SENSORS TECHNOLOGIES for AUTOMATED DETECTION and MONITORING of COTTON PESTS & DISEASES: Indian Work

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ICAC Researcher of the year-2025

Key points of discussion

- Indian cotton current situation
- Pest, disease problems: PBW havoc
- Current Management practices, Chemical, non-chemical
- Traditional detection, diagnosis and warning systems in India for P&D
- Sensor and AI-based technologies application, Indian perspective, Automated Detection and Monitoring: New Research Programs
- Summarization

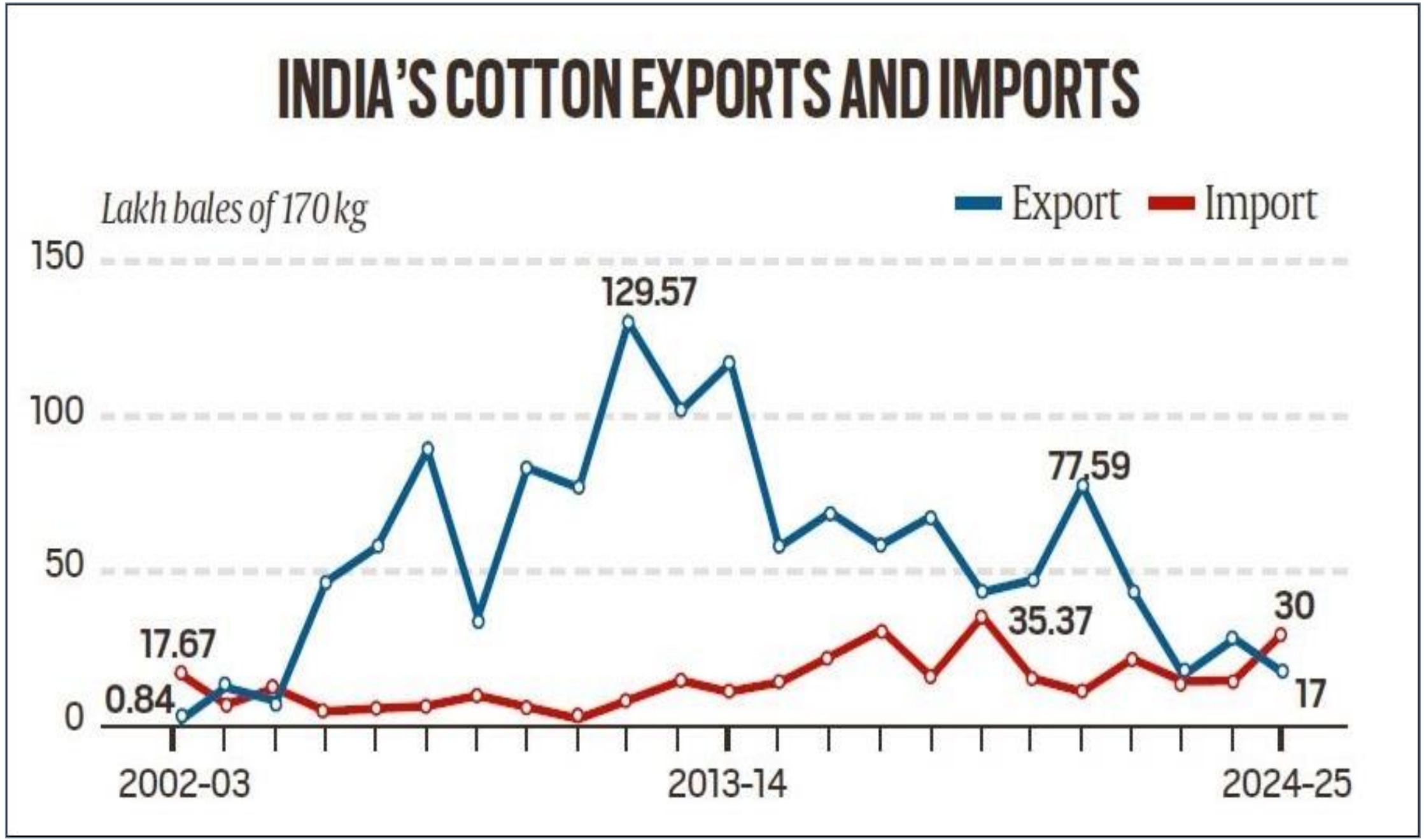
INDIAN COTTON

- Third largest crop in India grown on ~12.5 m ha by nearly 7 m farmers
- Small holder farmers(1-2 ha) contribute around 75% production, struggle every year with uncertainty in yield and income
- Cotton crop grown in three zones in India; North (March-October), Central (June to January) and South(October-March)
- North Zone cotton ~95 irrigated, Central ~80% rainfed and south ~ 50% rainfed , Overall, 65% cotton is rainfed
- One of the major reasons for annual loss of production and productivity is inability to manage the pests despite use of insect resistant Bt cotton sown on 95% area and heavy use of pesticides. (SEE CURRENT DECELERATION-----)

Source: Analysed by South Asia Biotechnology Centre, 2025

Source: Cotton Advisory Board/Cotton Association of India /Committee on Cotton Production & Consumption(1million=10lakh)

INDIA'S COTTON EXPORTS AND IMPORTS



Source: Cotton Advisory Board/Cotton Association of India /Committee on Cotton Production & Consumption

The Pests and Diseases of Cotton

- Cotton harbors several pests - Early-stage attack of sucking pests, Middle stage attack of early shoot borer/ American bollworm & late-stage damage of pink bollworm

- Boll Rot, Grey Mildew, Leafspots &TSV are some imp. Diseases.
  Insect pest dominate protection scenario

- Cotton farmers resort to continuous insecticidal sprays

Sucking Pest

Aphids, Jassids
Thrips, White fly

Bollworm

Spotted Bollworm
American Bollworm
Tobacco Cutworm
Pink Bollworm

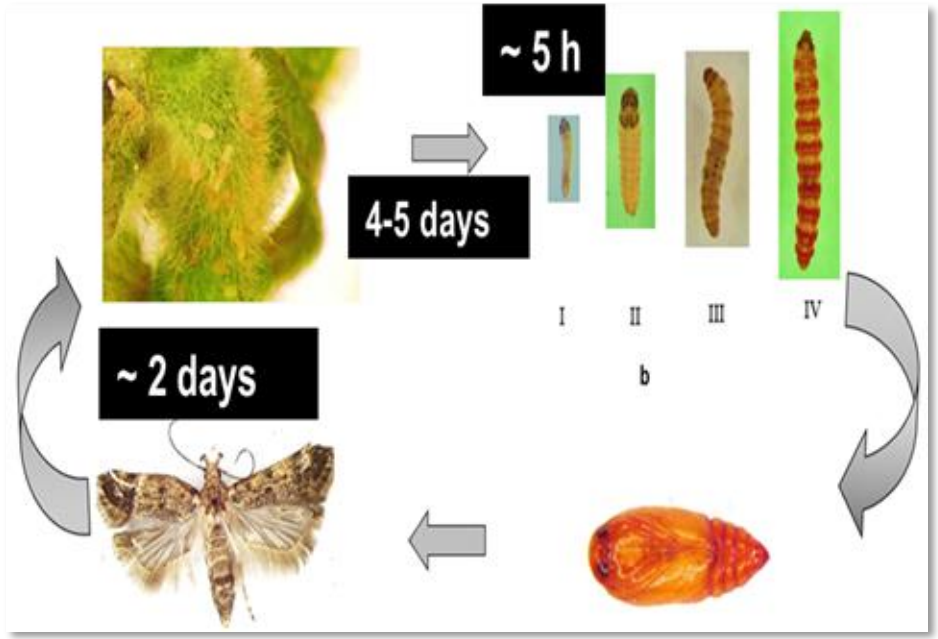
Other Pests

Mites, Leaf Roller
Leaf minor, Semi looper
Root Grub

PEST PROBLEMS IN COTTON ECOSYSTEM

➢ Pink bollworm

- ✓ **Development of resistance to Bt cotton**
- ✓ **Yield losses: 1.2-1.3 million bales, 12 -13 million INR, annually**
- ✓ **Internal feeder: inaccessibility of insecticides, poor control (≥60%)** ⬇
- ✓ **Narrow window of opportunity for effective control : ≤ 1 week**
- ✓ **Timings of sprays are critical**



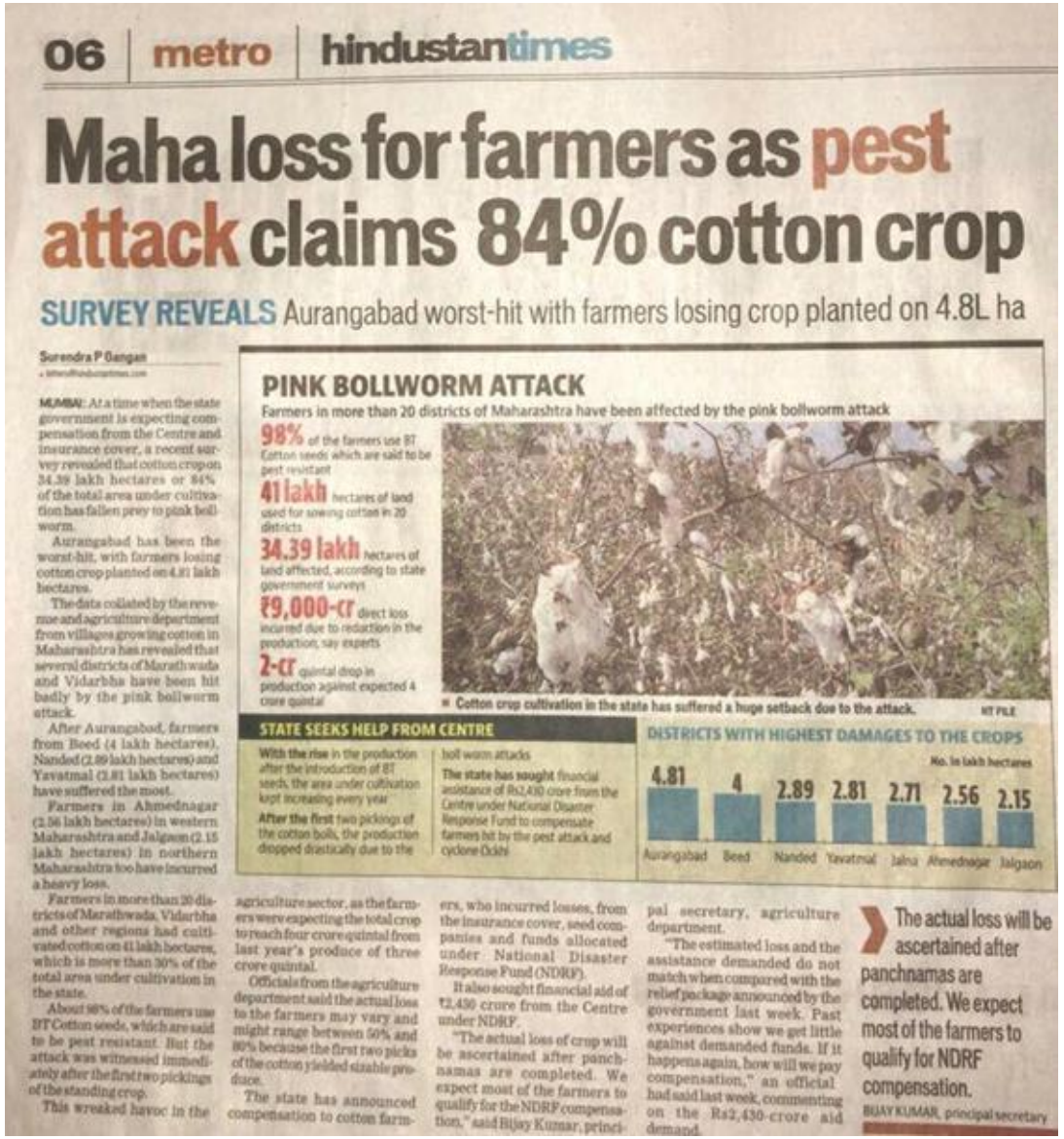
➢ Sucking pests

- ✓ Jassids, thrips, & whiteflies
- ✓ Increasing damage in post Bt cotton phase
- ✓ Significant yield loss due to early season attack

➢ Consequences

- ✓ Increased pesticide use
- ✓ Pest resistance
- ✓ Environmental contamination
- ✓ Increased cost of crop protection

National & Local Media Attention



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Maha loss for farmers as pest attack claims 84% cotton crop

SURVEY REVEALS Aurangabad worst-hit with farmers losing crop planted on 4.8L ha

Surendra P Gangan

MUMBAI: At a time when the state government is expecting compensation from the Centre and insurance cover, a recent survey revealed that cotton crop on 34.39 lakh hectares or 84% of the total area under cultivation has fallen prey to pink bollworm.

Aurangabad has been the worst-hit, with farmers losing cotton crop planted on 4.81 lakh hectares.

The data collated by the revenue and agriculture department from villages growing cotton in Maharashtra has revealed that several districts of Marathwada and Vidarbha have been hit badly by the pink bollworm attack.

After Aurangabad, farmers from Beed (4 lakh hectares), Nanded (2.89 lakh hectares) and Yavatmal (2.81 lakh hectares) have suffered the most.

Farmers in Ahmednagar (2.56 lakh hectares) in western Maharashtra and Jalgaon (2.15 lakh hectares) in northern Maharashtra too have incurred a heavy loss.

Farmers in more than 20 districts of Marathwada, Vidarbha and other regions had cultivated cotton on 41 lakh hectares, which is more than 30% of the total area under cultivation in the state.

About 98% of the farmers use BT Cotton seeds, which are said to be pest resistant. But the attack was witnessed immediately after the first two pickings of the standing crop.

This wreaked havoc in the agriculture sector, as the farmers were expecting the total crop to reach four crore quintal from last year's produce of three crore quintal.

Officials from the agriculture department said the actual loss to the farmers may vary and might range between 50% and 80% because the first two picks of the cotton yielded sizable produce.

The state has announced compensation to cotton farmers, who incurred losses, from the insurance cover, seed companies and funds allocated under National Disaster Response Fund (NDRF).

It also sought financial aid of ₹2,430 crore from the Centre under NDRF.

"The actual loss of crop will be ascertained after panchnamas are completed. We expect most of the farmers to qualify for the NDRF compensation," said Bijay Kumar, principal secretary, agriculture department.

"The estimated loss and the assistance demanded do not match when compared with the relief package announced by the government last week. Past experiences show we get little against demanded funds. If it happens again, how will we pay compensation," an official had said last week, commenting on the Rs2,430-crore aid demand.

> The actual loss will be ascertained after panchnamas are completed. We expect most of the farmers to qualify for NDRF compensation.
> BIJAY KUMAR, principal secretary

PINK BOLLWORM ATTACK

Farmers in more than 20 districts of Maharashtra have been affected by the pink bollworm attack

98% of the farmers use BT Cotton seeds which are said to be pest resistant

41 lakh hectares of land used for sowing cotton in 20 districts

34.39 lakh hectares of land affected, according to state government surveys

₹9,000-cr direct loss incurred due to reduction in the production, say experts

2-cr quintal drop in production against expected 4 crore quintal

Cotton crop cultivation in the state has suffered a huge setback due to the attack. HT FILE

STATE SEEKS HELP FROM CENTRE

With the rise in the production after the introduction of BT seeds, the area under cultivation kept increasing every year

After the first two pickings of the cotton bolls, the production dropped drastically due to the boll worm attacks

The state has sought financial assistance of Rs2,430 crore from the Centre under National Disaster Response Fund to compensate farmers hit by the pest attack and cyclone Ockhi

DISTRICTS WITH HIGHEST DAMAGES TO THE CROPS

No. in lakh hectares

सकाळ

अॅग्रोवन

आजच्या अंकासोबत

रोग-किडींमुळे कापसाला १५ हजार कोटींचा फटका

- शेतकरी मेटाकुटीस
- नुकसानीचा पंचनामा आणि मदत मागणी

टीम ॲग्रोवन

पुणे : महाराष्ट्रात कधी नव्हे, इतके मोठे संकट यंदा कापूस उत्पादक शेतकऱ्यांवर घोंघावत आहे. राज्याचे मुख्य पीक असलेल्या कापसावर बोंडअळीसह इतर रोग-किडींचा ३० ते १०० टक्क्यांपर्यंत प्रादुर्भाव झाल्याने पीक नुकसान १५ हजार कोटींच्याही पुढे जाण्याची भीती व्यक्त होत आहे. प्रतिकूल हवामानाने फवारण्यांसह उत्पादन खर्चातही मोठी वाढ केली असून, कापूस काढणीचा दरही यंदा १० ते २० रुपयांदरम्यान आल्याने संकट अधिक गहिरे झाले आहे. अशातच उशिरापर्यंत बॉन्सूर आणि बेमोसमी पावसानेही काढणी अवस्थेतील कापसाचे मोठे नुकसान केल्याने शेतकरी मेटाकुटीस आला आहे.

