National
Narrowband
Network
Co.

Committee Secretary
House of Representatives Standing Committee on Agriculture and Industry
PO Box 6021
Parliament House
Canberra ACT 2600

Dear Sir/Madam,

Please find attached a submission to the Parliamentary Inquiry on Agricultural Innovation from NNNCo Pty Ltd.

NNNCo is in the process of developing a network to support the Internet of Things (IoT) nationwide.

NNNCo firmly believes that an IoT environment is crucial to the success of agricultural innovation. We are convinced that IoT, applied appropriately with government support, will significantly improve Australia's agricultural productivity, especially in these times of climate change and other external challenges. Further, IoT, applied correctly, will offer the opportunity for Australia to align with agriculture innovations in other parts of the world.

We would be pleased to provide further information to the Inquiry, if sought.

Yours sincerely,
Rob Zagarella, CEO and Founder

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National Narrowband Network Co.

Submission to Parliamentary Inquiry into Agricultural Innovation

Why IoT matters

The Internet of Things (IoT) is coming to agriculture. Smart agriculture solutions involving technology are being developed across Europe and the US. Chinese scientists are also heavily researching the field.

Global investment in smarter agriculture is increasing. The pace is accelerating in 2015 with this being in the top 3 areas for technology investment.

At the same time agriculture productivity growth in Australia has slowed from close to 3% per annum to around 1% per annum. Despite this, Australia currently produces and exports a significant surplus of agricultural products. Based on simple population growth projections and current productivity growth in the agricultural sector, projections suggest that Australia would remain a significant net exporter through to 2055 and beyond.

However ABARE has estimated that by 2050, with the impact of climate change, agriculture exports could reduce by between 15% and 79% compared to present day figures. If nothing is done, there is a danger for Australia that it may not be able to produce sufficient food to feed itself by a date just beyond 2050.

We need a force multiplier that will deliver greater agricultural productivity. Given small farm holdings contribute 70% of global food production and small farms are key constituents in Australia, any solution will need to work not only for the 'big guys', but also for the smaller concerns.

To date IoT has delivered most returns for the larger farms that can afford the investment- at least in the US where it has had the biggest impact. Europe has focused on a broader constituency and seems to be making significant progress too. We can learn and need to learn from the mistakes and successes of Europe, the US and other countries. We have set out below what we understand to be the major barriers to the adoption of emerging technology to achieve technological advancement in Agriculture.

The challenges moving forward

The biggest challenge in forging a successful path forward for Australia is ensuring that the investment made and the initiatives undertaken are done within an understood larger context.

Both IoT and agriculture are and will continue to be subject to major technological advances in data management, communications and applications development.

Agriculture is constantly also the recipient of major scientific advances. Agriculture is also under threat from changing climate conditions, loss of water quality, pests and disease and the loss of bee populations to name a few. A sound IoT strategy can increase productivity and at the same time help to better deal with these threats.

The challenge is with all the information and opportunities, where do we start and how do we make sure that we make the best use of limited resources. How do we make progress with as few missteps as possible? This paper attempts to answer those questions by looking at the varied experiences of other jurisdictions compared to Australia relative to the emerging technologies that are most relevant to the agricultural sector. We then examine a possible plan of attack. This approach should ensure Australia is able to advance and build up capability and value and at the same time maintain direction within a constantly changing landscape.

Emerging Technology Relevant to the Agricultural Sector

NNNCo holds the view that three emerging technologies are most relevant to the agricultural sector. These are:

- Sensor technology to be able to able to collect relevant data at a price point that can be afforded by the agricultural sector and the Australian economy;

- Connectivity to assure efficient collection of the data from the sensors, using appropriate networking technologies that are low powered, low cost and potentially ubiquitous; and

- Data storage and management techniques that can be used to transform data collected from many sources into information, projections and suggested actions for individuals and the sector to significantly and sustainably improve agricultural sector productivity.

These technologies all form part of the Internet of Things (IoT) ecosystem. Experience in Europe and the USA and to a lesser extent Australia and New Zealand, indicates that there are both significant savings and yield benefits. A table comparing these is included as Schedule 2.

