ICAR-National Agricultural Higher Education Project

Annual Progress Report: April 2020 to March 2021

Component 1b: Centre for Advanced Agricultural Science and Technology

Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra

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Executive summary

Name of the AU: Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar. Maharashtra
Project Title: Centre for Advanced Agricultural Science and Technology for Climate Smart Agriculture and Water Management (CAAST CSAWM)

Executive Summary:

The Centre for Advanced Agricultural Science and Technology (CAAST) for Climate Smart Agriculture and Water Management (CSAWM) is functional since 2018 at Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri. It is implemented through the National Agricultural Higher Education Project (NAHEP), a flagship project of the Indian Council of Agricultural Research (ICAR) New Delhi. Its thrust areas are climate smart agriculture and water management, Geo-informatics (RS/GIS), UAVs (Drone), Robotics, IoT, and precision agriculture.

Broad Activities/ Achievements during the year from April 01, 2020, to March 31, 2021

Mahatma Phule Krishi Vidyapeeth, Rahuri has been awarded the CAAST on Climate Smart Agriculture and Water Management with the main objectives of:

1. To develop the capacity amongst the faculties and scientists for the development and adoption of the precise Climate Smart Agriculture and Water Management technologies
2. To start the one year Post Graduate Diploma in "Climate Smart Agriculture and Water Management" for developing the human resources enabling them to start entrepreneurship and be employable in the public sector and private industries, strengthen the current M.Sc., M. Tech. and Ph. D. programme (for their research projects); and make provision for the perspective beginner/middle-level faculties/researchers for Post Doctorate studies in precision water management, precise climate smart agriculture and Geo-informatics
3. To develop an integrated system including RS/GIS and GPS tools, modelling and SDSS tools using unmanned aerial system (UAS, aka, drone) and sensor-based technologies; and mobile applications and their applications for climate smart and precision agriculture and water management and
4. To conduct end-to-end capacity building through on-the-job training and case study-based learning; enhance the employment and placement rate; and business and entrepreneurship opportunities.

The broad activities emphasizing the significant achievements are highlighted below,

1. Capacity Building

The focus of this Centre has been to develop the capacity for the development and adoption of climate smart agriculture and precision water management technologies amongst the students and faculties of MPKV Rahuri through International/National training, webinars, workshops, conferences, symposia, students-industry interface, guest lectures, exposure visits and demonstrations on different thematic areas.

The lockdown in India started from the last week of March 2020 due to Covid 19 pandemic. However, the CAAST-CSAWM immediately shifted to the online mode of learning. During the last week of March 2020, the CAAST-CSAWM developed the online learning model and methodology for organizing multisession online training programmes. Accordingly, it declared the first online national training programme in India in the first week of April 2020. Since then, CAAST-CSAWM has organized 05 International, 33 national training programmes, 16 workshops, 12 webinars, 54 experts lectures, 07 demonstrations, 06 exposure visits consisting of 527technical sessions of 1.5-2.0 durations benefiting 20747 students and faculties of MPKV and 21047 students and faculties from other agricultural universities and 4340 farmers from Maharashtra state.

While organizing all these training programmes, webinars, and expert lectures, the participants were asked to complete pre and post-evaluation Proforma developed by CAAST-CSAWM consisting of about 10 questions related to the topic. After analyzing 17902 participants' responses, the average learning outcome of the organized training programmes was 80.87%.

Further, as a result of participation in online capacity development programmes, 34 M. Sc, M.Tech, and 37 Ph.D. students from different disciplines have taken research topics in different thematic areas of Climate Smart Agriculture and Water Management. The organization of the online training programmes, workshops and symposia also helped us to develop linkages with various International

and National organizations such as Washington State University, USA, Netafim Pvt. Ltd., Pune, Vasantdada Sugar Institute, Pune, Indian Society of Agriprofessionals, New Delhi, Indian Society of Soil Science, Society of Automotive Engineers and Drought Action Network and several industries, with whom CAAST had organized joint training programmes. In some of these programmes and events, the Alumni Association of Dr. Annasaheb Shinde College of Agricultural Engineering & Technology also joined hands with the CAAST project.

The CAAST, MPKV, was the first in India to shift to online learning mode. Therefore, we were able to explore the availability of experts during the lockdown period quickly and provided opportunities to students, faculties, and farmers who were otherwise clueless about what to do during the lockdown period and engaged them and kept them in positive and learning mode.

2. Academic Programmes

A. **Post-Graduate Diploma**: CAAST-CSAWM developed the module-based framework for the postgraduate Diploma in climate smart agriculture and water management. This module-based programme consists of four modules spread over 52 weeks, i.e. one year. Module -1 is of 10 weeks duration, consisting of 3 courses of 3 weeks, followed by "Industry and Farmers Days". Module-2and 3 are of 13 weeks duration each, consisting of 3 courses of 3 weeks duration each followed by a project of 3 weeks duration. Module-4 is of 16 weeks duration followed by a Project of 6 weeks duration. The PG Diploma framework and the 71 courses (related to CAAST-CSAWM thematic areas) to be offered in each module have been finalized during eight workshops and brainstorming sessions conducted at MPKV, Rahuri and Pune campuses with 28 National and International partners. This programme will be offered in the following five different specializations depending on the courses completed by the student.

   a. *Climate Smart Agriculture - Geoinformatics (GI)*
   b. *Climate Smart Agriculture – Natural Resources Management (NRM)*
   c. *Climate Smart Agriculture – Robotics, Drones, IoT& Precision Farm Machineries (RDI)*
   d. *Climate Smart Agriculture – Precision Water Management (PWM)*
   e. *Climate Smart Agriculture – Social Science (SS)*

   The CAAST-CSAWM devised the process for the development of the PG Diploma framework, course curricula, course contents, rules and regulations that consisted of the organization of brainstorming sessions and workshops involving all the stakeholders, including experts, industry partners, national and international institutes/organizations, NGOs, development departments, students. CAAST-CSAWM has organized 69 brainstorming sessions and 47 workshops, inviting 321 experts from different partnering organizations in this process.

   The entire framework, module-based courses, rules, and regulations have been approved by the Academic Council and Executive Council of MPKV Rahuri. Further, this PG Diploma has also been approved by the Maharashtra Council of Agricultural Education and Research (MCAER), Pune (coordinating body of all the four Agril. Universities in Maharashtra).

   MPKV Rahuri is ready to implement the PG Diploma programme as soon as the University campus is open for the students (as this would be the first batch, it was decided not to start the PG Diploma in the online learning mode).

B. **Strengthening of on-going Masters and Doctoral programs:** CAAST-CSAWM is strengthening existing masters (M.Sc., M.Tech.) and Doctoral (Ph.D) programs in different related disciplines by developing 07 courses related to the climate smart agriculture and water management as audit, non-grade or optional courses; and providing the opportunities to the students to complete their research projects on the topics related to climate smart agriculture and water management. The main aim of strengthening M.Sc./M. Tech and Ph.D. programmes is to make the students gain expertise in climate smart agriculture and water management, develop valuable tools and technologies, and write research papers in high-quality peer-reviewed journals on different thematic areas of climate smart agriculture water management. The students have already started undertaking projects related to climate smart agriculture and water management with the facilities and knowledge networking developed through CAAST-CSAWM. The audit and optional courses will be offered from the ensuing semester.

C. **Post-Doctoral Research Programme (PDF):** The sensitization workshops were organized from time to time to encourage prospective students/ candidates to register for the full-time PDF programme. As a result of this, 28 candidates have shown interest in the PDF programme, out of which the application process of 05 aspirants is in process. The research topics of 02 aspirants based on the thematic areas of CAAST-CSAWM were finalized. However, 26 candidates did not join

due to non-availability of financial support, and 2 candidates will join when students are allowed to join the studies in the University at the backdrop of the Covid Pandemic.

D. **Certificate courses:** The project aims at building the capacity and providing the training to the graduate or postgraduate individuals, faculties/scientists of MPKV, other Universities and Research Organizations; and the practitioners from the development departments and other concerned organizations in climate smart agriculture and water management to enable them to adopt these technologies for the productive and sustainable agriculture and provide the business and entrepreneurship opportunities. In this context, CASST-CSAWM has formulated the certificate courses of three weeks durations for the PG Diploma. These courses will be offered as (i) one course of three weeks, (ii) the combination of different courses of three weeks, (iii) one module of three certificate courses with or without a project or (iv) the combination of different modules. From March 2021, CAAST-CSAWM has declared the schedule of 11 standalone certificate courses (3 weeks each) and two modules (consisting of 3 certificate courses each) and completed three certificate courses on ***Organic Farming***, ***Basic Geoinformatics*** and ***Fundamentals of UAVs***. The total number of beneficiaries was 272. The revenue generated from the registration fees of these certificate courses was Rs. 4.35 lakhs.

3. Out of box research initiatives

Recognizing the importance of, Geo-informatics (RS/GIS), Drone, Robotics, IoT, and Precision agriculture technologies in climate smart agriculture and water management, CAAST-CSAWM developed the concept of real-time management of the inputs by using different gadgets and sensors for making farming attractive. Based on these concepts, the CAAST-CSAWM developed/developed several sensors, IoT, mobile, robotics, and drone-based technologies with active inputs from the research associates and association with PG students. These developed technologies include,

a. Development of Mobile and Web-Based Technologies

- Spatial ETr mobile and web applications
- Phule-SANMAN
- Phule soil textural triangle mobile App
- Smart weather mobile and web application
- VLCCP mobile and web application
- Teacher Evaluation System (TES)

b. Development of IoT Based Technologies

- Weather-based IoT System for precision irrigation scheduling
- Soil Moisture Sensor-based IoT System for precision irrigation scheduling
- Trench water level recorder
- Automatic ring infiltrometer
- Hydraulic conductivity meter
- Pump Controller for enabling automatic operation of pumps
- Automatic Weather Station (High, Low and Compact)

c. Development of Drone and Robotics Based Technologies

- Climate Resilient Resource Conservation Technologies for Sustainable Sugarcane production
- Development of VLCCP
- Gender attitude towards environmental protection during COVID-19
- Spatial Estimation of Rainfall Distribution
- Erodibility status of soils in Ahmednagar district
- Development of spectral signature for wheat
- Change Detection of Land Use Land Cover Mapping Using Google Earth Engine
- Exploration of Groundwater Potential Zone
- The effect of different crop growth stages on rainfall interception losses
- DSSAT Modelling for Chickpea and Wheat

Some of the above-developed technologies (web-based and mobile-based applications) have been submitted for copyright and received copyright registration for Student's Evaluation System (TES) mobile application. Also, the process of submitting other technologies for patents and copyrights is in the process.

d. 76 (61 students + 15 CAAST faculties)planned and implemented their research projects on the thematic areas of climate smart agriculture and water management. These students completed research projects on Geo-informatics (RS/GIS), Drone, Robotics, IoT, Google earth engine

applications and precision agriculture technologies. In addition to this, the students who have undergone international training at AIT, Bangkok, completed 20 individual projects.

e. Upgraded remote sensing and GIS CAD-CAM, Hydro informatics, Soil Health labs, drones, Robotics and Hyper-spectrometers labs.

f. The climate smart block has been developed in a 10 ha area to demonstrate the climate smart technologies to the students and faculties and provide the facilities to the PG students to undertake the research experiments in climate smart agriculture and water management. The revenue from the crop-based field experiments was Rs. 6.2 +lakh.