पान ४ वर ▸

शिवना, ता. सिल्लोड, जि. औरंगाबाद : कपाशीवर पडलेल्या गुलाबी बोंडअळीच्या प्रादुर्भावाला कंटाळून शिवना परिसरातील शेतकऱ्यांनी आता कपाशीच्या उभ्या पिकांत शेळ्या-मेंढ्या व गुरे चारण्यासाठी सोडली आहेत. (छायाचित्र : सुभाष होळकर)

यंदाचे कापसातील संकट
- गुलाबी बोंडअळी
- दहिया आणि जिवाणूजन्य करपा रोग
- लाल ढेकूण
- तांबेरा विकृती
- कापूस बोंडावरील पाऊस

> रोगांच्या काळात कापूस उत्पादकांनाच्या हाताबाहेर उडालेल्या बाजाराला मिळू शकले. साध्या तरी या कापूस उत्पादकांचे पाडाने ऐकण्याची कुणी बांधावर जात नसल्याची दुर्दैवी स्थिती आहे. शासनाने विद्यापीठ कृषिशास्त्रज्ञांचे पुन्हा नीट्याचेत.
> – रघुनाथदादा पाटील, शेतकरी नेते

> बोंडअळीमुळे कापूस उत्पादन मोठ्या प्रमाणात घटले. शासनाने या परिस्थितीत कापूस उत्पादकांना सरसकट नुकसानभरपाई दिली पाहिजे ही स्वाभिमानीची मागणी आहे.
> – रविकांत तुपकर

> नव तंत्रज्ञानाचे आम्ही नेहमी स्वागत केले आणि करत राहणार. बोंडअळी प्रतिकारक बीटी कापसाला आम्ही प्राधान्य दिले. पंधरा वर्षे आमच्या परिसरात ५० ते १०० टक्क्यांपर्यंत कापसावर बोंडअळी आली आहे. यामुळे मोठे नुकसान झाले आहेच, परंतु यास नव तंत्रज्ञान वापरून प्रतिकारक वाण पुन्हा देण्यात यावा, अशी आमची मागणी आहे.
> – गणेश नागोटे, कापूस उत्पादक शेतकरी, अकोला

आढावा बैठकीतच शेतकऱ्यांनी अंगावर घेतले रॉकेल

CURRENT MANAGEMENT PRACTICES FOR PBW

NON-CHEMICAL management tactics

@ Clean cultivation, sanitation and destroying the bollworm affected residual plant parts

@ Follow crop rotation: to break the pest life cycle as PBW is essentially Oligophagous, restricted mainly to Malvaceous plants

@ Monitoring the incidence through installing PBW-specific pheromone traps @ 5 per ha at 40 DAS

@ Preventive spray at 50-60 DAS: Neem seed kernel extract (NSKE) 5% + Neem oil 5 ml

@ Between 60-and 120 DAS, biocontrol system also can be adopted. Release egg parasitoid, *Trichogrammatoidea bactrae* @ 60,000 parasitized *Corcyra* eggs per acre, thrice at 15 days interval

@ Adoption of mating disruption technologies like; PBKnot and Cremit

Source: Analysed by South Asia Biotechnology Centre, 2025


PB KNOT

Source: South Asia Biotechnology Centre, 2022

Participatory Technology Transfer of PBKNot Mating Disruption

CURRENT MANAGEMENT PRACTICES FOR PBW

CHEMICAL measures

Crop age 60-120 DAS

- Profenphos 50%EC @ 1500ml/ha (3 ml/litre of water)
- Indoxacarb 14.4 SC @ 500 ml per ha(1 ml per litre of water)
- Chlorpyriphos 20 EC @ 1250 ml/ha(2.5 ml/litre of water)

Crop age > 120 DAS

- Cypermethrin 10EC @ 500 ml/ha (1 ml/litre of water)
- Lamda cyhalothrin 5EC @ 500 ml/ha (1 ml/litre of water)
- Fenvelarate 10 EC @ 500 ml/ha (1 ml/litre of water)

Source: Analysed by South Asia Biotechnology Centre, 2025

CURRENT DETECTION & MONITORING PRACTICES

Source: Analysed by South Asia Biotechnology Centre, 2025

Install pheromone traps @ 5/ha for monitoring

- ✓ At crop age of 40-45 DAS
- ✓ Count the moths in traps at least once in a week, Physically
- ✓ 7-8 moths/ trap/ night: ETL for PBW
- ✓ Change the lure as per specifications 0n the label

Green boll infestation assessment

- Weekly random inspection of 50 green bolls per ha
- ETL: >10% infestation
- Spray as per recommendations

CHALLENGES IN CURRENT MONITORING

➢ Monitoring tool used for estimating pest density

- ✓ Sticky traps (yellow and blue) for sucking pests
- ✓ Sex pheromone traps for pink bollworm

➢ Manual counting process

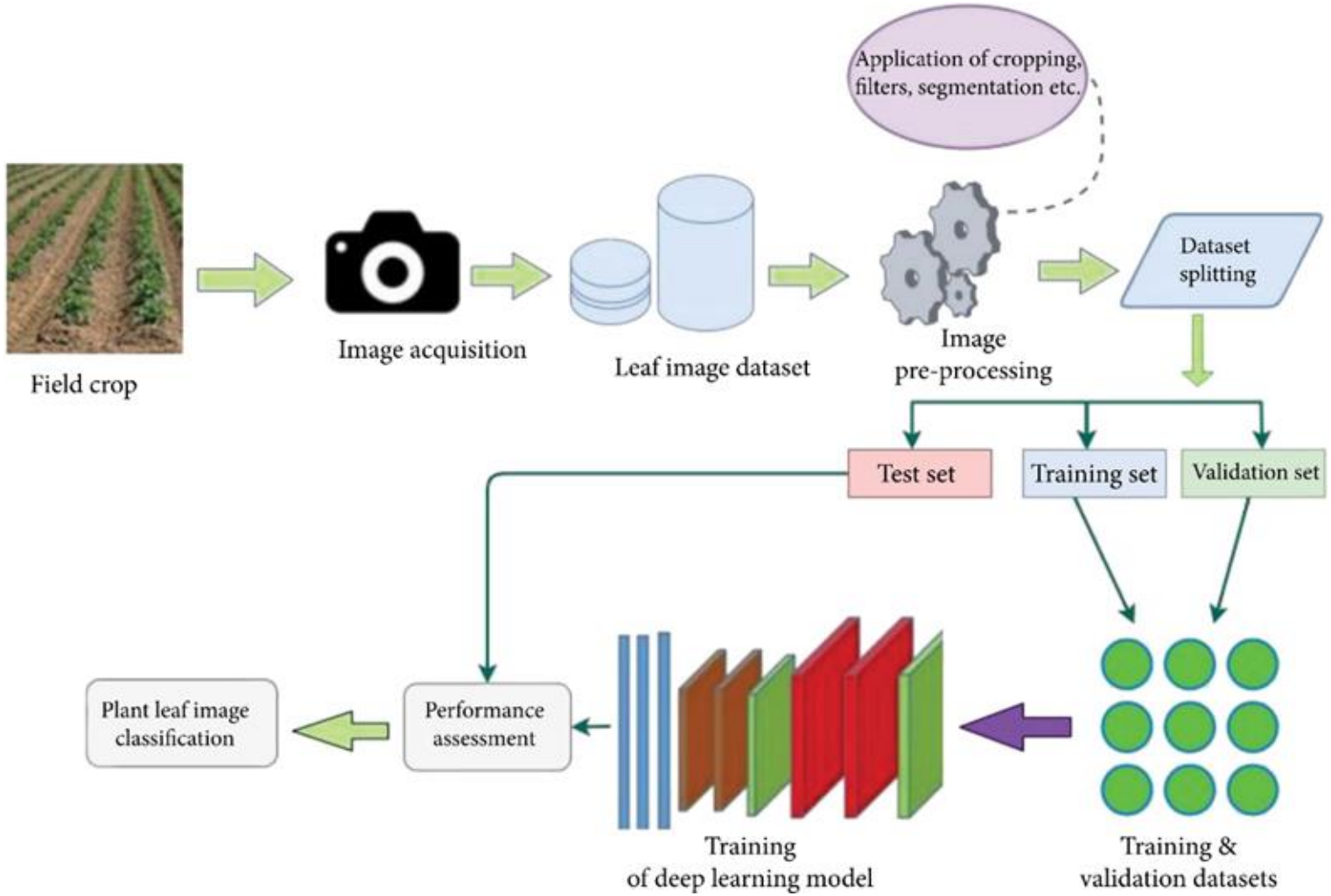
- ✓ Tedious/ laborious
- ✓ Time consuming
- ✓ Inaccurate/ inconsistent
  in predicting pest dynamics enabling timely control
- ✓ Bottleneck: Area wide IPM
  No real-time information on critical timings of pest occurrence

➢ Hence :Lack of timely measures

Yellow sticky trap

Pheromone trap

Detection & Monitoring of Pests and Diseases :AI TECH



- Monitoring, early detection and timely intervention are the key elements in a pest management programme.
- Pest identification is done by trained crop protection personnel and experienced farmers. However, manual identification is subjective, inefficient, and delayed.
- Advances in computer vision by deep learning have paved the way for AI-based pest and disease diagnosis.

SOLUTIONS IN AI TECHNOLOGY

- ✓ **Cotton Ace App: Physical +Automatic, developed by a private company, Wadhwani AI to help farmers to manage pests.**

- ✓ **Installs pheromone traps in field for PBW, upload photos to App, based on ETL generate coloured- coded alerts**

- ✓ **Solution offered to problem in AI technology: Developed a system of COTTON MICROCLIMATE AND INSECT MONITORING(C-MAIM)**

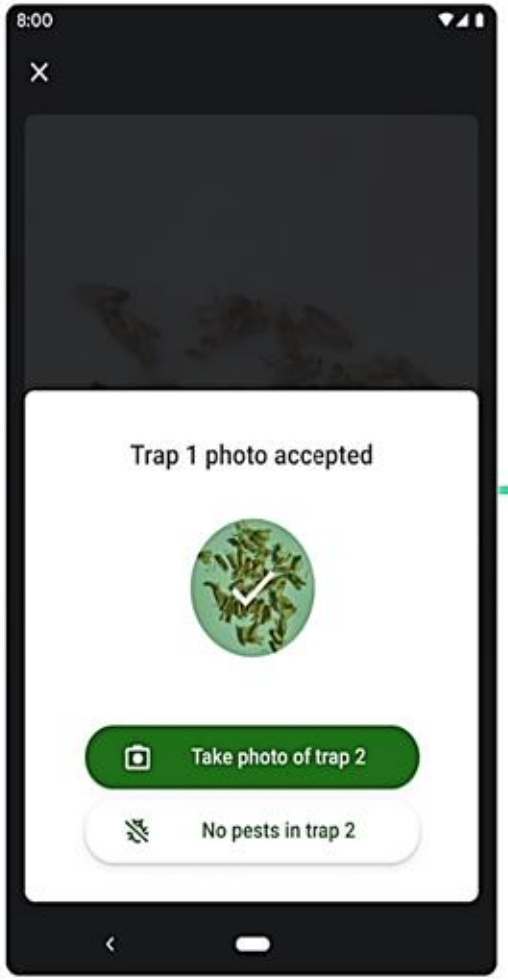
AI-based Pest Management App

CottonACE

A farmer or extension worker empties the moths from the pheromone trap.

He then opens the app and captures 2 trap images.

The pests are detected and counted from the image uploaded.



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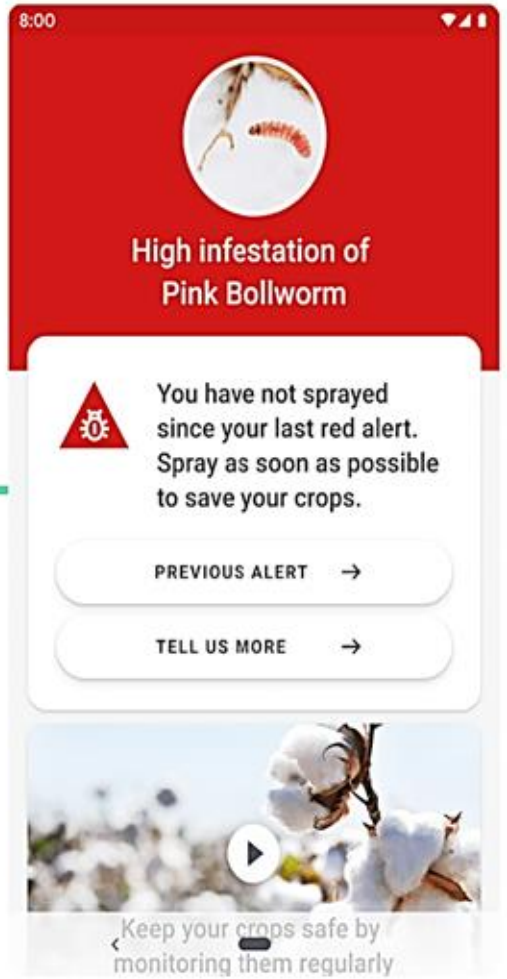
An advisory is then generated on the app.



C-MIMS: Cotton Microclimate and Insect Monitoring System developed

- ✓ Harnessing the potential of cutting-edge digital technology based IoT and AI tools

Developed a system

- ✓ **Cotton Microclimate & Insect Monitoring System (C-MIMS)**
- ✓ 5G enabled AI powered wireless sensors, imaging & ML algorithms