Context to date

To date, Europe and the US have taken different paths. In the US the major drivers for technological advances in agriculture, including IoT, have tended to come from major agriculture industry players such as Monsanto, DuPont and John Deere. They have relied on market power and major investment to develop largely bespoke solutions. They are now being challenged by startups with investment from VC's growing as technology in agriculture becomes one of three investment foci.

Europe has adopted a more collaborative approach to agricultural innovation- with a major group, EPI-AGRI, bringing together major players including farmers, universities, innovators and communications players for example. This group is providing a focus for interested parties, funding, education and skills development etc. Europe has also embraced connectivity standards for IoT- LoRaWAN, and SigFox, which are being increasingly adopted.

Australia has a number of initiatives underway in agricultural technology, many involving the CSIRO, as well as a group who have taken interest in IoT in agriculture. However the direction and focus of these multiple initiatives is unclear. The result of the varied initiatives without a central focus is that Australia has a number of exciting innovations, but without the momentum to scale and deploy these rapidly across the country in a cohesive manner.

Barriers to the introduction of IoT

The following is a list of the major barriers to the early and effective introduction of IoT to support the growth of agricultural productivity in Australia.

- The effort and cost of building up sufficient data to support analysis and decision making
- The lack of a ubiquitous low cost connectivity solution
- Investment required to implement such a connectivity network solution
- A fragmented approach to multiple IoT initiatives to date
- No broad based, influential and multi-partite community of interest that would ensure the right priorities with the people
- Poor record of commercialization of research and innovation may result in us buying back our own ideas from overseas
- Insufficient skills, infrastructure and applications to store, analyse and present data
- No agreed standard for data acquisition and transmission, which may mean Australian innovations become 'orphans'.
- Lack of an agreement with regard to radio spectrum to be used to support the collection of data from sensors in the field

An Agile Path

In order to build scale and achieve sustainable results, it will be important to define a clear path that enables Australia to build an IoT in agriculture capability that has momentum and will be able to build on itself. Figure 1 below shows a suggested path that will address this need.

This path takes in to account the following:

- The need to maintain focus on agricultural priorities and clarify what needs to be done and in what order
- The need to build up capability and knowledge progressively
- The importance of applying open standards as far as possible to avoid having to 'throw' away' valuable initiatives that later 'don't fit'.

Phased Approach to Data Collection and Use

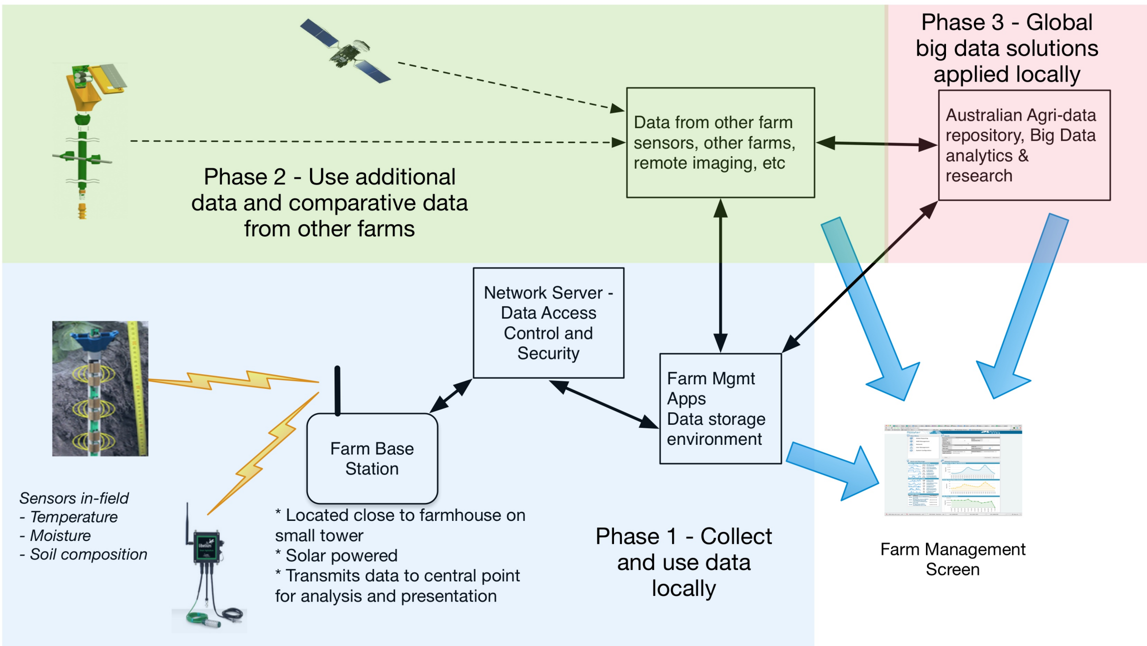

Figure 1

Recommendations for the introduction of IoT in Agriculture

In order to achieve the outcomes of a flourishing, open and growing IoT community in agriculture in Australia, we recommend the following.

