by Telemaco Melia, VP and General Manager of EchoStar Mobile

The Internet of Things

Can agritech and IoT enable the agriculture sector to become more sustainable?

The global population recently reached the landmark figure of 8 billion people, with the UN expecting it to rise to 9.8 billion by 2050. Feeding all these people will be a major challenge for the world's farmers. In fact, the UN estimates that feeding this population would require raising overall food production by some 70 percent from the baseline figure of 2005/07. [1]

One way to do this is to increase crop yields and some success has already been achieved. According to the UN Food and Agriculture Organization (FAO), countries such as Belgium and Denmark have improved wheat yields to approaching nine tonnes per hectare, around double for the corresponding figure in 1961. [2]

Despite these improvements, there remains scope for more, with many countries able to improve their wheat yields by three tonnes-per-hectare or more. There is similar scope with other cereal crops - for example, Nepal has the potential to improve its barley yield by over four tonnes-per-hectare.

More food and a better environment

While producing more food to meet the needs of a growing population, we must also protect the environment. Although it seems counterintuitive, feeding more people through improving crop yields also protects natural habitats. In a 'business as usual' scenario with existing yields, global cropland would need to increase by 26 percent, an area the size of India and Germany combined, to feed the projected population of 2050. By contrast, closing yield gaps by improving yields from their current figures to 80 percent of their maximum potential would largely eliminate the need to expand existing croplands. [3]

Another priority as we improve crop yields is to conserve and protect the water sources that agriculture relies on. With agriculture accounting for over 70 percent of water use worldwide and over 40 percent in many OECD countries, [4] demands for new food stuffs and products are expected to keep use high.

For example, growing demand for biofuels could see agriculture's demand for water rise dramatically, with these crops possibly requiring as much water as fossil fuels to produce.

As well as water sources, soil health, and insect and bird populations must also be protected from the harmful effects caused by fertiliser run off and excess use of pesticides.

Soil used for agriculture gradually becomes degraded and less productive over time, making it less suitable for future crops. Farmers want to use their resources effectively and sustainably to ensure they are always getting the most from their land without damaging it.

Better information makes for better farming

With these increasing demands and challenges, tomorrow's farm will need to be more efficient. The greater yields needed will have to be achieved with fewer inputs in the form of energy or chemicals. This will not only save nature from this chemical stress and the excessive nutrients that can cause imbalances in water courses, but also reduce farming's carbon footprint by

decreasing the need for energy in the production, transport and application of these materials.

To achieve these goals will require accurate information. With better and more timely information about their land and the crops growing on it, farmers can make better decisions, ensuring the best outcomes for crops, soil, water sources, and stored products such as harvested grains.

Sensors that can tell farmers about aspects such as soil temperature, water levels, and rainfall are already providing famers with the opportunity to know more about their land and its condition. Yet so far, these sensors have been isolated and their utility has been reduced by the need to visit the sensors in person to read the acquired data.

This has all changed for the better with the development of the 'Internet of Things' (IoT). The IoT consists of physical objects that have "smart" capabilities to collect data about their physical world. This data is transmitted through communication networks to computers that process, store, and analyse this data.

Depending on the software used, such a system can also produce information that allows farmers to take action - with the ability to see what is happening on their farm in real time (often on familiar smart devices such as smartphones and tablets), farmers can take the best informed decision to adjust their plans as conditions change.

The smart farm

These linked sensors and easily accessible information give farmers the chance to achieve greater productivity in a number of farming use cases.

One of these is known as precision agriculture, which uses IoT data to help farmers plan their operations in greater detail. For example, it allows them to decide exactly where, when, and how to use resources such as fertiliser, pesticides, and irrigation, and in what amounts. Crops obviously grow better and reach their full maturity faster when they receive the ideal amount of water. With an accurate indication of how much water each field needs, farmers can provide enough water but not too much. By taking the guesswork out of watering crops, a soil moisture monitoring system can reduce water consumption by around 20 percent.

With sensors providing data on soil moisture, weather and crop health, farmers can make better decisions about when to plant crops and how to care for them throughout the growing season as weather and other conditions change.

Monitoring the health of crops as they develop is also vital. Sensors can be fixed at sites in the fields or mounted on drones, sending back data on the health of crops and identifying field sites that need extra intervention.

