**Agriculture Webinar Episode 2**
**Precision Agriculture and Sustainable Solutions/Policy Brief**

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Technology applications are critical to make agriculture competitive, efficient, cost effective and profitable, hence sustainable. The Green Revolution could have not occurred with the adoption of high yielding varieties (HYV) alone. That was a combination of HYVs, chemical fertilizers and mechanization. The quantitative gains from HYVs and chemical applications could be handled with machines only. Precision agriculture is an evolved version of technology applications where the mechanization has combined the use of remote sensing, satellite imagery, digital cameras and sensors, IOTs, artificial intelligence etc. for better machine operations and sustainable solutions. While we are struggling to achieve a desirable level of mechanization, the world has moved ahead with better options. Our lag in catching up with the technology revolution has made agriculture uncompetitive due to high cost of production and lower yields. Last Spring, we harvested 25 MT wheat from 21 million acres i.e. just over a ton per acre or <3 MT/h while USA record is 12 MT/h and New Zealand of 17.4 MT/h.

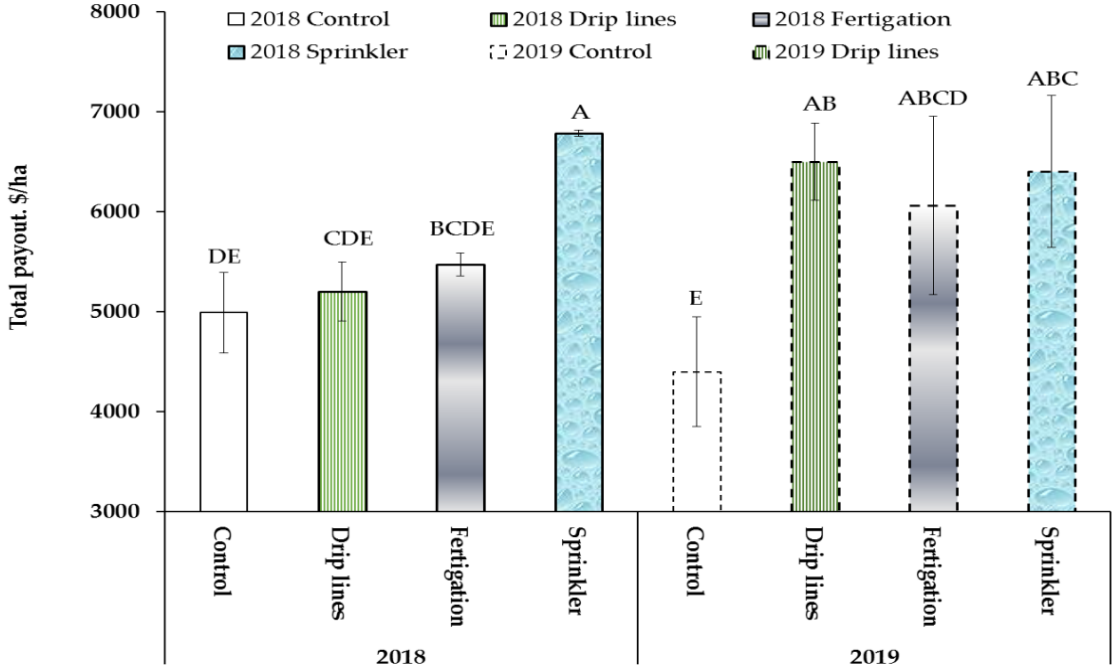


Fig. 1: *Payout per hectare for different high efficiency irrigation systems in Atlantic Canada. This research was carried out to implement irrigation based on crop needs to achieve sustainable water management. The crop water requirements were determined using advanced precision agriculture technologies to achieve site-specific irrigation.*

The digital divide has been considerably narrowed in term of internet usage and wireless communications in the country. But our ability is limited to make use of such applications for improving farm productivity. We have to adopt off-the-shelf available technologies, a low hanging fruit. Adaptation and indigenous R&D would be required for further improvements only.

This episode was organized to understand the potential of precision applications and to engage the stakeholders for fast tracking the precision agriculture agenda. A 150 minutes session was attended by 155 participants logged in from 10 countries. Notably, the President Engineering Council of Pakistan, Mr. Javed Qureshi also attended this meeting. The Federal Minister for Food Security and Research-Syed Fakhar Imam addressed the webinar and emphasized precise use of inputs, particularly water. He also eluded to the technology applications in the full value chain of commodities.