	Recommendations
1	Commence the collection of data as soon as possible from in the field. **Ensure that appropriate connectivity is in place to acquire and transport data to a suitable repository.** In this regard NNNCo proposes that the LoRaWAN specification be adopted to the necessary connectivity.
2.	Adopt a suitable low powered, low cost IoT connectivity solution that can collect data from widespread sensors. NNNCo recommends the adoption of the LoRaWAN standard in this case – see Schedule 3 for further information.
3.	Perform a Proof of Concept (POC) trial of the proposed technology to determine its capabilities, confirm costs, maintenance requirements, and best approach to installation and set up.
4.	The Government allocate an estimated capital investment of $800million to provide an IoT network capable of covering 2.5 million km^2 with an ongoing estimated operational investment of $72million to maintain and operate the network. See Schedule 1 for the derivation of these cost estimates.
5.	Support the establishment of a national body comprising key influential stakeholders consisting of the Department of Agriculture, State Agriculture agencies, CSIRO, Farm Lobbies, major agricultural suppliers, representatives of the farming communities, universities and research groups, and major innovators in this space. This body will have the mission to provide focus and communication of needs, initiatives and outcomes for the provision of a coordinated approach to the innovation in agriculture including data collection and analysis and the use of IoT in agricultural innovation.
6.	Support universities and research institutions to build up public data repositories and data analysis skills.
7.	Work with the Department of Communications and the Australian Media and Communications Authority to set aside spectrum in the 928MHz to 935MHz band for the sole purpose of IoT related activities.

The need for a network solution

Without the early introduction of a suitable network solution, the acquisition and consolidation of critical data will take longer than ideal. The building out of a suitable network is the critical first step. Any connectivity solution needs to be both a commonly accepted standard and suitable for Australian conditions.

NNNCo is in the business of providing the connectivity between the sensors, wherever they may be, and a central repository of data.

NNNCo has identified an IoT technology that it believes meets the need for low power and low cost. This technology is based around the LoRa (Long Range) specification that makes use of publically available spectrum to connect ‘things’ to a central server, as part of the Internet of Things (IoT).

We believe a sustainable network can be provided to support Australian farming interests at an upfront capital cost of $800m.

We have already invested in the first steps towards constructing our own network and central repository of data. This is enabling our experienced engineers and planners to more reliably assess the network coverage and costs and understand the best way to manage a rapid rollout and data management environment.

We are supportive of a collaborative network construction and operation model. Our key aim is to ensure scale benefits that data is compatible across all collection mechanisms and can be used to achieve maximum benefit.

If the $800million investment leads to a 5% increase in agricultural productivity then the annual benefit to Australia would be $2billion of additional revenues per annum.

More information is provided in the attached Schedule 1.

Schedule 1- Estimated costs of Investment in an IoT network for Australian agriculture.

When considering the cost of providing such a network, NNNCo's capital estimates are based on the following:

- Assume that an IoT base station can cover an area of 25km^2 in a rural environment,
- There are 10 sensors per km^2 – thus expect 250 sensors per base station
- There is around 2.5million km^2 of arable land in Australia that can benefit from an IoT network,
- The estimated cost of a sensor, when scale factors are applied, are $20 each, hence sensor costs per base station would be 250 x $20 = $5000
- The cost of an installed base station, including connectivity to a backhaul service, is estimated to be $3000 (equipment and installation costs)
- To provide coverage of 2.5million km^2 would require 100,000 base stations if each covered 25km^2
- The estimated overall cost of the IoT network would be $800million overall, being;
    - Sensors - $5000 x 100,000 = $500million, and
    - Base Stations - $3000 x 100,000 = $300million

This projected capital investment appears large, but to place it in context, $800million is around 2% of Australia's annual agricultural revenues of $40billion per annum. It also compares well against the NBN, which is now projected to cost between $46billion and $56billion.