4. Knowledge Dissemination

A. Climate Smart and Digital Villages: The CAAST-CSAWM developed 09 climate smart and digital villages in collaboration with different partnering organizations for capacity building of students and faculties through on-the-job training and case study based learning. These villages are Manhere, Ambevangan, Ladgaon, Titavi, Kodani, Pimparkane and Dongarwadi in Akole Tahsil of the Ahmednagar district to be developed as the climate smart villages in association with BAIF and NABARD. Villages to be developed as the digital agriculture villages are Buchkewadi in Junnar Tehsil of Pune district in association with LUPIN and NABARD; and village Baburdi Ghumat in Nagar Tahsil of Ahmednagar district in collaboration with the Alumni Association of Dr. Annasaheb Shinde College of Agricultural Engineering, Rahuri, SEWA NGO and NABARD. The different activities to be performed to develop the climate smart villages and digital agriculture villages will be accelerated once lockdown is over (these activities are currently on hold except for online training programmes for the farmers in those villages). This Centre has organized online and offline workshops, training programmes and field visits to the selected villages to create awareness of the farmers and adopt climate smart and digital technologies.

B. Training Programme: Nine online and two offline training programmes in the local language were organized for the farmers in Maharashtra to train them on different aspects of climate smart agriculture and water management. The farmers were found receptive to the online training programme, and the responses from them were encouraging.

C. Crop Contingent Plan: The Centre has developed a procedure for downscaling the District Level Crop Contingent Plan to the village level and prepared crop contingent plans for the seven villages. The preparation of the crop contingent plan for the Buchkewadi and Bamburdi Ghumat villages is in the process.

D. Certificate courses: The project aims at building the capacity of graduate or postgraduate individuals, faculties/scientists of the University and Research Organizations; and the practitioners from the development departments and other concerned organizations in climate smart agriculture and water management by providing them on-the-job training by end-to-end capacity building through and case study-based learning; and thereby enhance the employment and placement rate; and business and entrepreneurship opportunities. In this context, CASST-CSAWM offered the Certificate Courses as detailed above.

E. Expert lecture series: To make the expertise and experience available to the students and faculties, the CAAST-CSAWM organized the experts' lecture series in which one or two experts address the students and faculties for about one hour along with the interactions. 54 lectures of the experts were organized.

F. This Centre has organized 5 weeks online training programme on competitive examinations and test series for JRF/SRF, NET, ARS, PhD entrance. A two-week online lecture series on agriprenuership and placement opportunities in agriculture and allied sectors, a four-day national training programme on national and international agricultural higher educational opportunities, was organized. As a result of these training programmes, 55 Students qualified for the JRF/ SRF / NET examinations, and 125 got admissions for the PhD programmes in different Agricultural Universities.

Progress made during FY 2020-21 under NAHEP

1.1. Output-outcome monitoring

S. N.	Particulars	Apr '20 to March '21		Remarks (Action plan for areas where improvement is needed)
		Plan	Achievement	
1.	Number of technologies transferred to industry / private sector / national / international organizations	250	280	Increased collaboration with industry, private sector, national and international organizations; and attempts for obtaining copyrights, patent
2.	Number of students selected in JRF / SRF / ARS	45	55	
3.	Number of students who were admitted to foreign universities	-	-	Students will be encouraged to take admission to foreign universities by organizing additional special workshops and sessions
4.	Number of students who received National Young Scientist Award	-	-	Master and Doctoral students will be encouraged by organizing additional capacity building programmes
5.	Number of students received ICAR's Jawaharlal Nehru thesis Award	-	-	• 9 students applied for ICAR's Jawaharlal Nehru Thesis Award • Organizing capacity building programmes on research effectiveness • These attempts will be continued
6.	Number of students awarded at Agri-Unifest	-	-	Not organized due to Covid 19
7.	Number of students awarded at Agriuni sports meet	-	-	Not organized due to Covid 19
8.	Number of industry-sponsored projects and positions in cutting-edge areas of agri-science	05	09	The efforts to increase the collaboration with industry and private sectors will be continued
9.	Number of competitive grants from a national/international funding agency	50000 lakh	41034.73 lakh	The Young Scientists will be encouraged by organizing the brainstorming sessions
10.	Number of international training programmes undertaken by faculties under CAAST comp	03	05	
11.	Number of national training programmes undertaken by faculties under CAAST comp	30	33	
12.	Number of international trainings undertaken by students under CAAST comp	03	05	
13.	Number of national trainings undertaken by students under CAAST comp	30	33	
14.	Number of direct beneficiaries of the project	30,000	39139 (students and faculty) 4340	

			farmers	
15.	Number of female beneficiaries out of total direct beneficiaries	10000	16932	

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Observation
• CAAST-CSAWM, MPKV, Rahuri is the pioneer in conducting online national and international training programmes, workshops, webinars, expert lectures and farmers trainings • 16169 Faculties & 22970 Students received benefits. • The average learning outcome of training programmes (2020-21): 80.87 % • Successfully organized three weeks of online certificate courses on the thematic areas of climate smart agriculture and water management • The revenue generated from the registration fees of certificate courses was Rs. 4.35 lakh • 34 Master and 37 Doctorate students have undertaken research projects on natural resource management practices with advanced technology • 48.65 % increase in JRF / SRF / ARS • 09 students applied for the ICAR Jawaharlal Nehru Thesis Award • 43.26 % of female beneficiaries • 11 proposals submitted for externally funded projects • Activities for specific areas such as the Young Scientist Award/J.N.Awards and International Fellowship need to be enhanced.

1.2. Input and activity monitoring

Total funds received during 2020-21 by PIU (INR Lakhs)	399.52 Lakhs
Total funds received till 2020-21 (Cumulative) (INR Lakhs)	1911.56 Lakhs
Total expenditure during the year 2020-21 (INR Lakhs)	643.03 Lakhs
Total expenditure till 2020-21 (Cumulative) (INR Lakhs)	1485.99 Lakhs

Input / Activity indicator	**Sub- head / category**	**Apr'20 to March'21 Expenditure/input in INR lakhs**		**Activity elaboration**
		Utilization	**Planned**	
Goods and equipment	Equipment, Plant & Machinery	**158.45**	**91.16**	Equipment and machinery, namely Unmanned Aerial Vehicles (drones) with application and sensors, servo motors, stepper motors, electrostatic sprayer, linear actuators and grippers, PLC and OPC, telemetry and RTK systems, agricultural tractor and robotic harvesting machine were purchased from the grants of Equipment, Plant and Machinery.
	Office equipment	**3.51**	**4.14**	Refrigerators, LCD projectors and multifunction machines, license copies of operating systems and Microsoft Office

Input / Activity indicator	Sub- head / category	Apr'20 to March'21 Expenditure/input in INR lakhs Utilization	Planned	Activity elaboration
				were purchased from the grants of office equipment
	Laboratory equipment	**87.96**	**69.37**	Automatic weather station (AWS), sensors for light detection, temperature, radiation measurement, sensors for water level monitoring, sensors for measurement of CO2, NH3, O2, ethylene were purchased. Further, protected cultivation structures viz., polyhouse, flat top shade net house and cable and post shade net house were erected from the grants of laboratory equipment.
	Furniture & fixtures	**2.56**	**2.57**	Storewel Plains, student benches, storage racks and waiting chairs were purchased from the grants of furniture and fixtures
	Computers and Peripherals	**8.00**	**8.30**	18 Desktop computers were purchased to establish student's laboratory as well as completion of day-to-day activities of the project
	Books and Journals	**8.28**	**8.28**	Online journals were subscribed. Further, books from different disciplines pertaining to thematic areas of the project, including reference books, were purchased.
Civil works	Minor repair and renovation work	**32.13**	**36.98**	Works of renovation of seminar hall, staircase and flooring with electricity and UPS backup were completed
Human capacity building	National level training	**0.00**	**0.00**	**NA**
	International level training	**0.00**	**20.71**	The expenditure on International Level Training could not be completed due to COVID 19 situation.
	Short visit/ seminars	**1.76**	**4.14**	The expenditure on faculty participation in seminars.
	Meetings and workshops	**0.91**	**2.90**	The amount was utilized to meet the expenditure during state and national meetings and workshops
Consultancy	National level consultancies	**12.83**	**29.00**	Seven individual consultants were hired from October 2020 to March 2021. The expenditure

Input / Activity indicator	Sub- head / category	Apr'20 to March'21 Expenditure/input in INR lakhs Utilization	Planned	Activity elaboration
				incurred for the remuneration to consultants.
Recurrent cost / Miscellaneous	Travel	**1.01**	**9.00**	The expenditure was incurred on field visits for students, staff meetings for collaboration with national partners etc.
	Contractual services	**206.97**	**194.84**	Salary of contractual staff, skilled workers, and office and field assistants was incurred from this head.
	Operational costs	**113.32**	**151.28**	Expenditure on recurring contingent charges for management and operating laboratories, farm inputs etc., was done through this head. Expenditure for contingencies required for innovative research projects, including the purchase of different components and spare parts for these projects, was incurred
	Institutional charges	**5.34**	**20.39**	Expenditure incurred on payment of auditor's fees, electricity bills and development of farm improvement activities through the University
Total		**643.03**	**653.06**	

Observation
• Due to the Covid-19 pandemic, some of the procurement activities were shifted to 2020-21. Therefore the utilization for 2020-21 was more than planned. • Total utilization of funds was 98.46% compared to planned expenditure during 2020-2021. • Despite Covid- 19 pandemic, the overall utilization was satisfactory, and all the activities planned on STEP have been completed.

