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Digital initiatives in horticulture for eastern India

The eastern states of India are rich in horticultural diversity, with prominent fruit crops including mango, litchi, banana, guava, pineapple, bael, and papaya. Significant vegetables like potato, onion, cauliflower, cabbage, pointed gourd, sponge gourd, and brinjal are also extensively cultivated. Bihar, notably, is a major supplier of these vegetables, particularly to eastern India, Uttar Pradesh, and Delhi. Bihar Agricultural University (BAU) has been instrumental in advancing horticulture through digital initiatives in eastern India, distributing 624 agromet advisory bulletins over three years, benefiting over 6.684 million farmers via the m-Kisan Portal and 1.611 million through WhatsApp. BAU's digital initiatives on *Kisan* Helpline, *Sawal Jawab*, Community Radio Station, *Kisan Gyan Rath*/ *Krishi Gyan Vahan* are also benefitting the horticultural farmers. By adopting precision technologies like drones, IoT and AI; BAU has enhanced pest control, irrigation, and yield predictions, contributing significantly to the horticultural productivity and farmer's income in this region though with limited extension services.

THE primary horticultural crops cultivated in the eastern states of India encompass a diverse array of fruits and vegetables. Notable fruit crops include mango (*Mangifera indica*), litchi (*Litchi chinensis*), banana (*Musa* spp.), guava (*Psidium guajava*), pineapple (*Ananas comosus*), bael (*Aegle marmelos*), and papaya (*Carica papaya*). Additionally, key vegetable crops such as potato (*Solanum tuberosum*), onion (*Allium cepa*), cauliflower (*Brassica oleracea* var. *botrytis*), cabbage (*Brassica oleracea* var. *capitata*), pointed gourd (*Trichosanthes dioica*), sponge gourd (*Luffa cylindrica*), and brinjal (*Solanum melongena*) are extensively grown. Bihar, in particular, plays a crucial role in supplying a variety of these vegetables to other regions within India, with significant distribution to neighbouring eastern states, Uttar Pradesh, and the national capital, Delhi. Considering the soil and agro-climatic condition, it is considered that there is a huge scope for increasing the areas and productivity of horticultural crops in this region which may create job opportunity and increasing the income of the farmers. Proper cultivation and promotion of horticultural crops can significantly help people in this region break free from the cycle of poverty. Even marginal and small farmers with limited landholdings can hope to increase their incomes through these opportunities. The primary bottleneck hindering horticultural growth in this region is a weak extension system. Currently, only about 30% of developed technologies reach farmers, with clear evidence of an elite bias in technology adoption. Although, Mission for Integrated Development of Horticulture (MIDH) and *Rashtriya Krishi Vikas Yojana* (RKVY) are major initiatives of the Government of India for promotion of horticultural crops apart from the state initiatives. Despite these initiatives, the horticultural growth in eastern India still faces numerous challenges.

Need for digital transformation in horticulture

In light of these challenges, digitalization has emerged as a transformative tool for modernizing horticultural crop cultivation and addressing the specific needs of horticultural farmers. In eastern India, the dissemination of agricultural technologies has been hindered by the state's vast and diverse geography, limited extension services, and the traditional public extension system's difficulty in reaching a large number of smallholder horticulture farmers. The traditional extension system, though well-intentioned, faces the challenge of connecting millions of farmers across the region with a limited number of extension personnel. The timely dissemination of relevant, location-specific information to the right farmers is critical but often difficult to achieve. Furthermore, the need to increase horticultural production under changing climatic conditions has created an urgent demand for innovative approaches to technology dissemination and knowledge sharing.

Bihar Agricultural University, Sabour, has proactively addressed these challenges by adopting digital technologies. Since its establishment in 2010, BAU has become a hub for agricultural innovations, especially through its application of Information and Communication Technology (ICT). Over the last decade, the university has incorporated diverse digital tools into its extension services, enhancing

Digital initiatives of BAU, Sabour

Inauguration of *Sawal Jawab* programme in gracious presence of State Minister, Vice Chancellor and MP

its ability to connect with farmers more effectively and with improved accuracy.