If the $800million investment leads to a 5% increase in agricultural productivity then the annual benefit would be $2billion of additional revenues per annum.

From an operational cost, a rule of thumb would be to assume that annual costs would be around 9% of the original capital cost. NNNCo estimates that the annual operational cost would be $72million per annum. This would be made up of:

- 5% equipment replacement costs - $40million per annum
- $10 per month per base station backhaul costs - $12million per annum (our estimate is that each base station would generate around 7.5MBytes of traffic per month – each Byte is valuable to Australia in terms of the benefits it offers)
- Support and regulatory costs $15million per annum
- Data centre costs $5million per annum (based on the collection of large amounts of data from other sources and the operation of servers "in the cloud")
- We assume that there are no billing costs – revenues would accrue from the support of the network, similar to how open source software providers achieve revenues.

Schedule 2- Cross Jurisdiction comparison of Precision Farming practices.

We have compared the support for innovation Precision Farming in Australia with that in other jurisdictions to gain an understanding of the current state, barriers and possible opportunities. In doing this we looked at three other examples; the USA, Europe and New Zealand. The differences in focus provide an interesting …

Jurisdiction	Key initiatives	Comment
USA	Initiatives led by large corporates such as Monsanto, Dupont and John Deere. Focus on end-to end-automation – data extracted, analysed and precise instructions provided to enable automated planting and soil management. Closed solutions with large corporations exercising control. However startups are starting to challenge.	Some farmer groups concerned about losing control and are building community support around relevant startups. Small farms cannot afford the upfront investment of data collection and systems.
Europe	EU supports EPI-AGRI, which provides advice and support to farmers. Unilateral involvement in decision making by farmers, universities and government. Focus on building and leveraging capability of farmers. Supported innovation and community.	Focuses on the skills of farmers rather than an ‘industrial planting’ approach.
New Zealand	Since 2013, initiatives supported by a collaborative group that includes large agribusiness, solution innovators, the two largest agricultural universities, startup/smaller solution providers and other research arms and national and regional government.	As for Europe.
Australia	Multiple, relatively fragmented initiatives. CSIRO has strength in this space with trials in Tasmania and multiple other initiatives with multiple parties. A longstanding community collaboration is now sponsored by major US players and appears to have been slow to leverage. There appear to be early signs of collaboration efforts beginning to engage major players across farming communities, universities, scientific research entities, startups, and larger agribusiness players and government. Tasmania appears to be a major contributor to research/trials. Bi-partisan support from states is limited.	Gaps in community education and support and splintered collaboration are hindering the opportunity for leverage. There is a significant risk of non-standard solutions/bespoke that may have a limited life and higher unit cost

Schedule 3- LoRa Communications Network Infrastructure

We understand the importance of standards and the need to clarify which standards will work best for Australia. Our research confirms that LoRaWAN (Long Range Wide Area Network specification) is the best solution for Australia, given our unique conditions. The LoRa specification provides the closest fit to Australian needs. Our close engagement with the LoRa Alliance has enabled us to test this in the field, confirming our confidence in this increasingly widely adopted global standard.

Why NNNCo prefers the LoRaWAN standard. In early 2015 NNNCo performed an in-depth analysis of the IoT solutions that were available. The criteria we used for our analysis included:

- Ability to be used in Australian ISM (Industrial, Scientific and Medical) spectrum bands;
- Open source, in the sense that information on the technology was openly available;
- A market place of competing providers offering equipment that adhered to the standard;
- A resilient RF modulation scheme that offered variable bandwidth, interference resistance and excellent coverage distances;
- Potential for very low cost solutions;
- A solution that provided assurances of privacy and security;
- A network management solution that was not proprietary;
- A range of end nodes and applications already available that could be adapted for offer in Australia;
- No unnecessary barriers to entry into the market set by requirements to make large investments, purchase of proprietary solutions, or take up of expensive spectrum.

Our analysis identified that the LoRaWAN solution offered the best fit to our requirements.