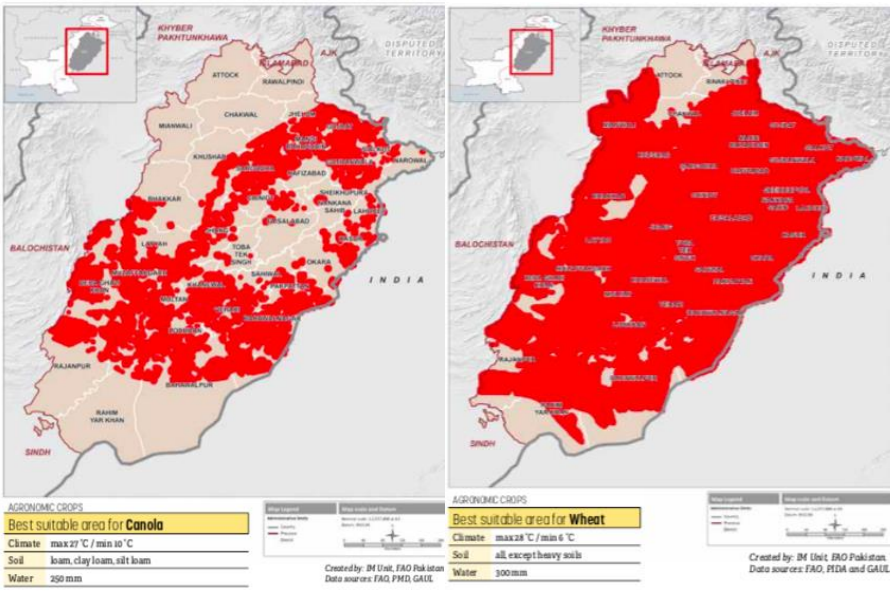


Fig.2: *Suitable areas for canola plantation in Punjab where, either wheat is being harvested or has the harvest potential. Similar Agro-ecological zoning has been done for nearly 50 crops, suggesting precision in decision making and diversification. This is an organic exercise which can be updated with the provision of current data/climate change. This Figure is copied from AEZs report.*

The technical session was opened with a brief presentation on the background and current status of precision agriculture by Dr. Qamar Zaman, Vice Chancellor, PMAS Arid Agriculture University, Rawalpindi. He quoted examples of precision from farm to fork where the cost of doing business is reduced and quality of the produce is improved. That was followed by a detailed presentation on digitization of farm mechanization by Dr. Travis Esau, Dalhousie University, Canada. He gave examples of site-specific application of pesticide in wild blueberry cropping system using intelligent sprayer and granule spreaders, precise harvesting, cleaning and traceability operations. Dr. Sun-OK Chung from the Chungnam National University, South Korea made a presentation on variable rate fertilizer application in grasses. Dr. Aitizaz Farooque from the University of Prince Edward Island, Canada gave a presentation on the use of deep learning, machine vision and artificial intelligence to assess the irrigation water needs

of potato on an as-needed basis. Dr. Azeem Khan from University of New England, Australia analyzed the potential for precision agriculture applications in Pakistan. He explained the use of freely available and continuously improving high resolution satellite imagery and weather data for decision support in agriculture. Dr. Khan referred to Agro-Ecological Zones (AEZ) study and Crop Suitability maps for Punjab, prepared by scientists and researchers from UAF and PMAS UAAR in collaboration with FAO, where he highlighted the scientific conclusion of crop diversification to restore soil fertility and reduce import bills of edible oil.

Moreover, Dr. Khan emphasized the paradigm shift needed in the agriculture departments to move from a conventional government functionary to a research for development organization that can solve indigenous problems of the farming sector. However, that may only be possible by capacity development and training of the employees. In continuation of that, need for curriculum revision for agriculture degree programs was highlighted. Agriculture all over the world is progressing from precision to decision agriculture. Therefore, agriculture universities must produce trained data scientists with solid background in mechanization, crop production technologies and environmental biophysics, to put the information into practice.

