Name: Vivek Suresh Babu

University of Warwick – MEng Manufacturing and Mechanical Engineering

Sainsbury Management Fellows: Mentor30Engineers Competition

Date of Submission: 28/02/2018

Essay Topic 3f: How do we Protect the Environment for the Future: Food Waste and Supply-Chain Optimisation Enhancing Production Efficiencies via Agriculture 4.0 and Digital Farming

I. The Problem:

Globally, it is estimated that a third of food produced for human consumption is wasted every year; this approximates to 1.3 billion tonnes of useful material being lost [3]. As the population continues to grow from 7.3 billion today to 9.7 billion in 2050, pressure will be inflicted upon the environment to produce more food [5].

Losses are observed at several stages in the supply chain. This includes: production, harvest and industrial processing, marketing and consumption. Food waste accounts for monetary loss to a variety of businesses in the supply-chain; producers, distributors and retailers all suffer from inefficiencies in farming yields, reducing their overall profits. The highest food wastage rate can be found in the fruit and vegetable industry; wastage rates could be as high as up to 50% in some countries [3].

Due to weather conditions, a large amount of fruit and vegetable types can only be produced naturally in tropical locations. Many of the countries with the required climate conditions are developing countries; they may not have the necessary infrastructure as industrialised countries do in their production methods. Hence, substantial amounts of crop are

wasted at the production stage due to: low quality of equipment, poor facility management and insufficient communication between supplier and distributor.

In industrialised countries more than 40% of food loss occurs at the retail and consumption stages, whereas in developing countries 50% of food is lost in the first two stages (production and processing) [3]. This report will focus on tackling inefficiencies at the start of the supply-chain; the methods described would therefore be more beneficial in developing countries where production efficiencies are relatively lower than in industrialised countries.

With recent developments in technologies such as cloud computing, smart sensors, IoT and improved data analytics (Big Data), it is expected that automated supply-chains could be formed; this would ultimately reduce time and effort spent on daily logistics, a focus on improving crop yield would therefore be targeted. With Industry 4.0 driving the future of the manufacturing industry, a similarly named idea called Agriculture 4.0 will revolutionise the way farming methods can take advantage of the latest technologies [1].