Key digital initiatives in horticulture

BAU's digital initiatives have revolutionized how agricultural knowledge and technologies are shared with farmers, especially those in remote areas. These initiatives span a variety of platforms and tools designed to ensure that farmers receive timely, accurate, and actionable information. Some of the promising digital initiatives of BAU, Sabour are Youtube channel, Farm Advisory through *Gramin Krishi Mausam Sewa* project (GKMS), *Kisan* Helpline, *Sawal Jawab*, Community Radio Station, *Kisan Gyan Rath/Krishi Gyan Vahan*, etc. The university has recently adopted a range of innovative digital initiatives, including the Internet of Things (IoT) and drone technology, to enhance the promotion and cultivation of horticultural crops.

Digital advisory services: The University has developed a robust digital advisory platform that provides farmers with real-time, location-specific information on weather conditions, pest and disease outbreaks and efficient crop management practices. Through mobile applications and SMS alerts, horticulture farmers are empowered to make informed decisions that reduce crop losses and optimize the use of resources such as water, fertilizers, and pesticides. This system is particularly beneficial for farmers in remote areas where access to traditional extension services is limited or unavailable.

Over the last three years, 624 agromet advisory bulletins were distributed to 66.84 lakhs farmers via the SMS service on the m-Kisan Portal (https://mkisan.gov.in/). Additionally, these bulletins were sent through WhatsApp groups, reaching 16.11 lakhs farmers. Advisory also available through the university website (https://bausabour.ac.in/agro-advisory-services.aspx#!)

Kisan Helpline: The *Kisan* Helpline is a part of the Integrated Plant Health Clinic at BAU, Sabour, has provided year-round support to horticultural farmers and agricultural practitioners across the states. With assistance from scientists across various agricultural disciplines, the helpline addressed a wide range of queries through both phone and WhatsApp. Between April 2023 and March 2024, the helpline received a total of 3,547 calls, of which 1,880 were via the basic phone and toll-free number. Additionally, 1,667 messages and images related to horticultural crop issues were submitted through WhatsApp. The inquiries covered various aspects of agriculture, with a significant emphasis on crop protection, horticulture, agronomy, extension and soil science. Experts offered solutions tailored to the specific challenges faced by farmers during and beyond the cropping season (*Kisan* Helpline Contact Numbers: Basic phone: 0641-2451035; Toll-Free: 18003456455; WhatsApp: 7004528893).

***Sawal Jawab*:** *Sawal Jawab* (from laboratory to field) is a live forum dedicated to horticultural and others crops, where farmers and youths engage directly with experts on various horticultural crop issues. Organized by the University, this programme is broadcasted on the BAU, Sabour YouTube channel twice a month. Farmers nationwide can participate in real-time discussions on scheduled horticultural topics and ask questions via chat or comments. The programme facilitates knowledge exchange on best practices for fruits, vegetables, medicinal plants, and ornamental crops. It covers crucial areas such as pest and disease control, soil health, irrigation, and organic farming techniques specific to horticultural crops. As an effective ICT-based tool, it connects research with field applications, enabling farmers to receive timely

Table 1. Agromet advisory services provided by BAU, Sabour

Year	Agromet advisory	Agromet advisory disseminated among the farmers	
	Bulletins generated (Nos.)	SMS through m-Kisan Portal (Lakhs)	SMS-through WhatsApp groups (Lakhs)
2021-22	208	17.24	2.65
2022-23	208	24.80	4.64
2023-24	208	24.80	8.82

