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Agriculture Modeling using Artificial Intelligence, Augmented Reality and Neural Network

09.04.2020

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[Agronomists handle all kinds of agricultural projects from small to large high-tech farms with the help farmers to develop and implement practices ensuring economical and environmentally viable operations for the future.](#_7nrv8mrsjmru) 147

[Agronomy is the scientific technology of using soil to produce plants for the purpose of food, fibre and fuel. Agronomists can work as farm managers, fertilizer and chemical store managers, lab and field technicians, crop management consultants, soil and water conservationists, inspectors or sales representatives for farm management services, financial institutions and food processing companies to perform land appraisal, soil testing or work in planning and managing positions in agriculture industry. Agronomist is a liaison between farmer and crop researchers to review research findings and to use knowledge to recommend solutions to farmers regarding new scientific developments in crop growing operations. Agronomists may be employed as plant breeders, plant pathologists and soil surveyors encompassing work in areas of plant physiology, plant genetics and soil science at research stations for federal and state government.](#_y9va14vgf5hi) 147

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[Agronomists are called crop doctors with a wide range of work concerned with the well-being and health of crops used for fuel, food production and land reclamation. Agronomists are scientists whose area of study is plants and soil in order to increase soil productivity; develop better cultivation, planting and harvesting techniques; improve crop yield, quality of seed and nutritional values of crops; and solve problems of agricultural industry. They are experts in the science of soil management for land reclamation and crop production to improve quality of seed and the nutritional values of crops. Agronomists conduct tests and are concerned with the practicing principles of soil management and crop production in fields. They conduct experiments to increase soil fertility and develop best methods for increasing crop productivity and quality. Primary duties of agronomists include, best way to use land after performing statistical analysis of data, measurement of soil salinity and nutrient levels for planting crops.](#_r2w39nghk5s) 147

[Agronomists examine crops for the signs of disease, insect or pest problem, weed issue or problem with the soil. They think critically to solve problems concerning planting, cultivating, harvesting and protecting crops from pests, weeds and harsh climates.Agronomist work with farmers to conduct experiments and help to grow best possible crop with extensive knowledge of Agriculture, crop science,chemistry,biology, ecology, earth science, genetics and economics. They evaluate crop data collected; to find ways to improve the next generation crop. Agronomists compare results with scientific research journals and reference books to pinpoint the cause and find a solution. They present research findings to farmers to use the information for growing and harvesting agricultural products. Agronomists help farmers to manage crop planting and implementing efficient farming practices; improving crop efficiency and sorting any agricultural](#_xoyzsidacdmd) 148

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# 

# Executive Summary

Agriculture is the backbone of humanity. There is one thing common across the globe and that is food production and the consumption by people. When it comes to the quality of life, food is one the most critical parameters to assess and hence every country focuses on providing the required help to their farmers in order to produce quality crops.

There are so many universities, NGOs, private sectors as well as international organisations such as the United Nations who do so much research to help these farmers predict the weather, demand for the good and plan accordingly. There are so many tools and software products helping the farmers in a few advanced countries to use Drones and IoT (Internet of Things) like technology and the results are extraordinary.

Farming is one part of the supply chain it comes to connecting producers to consumers. Unfortunately, there is so much content on the web that no one knows exactly what to refer to and what to ignore. On top of it, there are so many intermediaries who have got their vested interest not to educate the core members in the supply chain to bring transparency.

The supply chain has got another big challenge. It requires innovation at every step in the chain. Technologies like Blockchain to implement DLT (Distributed Ledger Technology) is one aspect, Machine Learning for predictive analytics, Big Data to process the data sent by so many parties, IoT to use sensors for Smart Farming and Artificial Intelligence using Neural Networking. Most of these are not known to several participants in the supply chain and hence most of the time chain breaks.

**Agrimaan** is the initiative to solve this problem and bring everyone on a common platform. Agrimaan™ acts like a superhero for them and it is termed as Agriculture Innovation using Machine Learning, Applied Analytics and Neural Networking.

This concept paper has been detailed out to provide the product design guideline and the implementation roadmap in a phased manner.