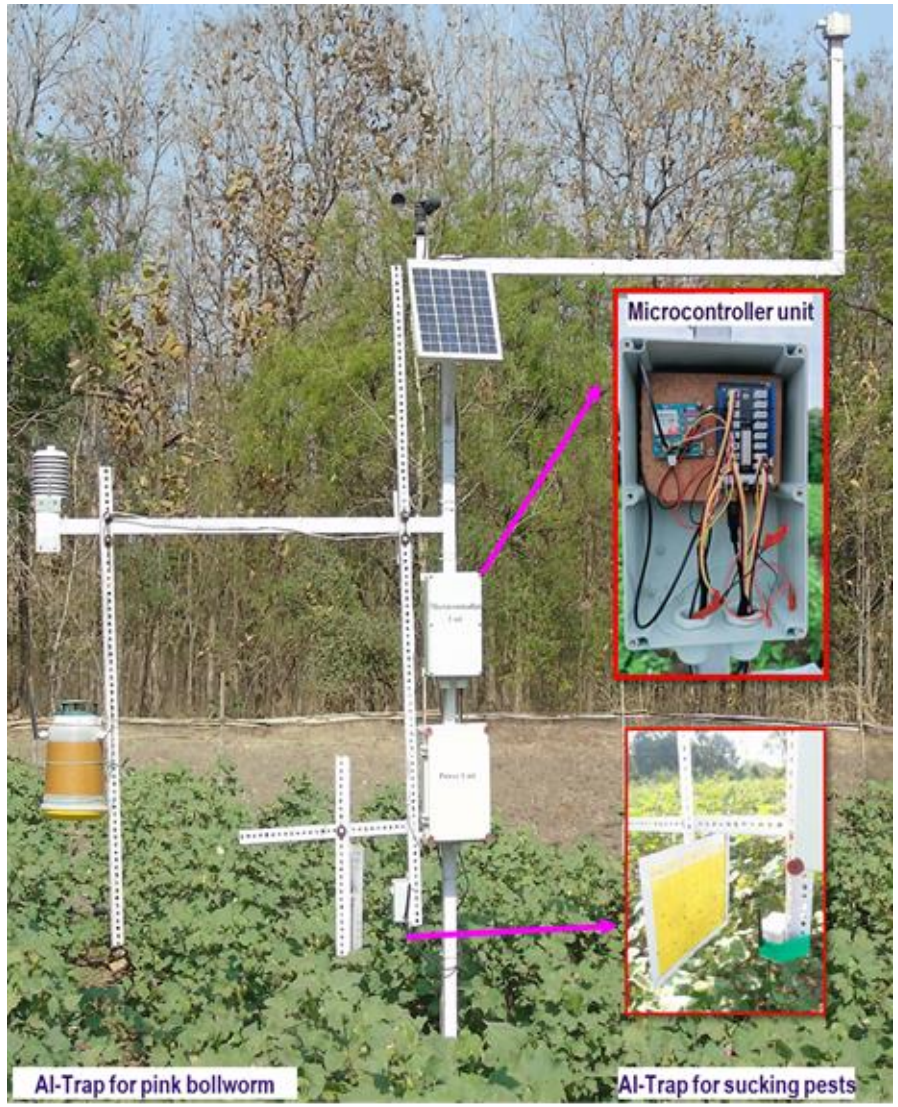
➢ Continuous monitoring

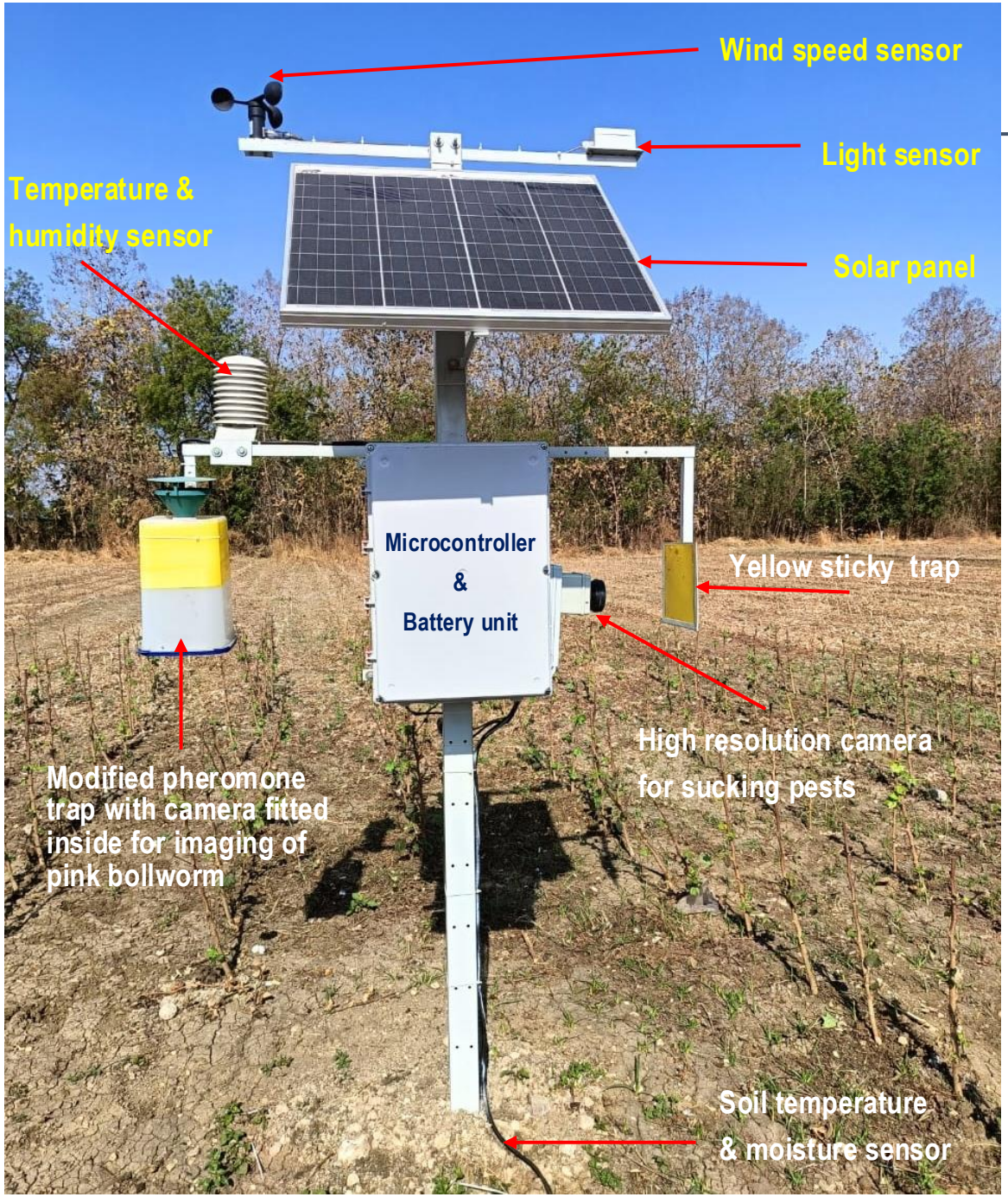
- ✓ Sucking pests detected on yellow sticky trap
- ✓ Pink bollworm moths detected in a pheromone trap

➢ Microclimate of cotton ecosystem

- ✓ Air temperature
- ✓ Relative Humidity
- ✓ Light intensity
- ✓ Wind velocity
- ✓ Soil moisture
- ✓ Soil temperature

➢ Updates on early warning and pest management



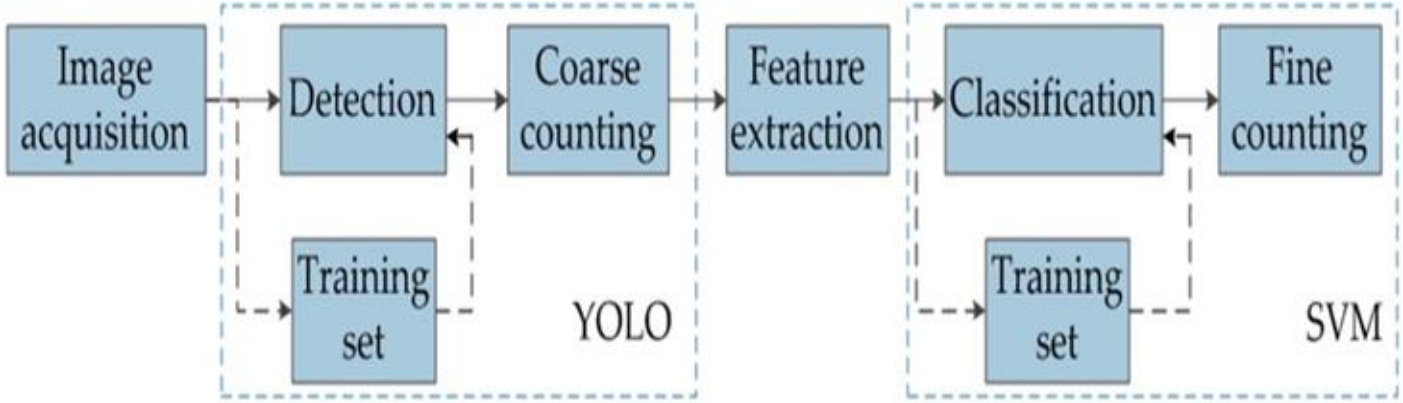


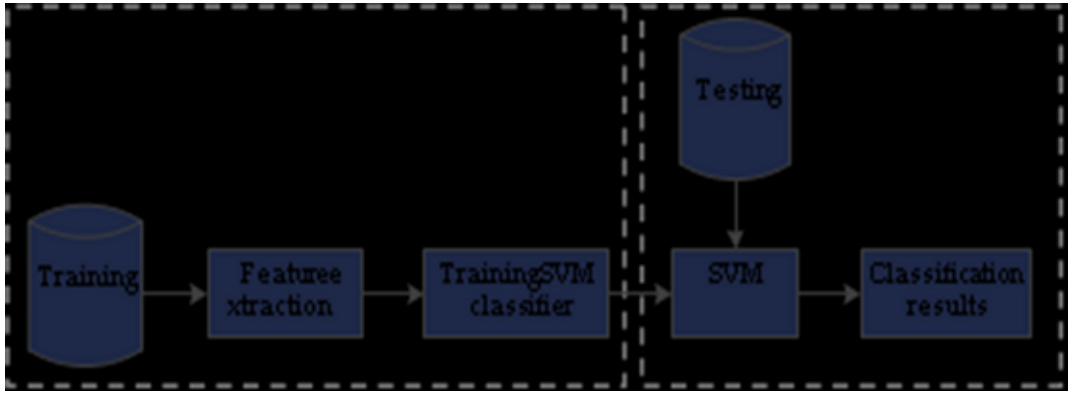
C-MIMS: Structure and mechanism

- **Weather sensor network**
  - ✓ Microclimate recording
- **Image acquisition system/ Pest detection**
  - ✓ 5G enabled AI powered night vision camera: 12.3 MP
  - ✓ **Sony IMX477R stacked**, back-illuminated sensor
  - ✓ Crystal clear images with fine details
  - ✓ Wide field of view (FOV) of 130 degrees
  - ✓ C-mount, CS-mount adaptable
  - ✓ **High-quality optical lens**
    - 16 mm Telephoto lens : for pink bollworm
    - 64 MP Arducam : for sucking insects
  - ✓ **Daily insect images & weather data sent to cloud server after every 10 min initially, now 1 hr.**
  - ✓ GPS module: tracking location of device

Algorithms employed for image processing, identification & counting of insects

- ✓ **Raspberry Pi 5 8GB Model: "Image processor"**
- ✓ **Computing capability**: insect counting and classifying
- ✓ Adopt the Raspberry Pi CS mount HQ Camera
- ✓ AI algorithm performs the processing of captured images using machine learning models trained on a vast image database
- ✓ Algorithm frames an object detection as a regression problem to **spatially separated bounding boxes** and associated class probabilities
- ✓ **S**uper **V**ised **M**achine (**SVM**) learning method used for classification
- ✓ Solve the problem of small sample, high dimensionality, nonlinearity, etc





Mechanism used in data transfer, processing and communication

Cloud server

Main hub for

- ✓ Receiving the field data from sensor device
- ✓ Running predictive models
- ✓ Data transfer to the users
- ✓ 24/7 high processing power

Facilities for

- ✓ Web hosting
- ✓ Data backup
- ✓ Data security
- ✓ Firewall protection

Communication/data transfer

- ✓ Hypertext Transfer Protocol (HTTP) for intercommunication
- ✓ Simple Mail transfer Protocol (SMTP) for emailing
- ✓ File Transfer Protocol (FTP) for file transfer and storage

Applicability over a large area

Making area-wide pest predictions

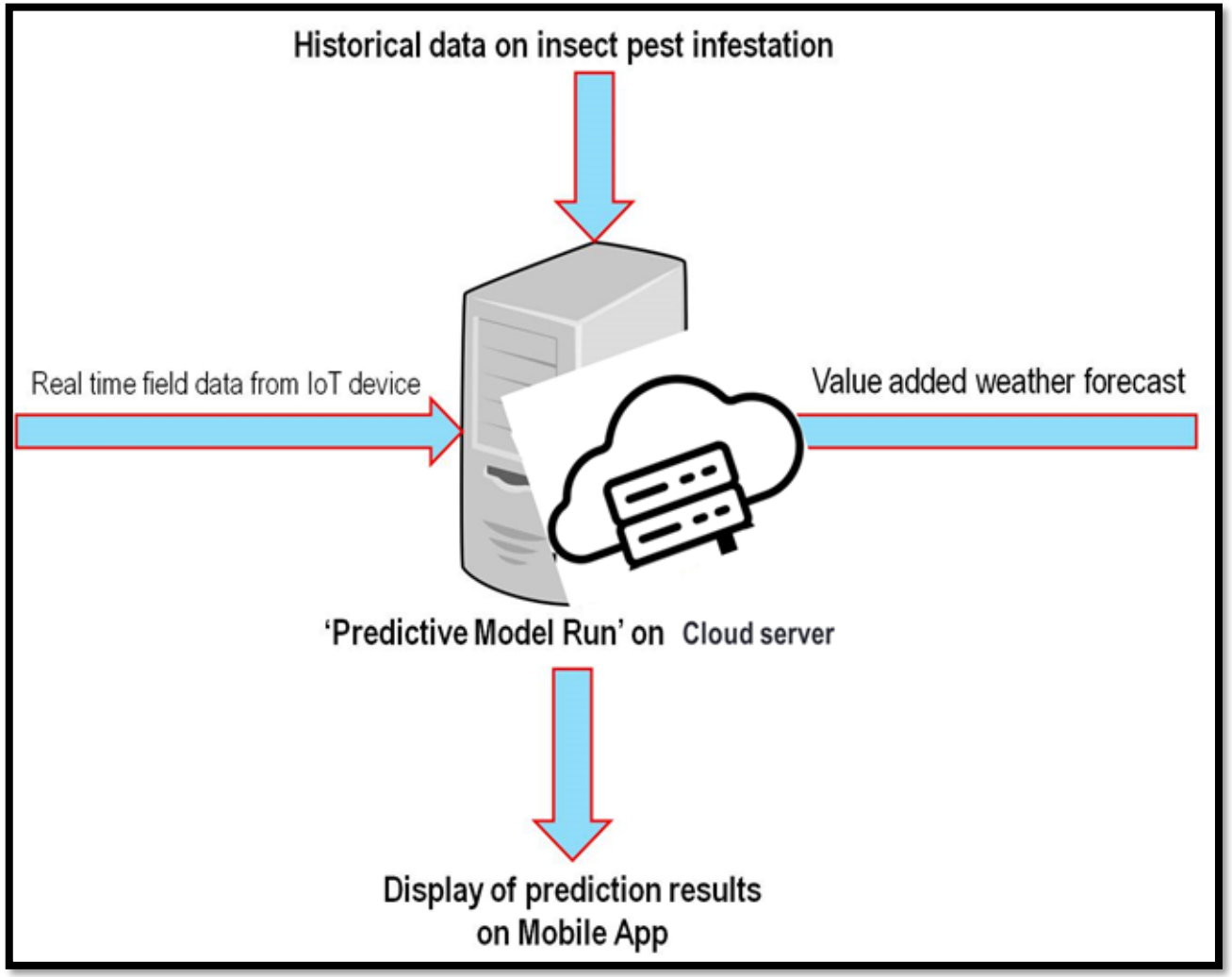
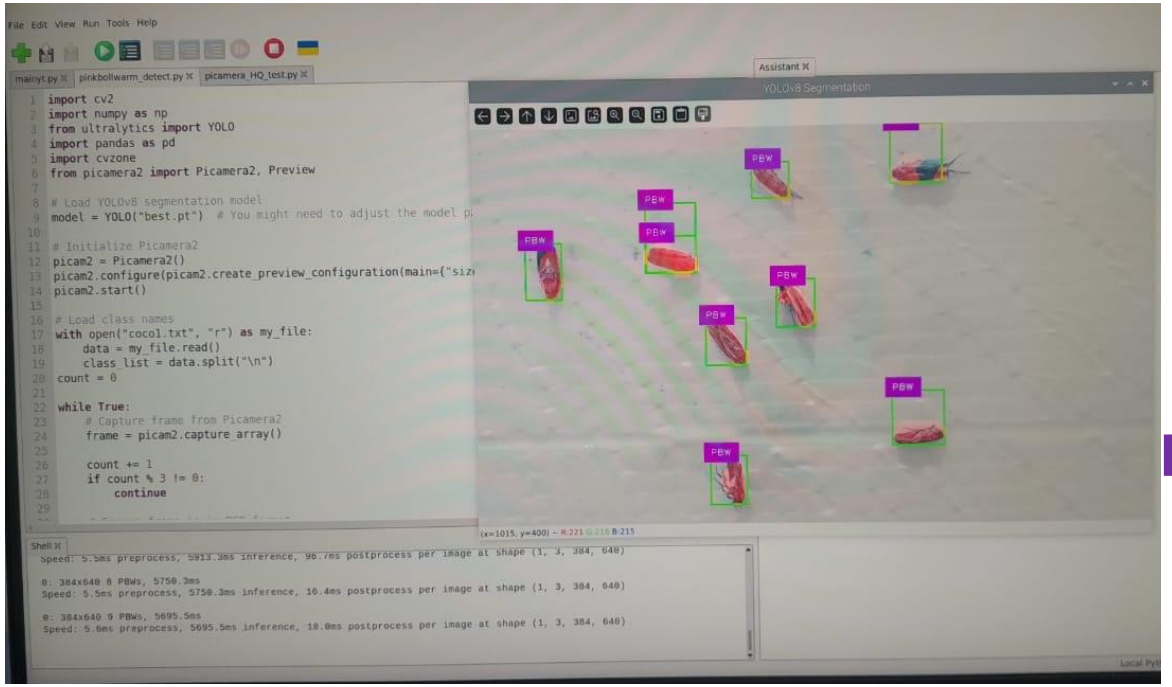
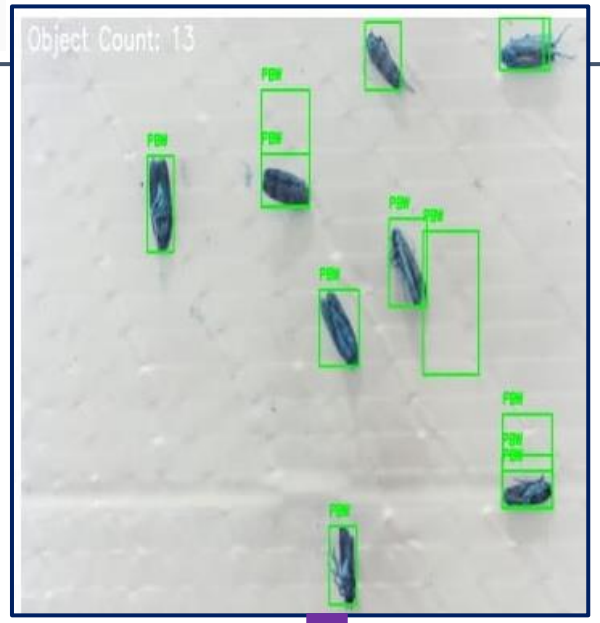
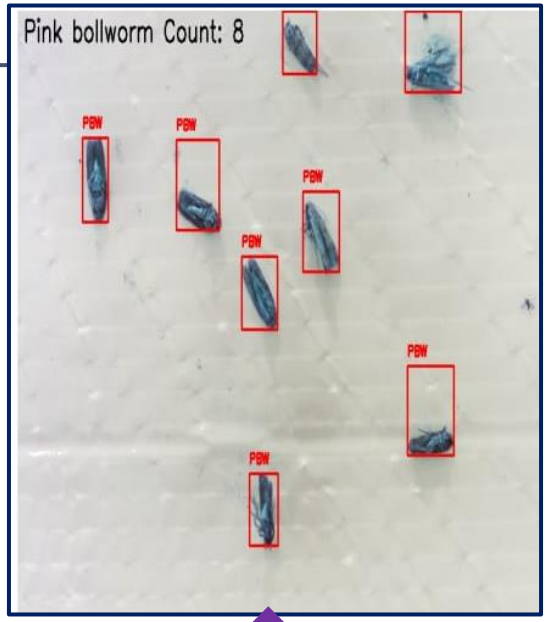