II. The Solution:

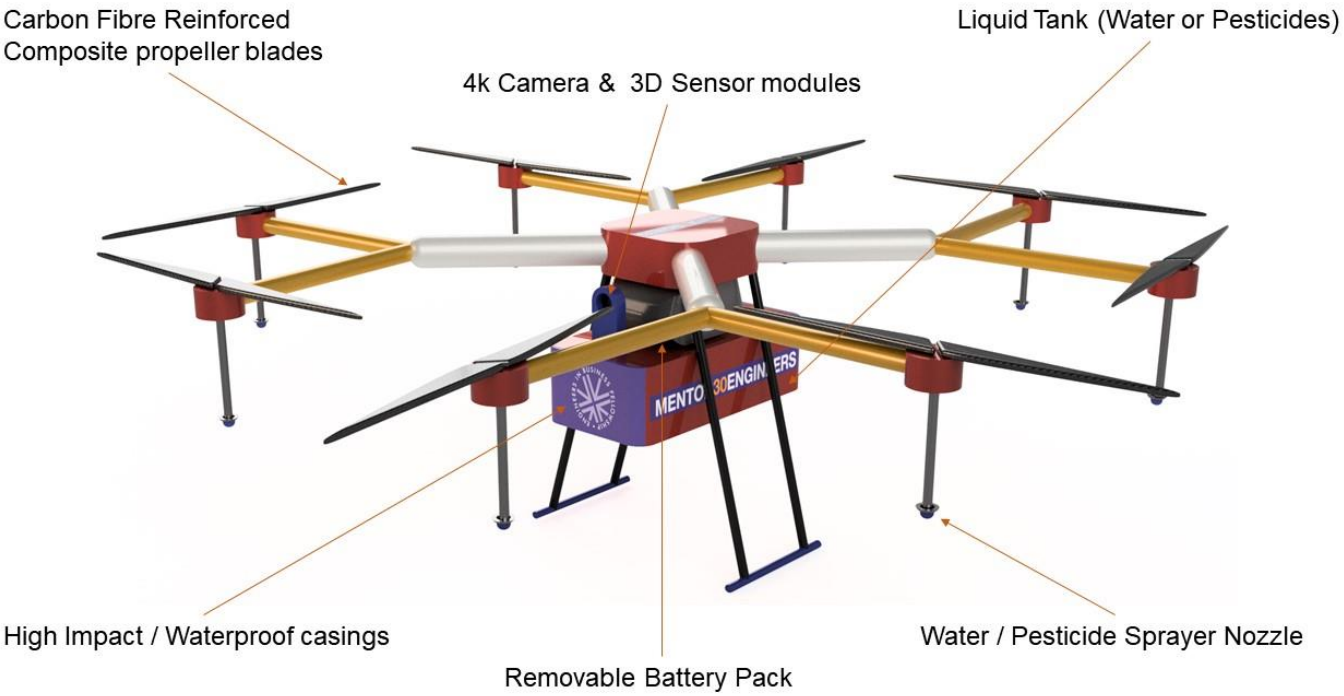

Figure 1: Concept drone created using Autodesk Fusion 360 [4]

Drones and other digital farming methods could be used to increase efficiencies in production on a farm. Precision farming uses drones along with soil sensors, weather measurement instruments and satellite data to manage real time crop data. This data is then sent to an interchange on the farm. The data is managed at the farm's office where suppliers are updated on crop quantities. Live buying behavior data of retailers will be readily available at the farm office to deal with crop growth and management; this data will formulate the number of crops required for harvesting and processing.

Over time the functions of the drone could be automated. Distributing water and pesticides across the farmland by a pre-determined route could be implemented from the start; drones are already used for farming in this fashion. A more intelligent process would be to combine smart sensors, Big Data and artificial intelligence to the drone. Parts of land where crop quality and yield are poor would have a higher attention; in turn this would increase productivity and efficiency of yield for the farm.

An agricultural drone as shown in figure 1 would be able to: count plant numbers, measure soil temperature, monitor soil H_20 levels, measure plant height or growth stage and field uniformity. In the future integration of data analytics will allow the drone to operate at its highest efficiency; the drone will understand the farmland at a "smart" level after successive times being used [4]. The price for a drone as shown in figure 1 could range from £10,000 - £50,000 depending on the camera or sensors attached [1].

In figure 2 (page 4) a concept farm design is shown. The design incorporates many of the technologies found in Agriculture 4.0. What is most noticeably different to current farming production systems is the importance of data; prior data collected, and demand targets required drive the production and harvesting processes. The data used will determine the maximum efficiency for the farm's crop, this will maximise the profits for both producers and retailers and reduce waste at the production stage [5]. Poor quality crop, which would not be selected by retailers (that is still suitable for consumption), could be sent to the animal feeding zone on the

farm automatically. Feeding typically accounts for 60%- 70% of livestock production costs, so significant cost savings can be made [2].

A digital farm will allow for a synchronous effect between supplier and distributor. Reaction times for the farm will be much faster if consumer demand changes. Overproduction or underproduction should be less of an issue, the bullwhip effect should be less prevalent.