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# Agriculture Domain Understanding

## What is Sustainable Agriculture?

In a simple term, Sustainable agriculture is all about meeting the requirement of food for the society without compromising the future generation. Sustainable agricultural systems benefit the environment by reducing soil degradation and erosion, maintaining soil quality and saving water.

Sustainable agriculture includes sustainable ways of farming based on the study of the relationship between organisms and environmental understanding of ecosystem services. The overall crops produced through sustainable agriculture by stewardship of natural and human resources are more healthy and nutritious. The interconnection between farming and other environmental aspects can be explored by using the tools and processes used in sustainable agriculture.

Stewardship of human resources considers present and future social responsibilities of the needs of rural communities, living and working conditions of labourers, consumer health and safety while for land and natural resources maintaining or enhancing the vital resources are necessary.

## Importance of Sustainable Agriculture

Practitioners integrate and apply sustainable agriculture for three main objectives. These are a healthy environment, economic profitability and social equity. Every *grower, food processor, distributor, retailers, waste managers and consumers* involved in the agricultural system plays an essential role in ensuring a sustainable environment. The common practices in sustainable agriculture and food systems include growers; using methods to *minimize water wastage*, *promoting soil health* and *reducing pollution levels in the farm*;

retailers and consumers concerned with sustainable value-based foods grown to promote farmers wellbeing; and researchers; crossing disciplinary lines, combining chemistry, economics, biology, genetic engineering, community development and many other fields. The broad theme of strategies are based on the range of potential ideas in three separate but related areas of concern in farming and natural resources; plant and animal production practices; political, social and economic context representing and interpreting the vision of sustainable agriculture.

Sustainable agriculture consists of a collection of practices and processes of negotiating competing interests of individual farmers and community members to solve complex problems related to food and fibre crops. The goal of sustainable agriculture is to meet current needs without sacrificing future prospects by protecting water quality and supply; sustainable land use while maintaining biodiversity and wildlife habitat; resorting to renewable ways of energy production and consumption; improving plant, animal production and labour practices to ensure social and economic equity. The systemic approach implies interdisciplinary inputs and efforts from researchers, farmers, consumers, policymakers and other stakeholders from various disciplines. The process of transitioning to sustainable agriculture for farmers requires a series of small and realistic steps based on personal goals and family economics.

## Traditional Farming Types

Here are seven different types of traditional farming:

|  |  |
| --- | --- |
| **Farming Type** | **Description** |
| Subsistence Farming | This is a type of farm that produces only enough food to feed the family with little or no surplus for sale. This type of farm is not meant to provide income, but would ideally produce all needed food, year-round. This is becoming increasingly popular among Americans who wish to live “off the grid.” |
| Commercial Farming | This is the opposite of a [subsistence farm, says Grade Stack](http://gradestack.com/CBSE-Class-8th-Complete/Agriculture/Commercial-Farming/14831-2938-2249-study-wtw), and is meant to provide income, often the sole form of income, for the farm family. It can consist of growing crops, raising animals for meat, eggs and dairy, raising fish, or a combination of these. It can also be called Mixed Form. |
| Crop Farming | These farms grow fruits, vegetables, or grain. Most large-scale industrial farms are monoculture farms, meaning they grow only one type of crop at a time and these crops are like cocoa, tea, coffee, rubber, spices or fruits like apples, avocado, grapes, oranges, mangoes, etc grown on a commercial basis. [The Union of Concerned Scientists](http://www.ucsusa.org/our-work/food-agriculture/our-failing-food-system/industrial-agriculture#.V_JbbpMrJsM) says this type of farm relies heavily on chemical inputs. Smaller farms tend to be more diversified. This is also called Plantation farming. The system requires good management and technical skills with a substantial amount of capital investment for machines, fertilizers and other facilities. |
| Fish Farming | Also called aquaculture, fish farming is booming. It involves raising large quantities of fish in large tanks. [According to Grist, although farmed fish](http://grist.org/food/everything-you-always-wanted-to-know-about-fish-farming-but-were-afraid-to-ask/) has a less-than-favourable reputation, well-managed fish farms are sustainable, clean, and can produce high-quality protein. |
| Dairy Farming | This type of farm focuses on raising animals for milk. The milk can then be used to make other dairy products like yoghurt and cheese. Most large dairy farms raise dairy cows, but some artisanal dairy farms may raise sheep or goats. |
| Poultry Farming | Most poultry farms raise chickens and turkeys for meat consumption, but some raise chicken for eggs. Large-scale farms are the norm, but consumer demand for locally-produced, pastured, and humanely raised poultry is growing. |
| Meat Farming | These farms exist solely to raise animals for slaughter and consumption. They can be divided into other categories like pig farms and cattle farms. |
| Arable System of Farming | Arable farming is practised on a small scale or commercial scale to grow only annual crops like cassava, plantain, vegetables, grains and legumes without mixed or pastoral farming. |