Dr. MJM Cheema explained the current precision agriculture and digitization projects at the Arid Agriculture University funded by PSDP. He also explained the potential uses of drones in agriculture, particularly in imagery and site-specific spray operations.

The audio/video recording of the event is available at the webpage of PAS www.paspk.org, www.uaar.edu.pk and at a YouTube link: https://www.youtube.com/watch?v=IKBx0Q4jPM8

There was a very active audience asking relevant questions. The most important question pressed by the audience was how to make precision agriculture and digitization relevant to the farming community of Pakistan where farm holdings are small. In his remarks, Dr. Kauser Abdulla Malik reminded the house of making use of locally manufactured laser levelers as one of the key elements in precision agriculture. Mr. Khalid Khokhar, President Kissan Itehad emphasized introduction of tillage practices to improve the organic matter contents of our soils under very intensive cultivation practices. As a representative of the Farmers Association of Pakistan, Malik Afaq Tiwana suggested packaging of available digital technologies i.e. laser levelling, remote sensing, auto-steering and drones. He also explained a service providers model currently piloted by the Habib Bank Limited where farmers profits have gone up highly significantly in the corn crop harvested last spring. The rice plant population has been doubled with machine transplanting offered by a service provider. However, creation of service providers for each commodity is needed. There is no single model suitable for all crops and farm categories. Out of box solution are to be practiced to make precision enabled mechanization (not just tractors) reach at all farm levels.

As a summary of the session, following observations and strategic policy recommendations have emerged:

1. Farm Mechanization in Pakistan is grossly insufficient and obsoleted. While the numbers must rise, it is time that that happens with a higher horsepower and available digital applications;
2. Realizing the limitations of the small farmers, the service providers option has to be made possible. That can only happen through a major investment strategy where public expenditure could incentivize private investment (credit) and entrepreneurship;

3. Most of the current horsepower and mechanized operation needs are already in the domain of a service of kinds (rented tractors and harvesters). That has to evolve into a state-of-the-arts category combined with the input supply on the one end and to the market at the other end. A better integration of services and supplies can also create economy of scales;
4. The access to data should be made a public good. The data applications could be developed as business propositions (Apps). Investment in human resources should be tailored to achieve that goal including curriculum reforms;
5. The data science has applications across the disciplines. The new curriculum should be integrative and horizontal.
6. A legislative debate should take place to enact laws for transforming agriculture with a modern profitable outlook instead of oft repeated stories of compassion, sufferings and dole outs;
7. The prioritized precision applications include tractors with higher horsepower and farm equipment in a range of categories:
    a. Deep ploughing, seed bed preparations and seed drilling with technology fitted tractors. Rice transplanters are a recent example of changing services category. The rice experience must be replicated for other major crops for customized mechanization.
    b. The application of laser levelers must remain a priority. There is a massive requirement for skill development of the operators of farm equipment, including laser levelers.
    c. Irrigation needs assessments should be developed with deep learning and machine vision technologies beyond uses of ET (evapo-transpiration) and tensiometer data.
    d. Irrigation systems transformation of canal waters require a bigger investment portfolio to create a user level water storage and application of HEIs (High Efficiency Irrigation). But all new technologies could be made mandatory for solar tube well water uses.
    e. Causes of poor adaptation of HEI technology should be determined and public programs be redesigned. Local manufacturing of plastic products used in HEI and mulching should be eased.
    f. Fertigation practices are yet to evolve to an easy form by an ordinary farmer and necessary investment in adaptation R&D is required.
    g. Variable rate applications of fertilizer, pesticide and weedicide are easy to adapt which are economical and environment friendly. The tractor assemblers must be required to meet the standards for digitization and electronic equipment/attachments.
    h. There is also a case for allowing free import of digitization equipment, tractor appendices and built up machines for precision agriculture.
    i. Drones procurement and usage in agriculture should be allowed free of encumbrance and unnecessary regulations.
    j. A data center should be established to integrate information from all available sources. The current AEZ exercises has provided a baseline which should be continuously improved.
    k. A law should be enacted to mandate crop rotation (including new crops) to keep our lands productive, improve soil health and investigate the potential of bio-circular economy for sustainable agriculture in Pakistan.