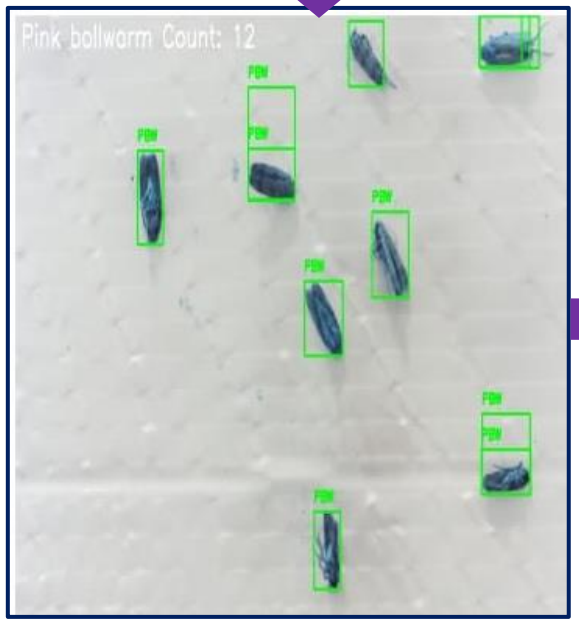
Image capture, processing & Counting

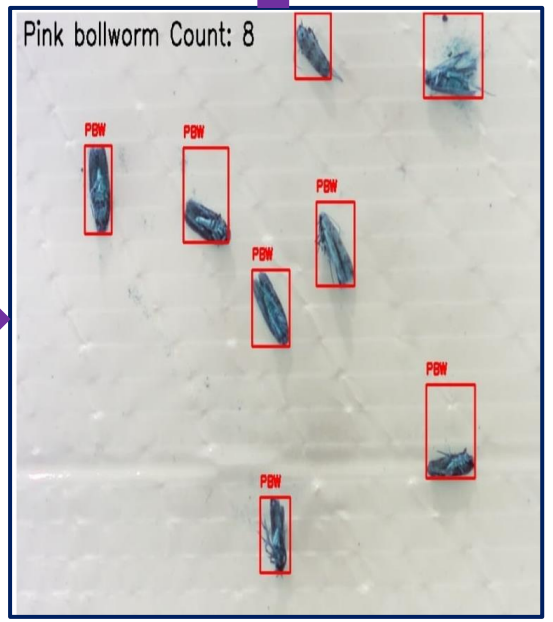


Pink bollworm





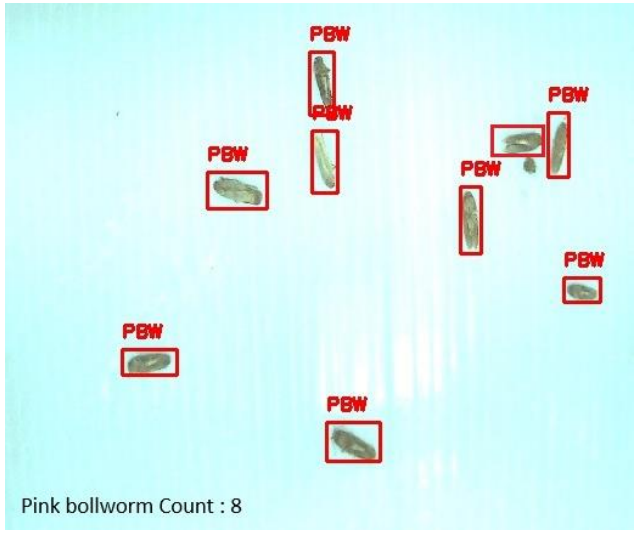


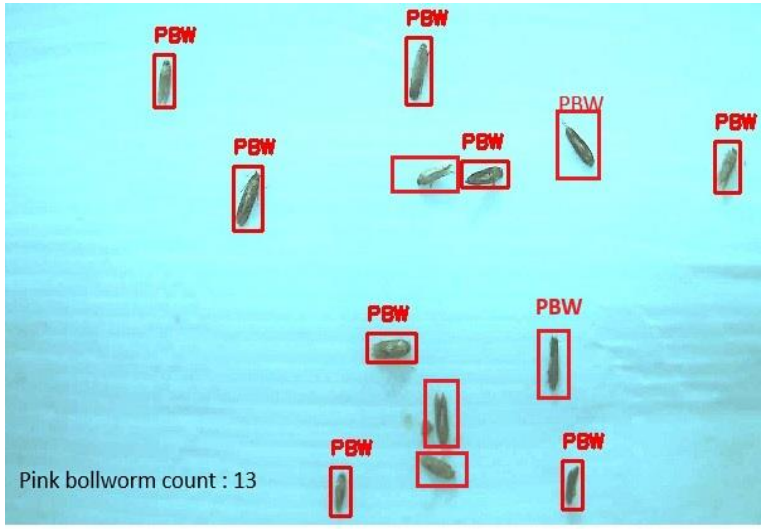


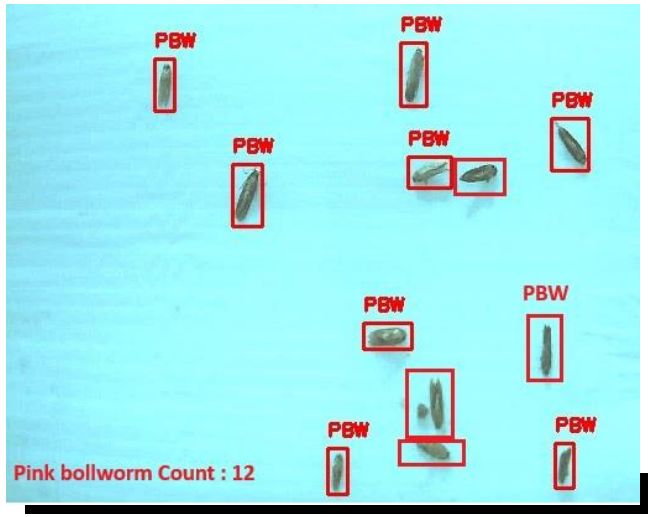
Accuracy of image processing algorithm: YOLO v12

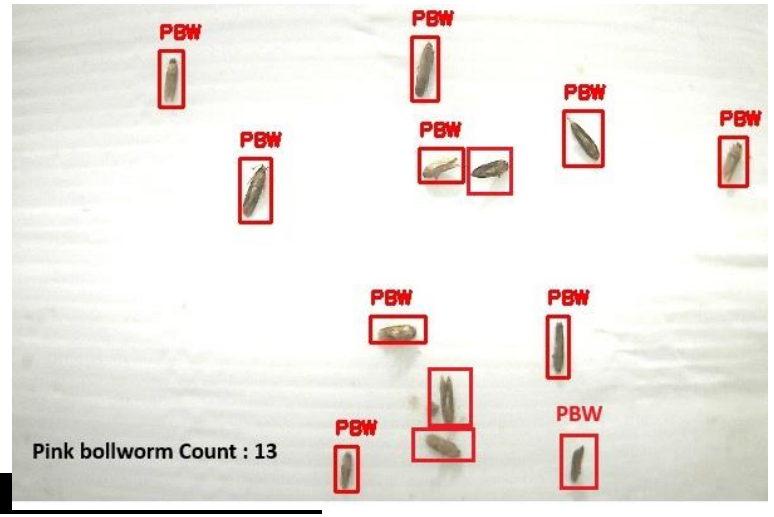
- Attention-centric architecture beyond traditional CNN-based YOLO models
- Capable of maintaining real-time inference speed
- Use of large image dataset trained at
  - Various light conditions
  - Angle or position of exposure

Training of image data set









Accuracy of C-MIMS

- ✓ Training of large image data set
- ✓ Improvement in accuracy of pest recognition and count algorithm

Obs No	Number of moths		Chi^2	Accuracy (%)
	C-MIMS count	Actual		
1	13	8	1.9	62
2	12	8	1.3	67
3	8	9	0.1	89
4	8	8	0.0	100
5	8	8	0.0	100
6	13	13	0.0	100
7	12	12	0.0	100
8	13	13	0.0	100
		Chi^2 Cal	3.4^{NS}	
		Chi^2 Tabular	12.6	

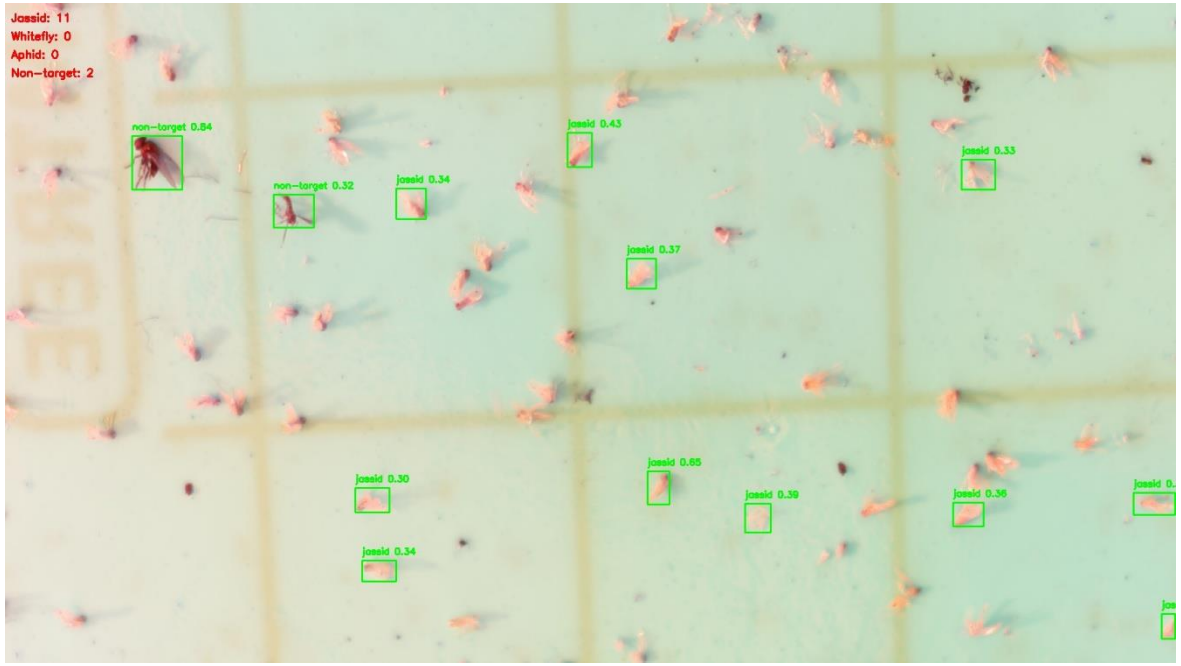
Image capture, processing & Counting

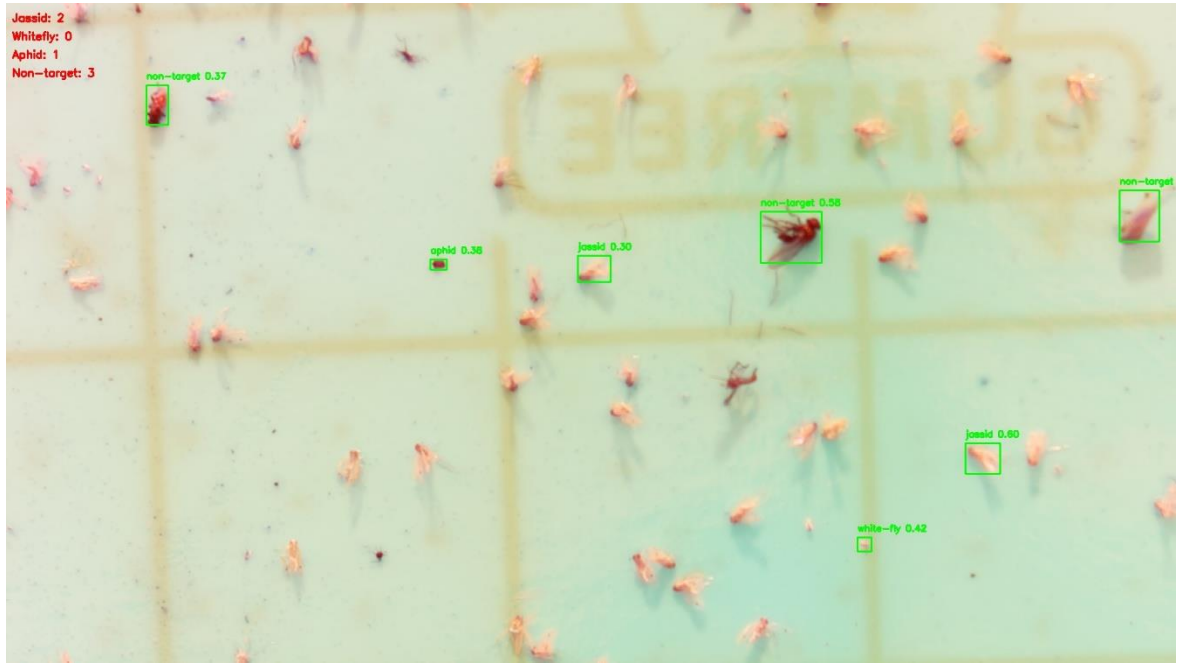
Sucking pests

SAHI: Slicing Aided Hyper Inference

- ✓ YOLO compatible
- ✓ Small object detection
- ✓ Innovative library
- ✓ Optimize object detection algorithms
- ✓ Large-scale & high-resolution imagery
- ✓ **Partitioning images into manageable slices**
- ✓ **Running object detection on each slice**
- ✓ **Stitching the results back together**

Training of image data set: Sucking pests





Number of images trained				
PBW	Jassids	Whitefly	Thrips	Non-targets
7000	4000	2500	1200	450

What is the applicability of C-MIMS: Pest Monitoring OR Prediction & forewarning?