## Precision Farming or Precision Agriculture

Precision agriculture is a modern farming practice which involves observing, measuring and responding to intra and inter-field crop variability. It is also called satellite farming with a site-specific crop farming management concept that makes the production process more efficient. Precision farming is employed to accurately manage field variations, reduces production costs and improves food yield using fewer resources. Precision agriculture allows growers and farmers to work with better soil in larger fields and manages them as a group of small fields. Precision farming involves strategic ways of guiding farmers in crop rotation, optimal planting or harvesting times and soil management to improve crop productivity and efficiency while reducing environmental impact.

Precision agriculture uses information technology to ensure optimum health and productivity of soil to meet crop requirements. The farmers require technical support and assistance for technology application of precision farming that combines the use of sensors, GPS (global positioning systems), robots, mapping tools and data-analytics in agricultural production like site-specific pesticide application, pest scouting, variable-rate irrigation or yield mapping to improve plant growth without increasing labour. The aim of precision farming is to minimize environmental impact but maximize economic return by optimizing crop yield and using optimum field-level management practices and advanced crop science technology to match the needs of farmers.

### Importance of Precision Farming

Use of precision agricultural practices is needed to apply water, nutrients and other agricultural inputs on crops grown in a wide range of soil environments depending on the basis of research on soil types, soil characteristics, soil temperature and humidity, weather patterns, growth factors and other parameters; helping farmers to increase productivity. Crop rotation applied to improve diversity and to monitor harvest time or irrigation rates along with technology, making modern agriculture more efficient. Farmers are able to use global positioning systems, GPS-computer guided tractors and other geo-referenced site-specific practices like electromagnetic soil mapping, soil sample collection, crop yield data collection, aerial imagery, crop or soil colour index maps and drainage level studies; increasing potential yields. Increase in use of geo-referenced data layers helping to subdivide large fields into small management zones, increasing crop production potential and farm efficiency. It also helps to manage time and saves water; reduces waste, environmental dangers and avoids misapplication of products.

Environmental variation in soil, weather, vegetation, water and other factors that determine the growth of healthy crops and higher yield are considered for farming success and conservation of natural resources. The goal of precision farming is to reduce potential environmental risks and improved agricultural yield which could be achieved by monitoring physicochemical parameters of soil and plant through sensors; continuous monitoring and real-time data collection of parameters by application of sensing devices in fields providing updated status to maintain optimal conditions for plant growth; and using integrated farm management techniques to improve productivity. This helps in saving time and cost; managing decisions by keeping farm records and reduces environmental pollution.

## Biodynamic Farming

Biodynamic farming was first introduced in Germany in 1924 by Dr Rudolf Steiner to combat rapid degeneration of soil, deterioration of food quality and seed viability and vitality that occurred due to chemical farming. Chemical farming is a consequence of world wars when the residues of chemicals used in warfare and weapon manufacturing were used against plant pests and weeds. Introduction of hybrid seeds and genetically modified seeds posed a great threat to the ecological balance on the earth. With many global disasters happening around due to the damage caused to our planet, people are becoming aware of sustainable practices.