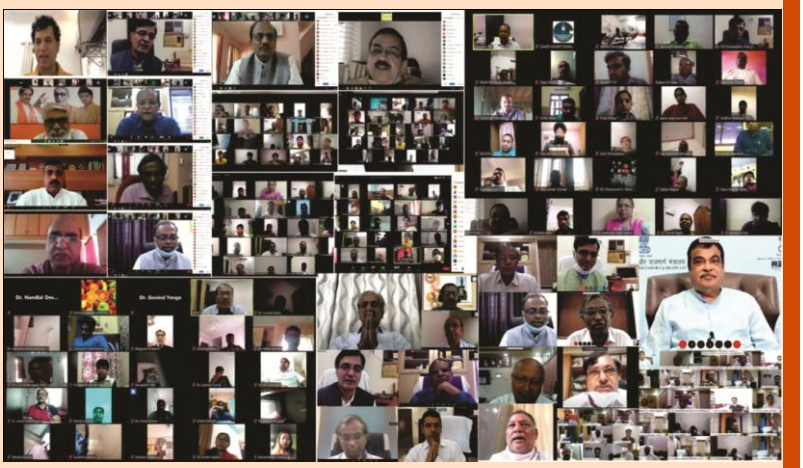
1.3. NAHEP outreach and other unique initiatives undertaken

a) Case studies/success stories developed under NAHEP

Illustrative: Success story

1. CAAST-CSAWM Online Training Module

The coronavirus pandemic and the resulting lockdown forced the immediate closure of schools, colleges and offices across India since the second week of March 2020. CAAST-CSAWM devised an action plan to counterbalance this challenging situation: it encouraged the team to work from home during the lockdown period for writing research papers, course curricula, conducting online certificate courses, and training programmes.



The project decided to conduct online training programmes for students and faculties of MPKV a+
nd other agricultural universities across India. The main objective was to use the opportunities to learn the different aspects of Climate Smart Agriculture through online training programmes.

The steps followed in the development of **the** CAAST-CSAWM Online Training Module are,

1. In house planning through online consultations
2. Preparation of Announcements, Brochures, Technical Programme
3. A technical programme designed for both morning and afternoon sessions of two hours each
4. Online applications are through the CAAST-CSAWM Website
5. Screening of the applications received
6. Selection of eligible participants. Formation of separate WhatsApp groups for the selected candidates. Information through email to the non-selected candidates.
7. The Centre provided all the training related information and practices through WhatsApp. It included using the online platform, participation norms in the training programme, session details, assignment links etc.
8. The Centre provided training to the selected participants through the online platforms (Zoom, Go to meetings, Webex, MS Teams, and Google Meet etc.). To others, links were provided for live streaming sessions through YouTube and Facebook platforms.
9. The trainees filled out the Pre-Training Evaluation proforma through Google forms on the first day of the training programme.
10. The participants posted their questions and doubts in the Chatbox. The resource persons directly responded to the participants' questions and doubts after the online session. Every session concluded with a quiz.
11. Online literature, including session notes, presentations and a compendium of the training material, was provided to the participants through email
12. The participants provided their feedback and the post-training evaluation proforma through the Google forms on the last day of the training programme.
13. Valedictory function on the last day included expert lectures by guests.
14. Online distribution of the Certificates to the eligible participants

Outcome

- Positive, meaningful and purposeful engagement of the students, faculties, resource persons and CAAST-CSAWM Team members, RAs and supporting staff during difficult COVID19 lockdown period enabling all to be in a proper state of mind during this period
- Online training programmes were of the capacity from 50 to 1000. The number of applications crossed 2500-3000, indicating the stakeholders' need for training, online activities and engagement during the lockdown period.
- The Centre has well-planned procedures for a complete online training programme, including online lectures, practicals, demonstrations, field visits developed and successfully implemented.

- Organized 61 online events (training, webinar, workshop, brainstorming sessions) and developed the capacity of over 50,000 students, faculties, practitioners, farmers etc., during the ten months, which otherwise would have required more than two years.
- Developed the confidence that the online capacity building programmes can be effectively implemented and hence, in turn, induced the culture of online training that have several positive facets

Benefits

- Throughout the lockdown period, the Centre conducted paperless online training programmes and did not use paper or plastic banners and posters.
- Saved tonnes of carbon footprint (estimates in progress) by eliminating the road/train/air travel of resource persons and participants; common food arrangements thus increased safety to the environment.
- Saved money (on account of travel, lodging and boarding and different arrangements required for the on-campus training) (estimates in progress)
- Saved precious time of the human resources for travelling, unnecessary staying that would now be used for more productive tasks.
- The Centre has achieved effective management of time promptness. Each training session started on time and completed on time.
- There used to be stress on the management due to the complexities of accommodation, arrangements for the training programme, transport, food, etc., causing less attention to the training's technical part. The online conduct of the programmes enabled a significant part of that energy for the technical aspects that are the most required.

Output

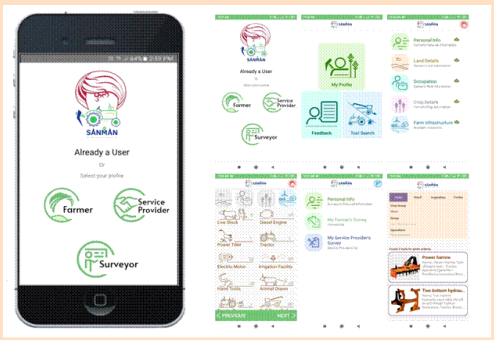
- Organization of **38** online training programs since lockdown started from 07 April, 2020, to 31 March, 2021
- Provided online training to 7237 students, 6045 faculty/scientists, 3025 field personnel/entrepreneurs/farmers.
- Organized 385 online sessions of 1.30 to 2.00hrs during this training program.
- 63000 applications received for the online training programs.

Observations

- We found the participants were shy of asking questions, doubts, and queries during in-person and on-campus training programmes. But in the online mode, there were innumerable queries, including the suggestions for the formulation of their research studies. The participants were more enthusiastic and active to post their comments after every session.
- Almost all the participants suggested organizing the training programmes through online mode.
- The Centre could easily access the resources persons, which otherwise was limited because of their pre-engagements, cancellation due to sudden commitments etc.
- Many organizations have shown interest to collaborate with the CAAST-CSAWM for online academic activities.
- The reach of the CAAST-CSAWM extended to all India-level, and several offers for collaborative research and education poured in.

2. Phule-SANMAN: A Mobile Application for Need Analysis of Mechanisation and Network Solutions

Agricultural mechanization plays a complementary role in agriculture. It contributes to increasing production, productivity and profitability by timely farm operations, enhancing input use efficiency, and reducing production costs. It also reduces labour requirement and human struggle, subsequently balance the labour exchange between agriculture and agro-based industries. Farm mechanization in India is still in its nascent stages and has achieved a meagre growth of less than 5% during the last two decades. The sector faces critical challenges in the large share of small and marginal farmers, declining land holding sizes, high cost of farm machinery and equipment, inappropriate technology, undeveloped markets, complex operations, complexity of legislation and insufficient policy framework. The significant factors deciding the



growth of agricultural mechanization in India are land size, cropping pattern, crops' market price, availability of skilled labour, and labour cost, which need proper assessment. To increase the mechanization level government launches new reforms, schemes and policies every year. Information regarding the latest techniques and invention is not readily available to farmers. The major obstacle is the collection of data and the dissemination of this information. Even though the data available through the printed reports, newspapers and the internet is authentic, the mechanization survey is the best tool for accessing the status and need for mechanization. It provides the mechanization index of that particular region, indicating how much area/crops brought under mechanization. A mechanization survey is done manually using a specific written format, which is very time-consuming and laborious. Farmers are reluctant to give information as they are not getting direct benefits. The data collected by surveyors may not be validated. Besides, it is not easy to analyze hand copy data and conclude. Therefore, it is necessary to use smart technologies for the mechanization survey to reduce the paperwork. Information and Communication Technologies (ICTs) facilitate faster access and information exchange. Mobile has become the world's most used device for transmitting data, voice, and various sorts of services. Mobile apps' introduction has been beneficial for better land and crop management when it comes to agriculture. Mobile applications allow end-users to quickly and effectively reach more comprehensive resources available in the market. Many farmers can perform their day-to-day farm-related activities using mobile apps. Many mobile apps provide information, online selling and buying of agricultural produce, advisory services and custom hiring services, e.g. IFFCO Kisan, Agri Market, Kisan Suvidha, CHC farm machinery, Tractor on rent, Trringo, JFarm services etc. The Mobile Application--Software to Access Need of Mechanization and Available Network Solutions" (Phule-SANMAN) assesses mechanization's current status, finds the gap, and suggests an optimum solution for mechanization with location and facilities of the service provider. The CAAST-CSAWM, MPKV, Rahuri, with the support of NAHEP ICAR, New Delhi, has designed the application that farmers and service providers can register and fill in the information themselves. A provision for an official person to register as a surveyor is also available after the administrator's approval through the admin panel. The surveyor can register and carry out the survey of farmers and service providers in the prescribed format. Farmers page includes personal information, occupation details, land details, irrigation facility, livestock and farm infrastructure available, i.e. diesel engine, electric motor, power tiller, tractor, animal-drawn implements, tractor-drawn implements and self-propelled machinery. The farmer has to select the category and enter the number to fill it. Approximately 5-10 minutes required to complete all information. The service providers are categorized as custom hiring service providers, manufacturers of agricultural implements and machinery and repairs and maintenance service providers. The service providers can register either anyone category or all categories. If one of the farmers has different agricultural machinery and provides custom hiring services, it is automatically registered as a custom-hiring service provider. The custom hiring service providers can add their services in the prescribed format with special features, photographs, the rate per hour, per acre, per hectare, operator details, etc. Agricultural implements and machinery manufacturers can add different products with features, photos, the rate per unit, and dealers' information. The repairs and maintenance service providers can add the facilities and services available with terms and conditions. This information of the service providers will be accessible to all farmers.The collected information helps understand the machinery available to farmers according to the cropping pattern. The data analysis enables us to find the gaps between the present mechanization and the required one. It results in a farm advisory to farmers to adopt precision technologies to reduce the cultivation costs with a higher yield. The application will also provide the information of different implements and machinery to farmers for understanding the working of particular machines, adjustments, and precision application of inputs to crops. The service provider information will help farmers contact them and avail themselves of services at minimum cost. Service providers will benefit from the general information of regional mechanization and cropping patterns. It will help them expand their businesses. The data generated can be utilized for policymaking to enhance mechanization. CAAST-CSAWM, MPKV, Rahuri has applied for copyright of the Phule SANMAN application

App Features:

- The App is available on the MPKV website and Google play store.
- Smallholdings farmers as end-users: Free of cost, user-friendly, and works offline.
- Useful to access mechanization by the digital survey of farmer infrastructure details
- Digital survey of available mechanization solution networks, i.e. service providers viz. custom hiring service,

repairs and maintenance service and manufacturer of agricultural implements

- Can register and survey the farmers and service providers.
- The location of the user automatically fetched
- The survey can be done offline mode, and the information can be uploaded to the server once the user gets the network
- The service provider can upload his product by using this App. The information can be made available to the end-user.
- Information on crop-specific and operation-wise agricultural implements available with the manufacturer.
- An App is also a useful tool for farmers, researchers, scientists, students, village level workers and service providers.
- Information collected can be analyzed for various parameters and useful for policymakers.
- A multilingual facility (Marathi and English etc.) is provided.