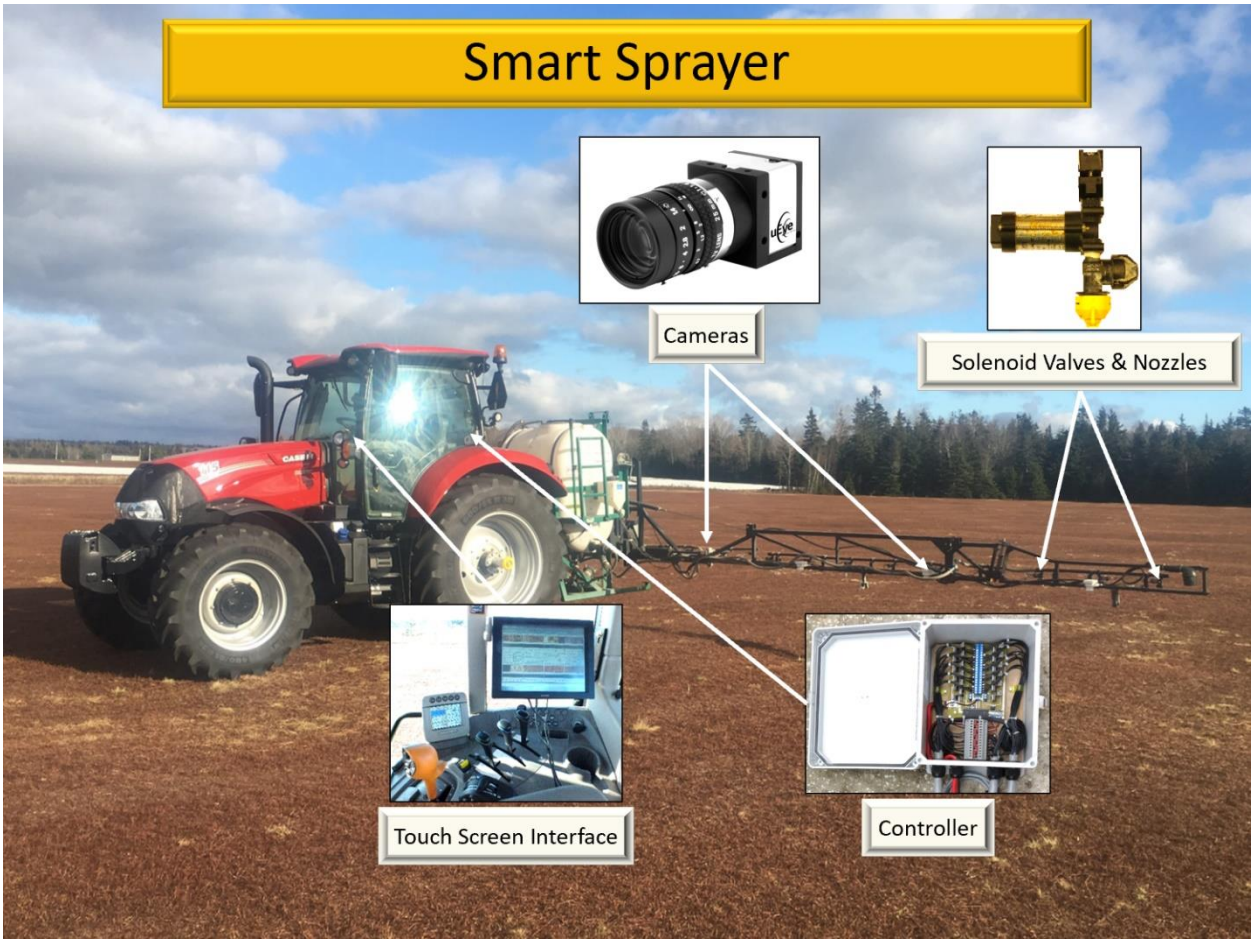


Fig. 3: *Development and evaluation of a smart sprayer for spot-application of agrochemicals in wild blueberry cropping system. This custom developed innovative sprayer comprised of machine vision, computer control, processing units, and solenoid valves. This sprayer is capable of differentiating weed, diseases, bare soil, and healthy plants on-the-go to achieve spot-specific and targeted application of agrochemical (herbicide on weeds, fungicides on diseased plants, no application in bare soil, and liquid fertilizers on wild blueberry plants only).*

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