- **Applicability: Both**
- **Predicting favorable weather conditions for pest**
  - ✓ Correlation between pest & weather data
  - ✓ Pest dynamics in response to changes in microclimate
- **Coupling of C-MIMS with phenology model**
  - ✓ Value added weather forecast
  - ✓ ARIMA: for predictive model run

Tensorflow

- ✓ ML platform for model building algorithm (www.tensorflo

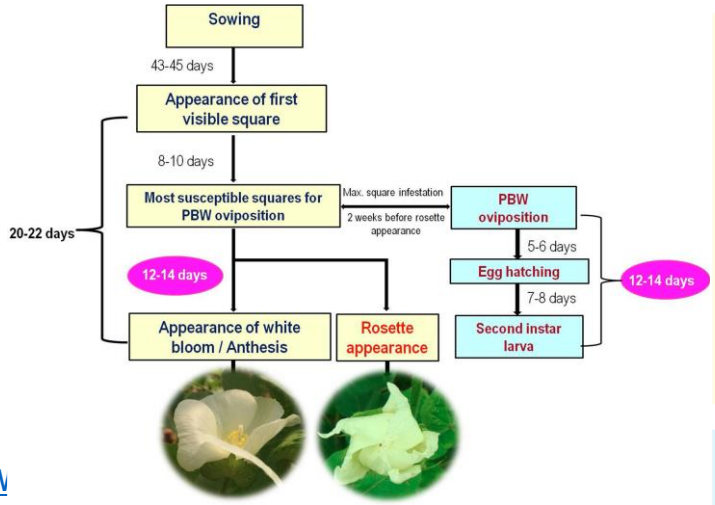
Python

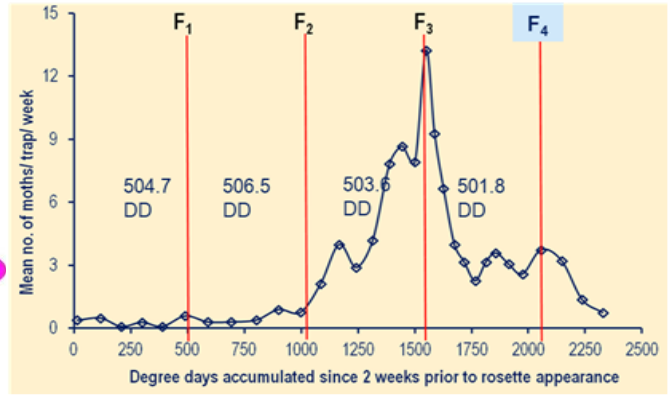
- ✓ Scientific computations/ program writing
- ✓ Efficient system integration
- ✓ Internet protocols supported: FTTP, HTTP, HTML, XML, E-mails (www.python.org)

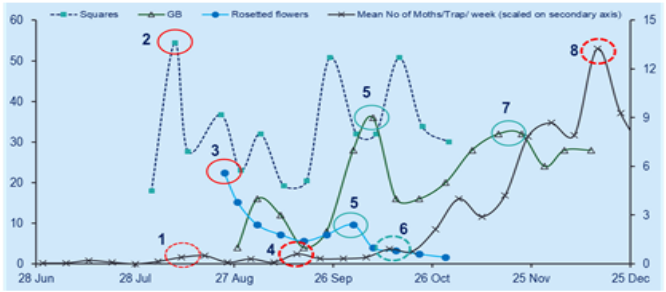
PHP: For Server Site Scripting

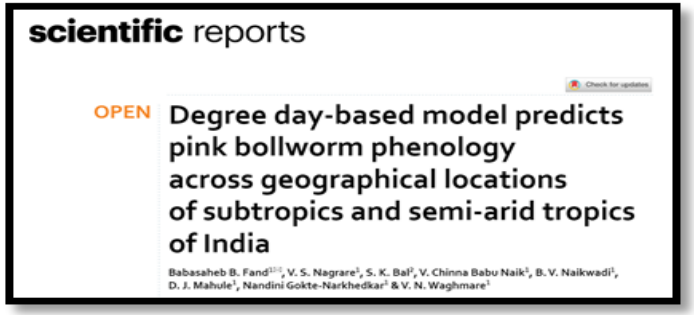
MYSQL: Database for data hosting on cloud server

Area wide IPM: Cloud server enables sending information over large area









How & what types of alerts & notifications C-MIMS will send to the end users?

➢ Mobile based messaging or emails

- ✓ Upon pest detection & counting, system sends alerts to the registered users
- ✓ Information consists of both the type and the number of insects detected

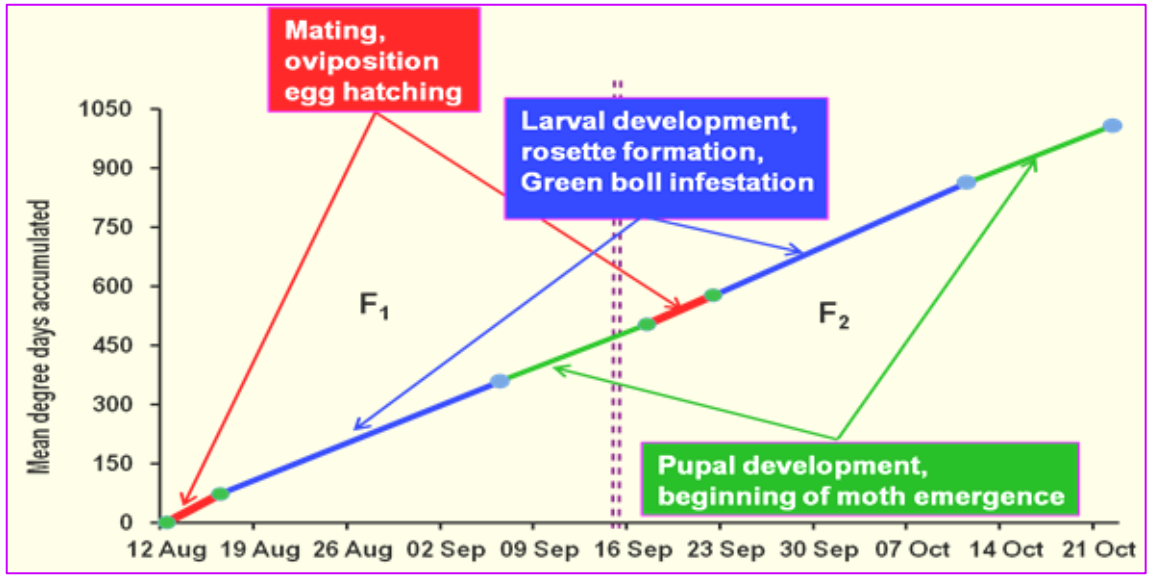
➢ Criteria to undertake pest control measures

Pest monitoring based alerts

- ✓ Based on action thresholds/ETLs that warrants control action
  - 5-8 moths per trap per night for 3 consecutive nights

Pest prediction based alerts

- ✓ Coupled results of C-MIMS and DD-phenology model
- ✓ Predicting critical life events
  - Beginning & peaks of moth emergence
  - Dates of oviposition & egg hatch
- ✓ Tracking no. of generations within a season



Approx. DD accumulated since biofix	Generation event	Duration (days)	Expected calendar date	Biological event	Suggested intervention
0-73	First	5	16 Aug	Mating, Oviposition, Egg hatching	Use of *Trichogramma bactriae* as biocontrol agent Spray of insecticides having ovicidal action
74- 360	First	21	06 Sept	Larval development (Larvae enter bolls and feed within)	Scouting/field sampling for assessing infestation levels • Rosette appearance, • Green boll damage
360 - 503	First	11	17 Sept	Pupal development to Beginning of adult emergence	Installation of pheromone traps for monitoring/mass trapping
504- 576	Second	6	22 Sept	Mating, Oviposition, Egg hatching	Use of *Trichogramma bactriae* as biocontrol agent Spray of insecticides having ovicidal action
577-862	Second	19	11 Oct	Larval development (Larvae enter bolls and feed within)	Scouting/field sampling for assessing infestation levels • Rosette appearance, • Green boll damage
863-1007	Second	11	22 Oct	Pupal development to Beginning of adult emergence	Installation of pheromone traps for monitoring/mass trapping

Alerts & notifications C-MIMS are sent to the end users

Mobile based messaging or emails

- ✓ Upon pest detection and counting, the system will send the alerts to the registered users
- ✓ Information will consist of both the type and the number of insects detected

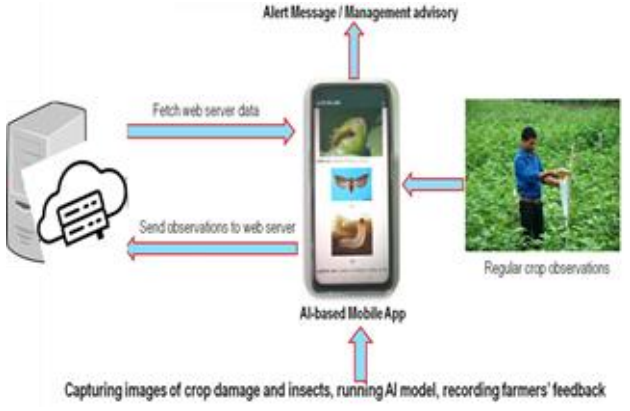
Criteria to undertake necessary pest control measures

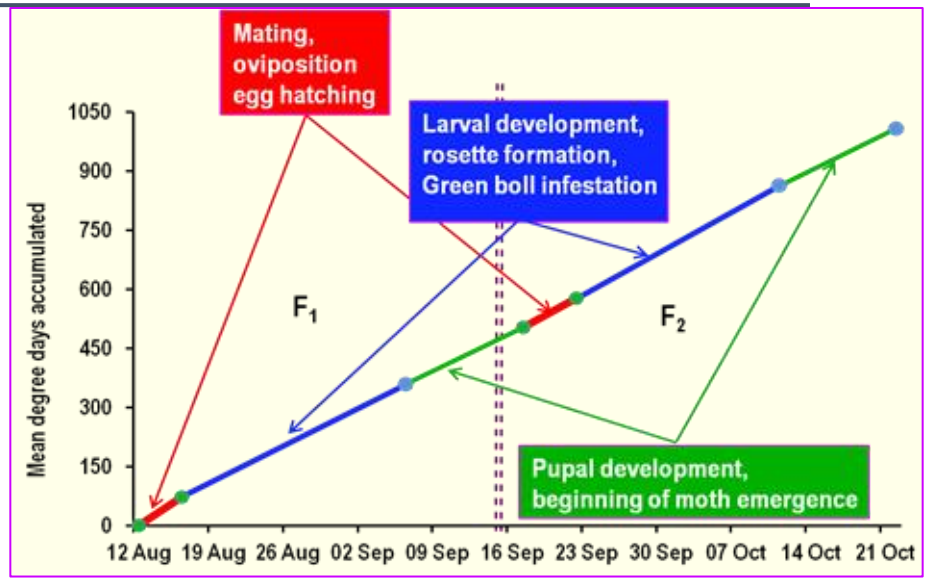
Pest monitoring based alerts

- ✓ Based on action thresholds/ETLs that warrants control action
  - 6 whiteflies per leaf
  - 8 moths per trap per night for 3 consecutive nights

Pest prediction- based alerts

- ✓ Coupled results of C-MIMS and DD-phenology model
- ✓ Predicting critical life events
  - Beginning & peaks of moth emergence
  - Dates of oviposition & egg hatch
- ✓ Tracking no. of generations within a season





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Web application

- ✓Image display
- ✓Predictive model output
- ✓Graphs
- ✓Pest alert/ Advisory

SmartTrap - Pink Bollworm

TRAP_ONE | TRAP_TWO

2024/03/26 17:14:37 Weather Summery | Pest Insect Summery

Pest Insects Detection System (PIDS .v 0.1)

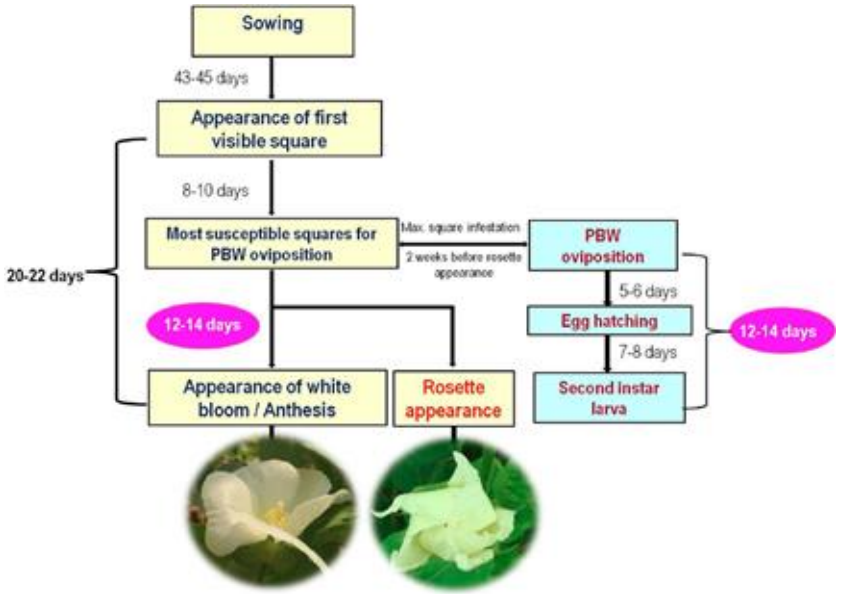
Micro Climate Monitoring System

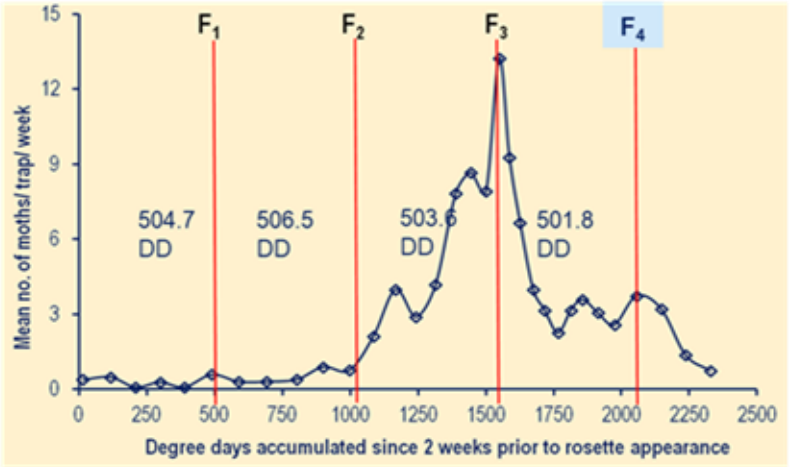
DateTime	Temp. (C)	Humidity (%)	Soil Temp.(C)	Soil Moisture(%)	Wind Speed (m/s)	PAR (umol)
2024-03-24 10:55:00	34.19	34.28	25.19	45.16	2.39	588.52572
2024-03-24 10:45:33	33.68	35.89	25.19	44.77	3.08	496.8675
2024-03-24 10:36:05	33.67	34.76	25.25	44.77	3.08	545.20411
2024-03-24 10:26:37	33.34	34.96	25.25	54.06	2.89	491.61161
2024-03-24 10:17:09	32.36	34.95	25.25	54.35	2.59	547.75411
2024-03-24 10:07:42	31.59	36.65	25.25	57.58	2.29	512.125
2024-03-24 09:58:14	31.48	35.41	25.25	55.82	2.99	497.93
2024-03-24 09:48:48	30.88	36.79	25.25	45.36	2.19	396.63839
2024-03-24 09:39:18	30.7	36.16	25.31	57.38	2.29	495.295
2024-03-24 09:29:50	30.1	36.38	25.31	57.87	3.28	461.3375
2024-03-24 09:20:23	29.53	37.66	25.37	44.38	2.09	440.13
2024-03-24 09:10:55	29.32	37.1	25.37	58.26	2.19	394.04589
2024-03-24 09:01:27	28.65	37.04	25.37	57.87	3.38	269.09589
2024-03-24 08:52:00	28.52	39.65	25.37	57.67	3.68	316.01589
2024-03-24 08:42:33	28.42	39.66	25.44	58.26	3.68	262.87661

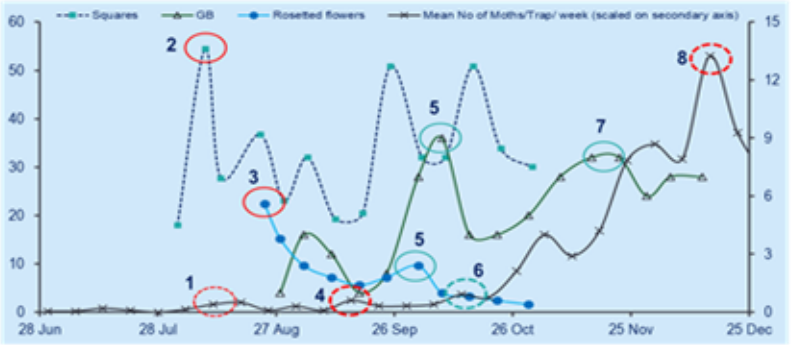
Applicability of C-MIMS: Pest Monitoring & Prediction