Biodynamics is concerned with how life on earth is influenced by the higher forces and the finer energies. Today, many people around the world validated this concept, attempted to document the effect of cosmos on Earth and published planting calendars for farmers and gardeners. This method is purely based on observation and relationship with nature.

Biodynamic farming is slowly gaining popularity across the world over the past few decades. Steiner presented farmers an altogether different way of looking at farming and earth in general and inter-relationships and interactions between all living things. He explained that chemical agriculture is a mere study of dead things in laboratories rather than observation of nature and interactions therein. He also believed that moving planets and stars have an impact on the life of plants, animals and human beings and that this very connection helps us understand how to work best with nature in a scientific way. The whole concept behind this is that these forces bring balance to the soil and the plants that grow in the soil and every living being that consume those plants.

### Principles of biodynamic farming

Biodynamic farming considers the following aspects to bring about a balance between all elements that support life:

* Life depends largely on the interaction of substance and energies. For instance, we eat food which provides us with energy.
* The plants that are grown in a well-balanced soil can give us substance as well as energy
* Competent use of organic matter enriches the soil
* Humus which is the fully digested crude organic matter maintains the fertility of the soil in a stable way
* Using cow dung for making compose owing to the presence of more beneficial bacteria attributed to the lengthy digestion process of cow
* Studying and applying the effect of cosmic forces on plant growth
* Simple and natural preparations which can be directly sprayed on the plants and soil to enhance the effects of movement of planets and stars
* Crop rotation to maintain the nitrogen content of the soil
* Weed growth is a sign of soil deficiencies. Thus they help us rectify the issue
* Burnt ashes of insects, weeds or dead animal skins can be used to make homoeopathic preparations that act as sustainable alternatives to chemical sprays

### Advantages of biodynamic farming

* Production of fruits and vegetables of superior quality
* High protein and vitamin content in the produce
* Higher yields than those produced by organic farming
* Natural ways to control insect pests and weeds

## Organic Farming

The word organic has become the buzzword in recent times owing to the growing awareness of consumers on the drastic effects of chemical-laden products on humans, animals and the environment. The label containing the words organic, green, natural and eco-friendly are drawing much attention from the public though they are exceptionally priced. Of course, it is not a fad, but just a way of getting back to our traditional way of producing and consuming food.

There is a lot of science behind the word organic and it is applicable in its own way to each field. For example, in dairy, a product is considered organic not just if the milk or milk products are free of antibiotics or hormones; also the cows should be fed with grass that is free of pesticides, fertilizers and GM seeds. For agricultural produce to be organic, the plants should not be treated with synthetic plant protection chemicals, sewage sludge or radiation. There are a variety of organic products available in the market ranging from baby foods, staples, breakfast cereals, soups etc.

### Basics of Organic Farming

The organic way of producing food is much beyond not choosing to use synthetic plant protection chemicals, genetically modified organisms, antibiotics and growth hormones. It is a holistic approach wherein the productivity is optimized by using various communities within the agriculture ecosystems such as soil organisms and livestock. The main objective of organic farming is sustainability and harmony with the environment. Nevertheless, the inclination of consumers towards organic products is majorly to avoid health issues incurred due to the use of chemical fertilizers.

### Key Components of Organic Farming

* It uses organic matter instead of chemicals to enrich the soil. This organic matter could be of plant or animal origin.
* It conserves soil for many years
* Crop rotation helps organic farmers preserve the soil quality and avoid monoculture
* Organic farming creates varied niches for organisms that act as natural foes of plant pests
* Weed control in organic farming is done by special techniques and machinery instead of chemical based weedicides

### Is there any difference between organic and 100% organic?

Yes. A product is considered 100% organic when all its ingredients are organic and is completely processed organically. On the other hand, it is called organic when 95% or more of its ingredients are organic with the remaining being approved chemical additives. If 70% to 90% of a product's ingredients are organic, it is labelled made with organic ingredients. There are some products with below 70% organic ingredients and labelled so.