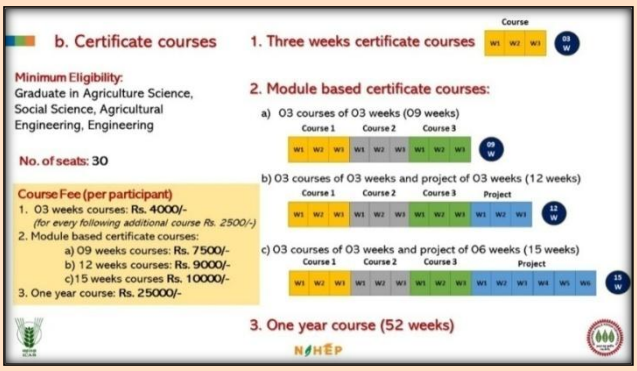
3. Development of Village Level Contingent Crop Plan

The District Agriculture Contingency Plans (DACPs) were developed by the ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, in association with other partners for 614 districts in India, to provide the technological interventions to manage various weather aberrations and extreme climatic conditions. These plans are helpful for preparedness and real-time implementation for sustainable agriculture production. All the collaborating partners who are involved in this endeavour decided to adopt these DACPs but at the same time realized the need to down-scale these plans to the village level for the implementation in real-time and also for the climate-proofing of watersheds. CAAST-CSAWM, MPKV, Rahuri developed the linkages with all active partners, including CRIDA, BAIF, NABARD, State Dept. of Agriculture, KVK Babhaleshwar, Krishi Seva Kendras, and the farmers in the villages started the process of down-scaling the plans to the village level.

Finally, they came out with the publication in English and Marathi languages that includes the procedure developed and adopted to down-scale the DACPs to village level and village level crop contingent plans for seven villages in Akole Taluka. The implementation plan was finalized by the convergence of CAAST and the active partners mentioned above after several brainstorming sessions, workshops, visits, and consultations. The students and faculties of MPKV also participated in them.

4.Certificate courses in Subjects related to Climate Smart Agriculture and Water Management

The project aims at building the capacity and providing the training to the graduate or postgraduate individuals, faculties/scientists of the University and Research Organizations; and the practitioners from the development departments and other concerned organizations in climate smart agriculture and water management to enable them to adopt these technologies for the productive and sustainable agriculture and provide the business and entrepreneurship opportunities. In this context, CASST-CSAWM has formulated the certificate courses of three weeks durations for the PG Diploma. These courses will be offered as (i) one course of three weeks, (ii) the combination of different courses of three weeks, (iii) one module of three certificate courses with or without a project or (iv) the combination of different modules. From March 2021, CAAST-CSAWM has declared the schedule of 11 standalone certificate courses (3 weeks each) and two modules (consisting of 3 certificate courses each) and completed three certificate courses on organic farming, basic Geoinformatics and fundamentals of UAVs. A total number of beneficiaries was 272. The revenue generated from the registration fees of these certificate courses was Rs. 4.35 lakh.



The following online three weeks standalone certificate courses organized

1. Organic Farming for Climate Smart Agriculture
2. Basic Geoinformatics

3. Fundamentals of UAVs.

A total amount of Rs. 4.35 lakhs revenue has been generated by offering these certificate courses to date. The students from the final year B.Tech (Agril. Engg.) are also taking advantage of these courses as part of their In-plant training. In turn, they will be attracted towards higher education on climate smart agriculture. Upon successful completion of these courses, a UG student or unemployed personnel can have a better job opportunity in Climate Smart Agriculture. 272 individual and 54 groups projects completed from three certificate courses. The learning outcome of these certificate courses was 80.66%, the result of eight projects are being submitted as research papers to different journals.

5.Post-Doctoral Research Programme in Climate Smart Agriculture and Water Management

Globally the agriculture and water management are moving towards precision, climate smart, location-specific, and real-time. Under such circumstances, it is necessary to develop the human resources in India by equipping them with the technologies and tools that suit the Indian agriculture and water sectors. It is expected that these sectors, which are currently in the infant stage in India, will expand geometrically to keep pace with fulfilling the goal of doubling farm income by 2022. Thus there is a need for both developing technologies and human resources. Hence, the Center for Climate Smart Agriculture and Water Management was proposed wherein it is envisaged to develop the tools and technologies; and build the capacity amongst the existing human resources, develop the capable human resources and technologies to adopt and implement the developed technologies.

In this regard, the CAAST for CSAWM, MPKV, Rahuri has started the Post Post-Doctoral Research Programme in Climate Smart Agriculture and Water Management from August 2019 with the following objectives

Objectives -

1. To strengthen the knowledge base of climate smart agriculture and water management in CAAST-CSAWM through in-depth and focused research by the committed researcher to further enhance and refine climate smart technologies.
2. To provide the seat for beginners to middle-level careerists to apply and strengthen their expertise for producing climate smart technologies
3. To create an interdisciplinary environment in the CAAST and MPKV for exchanging knowledge amongst the researchers
4. To provide benefit to MPKV, through the presence of the Post-Doctoral Fellows, in developing new knowledge in climate smart precision agriculture and water management and enhancing research productivity
5. To enhance the opportunities for producing high-quality publications and supervision of postgraduate degree/diploma students on multi-disciplinary aspects
6. To provide outstanding overseas researchers with the opportunity to develop their research skills and to transfer new skills to MPKV throughout their fellowship
7. To allow doctoral students to avail the opportunity to continue their doctoral research to establish a solid basis for positioning themselves favourably for further career opportunities
8. To develop the careers of post-doctoral fellows as academics by encouraging their participation in teaching and co-supervision of postgraduate degree/diploma students
9. To allow MPKV researchers to guide Post-Doctoral fellows and enhance research productivity through interactions with collaborating partners.

Duration – 1 or 2 Years Bench fee –No bench fee till the funding period of CAAST. No. of seats – 5

Eligibility (who can apply):

(A) Educational Qualification

1. For Agricultural Science Stream
Ph.D. in Agricultural Sciences
2. For Engineering Stream
Ph.D. in
(i) Agricultural Engineering specializing in Irrigation and Drainage Engineering, Soil and Water conservation engineering, Hydrology, Farm power, and machinery.
(ii) Civil Engineering with specialization in Water Resources/Hydrology or equivalent
(iii) Mechanical Engineering with specialization in Mechatronics/Robotics
(iv) Electronics and Telecommunications
(v) Computer science/Engineering
(vi) Remote Sensing and GIS/Geoinformatics
3. For the Social Science stream
Ph.D. in Social Science or equivalent
(B) Publications
At least five research papers in the reputed journal such as having Science Citation Index (SCI), NAAS rating of 5 and above, ISSN number or high impact factor

Outcome:

Strengthen the expertise to produce climate smart technologies
Development of World – Class research facilities for conducting various research
High-class research will be conducted with the help of Drones and IoT-based technologies.
Benefit to MPKV, through the presence of the Post-Doctoral Fellows, in developing new knowledge in climate smart precision agriculture and water management and enhancing research productivity
High Impact factor or NAAS-rated publications will be published by the Post-Doctoral Research fellows, which will be ultimately helpful for University Accreditation

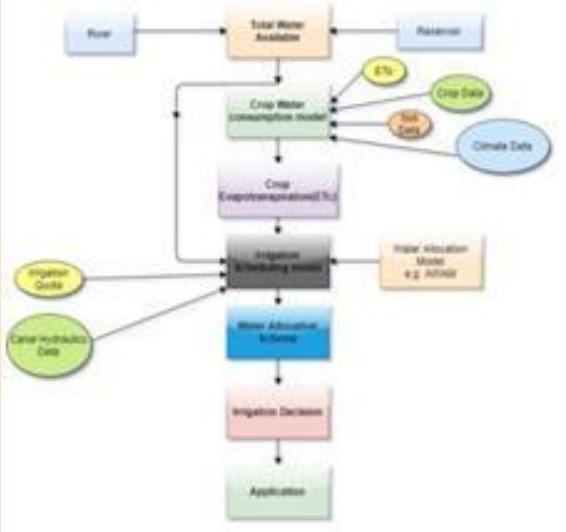
6.Drought Action Network

The Drought Action Network (DAN) is developed as a consortium of government institutions and non-governmental organizations in India for addressing the issues of drought under the guidance of the Indian Council of Agricultural Research (ICAR), New Delhi. The DAN focuses all the institutional energies on finding scientific solutions for drought prevention and mitigation in India. The CAAST-CSAWM is one of the lead technical partners in DAN and has developed linkages with InnosapienAgro-Technologies Pvt. Ltd. along with different ICAR institutions, Bayer Group of India, Agricultural Development Trust, Baramati, International Institute of Rice Research, Indian Institute of Millet Research, National Institute of Abiotic Stress Management (NIASM), Department of Agriculture, Govt. of India, FAO, India, Tata Trusts, CRIDA, APEDA, and Netafim. The convergence of linkages developed by CAAST-CSAWM has resulted in the Drought Early Warning System (DEWS) conceptual framework to mitigate and manage the agricultural drought.

