonstration Centre established in the College of Forestry under CAAST Project
6	Efforts has been initiated to start paid consultancy services of various tests of wood parameters
7.	Efforts has been initiated to start short term courses by utilizing the facilities developed under CAAST Project
8.	MoUs with other Institutes, industries, NGOs and FPOs

3.2. Sustainability plan for improving internal revenue generation through facilities and infrastructure created under the project

1	The state-of-art facility developed at the centre for food processing and quality control would be utilized for PG/PhD theses across the country, for the charges as approved by the university.

2	The coconut mechanical processing line established at the centre for coconut milk, dessicated coconut and VCO would be used for starups for incubation supports at nominal charges.
3	The renovated training hall at KAU ABI would be used for public/ private programmes for the charges as approved by the university.
4	Production and sale of various products developed through Revolving Fund-mode:
a	coconut wood products manufactured at Coconut Wood Technology Demonstration Centre at College of Forestry Wood Testing Unit of College of Forestry
b	Neera, coconut palm jaggery, coconut palm sugar and coconut sweet balls, neera sipup, neera syrup cookies etc in RF mode at Coconut Mission, College of Agriculture, Padannakkad
c	Coconut kernel based products like VCO and VCO based Face cream, Mouth wash,Hair cream, coconut curry powders, various drinks from coconut water etc in RF – SHG mode at RARS Pilicode and CRS Thruvananthapuram

4. Contribution of each individual in project

4.1 Name of Vice Chancellors(s) during project duration and contributions each PI, Co-PI and team along with their photographs

Honorable Vice Chancellors during the period : 1. Dr. R Chandrababu

2. Dr. B. Ashok, IAS

PROJECT DESIGNATION	NAME OF CENTRE and contribution		CAAST TEAM	Gender	contact details (email, mobile)
Co-Ordination at University level & Nodal Officer M&E	KAU- Director of Research	1	Dr. P. Indiradevi Professor (Retd)	F	9447416875 indiradevi.p@retd.kau.in
		2	Dr. Madhu Subramaniyan Professor	M	dr@kau.in 94471 00151
Principal Investigator	Coconut Mission, KAU (Neera, coconut crop improvement, briquetting)	3	Dr. Sujatha. R Professor & Associate Director of Research	F	sujatha.r@kau.in 94959 81544
Co-Principal Investigator	Agri Business Incubator (ABI), KAU (entrepreneurship, food technology, business Incubation)	4	Dr. Sudheer K.P.. Professor & Head	M	kp.sudheer@kau.in 9447689466
Procurement Officer & Co-Principal Investigator	Dept of Forest Products Utilisation, College of Forestry, Vellanikkara (coconut wood value addition)	5	Dr. Anoop E.V., Professor & Dean	M	anoop.ev@kau.in 94953 75541
		6	Dr. Anish M.C., Asst. Professor	M	anish.mc@kau.in 94977 42165
Nodal Officer, Social Security & Co-Principal Investigator	Dept. of Extension, College of Agriculture, Vellanikkara (COAV) (FPO analysis)	7	Dr. Binoo P Bonny Professor & Headf	F	binoo.pb@kau.in 94474 06793
Nodal Officer, Environmental Safety & Co-Principal Investigator	Agri Engineering Agriculture Research Station (ARS), Mannuthy (Mechanisation)	8	Dr. Suma Nair Asst. Professor	F	suma.nair@kau.in 9446157139
	Dept of Economics, College of Agriculture, Vellanikkara (COAV) (Market analysis)	9	Dr. P. Indiradevi (Retd)	F	indiradevi.p@retd.kau.in 9447416875
			Dr. Anil Kuruvila , Professor & Head	M	anil.kuruvila@kau.in 94972 33293
Nodal Officer Grievance Redressal	Dept. of Agri Engineering	10	Dr. Mini P.K., Professor & Head	F	mini.pk@kau.in 9496430794
Co-Principal Investigator	Regional Agricultural Research Station (RARS), Pilicode (Products from coconut kernel and trainings)	11	Dr. Satheesan K.N., Professor (Retd)	M	ansabivi@gmail.com 9567672816
		12	Dr. Meera Manjusha A.V., Asst. professor	F	meera.manjusha@kau.in 98955 14994
Co-Principal Investigator	Coconut Research Station (CRS) Balaramapuram & Dept of Plant	13	Dr. Radhakrishnan N.V., Professor & Head	M	radhakrishnan.nv@kau.in 94462 83898
		14	Dr. Joy M., Professor & Head	M	joy.m@kau.in 8547195426

	Pathology CoA, Vellayani (Products from coconut kernel and trainings)				
Co-Principal Investigator	Instructional Farm (IF), Vellanikkara	15	Dr. Anitha S Professor & Director (Seeds)	F	9446433292
Co-Principal Investigator	Dept of Soil Science & Agriculture, COA, Padannakkad (Briquetting)	16	Dr. Suresh P.R. Professor (Retd)	M	9447181544
	Dept of Soil Science & Agriculture, COA, Padannakkad (Biochemical analuysis)	17	Dr. Binitha N.K. Asst. Professor	F	99953 80561
Co-Principal Investigator	Dept of Community Science COA, Padannakkad (Food technology)	18	Dr. Krishnasree V Asst. Professor	F	9962001164
Co-Principal Investigator	Dept of Genetics & Plant Breeding, COA, Padannakkad	19	Dr. Vaijayanthi P.V. Asst. Professor	F	7411211803
Co-Principal Investigator	Dept. of Microbiology, CoA, Vellanikkara (Micrbial composting)	20	Dr. Boby V. Unnikrishnan Asst Professor	M	97395 19697
Co-Principal Investigator	Dept of Forest Products Utilisation, College of Forestry, Vellanikkara (coconut wood technology)	21	Dr. Vishnu R Asst. Professor	M	9447770412
Co-Principal Investigator	Dept. of Community Science, CoA, Vellayani	22	Dr. Geethalakshmi Asst. Professor	F	9446178477
Co-Principal Investigator	Kelappaji College of Agriculture Engineering and Technology (KCAET), Tavanur	23	Dr. Shivaji K.P. Professor	M	9895389801

4.1. Details of visits of PIU-NAHEP officials at your AU along with photographs (provide list)

- During the state level Inauguration in Septermber 2019, National coordinator (CAASTo and National Coordinator (M&E) visited KAU
- The National Director and National coordinator visited all centres of KAU in 2022 August
- The NAHEP National Director, AHEPC members,National coordinators and PIs from 13 CAAST centres in the country, and other officials have visited at KAU during the Annual review meeting of CAAST conducted at Kerala Agricultural University, Thrissur.
- The World bank team representing the implementation of ICAR-NAHEP CAAST program has also visited the KAU