GUEST ARTICLE

Towards Affordable and Sustainable Water-Smart Irrigation Services

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THERE IS A COMMON PERCEPTION in the agriculture sector that solutions for irrigation water management based on new technology that claim to be smart and precise are expensive. This notion is perhaps universal. In today's technology-driven world, we associate precision and smart agriculture with expensive drones or unmanned aerial vehicles (UAVs) with complex gadgets, expensive sensors or probes and costly sampling on site or in the laboratories. Such solutions often imply that they are likely to be out of reach of small landholding farmers, such as those in rural developing areas who are vulnerable to crop failures, or those in urban environments in the USA who need highly precise irrigation management services.

In South Asia, the water productivity for growing food is one of the lowest where irrigation water is often wasted by using more than what is required (Foley et al., 2011). Here we argue that water-smart technology for growing more food with efficient irrigation water management does not have to be costly or expensive to maintain in either rural or urban environments if it is designed right. We have demonstrated one such example of a precision and water-smart irrigation solution that we recently piloted in India. We believe the concept can apply equally to USA, Europe or other developed regions for urban farming communities.

Kritsnam Technologies together with Geokno have banded with Indian Institute of Technology (IIT)-Kanpur and the University of Washington to make precision and water-smart irrigation management both affordable and easy to use for a vast majority of farmers for India and around the world. The main idea behind an affordable precision and water-smart irrigation advisory system for farmers involves the use of low powered wide area network (LPWAN) gateway towers, each covering a tested radius of 6 km and potential radius of 45km line-of-sight in rural areas (de Carvalho Silva et al., http://bit. ly/2LXLHLb), satellites and numerical weather models that cover the globe, and inexpensive environmental sensors/probes that run on 2 AA batteries for years (Figure 1).

Figure 1. Schematic showing the main components of PANI based on satellites and weather models (upper right) combined with low-cost ground sensors in a LPWAN network (upper left) that produce plot scale irrigation advisory for the farmer (lower panel).

Evolution of Inexpensive Precision And Water-Smart Irrigation

Building on an earlier coarse-resolution Irrigation Advisory System (IAS) developed by the University of Washington that is now serving 100,000 farmers in Pakistan (see Hossain et al., 2017), two private companies - Kritsnam and Geokno, joined forces with the University of Washington to prototype an advancement – one that would be 'precise and water-smart' and yet inexpensive for small landholding farmers. Such an advancement could also find its use in urban agricultural environments of North America where high spatial and plot-scale precision is essential. Currently, the IAS in Pakistan is based entirely on satellites and numerical weather models and therefore it is limited by a spatial scale of 10 km with no plot-level details. The smaller land-holding farmers who grow a variety of crops each season, do not receive specific advises for their crop from such system. Our advancement for more precise and water-smart irrigation is called PANI – Provision for Advisory on Necessary Irrigation (PANI).

How PANI Works

PANI's basic structure is simple and innovative (Figure 1). Using LPWAN gateways on towers or treetops, regional command centers can be established for collecting local information on the small-scale spatial features as well as local scale atmospheric conditions from in-situ LPWAN based Automatic Weather Stations (rainfall, temperature, wind speed, humidity, pressure, solar radiation) (Figure 1). The LPWAN towers require modest power from solar power and therefore do not need to be connected to the electric grid. The inexpensive environmental sensors that need calibration and can then measure parameters on soil and weather conditions, can relay the information they gather in real-time to the LPWAN gateway towers.

Figure 2. An example of an urban farm in Phoenix, Arizona (courtesy of FoodTank at www.foodtank.com)

For example, an inexpensive sensor connected to an LPWAN node can collect data and relay it to the LPWAN gateway towers in real-time which further upload this data to the cloud using GSM/GPRS. In other words, these sensors, that run on 2 AA (pencil) batteries can 'talk' to regional command centers comprised of LPWAN gateway towers for up to 2 years without any maintenance. The LPWAN towers can also communicate with each other and collect all the information from far away locations to one common platform if the series of towers are in successive lines of sight. Finally, all this information can be uploaded to the cloud to a central database. The database also consists a GIS containing the plot details, e.g., plot location, soil type, type of seed and the stage of growth. The currently proven satellite-model based advisory of IAS can then be downscaled to the plot scale using the GIS database and an expert system and disseminated to farmers via SMS messaging or an app (Figure 1).

How Inexpensive is a Precision and Water-Smart System Like PANI?

A typical LPWAN gateway costs around $800 which includes solar power supply and cloud connectivity. Each LPWAN communication node costs around $80. A multi-sensor module that can measure air temperature, humidity, rainfall, atmospheric pressure and wind speed costs about $120, and a reliable capacitance based soil moisture sensor is available for about $80. One LPWAN tower can easily cover an area of 100 sq km, and about 100 environmental monitoring sensors can map weather and soil moisture variability in that area fairly well. If it is assumed that 100 farmers live in 1 sq. km installing an integrated system that can give farmer specific irrigation advisory will cost fewer than $5 per farmer.

Conclusion

We believe a concept like PANI, based on the internet of things, inexpensive sensors and satellite observations is universally applicable, even in regions of North America, particularly where plot sizes are small and crop variability is high, such as in urban agricultural environments (Figure 2). Today, urban agriculture is gaining attention as part of the discourse on smart cities (http://bit.ly/2Pl3PAS). Farmers engaged in urban farming in the USA need similar irrigation management services that are precise and tailored for small lands. If we are going to impact the smallest landholding farmers of the world, who today grow more than two-thirds of the world's food, agricultural innovation has to take advantage of the plethora of environmental sensing at multiple scales within a wireless environment. Such a solution has to be inexpensive and low on maintenance cost. PANI is built to have such sustainable features. ■

References

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