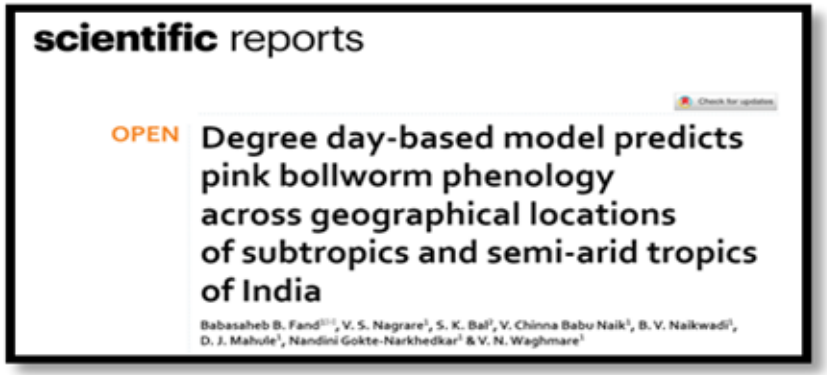
- **Predicting favorable weather conditions for pest**
  - ✓ Correlation between pest & weather data
  - ✓ Pest dynamics in response to changes in microclimate
- **Coupling of C-MIMS with phenology model**
  - ✓ Value added weather forecast
  - ✓ ARIMA: for predictive model run

Area wide IPM: Cloud server enables sending information over large area







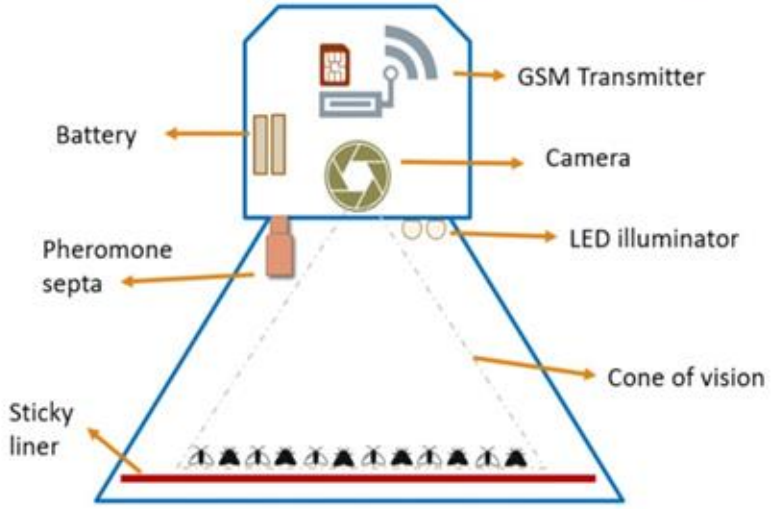


ICAR-CICR's AI based smart Pheromone Trap* for Real-time Monitoring of pink bollworm

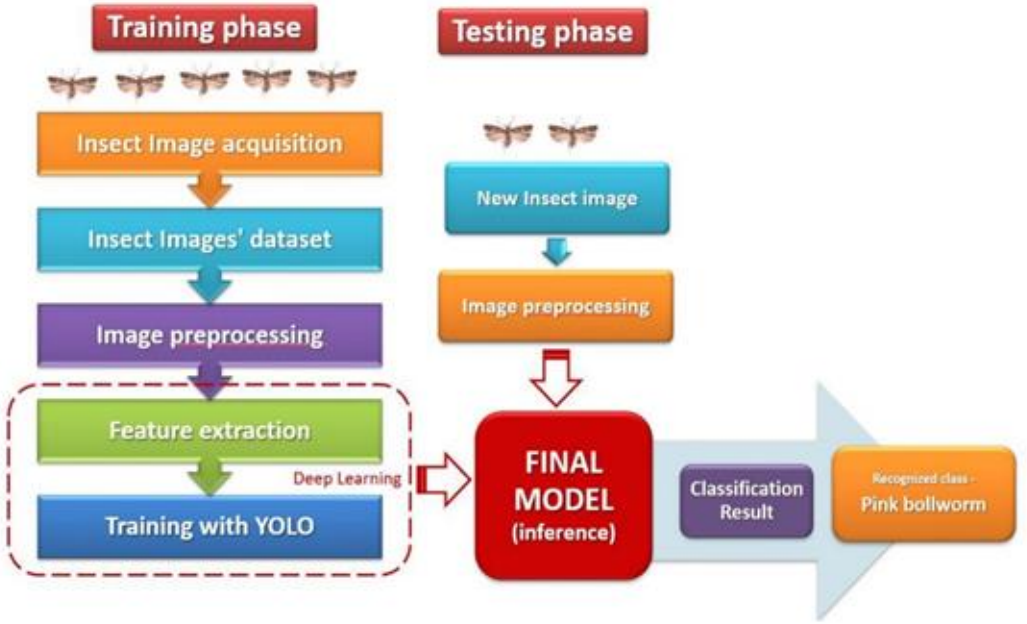
- ICAR – CICR has developed an artificial intelligence (AI) based smart pheromone trap* for the real-time monitoring of pink bollworm in cotton with a detection accuracy of 96.2%
- Deployed in pilot scale at major cotton growing districts of Punjab viz., Bathinda, Mansa and Muktsar in 18 villages to monitor the PBW
- Pest alerts and pest management advisories are disseminated to cotton farmers through mass media, mobile voice messages and social media

(K Rameash, 2024),
*Patent filed # 202421072205

Schematic Diagram of AI Trap

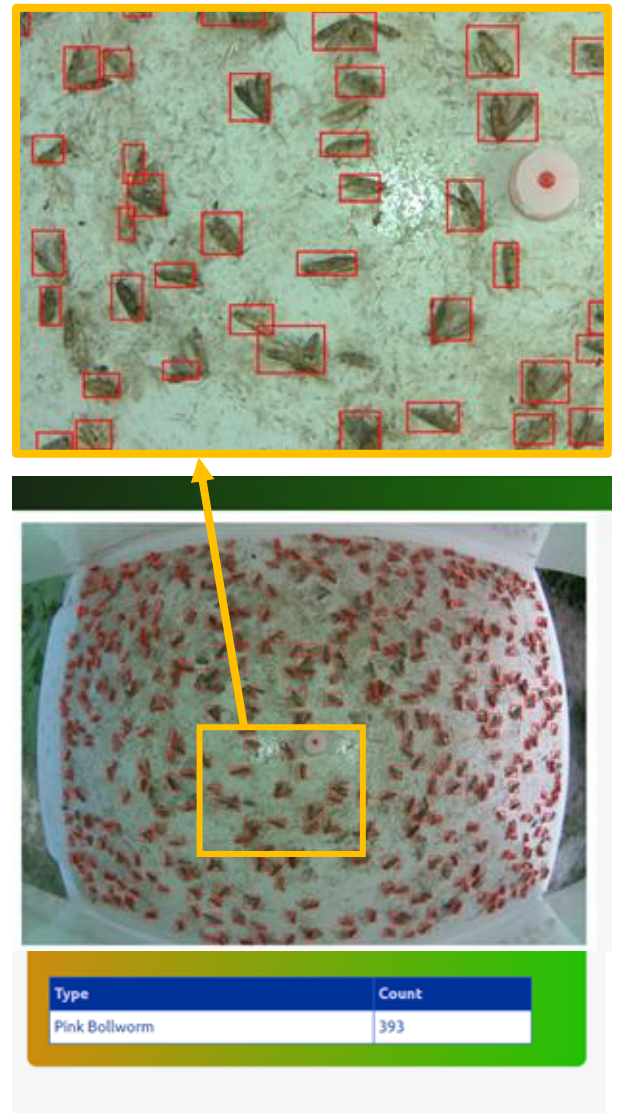


Development of image processing algorithms

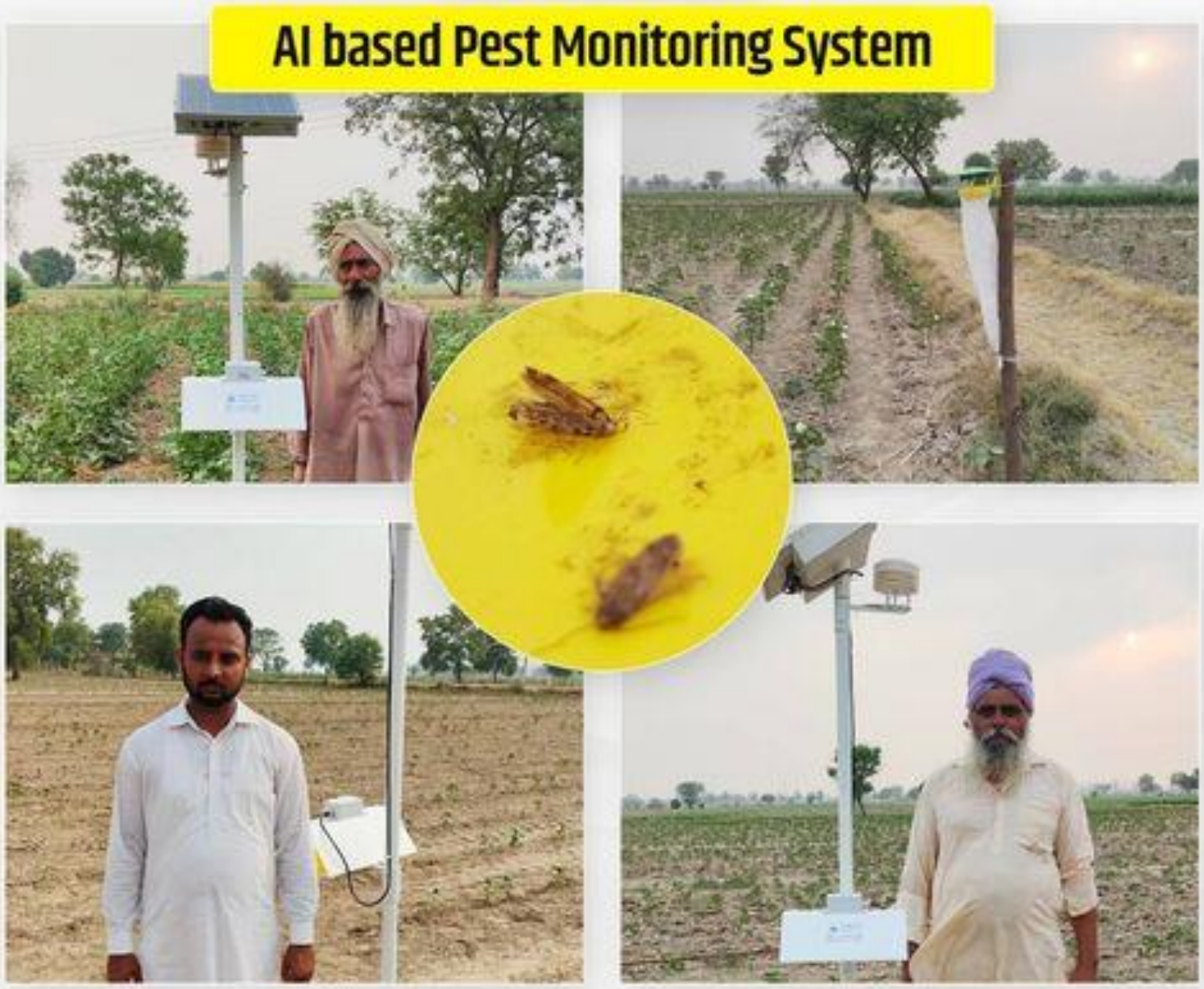


AI based smart Pheromone Trap for Real-time Monitoring of Cotton PBW in fields

- The pink bollworm problem in North Zone comprising of Punjab, Haryana, and Rajasthan has assumed high incidence, cause yield losses to the tune of 35-60% in cotton. The cryptic behavior and hidden infestation make the pest monitoring and management difficult.
- Hence the AI-developed tool was deployed in several farmers field to test its validity
- Some farmers with the monitoring tool



GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE
AND FARMERS WELFARE



businessline.

Companies / Markets / Portfolio / Opinion / Economy / PREMIUM

Home » Economy » Agri Business

ICAR to detect pink bollworm using AI-based traps on Punjab cotton farms

PREMIUM

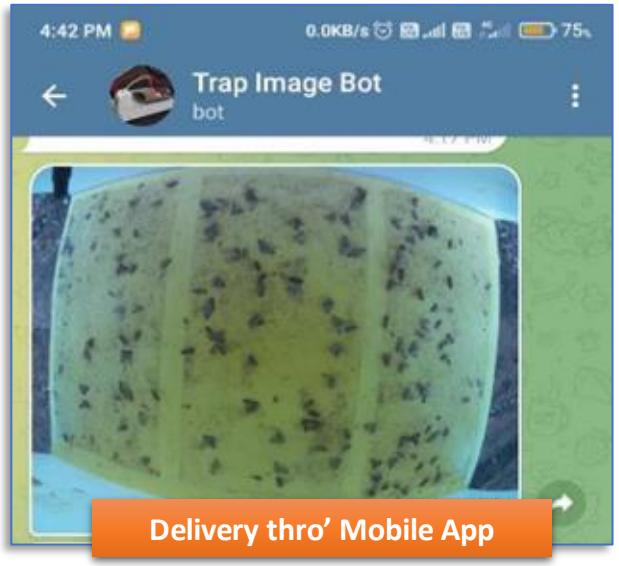
Updated - July 09, 2024 at 08:47 PM. | New Delhi

Farmers look for immediate relief from the pest that has financially affected them for three years in a row

BY BL NEW DELHI BUREAU

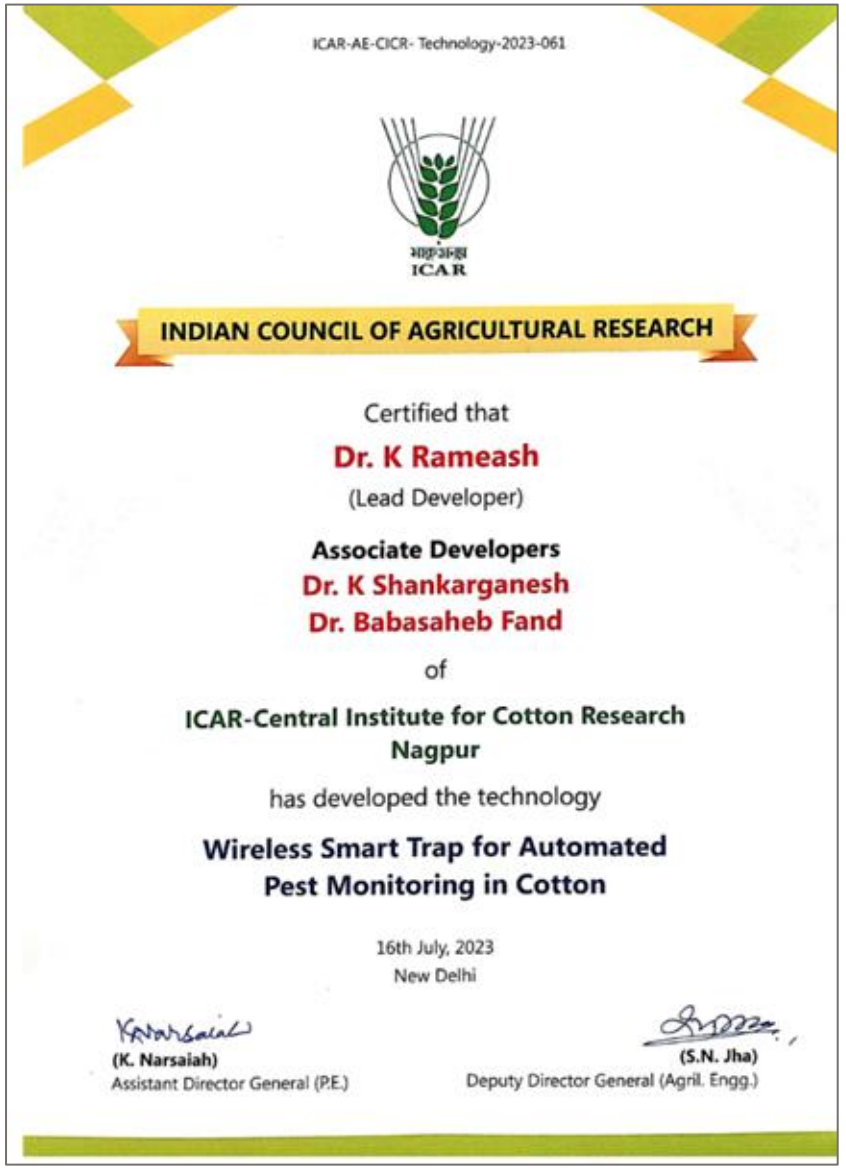
- Trap catch data – in app
- > 90% accuracy in detection
- ETL based decisions

CICR - Wireless smart trap for automated pest monitoring in cotton



The DDG (CS) Dr T.R. Sharma, and the ADG (CC) Dr R. K. Singh observing the smart trap

- The smart trap provides a real time trap catch of cotton pests as images with corresponding weather data via an e-mail client and mobile application.
- It houses four individual pheromone septa in a modified delta trap system to monitor key pests of cotton viz, *Pectinophora gossypiella, Spodoptera litura, Helicoverpa armigera* and *Earias vittella*.
- The pest dynamics could be studied to establish a reliable pest forewarning system in cotton.
- Multi location trap data can be synchronized to assess the target pest population in a wider area.