Overview Architecture including LoRaWan

The overall architecture of the proposed network is shown in Figure 2. The approach is a standard 'star network' approach, where agricultural sensors connect into the closest LoRaWAN Base Station. The sensors will connect using the ISM (Instrumental Scientific and Medical) band, which currently lies between 913MHz and 928MHz. The LoRa wireless technology is interference resistant, using spread spectrum transmissions over small channel bandwidths. What this means is that LoRa sensors can operate over long distances – up to 15km in the right circumstances

Data would be taken from the sensors and collected through the network via the NNNCo LoRaWAN network server. The data will then be presented to data storage servers, available for manipulation and further analytics.

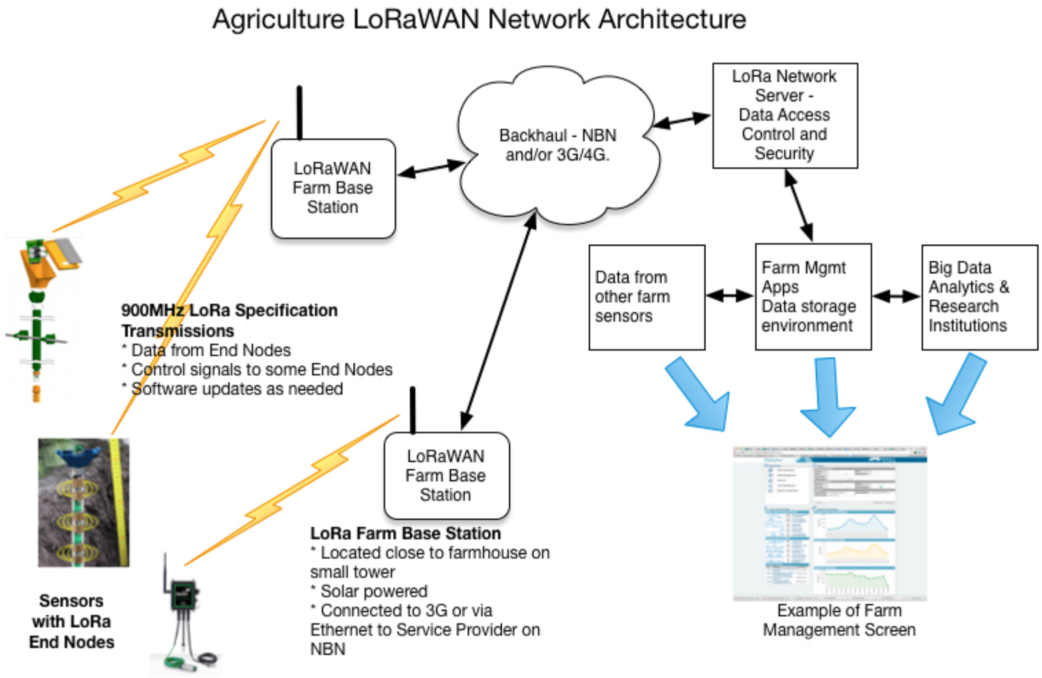

Figure 2: Proposed Agricultural LoRaWAN Network Architecture.

LoRaWAN Network Server

The Network Server is a core component of the NNNCo network as a service model and a strategic fit to its offering. The Network Server provides a number of network control and monitor capabilities such as:

- Allocation of sensor traffic to specific channels as required;
- Modulation and demodulation of traffic that traverses across the network between the sensor end nodes and the network server;
- Authentication and provisioning of sensor end nodes onto the network;
- Accurate measurement of accesses and traffic that flows across the network, as required for management and regulatory requirements;
- Error management – ensure that information is not corrupted during transmission from the sensors to the Network Server;
- API integration – ability to communicate with upstream servers; and
- End Node device management, such as remote upgrade of sensor end node software and firmware as needed.

LoRaWAN Base Stations

NNNCo has taken the following factors into account when selecting a Base Station vendor for a nationwide roll-out:

- Ability to operate in the Australian environment;
- Product Maturity;
- Price;
- Ease of installation;
- Reliability of operation; and
- Quality and stability of RF design.

There are a number of open standards based suppliers of base stations that can be leveraged (with small modifications) to suit the Australian environment. Manufacturers provide equipment that adhere to IP67 standards – capable of withstanding the worst that the Australian environment can offer.