7. Agri. Consortia Research Project (CRP) on Water (Canal Automation): Developing the protocol for automating the canal irrigation system for digital smart irrigation water management.

Canal automation offers an opportunity to save water and improve the efficiency of irrigation water supply projects and reduce the cost of water supply system operations. The overall water use efficiency of a manually operated system is about 40 %, and it is possible to increase it by 10 % by implementing automation. The advantages of automation are not limited to savings in operation cost and water, but it also alleviates the risk of water-logging and salinization. A further advantage is that it increases the equity, reliability, and accuracy of

water distribution. Canal automation also helps to know the volume of water delivered to the individuals or groups of farmers, from which it will be easy to get volumetric water charges accordingly. This approach is a useful tool for encouraging farmers to optimize the use of limited water allocations and increase productivity.



Automation of Canal Network is quite a recent concept. Though the work started in 1975, in developed countries, in India, partial implementation of the few projects started in 1995. Still, there is a need to back up the hardware part of the automation with the software part and decision support to adopt canal automation successfully. Therefore, it is proposed to develop the protocol for the small irrigation system or the tertiary level of the canal irrigation system. The project entitled "Developing the protocol for the automation of canal irrigation system for digital smart irrigation water management" is proposed with this view.

Objectives:

1. To develop the framework of canal automation by studying the different canal automation systems worldwide
2. To develop the different modules required for the canal automation viz. hydraulic module, hydrology module, irrigation management module; and water control module
3. To develop the decision support system for the canal automation
4. To develop the SCADA system based on the developed DSS
5. To design and develop IoT enabled and sensor-based water control devices

Duration – 2021-2026 (5 Years)

Funding Agency – Indian Council of Agricultural Research, New Delhi

Estimated Budget – 4 Crores

Partners-

1. ICAR-Indian Institute of Water Management, Bhubaneswar
2. National Institute of Hydrology, Roorkee
3. **MPKV- CAAST-CSAWM; and Dept. of Agril. Engineering**
4. M/s RTI International India, Pune
5. M/s Mechatronics Sys Pvt Ltd. Pune
6. Water Resources Department, Govt. of Maharashtra, Nashik

Water Resources Department, Govt. of Odisha.

Outcome:

- Improvement in Research Facilities
- Development of faculty skills in the field of Canal Automation
- Liaoning and Networking
- Development of Infrastructure facility
- Human resource development and employment generation.

8. IoT Enabled Sensor-Based Smart Irrigation Management System

Most of India is considered as the water-scarce region. Currently, in India, only 40 % of the total cultivable area is under irrigation. In some of the major states, the area under irrigation is less than 25%. It is estimated that we consume more than 80 % of the total available water for irrigating agricultural fields. However, due to increased urbanization; and the need for industrialization, water demand for both sectors is continuously increasing.

On the other hand, as the productivity of irrigated agriculture is more than 2-3 times the productivity of rainfed agriculture, there is a need to bring more area under irrigation to meet the food demands of the constantly increasing population. However, due to technical, environmental, economic and social reasons, there is a limit to creating additional water resources. Under these circumstances, the only alternative is to use the available water efficiently for irrigation so that more area can be brought under irrigation. Also, the requisite quantity of water can be made available for the domestic and industry sectors which are also backbone of the Indian economy.

There are several means to use the water available for irrigation efficiently. These means are complementary

to each other. One such means is to follow the appropriate irrigation scheduling. Irrigation scheduling means: how to apply? how much to apply?; and when to apply?. While modern irrigation systems such as sprinklers and drip are being promoted and increasingly used by the farmers for efficiently applying water, there is no proper attention provided on how much to apply and when to apply. Application of the correct quantity of water at the right time is important not only for enhancing agricultural productivity but precisely and efficiently using the available water resources. This is very important as "under-watering" will cause a loss of productivity, and "overwatering" will lead to water wastage.

There are several means to schedule the irrigations. But the most appropriate is to know the soil moisture in the root zone. Accordingly, decide whether the crop needs the moisture in the root zone, i.e. whether the irrigation is to be provided; and if so, how much quantity is to be applied in the root zone. Periodical measurement of the soil moisture in the root zone and then deciding the irrigation schedules (when to apply and how much to apply) for a specified irrigation system is a cumbersome task at the farmer's level. Therefore, there is a need to develop a suitable, farmer-friendly and affordable system based on the measurement of the soil moisture in the root zone to enable the farmers just to know the answer to these two important questions; and accordingly, automatically make "on" or "off" the system. At the same time, as a part of making the farming attractive and have reverse migration from the urban to the rural area, "irrigation", which is the most frequent agricultural operation, also needs to be made "smart"

Internet of Things (IoT) is one such advanced technology that enables to connect the things, people and decision support; and perform the tasks automatically and precisely by using real-time data and information. By the adoption of IoT technologies, farmers can optimize the use of water. IoT is the network of smart devices such as sensors that interconnects with each other with decision support on time. With this view, the project entitled "IoT Enabled Sensor-Based Smart Irrigation Management System" is proposed with specific objectives stated above.

Sugarcane and cotton being the important commercial crops that consume an appreciable share of water, and therefore, they are selected for testing and validation. For the subsequent adoption, a suitable IoT Enabled Sensor-Based Smart Irrigation Management System will be developed in the project.

Objectives:

1. To test the current technologies of precision, automatic and real-time irrigation scheduling; investigate the gaps and identify the measures for improvement.
2. To develop multi-depth soil moisture sensors for precision irrigation scheduling.
3. To develop the IoT enabled smart irrigation management system for precision, automatic and real-time irrigation scheduling at farm and cluster levels.
4. To test and validate the developed systems for different agro-climatic conditions

Duration – 2021-2026 (5 Years)
Funding Agency – Indian Council of Agricultural Research, New Delhi
Estimated Budget – 262.08 Lakhs
Partners-

1. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri
2. ICAR-Indian Institute of Water Management (IIWM), Bhubaneshwar
3. ICAR- Indian Institute of Horticultural Research (IIHR), Bengaluru
4. ICAR-National Research Centre for Grapes, Pune
5. Parth Infotech (PI), Pune

Outcome:

- The properly calibrated, validated and tested soil moisture sensors
- IoT enabled farm-based smart irrigation management system for real-time precise irrigation water management
- IoT enabled community-based smart irrigation management system for real-time precise irrigation water management
- The documentation of the information required for the precision irrigation water management

9. Sustainable Soil Management (SSM) Courses

CAAST and GIZ Pro-soil project collaborate on the development of details (teaching schedules, lesson plans and course materials) of sustainable soil management courses for the PG Diploma on climate smart agriculture and water management and standalone certificate courses. Further, GIZ appointed one external agency, the Centre for Environment Education (CEE), Ahmedabad, to develop course content and pedagogy for courses on Sustainable Soil Management for CAAST-CSAWM, MPKV, Rahuri (Maharashtra). Following five SSM courses are being updated by CEE in collaboration with the external experts and MPKV nodal faculties and Research Associates of the CAAST-CSAWM.

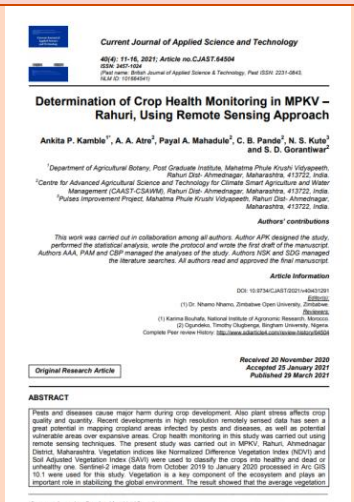
1. CSA-GI-204: Application of GIS & Remote Sensing technologies in NRM
2. CSA-NRM-307: Soil Management for Climate Smart Agriculture
3. CSA-NRM-309: Land Use Planning for Climate Smart Agriculture
4. CSA-NRM-311: Climate Smart Watershed Management
5. CSA-NRM-313: Weather-based Agro-advisory through ICT

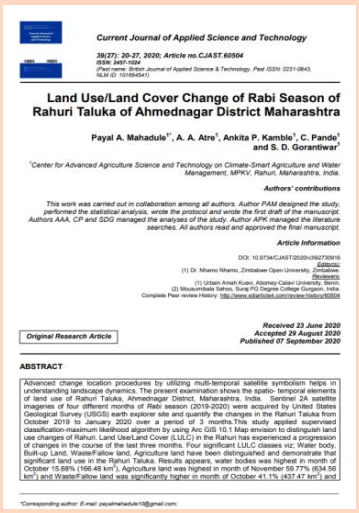
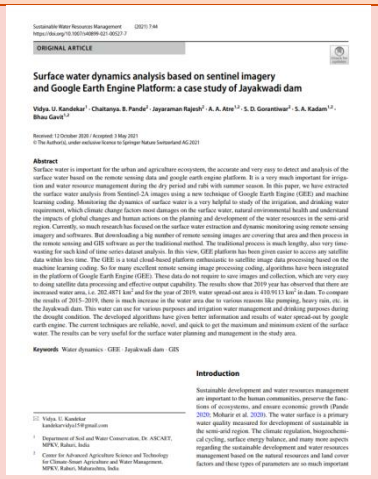
The convergence of MPKV CAAST and GIZ and CEE and other expert members have developed 05 SSM courses by developing course contents, teaching materials, and pedagogy. These courses will be offered in standalone certificate courses and PG diploma programmes of CAAST-CSAWM.

10. Determination of Crop coefficients

CAAST-CSAWM is Coordinating the projects on Determination of Crop Coefficients for the Major Crops by Lysimetric Studies at three agricultural universities of Maharashtra, including MPKV Rahuri. The efforts of CAAST-CSAWM linkages with VNMKV Parbhani and PDKV Akola have received this project funded by the Project on Climate Resilient Agriculture (PoCRA), Nanaji Deshmukh Krishi Sanjivani Prakalp, Government of Maharashtra. CAAST-CSAWM is the key technical coordinator for this project implementation at MPKV Rahuri, VNMKV Parbhani and PDKV Akola. Further, this project strengthened the network of lysimeters already developed by CAAST-CSAWM.