ICAR-AE-CICR- Technology-2023-061

ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. K Rameash

(Lead Developer)

Associate Developers

Dr. K Shankarganesh

Dr. Babasaheb Fand

of

ICAR-Central Institute for Cotton Research
Nagpur

has developed the technology

Wireless Smart Trap for Automated Pest Monitoring in Cotton

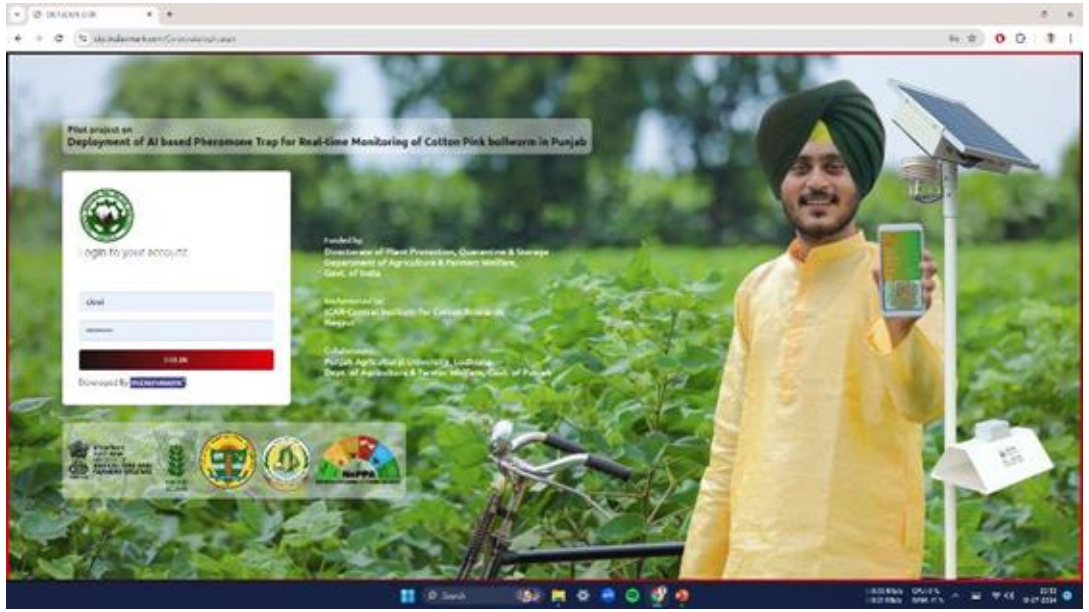
16th July, 2023
New Delhi

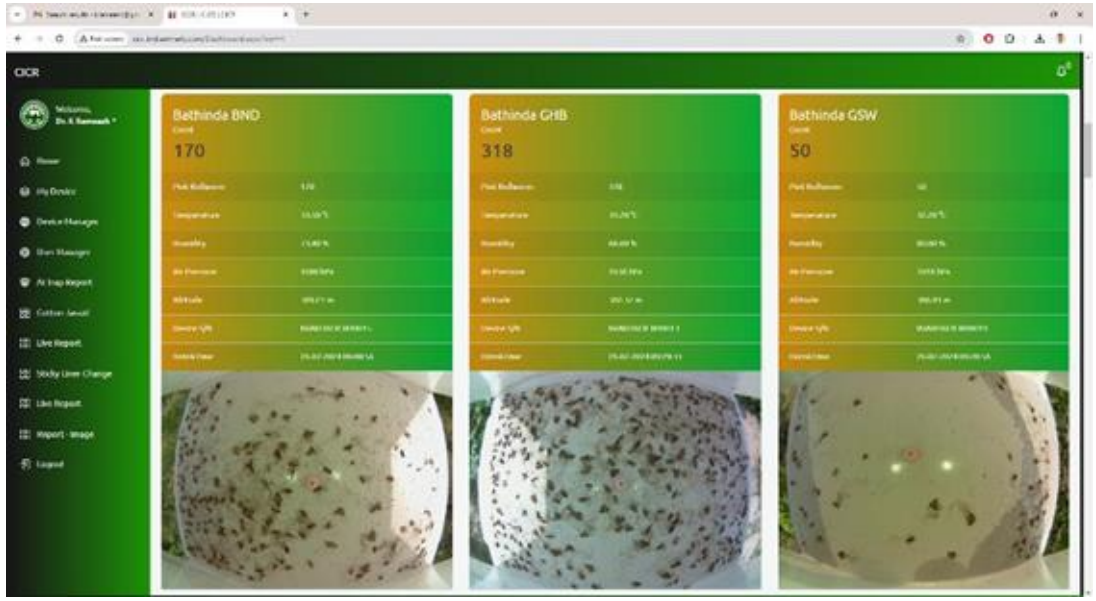
(K. Narsaiah)
Assistant Director General (P.E.)

(S.N. Jha)
Deputy Director General (Agril. Engg.)

(Rameash et al., 2022)

Development of web-portal to access AI Trap data





- A dedicated web portal https://cicr.indianmark.com/ is developed for the real-time information of the pink bollworm trap catch and corresponding weather data.
- Log-in credentials for the web portal were circulated to all the stakeholders for the data access.
- The web portal can be used the access the live trap information with the image, count of insects and weather data.
- Additional reports on the hourly trap catch, daily count report, ETL Report and Historical Report can be accessed.
- The information can be viewed and downloaded as Excel file for the required period.
- Provisions are given in the home page to show graphical representation of daily trap catch for all locations and weekly trap catch for individual locations, Weather data for all locations and ETL alert.

Key finding – AI Trap Project

Timely PBW management maintains the infestation below ETL even with reduced pesticide

PBW Damage	AI trap farmers	Conventional Farmers
Flower Infestation	2.3-5.2%	2.1-7.9%
Green Boll Damage	3.9-6.1%	3.6-24.3%
Open Boll Damage	5.2-8.9%	8.6-34.2%


PBW larva

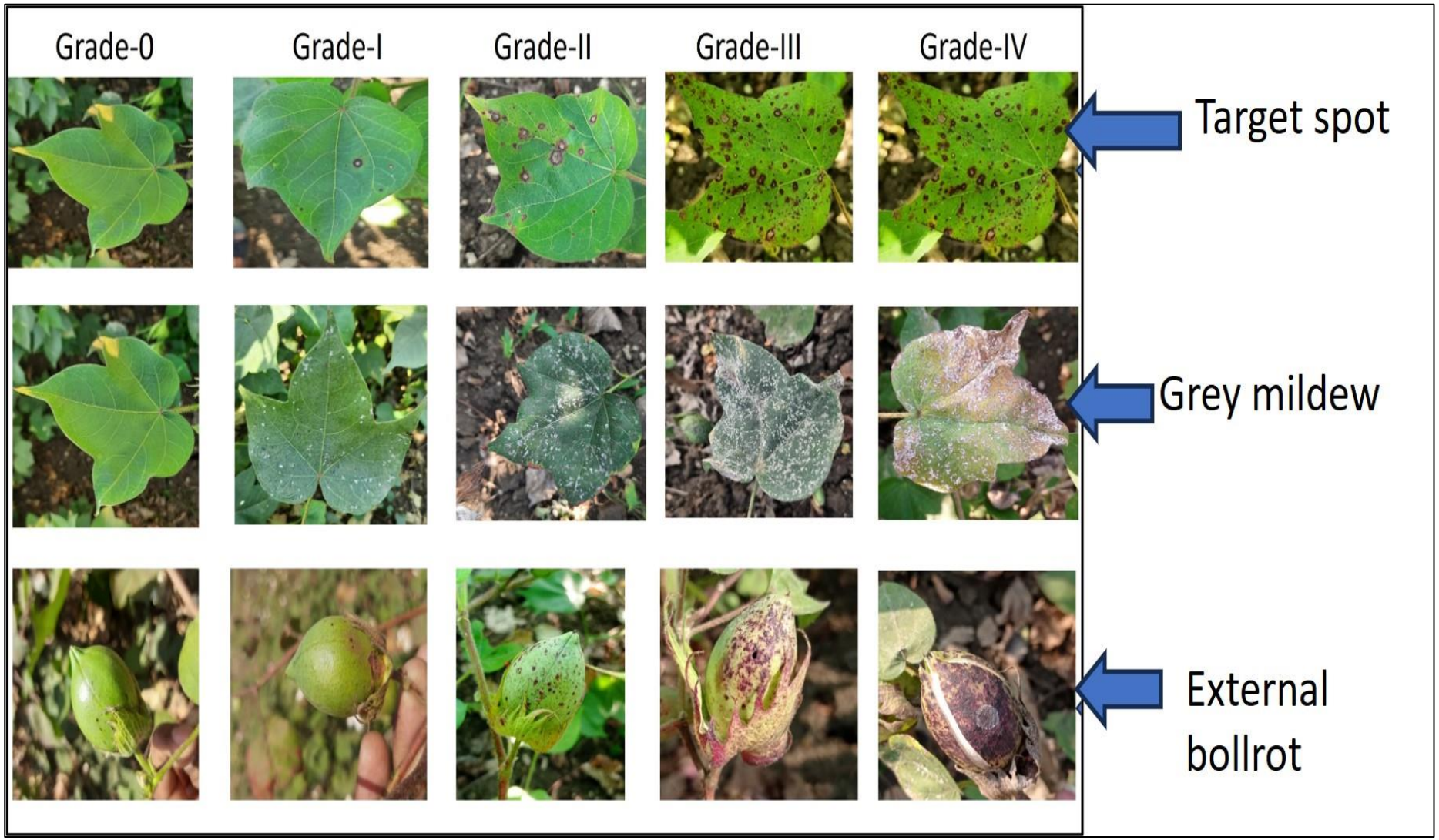

Flower Infestation


Green boll damage

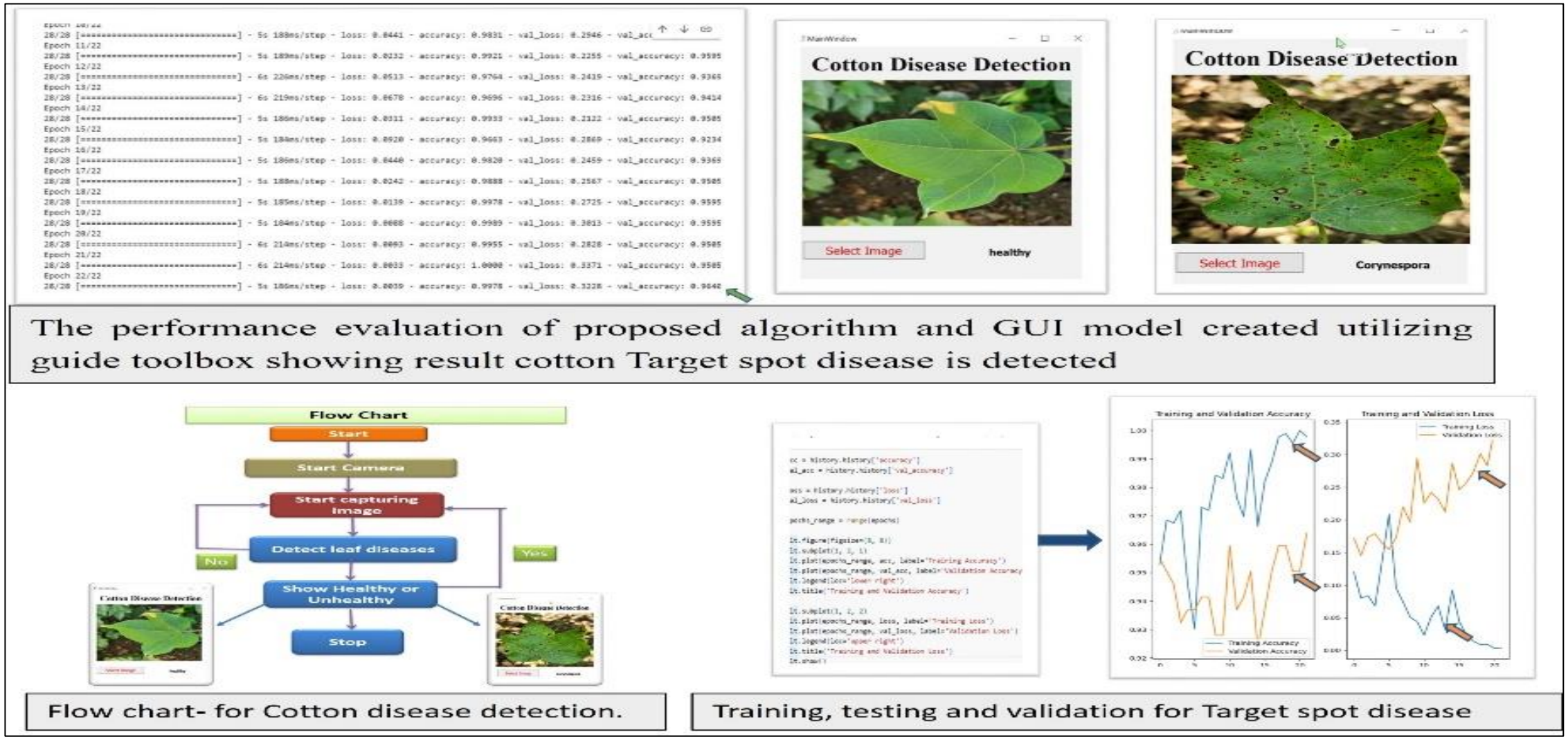

Open Boll Damage

- The AI Trap farmers received timely ETL alerts and sprayed an average of **6.2 insecticide sprays** (2.8 for PBW + 3.4 for sucking pests) as compared to **10.1 sprays** (4.9 for PBW + 5.2 for sucking pests) in non-ETL alert based conventional farmers.
- With the timely alerts the pink bollworm damage levels were kept below ETL even with a **38.61% reduction in pesticide usage** in AI Trap fields compared to conventional farmers fields.
- The use of **IoT tool** (AI Smart Trap) for real-time pest monitoring combined with **ICT tool** (Voice messaging via GSM mobile service / social media) for instant pest alert is successfully demonstrated for the first time in the country

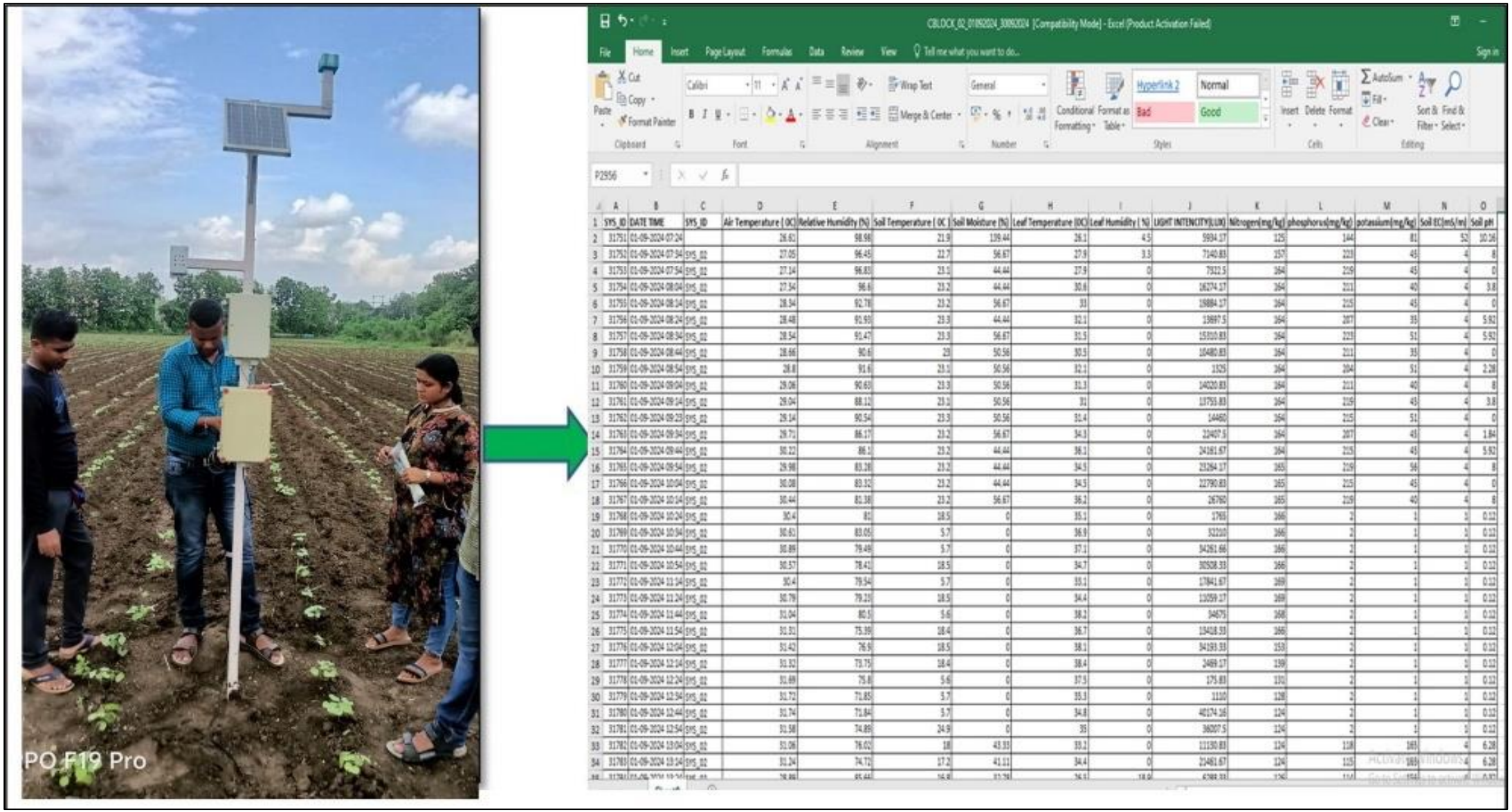
District	Village	ETL Alert Issued
Bathinda	Bandi	4
	Gehri bhagi	5
	Gurusar Shane wala	3
	Jodhpur romana	4
	Kuti Kishanpura	3
	Mehta	4
Mansa	Bhalai ke	5
	Burj bhalai ka	4
	Jheriyan walian	3
	Khiali chahila wali	3
	Khuduwali	2
	Tandian	4
Muktsar	Balamgarh	4
	Bhagsar	3
	Kothe Melak	3
	Mour	5
	Ramgarh Chungha	3
	Udekaran	4



Repository of images for the identification of different diseases and image capturing based on disease grades in infected and healthy crop.