### Advantages of organic farming

The advantages of organic farming can be discussed in both consumer and producer perspectives. The organic produce is of superior quality in terms of vitamin and mineral content. This function, in turn, results in higher sugar content of fruits and vegetables and a better taste. Since it is not loaded with toxic chemicals such as pesticides, fungicides and herbicides, it is considered healthy. Organic foods can be stored for longer periods of time than those that are grown conventionally. Organically grown crops are naturally devoid of diseases and pests. Above everything, organic farming ensures sustainability by protecting environmental

### Disadvantages of organic farming

Organic produce costs more since the yield from land is not as much as what farmers produce through conventional methods. Also, the production cost is high since a lot of labour and time are involved. There exists a lot of gap in distributing and marketing organic products. Novel sustainable strategies should be applied in order to cater to the needs of the growing population.

# Soil is the Key Ingredients for Sustainable Agriculture

Soil is the loose surface material consisting of inorganic particles and organic matter that covers most of the land surface. Soil provides the structural support and the source of water and nutrients for plants used in agriculture.

Good soil condition and fertility are basic to sustainable agriculture. An ideal soil should be well-drained, have a deep rooting zone, be easily penetrated by air, water, and roots, have a good water-holding capacity, have a balanced nutrient supply, and resist erosion. Soils vary greatly in their chemical and physical properties which depend on their age and on the conditions (parent material, climate, topography and vegetation) under which they were formed.

Processes such as leaching, weathering and microbial activity combine to make a whole range of different soil types, each of which has particular strengths and weaknesses for agricultural production. Following subsections provide introduction to soils and the major soil components.

## Inorganic component

Inorganic material is the major component of most soils. It consists largely of mineral particles with specific physical and chemical properties which vary depending on the parent material and conditions under which the soil was formed. It is the inorganic fraction of soils which determines soil physical properties such as texture and has a large effect on structure, density and water retention.

## Soil texture

The texture of soil is a property which is determined largely by the relative proportions of inorganic particles of different sizes. The following five size fractions are used to describe the inorganic fraction of soils:

* Gravel - particles greater than 2 mm in diameter.
* Coarse sand - particles less than 2 mm and greater than 0.2 mm in diameter.
* Fine sand - particles between 0.2 mm and 0.02 mm in diameter.
* Silt - particles between 0.02 mm and 0.002 mm in diameter
* Clay - particles less than 0.002 mm in diameter.

### Sand

Quartz is the predominant mineral in the sand fraction of most soils. Sand particles have a relatively small surface area per unit weight, low water retention and little chemical activity compared with silt and clay.

### Silt

Silt has a relatively limited surface area and little chemical activity. Soils high in silt may compact under heavy traffic and this affects the movement of air and water in the soil.

### Clay

Clays have very large surface areas compared with the other inorganic fractions. As a result clays are chemically very active and are able to hold nutrients on their surfaces. These nutrients can be released into soil water from where they can be used by plants. Like nutrients, water also attaches to the surfaces of clays but this water can be hard for plants to use.

There are many different types of clays. The ability of clays to swell and to retain a shape into which they have been formed, as well as their sticky nature, distinguish them from sand and silt.

## Soil textural class

The relative proportion of sand, silt and clay particles determines the physical properties of soil including the texture. The surface area of a given amount of soil increases significantly as the particle size decreases. Consequently, the soil textural class also gives an indication of some soil chemical properties.

The exact proportions of sand, silt and clay in a soil can only be determined in a laboratory but a naming system has been developed to approximately describe the relative proportions of sand, silt and clay in soil. This classification of soil can be undertaken in the field where particular properties indicate possible textural classes.