Community radio initiative of BAU, Sabour

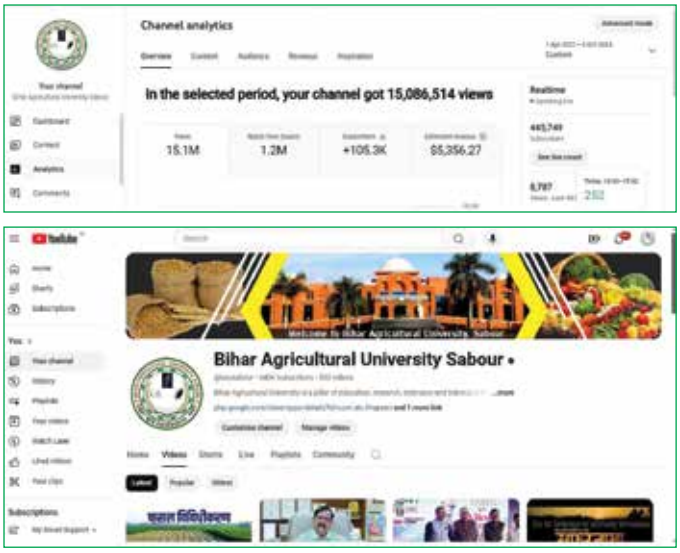
advice, make informed decisions, and enhance their horticultural practices.

Community radio for horticultural updates: The university leverages community radio to broadcast daily programme on horticultural best practices, pest management strategies and weather forecasts. This initiative ensures that farmers in remote areas without internet access can also stay updated on essential farming information, thus bridging the digital divide in rural communities. Over the past three years, a total of 75 radio programmes have been broadcasted specifically for horticulture farmers. These programme provide valuable information on best practices, efficient pest management, crop care, and market updates, making essential knowledge accessible even in the remote areas without internet access.

Krishi Gyan Vahan (Mobile Knowledge Vehicle): It is a mobile knowledge vehicle equipped with multimedia content on farm science and technology, which serves as a critical tool for technology dissemination in the domain of Horticulture. Launched by the Hon'ble Chief Minister of Bihar, this vehicle brings expert guidance directly to farmer's doorsteps. In addition to showcasing audio-visual materials, the *Gyan Vahan* is equipped for onsite soil testing, offering immediate soil health analysis and issuing soil health cards to horticultural farmers. By visiting remote villages, it significantly reduces the need for farmers to travel to distant testing facilities. Although the *Gyan Vahan* has reached large numbers of farmers since its commencement. It has visited more than 87 cities across 52 blocks within 12 districts and it has managed to benefit more than 6,746 farmers in the last quarter. One an average it reached 25,000 farmers/per annum for the last three years.

Participation of farmers in *Krishi Gyan Vahan*

Social media for agricultural extension: Social media platforms such as Facebook, WhatsApp, and YouTube are increasingly being used by BAU to disseminate information related to horticultural crops. Farmers join dedicated groups where they can access tutorials, success stories, and expert advice. Live Q&A sessions and videos on new technologies to further expand BAU's out-reach, making horticultural knowledge more accessible to a broader audience. In the last three years, more than 15 million views and more than 105K subscribers of



Social media initiatives of BAU, Sabour

BAU YouTube channel for getting technical inputs on agriculture subject in general and horticulture in specific.

Technical films on horticultural crops: BAU, Sabour has produced a series of technical films designed to educate farmers on advanced horticultural techniques, pest control measures, and post-harvest technologies. These films, broadcast on local television and made available online, visually demonstrate complex farming practices, making it easier for farmers to adopt new methods. University had developed around >500 plus technical films for the farmers out of which around 20% address the Horticultural issues of the eastern India, viz. mango, litchi, banana, guava, aonla etc. cultivation and value-addition.

Precision horticulture with IoT and AI: The integration of Internet of Things (IoT) devices and Artificial Intelligence (AI) into horticulture has enabled farmers to monitor critical environmental parameters such as soil moisture, nutrient levels, and weather patterns in real time. IoT sensors, connected to mobile applications, provide farmers with timely advice on irrigation, fertilization, and pest control. AI models further enhance decision-making by predicting crop yields and advising on optimal harvest times, helping farmers to plan more effectively and improve marketability of the perishable produce.