Activity: Image based identification of cotton diseases: Algorithms of image processing and identifying diseases during crop season



SYS_ID	DATE TIME	SYS_ID	Air Temperature (OC)	Relative Humidity (%)	Soil Temperature (OC)	Soil Moisture (%)	Leaf Temperature (OC)	Leaf Humidity (%)	LIGHT INTENCITY(LUX)	Nitrogen(mg/kg)	phosphorus(mg/kg)	potassium(mg/kg)	Soil EC(mS/m)	Soil pH
31751	01-09-2024 07:24		26.61	98.98	21.9	139.44	26.1	4.5	5934.17	125	144	81	52	10.16
31752	01-09-2024 07:34	SYS_02	27.05	96.45	22.7	56.67	27.9	3.3	7140.83	157	223	45	4	8
31753	01-09-2024 07:54	SYS_02	27.14	96.83	23.1	44.44	27.9	0	7922.5	164	219	45	4	0
31754	01-09-2024 08:04	SYS_02	27.54	96.6	23.2	44.44	30.6	0	16274.17	164	211	40	4	3.8
31755	01-09-2024 08:14	SYS_02	28.34	92.78	23.2	56.67	33	0	18884.17	164	215	45	4	0
31756	01-09-2024 08:24	SYS_02	28.48	91.99	23.3	44.44	32.1	0	13697.5	164	207	35	4	5.92
31757	01-09-2024 08:34	SYS_02	28.54	91.47	23.3	56.67	31.5	0	15310.83	164	223	51	4	5.92
31758	01-09-2024 08:44	SYS_02	28.66	90.6	23	50.56	30.5	0	16480.83	164	211	35	4	0
31759	01-09-2024 08:54	SYS_02	28.8	91.6	23.1	50.56	32.1	0	1325	164	184	51	4	2.28
31760	01-09-2024 09:04	SYS_02	29.06	90.69	23.3	50.56	31.3	0	14020.83	164	211	40	4	8
31761	01-09-2024 09:14	SYS_02	29.04	88.12	23.1	50.56	31	0	13755.83	164	219	45	4	3.8
31762	01-09-2024 09:23	SYS_02	29.14	90.54	23.3	50.56	31.4	0	14480	164	215	51	4	0
31763	01-09-2024 09:34	SYS_02	29.71	86.17	23.2	56.67	34.3	0	22497.5	164	207	45	4	1.84
31764	01-09-2024 09:44	SYS_02	30.22	86.1	23.2	44.44	36.1	0	24181.67	164	215	45	4	5.92
31765	01-09-2024 09:54	SYS_02	29.98	83.28	23.2	44.44	34.5	0	23264.17	165	219	56	4	8
31766	01-09-2024 10:04	SYS_02	30.08	83.32	23.2	44.44	34.5	0	22790.83	165	215	45	4	0
31767	01-09-2024 10:14	SYS_02	30.44	81.38	23.2	56.67	36.2	0	26782	165	219	40	4	8
31768	01-09-2024 10:24	SYS_02	30.4	81	18.5	0	35.1	0	1783	166	2	1	1	0.12
31769	01-09-2024 10:34	SYS_02	30.61	83.05	5.7	0	36.9	0	51210	166	2	1	1	0.12
31770	01-09-2024 10:44	SYS_02	30.89	79.48	5.7	0	37.1	0	54261.66	166	2	1	1	0.12
31771	01-09-2024 10:54	SYS_02	30.57	78.41	18.5	0	36.7	0	30508.33	166	2	1	1	0.12
31772	01-09-2024 11:14	SYS_02	30.4	79.34	5.7	0	35.1	0	17841.67	169	2	1	1	0.12
31773	01-09-2024 11:24	SYS_02	30.79	79.21	18.5	0	34.4	0	13059.17	169	2	1	1	0.12
31774	01-09-2024 11:44	SYS_02	31.04	80.1	5.6	0	38.2	0	34675	168	2	1	1	0.12
31775	01-09-2024 11:54	SYS_02	31.31	75.39	18.4	0	36.7	0	13418.33	166	2	1	1	0.12
31776	01-09-2024 12:04	SYS_02	31.42	76.9	18.5	0	38.1	0	34193.33	153	2	1	1	0.12
31777	01-09-2024 12:14	SYS_02	31.32	73.75	18.4	0	38.4	0	2489.17	139	2	1	1	0.12
31778	01-09-2024 12:24	SYS_02	31.69	75.8	5.6	0	37.5	0	175.83	131	2	1	1	0.12
31779	01-09-2024 12:34	SYS_02	31.72	71.85	5.7	0	35.3	0	1110	128	2	1	1	0.12
31780	01-09-2024 12:44	SYS_02	31.74	73.84	5.7	0	34.8	0	48174.16	124	2	1	1	0.12
31781	01-09-2024 12:54	SYS_02	31.58	74.89	24.9	0	33	0	36007.5	124	2	1	1	0.12
31782	01-09-2024 13:04	SYS_02	31.06	76.02	18	43.33	33.2	0	11130.83	124	128	165	4	6.28
31783	01-09-2024 13:14	SYS_02	31.24	74.72	17.2	41.11	34.4	0	21461.67	124	123	165	4	6.28

Activity: IoT & Wireless sensor network testing and applications to provide weather-based disease alerts.

OTHER APPLICATIONS OF AI TECHNOLOGY

- ✓**Developed smart irrigation system using sensors**
- ✓A micro (drip/ sprinkler) irrigation system with soil moisture, temperature, and pressure sensors with solenoid valves and wireless control switch forms a basic smart irrigation system.
- ✓ Fertigation is the process of precise delivery of chemical fertiliser through the irrigation water.
- ✓This initially tried in orange cultivation in Nagpur organges and now being extended to cotton

Challenges in Implementing AI for Agriculture

- AI systems require a **great deal of data** to train machines and to make precise predictions.
- Requires a huge initial investment, skilled manpower, concentrated research and development plans and a considerable **cost on operation and maintenance**.
- Concerns about **data privacy and security**, particularly regarding sensitive information about crop yield and growth
- Internet connectivity and **bandwidth limitations in remote locations** may restrain the adaptability of AI
- Continuous **education and training** are required to help farmers implement AI software and hardware properly

Policy Paradigm Shift of GOI towards AI and Digital Farming System

- **Tech Enabled Transformation:** The Government of India envisions a tech-enabled transformation of agriculture, where Artificial Intelligence (AI) and digital platforms become the backbone of decision-making, productivity, and resilience.

- **National Strategy on Artificial Intelligence (NITI Aayog):** Identifies agriculture as a priority sector, emphasizing the deployment of AI-driven solutions across the entire agri-value chain—from predictive analytics and crop monitoring to pest surveillance and market forecasting.

- **Strong Policy Push: Digital Agriculture Mission -** In a landmark move, the Digital Agriculture Mission received an allocation of USD 55 million (FY 2023–24), signalling a strong commitment to mainstream digital technologies in Indian farming.

- **Technologies like drones, smart sensors, mobile apps will help generate information for farmers in real time**

Source: Analysed by South Asia Biotechnology Centre, 2025

Digital Solutions : Key Challenges in Indian Cotton

1). **Fragmented Land Holdings**

Challenge: Low productivity, inefficient mechanization, high input costs.

Digital Solutions:

- **Farmer Producer Organizations (FPOs) & Digital Cooperatives**: Enable aggregation of land, produce, and inputs via digital platforms.
- **Farm Management Software (FMS)**: Apps like KisanHub, AgNext, CropIn help track operations, inputs, and productivity even for small plots.
- **Uber-style Equipment Sharing Apps**: Platforms like Trringo, EM3 AgriServices allow farmers to rent machinery, reducing CAPEX burden.

2). **Pest and Disease Outbreaks: Regional changes**

Challenge: Unpredictable infestations, lack of timely diagnosis, overuse of pesticides.

Digital Solutions:

- **AI-based Pest Forecasting Tools**: Use satellite data + weather patterns + local inputs to issue real-time alerts (e.g., Plantix, AgroStar, Agronaut).
- **Remote Sensing & Drones**: Enable precision spraying, crop health imaging, and early pest detection.
- **Decision Support Systems (DSS)**: Platforms like FASAL, Krishi Network, or e-SAP provide crop-specific pest management recommendations.

Source: Analysed by South Asia Biotechnology Centre, 2025

Digital solutions: Continued

3) Climate Change

Challenge: Erratic rainfall, rising temperatures, declining soil health.

Digital Solutions:

- **Smart Weather Advisory Services**: Hyperlocal weather updates via SMS or apps (e.g. Skymet, IMD, GramCover) enable climate-resilient decision-making.
- **IoT Sensors & Soil Monitoring**: Devices that track soil moisture, temperature, pH to optimize irrigation and fertilizer use.
- **Digital Water Management**: Tools like Sathguru Water Management Platforms guide micro-irrigation and fertigation schedules.

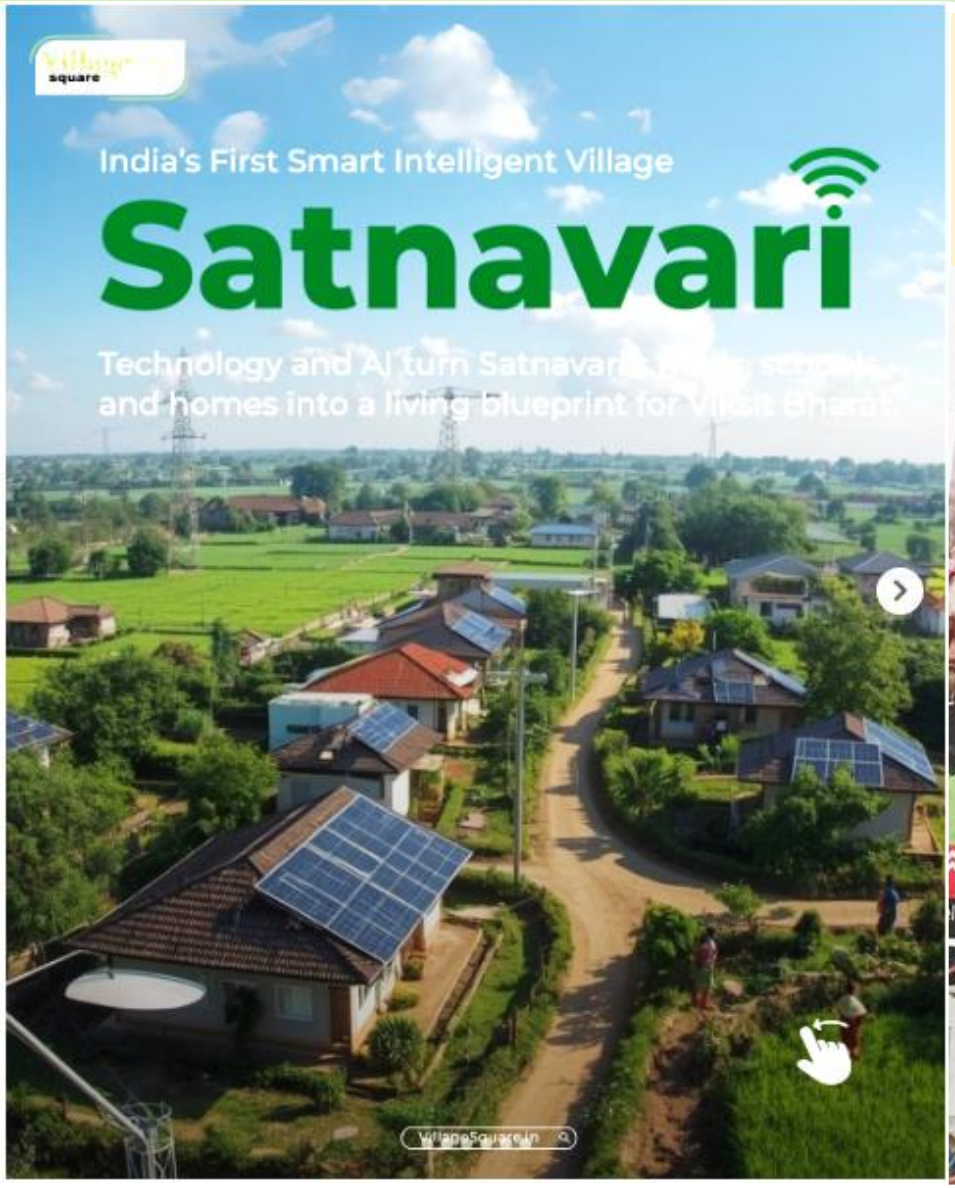
4) Cross-Cutting Technologies for Resilience

Technology	Role in Mitigating Challenges
GIS & Remote Sensing	Mapping crop stress, disease spread, climate risks
Cloud Platforms	Storing and analyzing large-scale farm data
Mobile Apps	Reaching millions of smallholders with timely advice
AI & Big Data	Predictive analytics for pest risk, yield, and weather
Agri-Fintech	Digital credit, insurance, and e-market access
e-Marketplaces	Platforms like eNAM, DeHaat, AgriBazaar boost reach

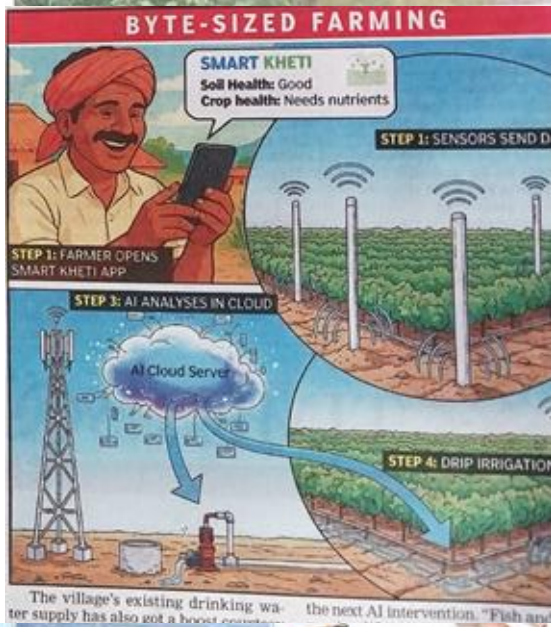
Source: Analysed by South Asia Biotechnology Centre, 2025

INDIA'S 1ST SMART, SATNAVARI

In the village, 40km off Nagpur, farmers irrigate cotton fields with an app. Here. AI-POWERED VILLAGE sensors advise' farmers on soil's water needs & drones detect crop diseases



When Satnavari Sleeps, AI Sensors Tick & Track



The village's existing drinking wa- ter supply has also got a boost

the next AI intervention. "Fish and

Thank you for your attention

"Let’s make cotton the benchmark of sustainable prosperity."