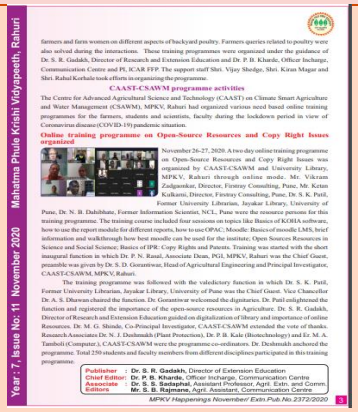
b. Knowledge management and outreach initiatives (development of collaterals, newsletter, social media outreach activities, creation of a website, experiential learning workshop, exposure visits,

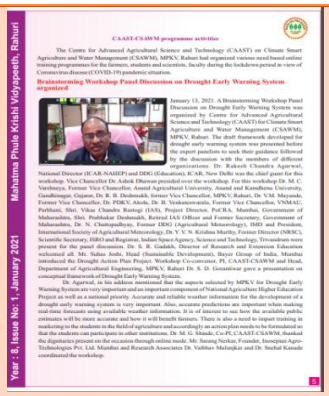
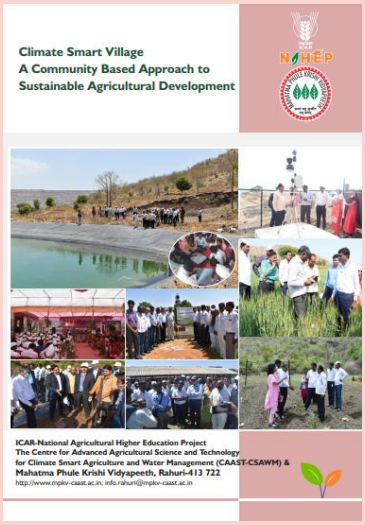
Sl. No	Category of the collateral	Brief summary	Snapshot/cover page	Weblink (if any)
A.	**Articles**			
1	Article (research-based)	**Title:** Determination of Crop Health Monitoring in MPKV Rahuri, Using Remote Sensing Approach **Authors:** Ankita P. Kamble, A. A. Atre, Payal A. Mahadule, C. B. Pande, N. S. Kute and S. D. Gorantiwar **Journal Name:** Current Journal of Applied Science and Technology	 Current Journal of Applied Science and Technology 40(4): 11-16, 2021; Article no.CJAST.64504 Determination of Crop Health Monitoring in MPKV – Rahuri, Using Remote Sensing Approach Ankita P. Kamble, A. A. Atre, Payal A. Mahadule, C. B. Pande, N. S. Kute and S. D. Gorantiwar ABSTRACT	https://www.journalcjast.com/index.php/CJAST/article/view/31291/58714 (doi.org/10.9734/cjast/2021/v40i431291)
2	Article (research based)	**Title:** Application of NDVI in Vegetation Monitoring using Sentinel -2 Data for Shrirampur Region of Maharashtra **Authors:** Ubale Sonali Jakku Prasanna, A. A. Atre, C. Pande and S. D. Gorantiwar **Journal Name:** International Journal of Current Microbiology and Applied Sciences (IJCMAS)	 International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Volume 10 Number 01 (2021) Original Research Article Application of NDVI in Vegetation Monitoring using Sentinel -2 Data for Shrirampur Region of Maharashtra ABSTRACT Introduction	https://www.ijcmas.com/abstractview.php?ID=20943&vol=10-1-2021&SNo=98 (doi.org/10.20546/ijcmas.2021.1001.098)
3	Article (research-based)	**Title:** Change Analysis of Grape Area for Mavadi Village of Nashik Region Using Satellite Data **Authors:** V. S. Ghule, S. A. Ranpise, S. P. Shinde, C. B. Pande, and A. A. Atre **Journal Name:** Multilogic In Science Journal	 MULTILOGIC IN SCIENCE ISSN 2277-7601 CHANGE ANALYSIS OF GRAPE AREA FOR MAVADI VILLAGE OF NASHIK REGION USING SATELLITE DATA Abstract Introduction	https://ycjournal.net/Multilogicinscience/ResearchPapers.aspx

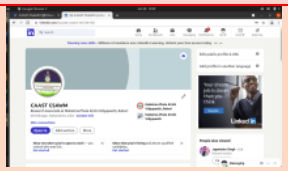
4	Article (research-based)	**Title:** Identification of Cropping Pattern in Khadambe bk. using Sentinel 2 Images and Arc GIS Software **Authors:** KA Chavan, P. S. Bodake, C. B. Pande, A. A. Atre, S. D. Gorantiwar and A. D. Rau **Journal Name:** International Journal of Current Microbiology and Applied Sciences		https://www.ijcmas.com/abstractview.php?ID=19159&vol=9-9-2020&SNo=141 doi.org/10.20546/ijcmas.2020.909.141
5	Article (research-based)	**Title:** Land Use/Land Cover Change of Rabi Season of Rahuri Taluka of Ahmednagar District Maharashtra **Authors**: Payal A. Mahadule, A. A. Atre, Ankita P. Kamble, C. Pande and S. D. Gorantiwar **Journal Name:** Current Journal of Applied Science and Technology		https://journalcjast.com/index.php/CJAST/article/view/30916 doi.org/10.9734/cjast/2020/v39i2730916
6	Article (research-based)	**Title:** Surface water dynamics analysis based on sentinel imagery and Google Earth Engine Platform: a case study of Jayakwadi dam **Authors:**Vidya. U. Kandekar, Chaitanya. B. Pande, Jayaraman Rajesh, A. A. Atre, S. D. Gorantiwar, S. A. Kadam BhauGavit **Journal Name:** Sustainable Water Resources Management		https://link.springer.com/article/10.1007/s40899-021-00527-7 doi.org/10.1007/s40899-021-00527-7

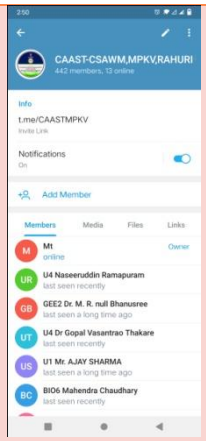
7	Article (research-based)	**Title:** Training Need of MPKV Ph.D. Students towards Application of Drone Technology in Agriculture **Authors:** M. S. Anarase, G. K. Sasane, S. A. Dhenge, S. D. Gorantiwar, P. A. Ghadage1 and R. B. Kalamkar **Journal Name:** International Journal of Current Microbiology and Applied Sciences		https://www.ijcmas.com/9-92020/M.%20S.%20Anarase,%20et%20al.pdf doi.org/10.20546/ijcmas.2020.909.427
8	Article (research-based)	**Title:** Drone and its Applications in Agriculture **Authors:** R. B. Kalamkar, M. C. Ahire, P. A. Ghadge, S. A. Dhenge and M. S. Anarase **Journal Name:** International Journal of Current Microbiology and Applied Sciences		https://www.ijcmas.com/9-62020/R.%20B.%20Kalamkar,%20et%20al.pdf doi.org/10.20546/ijcmas.2020.906.363
B.	**Reports**			
1.	**Newsletter** April, 2020	MPKV, Rahuri publishes a newsletter entitled "MPKV Happenings" regularly in print form and on its website. CAAST-CSAWM provides inputs to this newsletter. The CAAST-CSAWM uses this platform to disseminate its activities to the wider audience		http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20April%202020_20200706034710.pdf

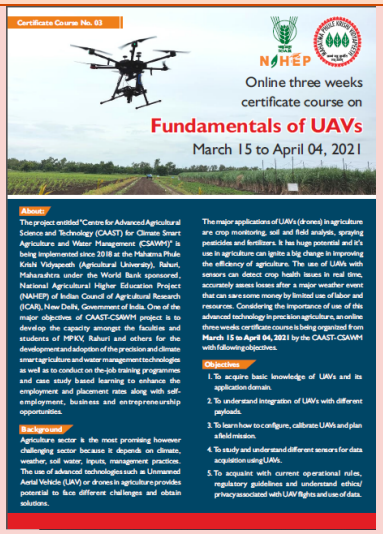
2.	May 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20%20May%202020_20200819044313.pdf
3.	June 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20June%202020_20200911065633.pdf
4.	July 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20July%202020_20201001030130.pdf
5.	August 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20August%202020_20201026060323.pdf

6.	September 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20%20September%202020_20201229092225.pdf
7.	October 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20%20October%202020_20210105110217.pdf
8.	November 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20%20November%202020_20210112093121.pdf
9.	December 2020			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20%20%20December%202020_20210121033705.pdf

10.	**January 2021**			http://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20January%202021_20210331034515.pdf
2.	**Climate Smart Village Jurisdictions**	The CAAST-CSAWM project has adopted nine villages in the University's jurisdiction to disseminate specific climate smart technologies. Buchkewadi, a village in Junnar tahsil of Pune district, is being developed in association with NABARD and Lupin Ltd., Mumbai, 07 villages from Akole tahsil are being developed in association with NABARD and BAIF, Pune and one village Baburdi Ghumat, Tah Nagar, Dist. Ahmednagar is being developed in association with SEVA NGO, Ahmednagar, and the Alumni, Association, Dr. ASCAET, MPKV, Rahuri. The CAAST-CSAWM has been continuously organizing different extension activities at these villages for the dissemination and adoption of technologies related to the climate smart agricultural and water management such as exposure visits, group discussions & meetings, training programmes, workshops, demonstrations, expert advisory services, diagnostic field visits;		http://www.mpkv-caast.ac.in/page/progressreport/progressreports

		and advising the concern agencies on adoption and dissemination of climate smart technologies in these villages.		
D.	**Social media outreach**			
1	YouTube Channel	Total Subscribers: 4960		https://www.youtube.com/channel/UCes_cc0eScXBcf12pOx7C_A
2	LinkedIn	Total Subscribers: 9600		https://www.linkedin.com/company/ccsawm
3	Facebook	Total Subscribers: 1414		https://www.facebook.com/ccsawm
4	Twitter	Total Subscribers: 844		https://mobile.twitter.com/CCsawm
5	Instagram	Total Subscribers: 710		http://instagram.com/ccsawm?utm_source=qr