Some of the technical films on horticultural crops available in BAU YouTube channel

Drone technology: Drones have emerged as a powerful tool for managing large horticultural fields. At BAU, Sabour drones are used to monitor crop health, assess plant growth, and apply inputs such as fertilizers and pesticides with precision. This technology reduces labour costs, ensures the uniform application of inputs,

Pineapple plantation monitoring through drone

and enhances overall productivity by enabling precision farming techniques.

Challenges and Future prospects

Despite the remarkable success of BAU's digital initiatives, challenges remain. Limited digital literacy among farmers, gaps in rural infrastructure, and the cost of advanced technologies such as drones and IoT devices are significant barriers to widespread adoption. To address these challenges, BAU is working closely with governmental agencies, private sector players, and non-governmental organizations (NGOs) to expand digital infrastructure and increase farmers' access to these transformative tools.

Looking ahead, continuous innovation in digital technologies and the active involvement of policy makers will be crucial to scaling up these initiatives. With ongoing support, BAU's digital horticultural ecosystem has the potential to become a model for the entire Eastern Indian region.

Strategies for promoting digital initiatives in eastern India

To modernize horticulture, establishing a Digital Horticulture Knowledge Hub is essential, alongside leveraging mobile applications for farmer support and implementing remote sensing and IoT technologies. Promoting digital literacy among farmers and developing e-market places for horticultural products will facilitate seamless trade and knowledge access. Digital payment solutions should be introduced, supported by virtual advisory and extension services to enable real-time assistance. Utilizing data analytics for predictive insights and promoting collaborative platforms for knowledge sharing will further empower farmers. Strengthening digital infrastructure in rural areas is critical, with block chain integration to ensure traceability and transparency. AI-powered crop management tools can optimize farm operations, while cloud-based farm management systems and online training via webinars will support skill development. Virtual reality can be utilized for demonstrations and training, while digital marketing for horticultural products enhances market reach, completing a robust framework for a digitally-enabled horticulture sector.

SUMMARY

The digital initiatives pioneered by Bihar Agricultural University are revolutionizing horticulture in Eastern India by integrating cutting-edge technologies into farming practices. Through tools such as video conferencing, mobile applications, IoT, drones and social media; BAU is empowering horticultural farmers to make informed decisions, improve productivity and access markets. These efforts are not only enhancing horticulture farmers' livelihoods but also contributing to the sustainable development of the sector. BAU's digital strategy serves as a blueprint for the modernization of horticulture sector across the region.

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Infestation of lesser grain borer on roasted makhana seeds under storage

The internal stored grain insect (lesser grain borer), *Rhizopertha dominica* (Coleoptera: Bostrichidae) was found infesting on the roasted makhana seeds of 3 standard size grades, i.e. 7 mm, 9 mm and 11 mm. It was recorded that insects preferred to feed on 11 mm size seeds, followed by 9 mm and 7 mm, respectively. Both grub and adult stages were able to cause substantial damage. The adult laid the eggs on the seeds by entering inside the kernels through the apical natural opening. The average temperature and relative humidity for *R. dominica* development was maintained as 32.5 ± 1°C and 70 ± 5°C, respectively. It took 35–50 days for completing its life cycle, which included four stages: egg, larva, pupa and adult. Females laid about 200–500 eggs in their lifetime, singly. Incubation period lasted for 5±0.3–9±0.4 days, while larval and pupal period took 30±5 and 8±2 days, respectively. Mean longevity of adult male and female was 26 and 17 weeks, respectively. The damage potential was assessed using the artificial infestation (purposive samples) with different numbers of tested insect. The study indicated that significant loss of roasted makhana seeds during 15 days of storage with 40±1.24% losses, caused by 10 adults per 100g seeds. The total quantitative losses observed for 6 months storage period was 64±1.16% in the samples with 10 adults per 100g of roasted makhana seeds. The initial losses were very high and became slow after 20 days. Presently available method of fumigation by aluminium phosphide was practised and found feasible for the insect control.

Internal makhana feeding

Lesser grain borer (adult and grub)

Source: ICAR Annual Report 2022-23