To estimate texture in the field, crush a small sample of soil (10 to 20g) in one hand. After removing any gravel or root matter, work the soil in the fingers to break down any aggregates which may be present. With the sample moist but not sticky, the textural class can be estimated by the feel of the sample between the fingers

### Textural class description

Following are the set of properties for the Soil Texture:

* Sand - A sand has a loose gritty feel and does not stick together. Individual sand grains can be seen or felt.
* Loamy Sand - In a loamy sand particles barely stick together and a moulded piece of soil just holds its shape.
* Sandy Loam - A sandy loam sticks together more than a loamy sand but can be easily broken. Individual sand grains can be felt and heard if a wet sample is rubbed between the index finger and thumb and held close to the ear.
* Silty Loam - A silty loam is like a loam but has a smooth silky feel when a moist sample is pushed between the index finger and thumb. On drying a sample can form a hard lump but this may be broken by hand.
* Loam - A loam breaks into crumbs but will tend to stick together. Sand grains cannot be felt in a moist sample which when squeezed will retain its shape when handled freely. Loams are usually soft to the feel.
* Sandy Clay Loam - A sandy clay loam is like a clay loam but sand grains can be felt (and heard - see Sandy Loam)
* Silty Clay Loam - A silty clay loam is like a clay loam but silty as well and smooth to the touch.
* Clay Loam - More easily moulded into a shape than a loam, a clay loam rolls out to a thin ribbon between the palms while a loam will break-up. When dry a clay loam will form a lump but is not as tough to break as a clay.
* Sandy Clay - A sandy clay is like a clay but sand grains can be felt (and heard - see Sandy Loam).
* Silty Clay - A silty clay is like a clay but smoother.
* Clay - Clays are tough and can be moulded into shapes when moist. Clays form a long flexible ribbon when rubbed between the palms and the ribbon can often be bent into a "U" shape without breaking. Clays dry into very hard clods.

It should always be remembered that soil texture often varies with depth and that the properties of the topsoil are affected by the properties of the subsoil.

## Soil Structure

Structure is the arrangement of soil particles and the pore spaces between them. A soil with structure which is beneficial to plant growth has stable aggregates between 0.5 and 2 mm in diameter. Such soils have good aeration and drainage.

### Chemical properties

The inorganic minerals of soils consist primarily of silicon, iron and aluminium which do not contribute greatly to the nutritional needs of plants. Those in the clay fraction have the capacity to retain nutrients in forms which are potentially available for plants to use.

### Organic component

The organic matter of soil usually makes up less than 10% by weight of soil. It can be subdivided into the living and the non-living fractions. The non-living fraction contributes to the soil's ability to retain water and some nutrients and to the formation of stable aggregates.

## Soil Organic matter

Organic matter is widely regarded as a vital component of a healthy soil. It is an important part of soil's physical, chemical and biological fertility, The organic matter fraction of soils comes from the decomposition of animal or plant products such as faeces and leaves. Soil organic matter contributes to stable soil aggregates by binding soil particles together.

Plants living in soil continually add organic matter in the form of roots and debris. Decomposition of this organic matter by microbial activity releases nutrients for the growth of other plants.

The organic matter content of a soil depends on the rates of organic matter addition and decomposition. Soil micro-organisms are the primary agents responsible for the decomposition of organic matter such as plant residues. Initially, the sugars, starch and certain proteins are readily attacked by a number of different micro-organisms. The more resistant structural components of the cell wall are decomposed relatively slowly. The less easily decomposed compounds, such as lignin and tannin, impart a dark colour to soils containing a significant organic matter content.

The decomposition rate of organic materials depends on how favourable the soil environment is for microbial activity. Higher decomposition rates occur where there are warm, moist conditions, good aeration, a favourable ratio of nutrients, a pH near neutral and freedom from toxic compounds.

## Soil organisms

The soil contains numerous organisms ranging from microscopic bacteria to large soil animals such as earthworms. The soil micro-organisms include bacteria, fungi, actinomycetes, algae, protozoa and nematodes.

The diversity of soil organisms can both assist and hinder plant growth. Beneficial activities include organic matter decomposition, nitrogen fixation, transformation of essential elements from one form to another, improvement in soil structure through soil aggregation, and improved drainage and aeration. Under some circumstances soil organisms compete with plants for nutrients.

Bacteria are the smallest and most numerous micro-organisms in the soil. They make an important contribution to organic matter decomposition, nitrogen fixation and the transformation of nitrogen and sulphur.

The fungi and actinomycetes contribute beneficially to organic matter decomposition. The group of large soil animals includes earthworms, which incorporate organic matter into the soil as well as improving aeration and drainage by means of their channels. Some soil fungi, nematodes, and insects feed on roots and lateral shoots to the detriment of plants.