Correct fertiliser use is also vital. Sensors can notify the farmer that fertilisers in the soil have been depleted – they can then use maps of crop yields to decide which areas need more fertiliser. Keeping a track of how much fertiliser has been used throughout the season and on which areas helps inform the buying frequency of fertilisers. An accurate picture of use ensures that not too much working capital is tied up in fertiliser, controlling costs and allowing a greater profit margin.

It also avoids overuse of fertilisers, which can lead to run offs into the surrounding land and water courses, potentially leading to a damaged local environment.

Crop monitoring systems can also aggregate data about factors such as humidity, rainfall, and temperature, allowing farmers to harvest at exactly the correct time to maximise crop quality and yield.

One of the essential aspects of cereal production is storing grain following harvesting. It's well known that cereals must be stored at particular temperatures to ensure their preservation – for example, long term storage of wheat requires temperatures to be maintained at no greater than 5°C, with a moisture level of 14.5 percent. [5] IoT sensors can help by warning of conditions that could encourage the growth of mycotoxins or insect infestations, allowing timely intervention to prevent these risks.

Generally, IoT ensures that crops, fields and storage facilities need fewer in-person visits and allows manual tasks to be replaced with automated processes. Farm machinery, storage barns, gates, and other equipment can all be monitored.

This saves time and allows fewer people to manage larger farms. As well as this, it also cuts down the time that vehicles have to operate, saving fuel and costs and preventing pollution.

Where people are needed, IoT sensors can also track the health and location of farmworkers to ensure their safety.

The connected farm

To achieve these benefits, we need to ensure we have a connectivity method that links the sensors and allows us to bring in the data that they capture. Because of the distances involved, the terrain and the tasks caried out, agriculture isn't suited to hard wired, fixed line connections – for one thing, the data capacity of these types of fixed line is much higher than necessary and so would be much too expensive for farm use. These lines could also be easily damaged by ploughing and other farm operations.

The sensor devices need to communicate back to a gateway, which could be a few kilometres away from where the data is actually captured. The connectivity method also needs to be easy to deploy – with no access to mains power, a sensor needs to work for long periods on a single battery and also not be reliant on cellular coverage, which can be patchy or non-existent in rural or remote areas.

An ideal connectivity method for farming use is the Long Range Wide Area Network (LoRaWAN®) protocol. This is a low bandwidth data connectivity method specified by the LoRa Alliance and which matches all of these requirements.

LoRaWAN® is designed to provide the lower data rates required by the connected farm. Able to transmit data over many kilometres to meet the needs of even the largest farms, it is also low power, with sensor nodes that can operate for a long time, even several years, without a change of battery. Because it relies on universal protocols, the connectivity can be shared across multiple devices, with soil sensors, irrigation systems, agricultural machines, and many other applications all making use of the same system.

Although several connectivity providers offer access to LoRaWAN® networks, farmers can gain even more flexibility by routing the data via satellite. This method means that farms in very remote areas or far from any land based network can still access their sensors' data across the property. Sensors located in deep valleys or other terrain that poses challenges to signal propagation can still report their data.

Get farm data across a continent

One such solution offers LoRaWAN® coverage across Europe using a large, high capacity satellite. For example, there may be IoT sensors at a farm measuring parameters such as soil temperature, moisture levels, or the level in a water tank.

These sensors would send their data to a LoRaWAN module. The module then uses licensed S-band frequencies to send the data to the satellite. The frequency band is important because it can be affected by interference. S-band offers great advantages over other bands, in particular its significant resistance to signal fading caused by rain, snow, and ice. This makes it ideal for monitoring in inclement weather, ensuring that data can be accessed by the farmer at all times, whatever the conditions.

From the satellite, it is sent to the Internet via a satellite gateway Earth station and a LoRaWAN® compatible network. The data is then ready for the farmer to access on their smart device.

Even greater benefits are gained from the use of a technique called LoRa® Frequency Hopping Spread Spectrum [LR-FHSS], which allows the IoT devices to send data directly to the satellite. The result is greater reliability, higher performance, a lower power consumption and an even greater resistance to interference.

IoT can clearly bring great benefits to farmers, but the data needs to be accessible at all times. Using satellite enabled LoRaWAN®, IoT data from sensors will always be available, whatever challenges are thrown up by distance, topography, and weather.

When farmers know more about what is happening on their land, they can make their farm more manageable, profitable, and sustainable. The result is increased yields, reducing the need for extra land for crops, protecting the environment, and improving the world's food security.

References:

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