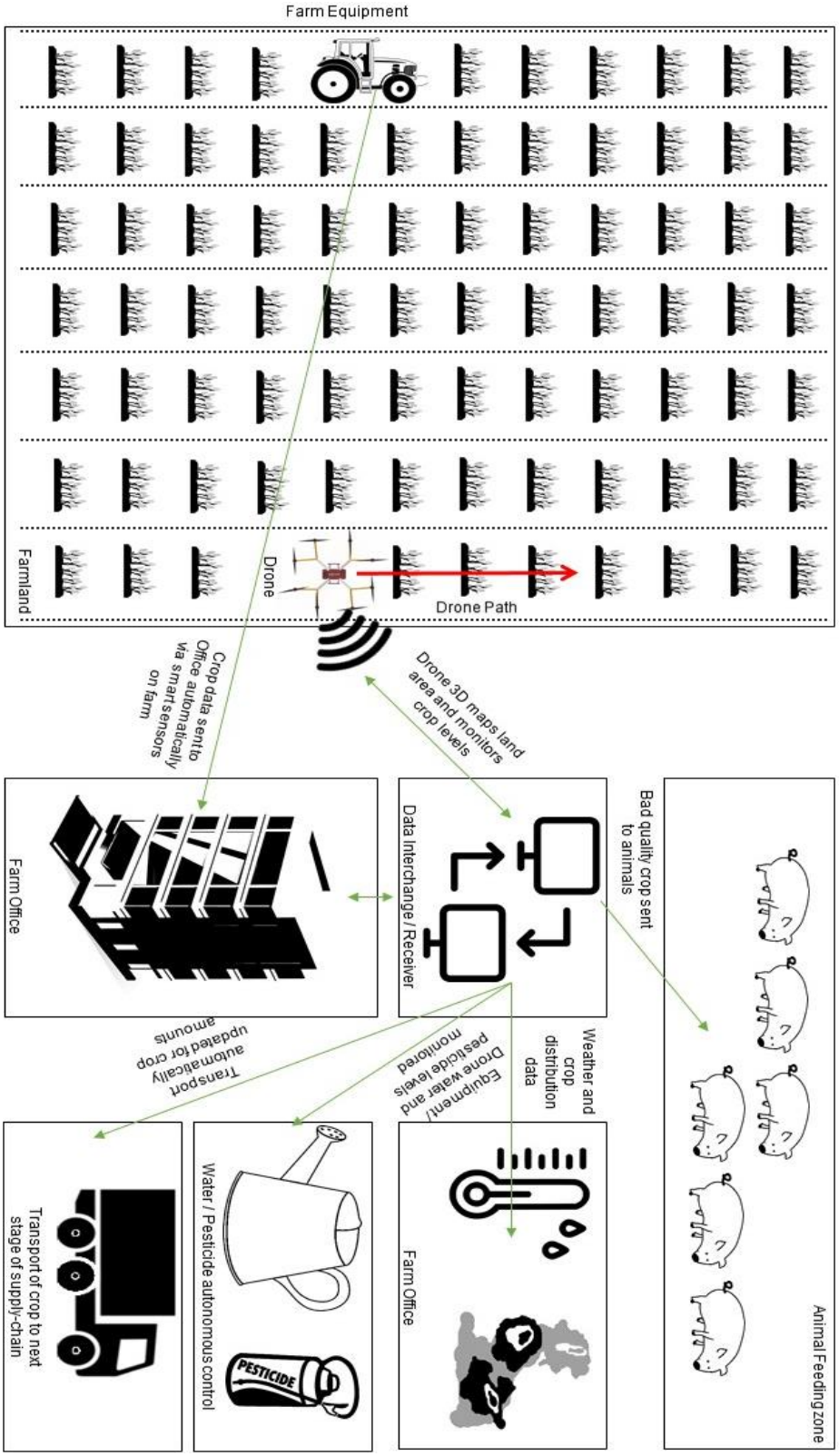

Figure 2: Farm Plan implementing Agriculture 4.0 mechanisms

III. Impacts on Society

Agriculture 4.0 and digital farming methods will greatly increase farm productivity and efficiency. There will be substantial reductions in food waste from the supply-chain at the production stage [5]. The negative environmental effects will decrease, as fuel, water and pesticide amounts required will all be reduced (due to automation of machines and data analytics). Challenges that face the full-scale operation of Agriculture 4.0 could be that there needs to be active data collaboration between producers, distributors and retailers; whilst this may be a potential challenge, all participants will increase profits if they do so. Eventually consumers may even benefit from digital farming in the form of lower food prices [5].

Researchers have estimated that production must be 70% more efficient in 2050 to meet global food needs [3]. Almost all land suitable for farming is already being farmed on, therefore farmers must seek ways to maximise yield. The methods outlined in the solution pave the way for automation and technological advancement in farming, thus increasing profits and crop yield for businesses in the supply chain.

IV. References

[1] Accenture UK. (2017). *Digital Agriculture.* Retrieved from https://www.accenture.com/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Digital_3/Accenture-Digital-Agriculture-Point-of-View.pdf

[2] Becker, G. S. (2008). *CRS Report for Congree.* Retrieved from Livestock Feed Costs: http://nationalaglawcenter.org/wp-content/uploads/assets/crs/RS22908.pdf

[3] Food and Agriculture Organization of the UN. (2016). *Food Loss and Waste Reduction Key Findings.* Retrieved from https://bestdroneforthejob.com/drone-buying-guides/agriculture-drone-buyers-guide/

[4] Nixon, A. (2017). *Drones for Agriculture Buying Guide.* Retrieved from https://bestdroneforthejob.com/drone-buying-guides/agriculture-drone-buyers-guide/

[5] The Economist. (2016). *The Future of Agriculture.* Retrieved from https://www.economist.com/technology-quarterly/2016-06-09/factory-fresh