Soil erosion, soil structural decline and organic matter decline under cropping have been recognised as the major soil management problems for the State.

## Soil pH & Liming

Soil pH affects the solubility of minerals or nutrients essential for plant growth.

## Soil Compaction & Controlled Traffic Farming

There are many myths and misunderstandings surrounding soil compaction and controlled traffic farming systems, and the use of tracked versus wheeled machinery.

## Soil Erosion (Problem and Solutions)

There are three main types of soil erosion.

1. *Mass Movement*: Soil loss and movement due to the effects of gravity, including; landslips, slumps and slides.
2. *Water Erosion*: Details of soil erosion types caused by water.
3. *Wind Erosion*: Erosion resulting from the movement of the wind.

### Soil Erosion Control

Maintenance of ground cover, preventing and controlling runoff for stopping soil erosion.

#### Maintenance of Ground Cover

Maintaining ground cover is critical for reducing the effects of raindrop impact and aggregate disintegration from slaking. Ground cover prevents raindrops from directly striking the soil surface and allows rainfall to slowly penetrate the soil surface. A number of options exist for maintaining vegetation or residue cover during and between cropping operations. These include sowing a cover crop, retaining cereal stubble and direct drilling into a stubble mulch.

##### Cover Crops

A cover crop can be sown between cropping operations or as a companion crop during the early stages of crop development. An example of a cover crop system used in Tasmania is sowing oats with onions. The oats are either sowed before the onions and are burnt off with non-selective herbicide just prior to onion emergence, or the oats and onions are sown together and burnt off about 3 weeks after onion emergence with a selective herbicide. Difficulties with the use of cover crops include competition for soil moisture and sunlight with the cash crop.

* Sown between cropping operations or as a companion crop during the early stages of crop development
* Short term 'solution' to ground cover, ie sowing oats with onions (use of selective herbicide).

##### Stubble Retention

Retaining a cereal stubble provides ground cover and organic matter during fallow periods and successive crops. Advantages of cereal stubble include no competition with the crop and reduced herbicide use. Difficulties with tillage and sowing through the cereal stubble may be overcome by finely chopping the stubble before sowing and modifying direct drilling equipment.

* Provides ground cover and organic matter
* Weed control and reduces herbicide use
* Requires development of stubble management techniques and equipment.

##### Direct Drilling

Direct drilling into crop stubble, reduces tillage and cultivation costs, increases organic matter inputs, increases ground cover, and reduces time and labour. Direct drilling is appropriate for all soil types provided it is well managed with respect to soil moisture, stubble preparation and appropriate use of machinery. The success of direct drilling is largely determined by the amount of organic matter which can be incorporated into surface soils. Under good management, the crumb structure or natural tilth of the surface layers should improve with the increased organic matter levels.

* Increases ground cover and organic matter.
* Reduces tillage and cultivation costs
* Time and labour
* Erosion
* Organic matter loss.
* Requires good stubble management
* Correct soil moisture
* Good initial soil structure
* More seed.

##### Soil Organic Matter

Soil organic matter is important for good crop production and preventing erosion. Organic matter and microorganisms cement individual soil particles into large stable aggregates which resist erosion. Soils with stable aggregates are able to withstand the forces of raindrop impact and slaking and have more and better-connected pore spaces which transmit water from the soil surface reducing runoff.

Erosion may be prevented by adopting cropping systems which either prevent the loss of organic matter or return organic inputs back into the soil. Organic matter is lost from the soil by oxidation during tillage and cultivation operations. Means to minimise organic matter loss include; direct drilling, reduced use of powered tillage implements, minimal cultivation, appropriate herbicide use and chemical fallows.

* Organic matter is the 'glue' that holds soil aggregates together
* Enables soils to resist erosion
* Lost by oxidation during cultivation
* Maintained by reducing fallows, incorporating green manures and minimising tillage.