6	Telegram Channel	Total Subscribers: 442		https://t.me/CAASTMPKV
E.	**Website**			
1	Website of the project and web-based content management system	1. Information about the project objectives, events organized, library, innovations, training program, procurement and recruitment advertisement. 2. The registration portal for training programs and webinar 3. The registration portal for the certificate course		http://www.mpkv-caast.ac.in/
F.	**Experiential learning workshop/certificate courses**			
1.	Online Three Weeks Certificate Course on Climate Smart Organic Farming	Organic agriculture is an integrated production management system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycle and soil biological activity. Organic agriculture follows the principles and logic of living organisms in which all elements are closely linked with one another. This is accomplished by using various agronomic, biological and mechanical methods. Organic farming is a broad-spectrum production system that is supportive of the environment. Three weeks online certificate course		http://www.mpkv-caast.ac.in/page/certificate courses

		organized from February 15 to March 07, 2021, by the CAAST-CSAWM and Organic Farming Research and Training Centre, MPKV, Rahuri		
2.	Online Three Weeks Certificate Course on Basic Geo-Informatics for Climate Smart	Geoinformatics is an emerging field, and there is great demand for geoinformatics professionals due to its application potential in several fields such as agriculture, rural and urban planning, environmental monitoring, natural resources management, natural hazards and disasters management etc. The GIS software, tools and satellite data products can help detect cropping patterns, soil moisture, flood, weed and disease, and perform efficient irrigation water management and predict yield and crop quality. Geo-informatics technologies deal with the acquisition, storage, processing and dissemination of spatial information. Online three weeks certificate course on basic geo-informatics for climate smart agriculture organized from February 22 to March 14, 2021		http://www.mpkv-caast.ac.in/page/certificate courses
3.	Online three weeks certificate course on "Fundamentals of UAVs."	The agriculture sector is the most promising. However, it is a challenging sector because it depends on the climate, weather, soil water, inputs, and management practices. Advanced technologies such as Unmanned Aerial Vehicle (UAV) or drones in agriculture provide the potential to face different challenges and obtain solutions. The major applications of UAVs (drones) in agriculture are crop monitoring, soil and		http://www.mpkv-caast.ac.in/page/certificate courses

		field analysis, spraying pesticides and fertilizers. It has huge potential, and its use in agriculture can ignite a significant change in improving the efficiency of agriculture. UAVs with sensors can detect crop health issues in real-time and accurately assess losses after a major weather event that can save some money by limited use of labour and resources. The online three-week certificate course on the fundamentals of UAVs was organized from March 15 to April 04, 2021		
4.	Brainstorming Workshop on Drought Early Warning System	The Drought Action Network (DAN) is being developed as a consortium of government institutions and non-governmental organizations in India for addressing the issues of drought by developing drought early warning system. The DAN is an effort towards focusing all the institutional energies towards finding scientific solutions for drought prevention and mitigation in India. With this context, CAAST-CSAWM, MPKV, Rahuri organized a brainstorming workshop and an expert panel discussion on Wednesday, 13 January 2021.		https://mpkv.ac.in/Uploads/Comunication/MPKV%20Happenings%20January%202021_20210331034515.pdf http://www.mpkv-caast.ac.in/page/training/trainingprograms

5.	One day online Workshop on "Finalization of Audit Course Syllabus of Precision Agricultural Machinery	The world population is increasing day by day and projected to reach 8.5 billion people by 2045, so the expected agricultural consumption will also increase in the same time period. In order to feed this larger population, food production can be increased by using the precision agricultural machinery and advance technologies in agricultural production. One day online Workshop on "Finalization of Audit Course Syllabus of Precision Agricultural Machinery organized on 4th November, 2020.		http://www.mpkv-caast.ac.in/page/training/trainingprograms
6.	One day online Workshop on Finalization of Audit Course Syllabus of UAV, Robotics and IoT for Precision Agriculture	The use of advanced technologies such as drones, robots and IoT in agriculture is havingthe potential to face several challenges. The major applications of drones in agriculture are crop monitoring,spraying, eld mapping etc. Robots are used in□soil and agricultural to reduce labour in farming operations like automatic weeding, fresh fruit harvesting, crop seeding and milking in dairy which saves human effort as well as time. The Internet of Things can enable the next wave of life enhancing services in agriculture. One day online Workshop on "Finalization of Audit Course Syllabus of UAV, Robotics and IoT		http://www.mpkv-caast.ac.in/page/training/trainingprograms

		for Precision Agriculture" organized on November 06, 2020		
7.	Introductory workshop on Jagriti Yatra March 10, 2021 at 1100 hrs.	Jagriti Yatra is a 15 days long, national train journey that covers 8000 kilometers across the length and breadth of th th India. Every year, from December 24 to January 8 it takes 500 highly motivated youngsters (with some participation of international students), selected from thousands of applicants, to meet inspiring role models of India. The aim is building India through Enterprise with India's youth by exposing them to individuals and institutions that are developing unique solutions to India's challenge. Through this national event Jagriti Yatra has begun to inspire youth to lead and create enterprise solutions. Introductory workshop on Jagriti Yatra organized on March 10, 2021		http://www.mpkv-caast.ac.in/training/trainingprograms
G.	**Exposure visits**			
1.	Exposure visit to Buchkewadi village, Tah. Junnar. Dist. Pune	December 5, 2020. The CAAST-CSAWM, MPKV, Rahuri had organized a scientific visit to Climate Smart Buchkewadi village, Tal. Junnar, Dist Pune. On this occasion, Vice-Chancellor Dr. Ashok Dhawan, Dr. A. L. Pharande, Dr. G .R. Chintala, Chairman, NABARD, visited the IoT project, demonstration plot, biofertilizer unit and the farm pond		http://www.mpkv-caast.ac.in/

2.	Exposure visit to Bamburdi Ghumut. Dist. Ahmednagar	The Centre for Advanced Agricultural Science and Technology for Climate Smart Agriculture and Water Management, MPKV, Rahuri, organized an exposure visit on the Vanmahotsov and Krishi Din programme at Baburdi Ghumat Dis. Ahmednagar on July 01, 2020, Naik. Dr. A. L.Pharande, Dean (F/A) and Director of Instruction, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dr. S. D. Gorantiwar, Principal Investigator, and Dr. M. G. Shinde, Co-Principal Investigator, CAAST-CSAWM, MPKV, Rahuri, Dr. V. P. Kad, Dr. ASCAE&T, MPKV, Rahuri, were present. For this visit from the Alumni Associate of Agricultural Engineers Dr.ASCAE&T, MPKV, Rahuri Mr. Umesh Lagad, Trustee, SEVA, Ahmednagar, Mr. Amol Dhadge, Deputy Commissioner, GST and Mr. Shailendra Adsure, Kisan Corporation, Ahmednagar were present along with Sarpanch, Upsarpanch, Members of Grampanchayat, Krishi Sevak, Villagers and Farmers, from Baburdi Ghumat. Different plants such as tamarind, Indian gooseberry, Haritaki, Vibhitaki, Neem, Sacred fig, Pongamea oil tree, and Indian rosewood trees were planted during this event. The aforesaid programme was carried out following all the rules of the government for COVID-19		http://www.mpkv-caast.ac.in/

b) Unique initiatives undertaken due to Covid-19 disruption

1. Digital infrastructure

a. Virtual Classroom at MPKV, Rahuri

A virtual classroom has been established in our University as part of the network of virtual classrooms to strengthen agricultural education through ICT interventions under NAHEP Component 2 ICAR. In India, there were 18 locations where this facility was created under NAHEP Component -2, ICAR New Delhi. Through virtual classrooms, students stand to benefit from lectures delivered through video capture. The virtual classroom is not limited to hardware setup alone. It comes with a bundled multi-utility Agri-DIKSHA portal and a desktop application that can be installed on any platform. These classrooms are connected to a centralized Virtual Classroom software deployed at KrishiMegh at ICAR-IASRI. Through virtual classrooms, students stand to benefit from lectures delivered through video capture.

Furthermore, virtual classrooms will be part of the 'blended learning' method that combines online and in-person teaching/learning. Supporting virtual classrooms will include a centralized video library of lectures that will take learning "to the anytime & anywhere".The virtual classroom is not just limited to hardware setup; it comes with a bundled multi-utility Agri-DIKSHA portal and a desktop application that can be installed on any platform. Using the Agri-DIKSHA portal, students can access any subject/topic lecture on mobile/laptop/desktop. To date, MPKV, Rahuri delivered more than a hundred lectures by using Panopto software, which can be accessed by many students of India using the Agri-DIKSHA portal.

b. Digital Library

In this pandemic situation, the university library provides the online platform (Database): Digital Library through remote access to students and faculty.

- Jgate plus (CeRA)- Online Journal database
- Indianjournal.com- Journal related to agricultural science.
- E-books of 5 different publishers- CABI, CRC-Net base, Astral-International, NIPA International Art and Science Publisher.
- Krishikosh: An Institutional Repository Description-With the help of Krishikosh, we provide quality literature, including Theses, Journals, Articles, renowned books, reports etc., through online mode.
- Indiaagristat.com- This database provides online statistical information related to agriculture and allied sciences with 50 years of statistical information.
- JRF/SRF Database- We provide an online database called NIPA GENX dataset to prepare JRF/SRF following the ICAR Mandate. This database including more than 2 lakh online questions and test series related to the agriculture discipline.

2. Digital initiatives:

SN	Category of the collateral	Digital initiative	Practice before the introduction of the initiative	Practice after th introduction of the initiative
A. Online Training Programmes				
The lockdown in India started from the last week of March 2020 due to Covid 19 pandemic. However, the CAAST CSAWM immediately shifted to the online mode of learning. During the last week of March 2020, the CAAST CSAWM developed the online learning model and methodology for organizing multisession online trainin				

programmes. Accordingly, it declared the first online national training programme in India in the first week of April 2020. Since then, CAAST-CSAWM has organized 05 International, 33 national training programmes, 16 workshops, 12 webinars, 54 experts lectures, 07 demonstrations, 06 exposure visits consisting of 527 technical sessions of 1.5-2.0 durations benefiting 20747 students and faculties of MPKV and 21047 students and faculties from other agricultural universities and 4340 farmers from Maharashtra state.				
1.	**Online International Training Programmes**	1. Conservation Agriculture based Crop Management Technologies in Climate Smart Agriculture 2. Perspectives of Present and Future Weed Research under Climate Smart Agriculture 3. High-tech Agricultural Future Technology for Urban farming 4. Agriculture 4.0: Precision and Automated Ag Technologies 5. Water Resources Modeling	1. Participants need to present physically to attend the training programmes 2. Experts/ resource persons need to travel for delivering the lectures. 3. Less participation of participants from remote places and other states.	1. Explored the different online platforms 2. Developed the CAAST-CSAWM online learning module 3. Participations from across the country and globally. 4. The online training programmes were implemented without a single paper being used and printed, no paper/plastic banners, posters etc. 5. Saved money (on account of travel, lodging and boarding and different arrangements that are required to be made for the on-campus training) 6. Saved precious time of the human resources for travelling, unnecessary staying that would now be used for more constructive tasks.
2.	**Online National Training Programmes**	1. Fundamentals of Digital Marketing: I 2. Digital Farming in Context of Precision Water Management 3. Personality Development and Effective Communication, Skills and Stress Management 4. Fuzzy logic and its applications for Climate Smart Agriculture 5. Fundamentals of Digital Marketing 6. E-Resources of Libraries and Publication Ethics 7. Protected Cultivation Technologies for Climate Smart Agriculture 8. Effective Utilization of New Age e-Resources Technologies in Agriculture 9. Fundamentals of Drone Technology for Precision Agriculture 10. Aeroponics and Hydroponics Technologies for Precision Agriculture 11. Introduction to MATLAB and its Applications in Climate Smart Agriculture 12. Advanced Agrometeorological Techniques for Climate Smart Agriculture		

		13. Fundamentals of Pressurized Irrigation Methods 14. Introduction to Python Programming and its Applications in Climate Smart Agriculture 15. Smart Handling and Processing Systems of Horticultural Produce 16. Carbon Sequestration 17. Machine Learning and its Applications in Climate Smart Agriculture 18. Use of Media for Transfer of Agriculture Technology 19. Fundamentals of Robotics for Precision Agriculture 20. Advances in Smart Food Processing and Technologies 21. Soil and Water Conservation Interventions for Climate Smart Watershed 22. Advanced Agro-meteorological Techniques for Climate Smart Agriculture 23. Competitive Examination AIEEA(PG)JRF, AICE-JRF/SRF (Ph.D) and ICAR 24. Soft Skills to Enhance Professional Efficiency and Effectiveness 25. Agricultural Drainage for Waterlogged and Salt Affected Soils 26. Writing Research papers for high impact factor journals and Effective proposals 27. Crop weather modelling tools for climate smart Agriculture 28. Adaptive measures for efficient utilization of irrigation water on the farm 29. National and International Agricultural Higher Education Opportunities 30. Emerging Urban Farming Technologies for Vegetable Production 31. Intellectual Property Rights and patents in		

		Agriculture 32. Open Source Resources and Copyright Issues 33. Hands-on Training programme on the operation of UAVs for precision agriculture.		
B. Web applications				
1.	Development of mobile and web application	Smart weather mobile application and admin dashboard	The weather data recorded by the different Automatic Weather Stations are not directly available to the user, and it was sent to the cloud server. Every time the user needs to visit the location of AWS to check the particular weather data.	The Automatic Weather Station is now integrated with the developed Smart weather android mobile application and web dashboard. The real-time and derived weather data are now available on the developed applications that guide the end-user or farmer in planning different farming operations, such as irrigation, fertigation, spraying, sowing, harvesting, etc.
2.	Development of mobile and web application	VLCCP mobile and web application	The contingency crop plans were available at the district level. These plans were available on the CRIDA website in pdf format as well as a booklet in English. As a result, end-users and farmers are rarely able to use it.	CAAST-CSAWM has downscaled the district level contingent crop plan (DCCP) to the village level. The process document is published in the form of a book in Marathi and English language. Also, this document's mobile and web-based applications have been developed to make it readily available to all stakeholders and to access from anywhere.
3.	Development of Web-Based and Android mobile applications	Development of "Phule soil Textural Triangle" Android mobile and Web-Based application Brief Summary- To identify the exact type of soil in a particular area, one should need the exact percentage of Sand, Silt, and Clay. With these data points, one could calculate the soil type using Soil Textural Triangle	• The Manual/Traditional estimation of soil type by locating the points of the percentage of Sand, Silt and Clay on USDA textural triangle. • The Manual estimation of soil type for multiple points requires much more time than the initiative developed. No graphical representation can be shown in the digital form	• Ease of estimation of soil type by giving simple input of percentage of sand, silt and, clay • Unique multiple point input function. Easy to operate and user friendly.

		Figure by the traditional method. But if the points are more than 100 or 1000, then it is quite difficult to calculate where all points are lying on the triangle and is also time-consuming. The Centre has developed the "Phule Soil Textural Triangle" android mobile, and a Web-Based application has been designed to address this issue. A beauty of this application is that one gives no. of points as input, and all given input points will lie on the triangle and can be seen in digitized form.		
4.	Android application with web application	Teacher Evaluation System (TES)	• There was not any facility to capture the performance evaluation of the faculty or teacher by students. • The attendance system for the student was traditional. i.e. paper roll call was being maintained. • The teacher's performance by the student could not be assessed as it was time-consuming in the absence of a suitable App.	• TES (Teacher evaluation system) - An Android application with a Web-based Admin panel for Students' Attendance and teachers' performance evaluation is developed. • The database of all the subjects for B.Sc. (Agriculture), M.Sc (Agriculture), Ph.D. (Agriculture), B.Tech (Agriculture Engineering), M.Tech (Agriculture Engineering) and PhD (Agriculture Engineering) has been added to the system. • The developed mobile application has the following features; Web-based App to Add Colleges, Teacher data, Subjects, Student's data, Students' lecture wise attendance, Faculty's lecture-wise performance evaluation by students, Report Generation (classes conducted, Timelines and Weighted performance) • CAAST-CSAWM, MPKV,

				Rahuri registered for the copyright of this mobile application. • A One-day workshop on the TES (Teacher evaluation system) was conducted, and this application was handed over to the University.
5.	Spatial ETr mobile and web application	Development of Web and Mobile-Based Applications for Real-Time Estimation of Location-Specific Evapotranspiration (Spatial ETr)	• The Evapotranspiration estimated from evaporimeters and lysimeters (direct methods) and empirical and semi-empirical models (indirect methods). • Traditional methods like PAN evaporimeter were used to estimate the ETr and to plan for irrigation.	• The Spatial ETr web and Android-based application is developed to estimate the location-specific Evapotranspiration • It uses the Spatial Google map on background and code based on the Penman-Monteith model algorithm to estimate reference evapotranspiration in mm/day. • This application is user friendly and easy to use, giving farmers and technicians the ability to evaluate daily Evapotranspiration useful for many water management tasks in agriculture using an Android mobile device or any web browser. • Users can search the desired location by entering the name in the search box or drag and tap on the Google map to estimate the Evapotranspiration in mm per day.

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

Challenges	
1	The issues regarding indicators are primarily at the university level, and PIs of the project often find difficulties gathering the information at the university level. Though at MPKV, Rahuri, internal awareness programmes were organized to sensitize all on the philosophy of the project and problems were subsequently overcome. Still, it is also necessary at the PIU level to keep Deans/Director of Instructions in the loop for this purpose.
2	Climate smart and precision farming technologies were not easily grasped and accepted by practitioners and farmers and hence needed to be appropriately developed and disseminated in a meaningful form. However, through several capacity development programmes, this challenge is slowly overcome.
3	Networking with different organizations (Govt./ Private / NGOs) was a challenge for the CAAST-CSAWM, as every organization has its own objectives and vision, and to convince them for collaborative work in the CAAST-CSAWM project was a challenging task.
4	The delegation of powers, procurement, and financial rules and regulations are different from the university; hence, initially, certain hurdles were slowly smoothened out.
5	We were not familiar with the procurement procedure through STEP. The procurement was delayed initially due to delayed activation of STEP
6	Initially, it was understood that PIs need to complete all the procedures regarding the completion of civil works, including renovation. Generally, PIs and associated staff are not aware of many issues concerned with the legal aspect of civil works. These activities consumed a lot of work, often under a stressful environment. Hence the permission needs to be given to the Estate Office to complete these activities
7	Permissions from State Government for International visits/training programmes got delayed despite a letter from National Director to Secretary
8	The entire framework for PG Diploma, including guidelines, framework, courses, and course curricula, was finalized and approved by the Academic and Executive Councils. The programme is ready to be implemented now. However, because of uncertain and dynamically changing situations and the restrictions on the campus due to the COVID19 situation, even the regular academic programmes are hampered. Thus, the PG Diploma also could not be started.
9	Climate smart villages and digital villages; and Climate Smart Blocks: Non-conduct of many activities planned due to restrictions on the movement and travelling to the corresponding places
10	Indicators of PMTS is not matching according to the project objectives. Therefore, the output of the project is not reflected according to the achievements.
Lessons learned	
1	
2	
3	
4	

Plan ahead (Key activities) for the next reporting period:

1	Upgrading the CAAST-CSAWM into a Centre of Excellence for Climate Smart and Precision Agriculture: Two proposals (Centre of Excellence on Artificial Intelligence for Smart and Precision Agriculture (AISPA)) have been submitted to the State Government and Central Government.
2	Develop the pool of human resources for the development and adoption of smart technologies in Agriculture
3	Continue to develop the adaptable IoT and AI-based technologies for real-time and precision agriculture and explore the possibilities of their commercialization.
4	Develop the concept of Digital Agriculture Village and Climate Smart Village, and coordinate with the Government Development Departments for adoption
5	Formulation of a framework for integrated "on-campus; on-job and distance learning" mode PG Diploma
6	Framework for Virtual classroom approach and delivery by the expert teachers to students of all campuses/colleges in University simultaneously with Teaching Assistants assisting the students on other campuses/colleges.
7	Implementation of Post-Doctoral Porgrammes and start education programmes such as certificate and PG diploma (subjected to COVID19 pandemic situation) and; preparation of the course materials such as manuals and videos; establishment of smart classrooms.
8	Enhancement of the business and entrepreneurship opportunities in climate smart, precision and water management as per the call of Hon'ble Prime Minister of India for Self Reliant India Initiative (Aatma Nirbhar Bharat Abhiyaan)
9	Some of the important activities that can be extended and enhanced through the CAAST are Robotics and Drones, IoTs and Climate Smart and Digital Agriculture Villages.