##### Green Manure Crops

Organic matter may be returned to the soil by incorporating green manure crops into cropping rotations. Green manure crops such as ryegrass, oats, cereals, or lupins are turned back into the soil to be broken down into organic matter. As well as returning organic matter to the soil, green manure crops provide cover against erosion, biological ripping to improve soil structure, suppress weeds and fix atmospheric nitrogen (legumes).

The amount of organic matter returned to the soil depends on the amount of vegetative material, soil biological activity and climate factors. Typically a green manure crop of oats would return 6 t/ha dry matter to the soil, of which about 25% would be converted to organic matter, resulting in a return of 1.5t/ha organic matter or 0.075% increase in organic matter to a 20cm thick topsoil.

* Green manure crops increase soil organic carbon
* Provide cover against erosion
* Improving organic carbon levels with green manure crops is a slow process.

#### Preventing and Controlling Runoff

A number of means exist to control or prevent runoff from eroding cropping lands including

* ​cutoff drains to prevent run-on from entering cropping areas
* contour drains and mulched rip lines to stop runoff within paddocks
* grassed waterways to safely deliver water off paddocks.

Cutoff drains to divert water from coming onto the paddock, and safely carry water around the cropped area. Cutoff drains are usually a deep U-shape, the size and width dependent on the amount of expected runoff. Drains usually run along fencelines, headlands or across the slope. They are usually constructed with an excavator and trenching bucket. Drains should be installed in summer and where necessary hardened against scouring with either rock riprap or modified to have a grassed flat bottom.

* Stop runoff entering a paddock
* U-shaped open drains
* Follow fence lines and paddock boundaries.

##### Grassed Waterways

Grassed waterways can be used to control runoff within or adjacent to cropped paddocks. Grassed waterways are wide, shallow grassed channels that carry a large volume of water quickly down a steep slope. Grassed waterways are constructed to spread water evenly over the grassed surface and allow mechanical access for slashing or regular maintenance, they are usually at least 2.5 meters wide, with a minimum depth of 100-200mm.

Depending on the side slope, grassed irrigator runs can be installed using a grader, ridged moulder or spin drainer. Irrigator runs can also be grassed and used as a waterway. Grassed irrigator runs have a modified profile to allow water flow down the centre of the drain between the wheel marks to prevent the irrigator bogging on wet soils. Grassed waterways and irrigator runs should be sown immediately with perennial ryegrass, fescue and white clover. Seeds should be applied at twice the normal rate and fertilized.

* Carry a large volume of water quickly down a steep slope
* At least 2.5 meters wide, a minimum depth of 100-200mm
* Follow natural drainage lines
* Designed to spread water evenly over the grassed surface and allow mechanical access for slashing or regular maintenance
* Installed using a grader, ridged moulder or spin drainer
* Should be sown immediately with perennial ryegrass, fescue and white clover.

##### Contour Drains

Contour drains are temporary features which collect runoff from within the crop and divert it into grassed irrigator runs or waterways. Contour drains are installed immediately after planting. Contour drains should be no longer than 50m, 15-30 cm deep and installed on a slight grade to prevent silting. In stable krasnozem soils, contour drains are installed at 5-6% slope and 0.5-2% on erodable sandy soils. Contour drains, however, present difficulties with other cropping operations such as spraying and harvesting.

* Temporary, installed seasonally after planting
* Divert runoff into grassed irrigator runs or waterways
* No longer than 50m, 15-30 cm deep on a slight grade to prevent silting
* In stable krasnozem soils ~ 5-6% slope and 0.5-2% on erodable sandy soils
* Contour drains present difficulties with trafficking during other cropping operations such as spraying.

##### Mulched Rip Lines

Development of mulched rip lines has replaced the use of contour drains. Unlike contour drains the mulched rip lines do not require the construction of a ditch. Instead, the 'ripper mulcher' places two shallow rip lines and a trail of straw mulch on the soil surface. Contour drains and mulched rip lines work by breaking slope length and preventing the runoff from developing enough speed to scour and form rills. The spacing between contour drains and mulched rip lines are generally between 20-40 meters depending on slope, soil type, crop to be grown, organic matter levels, and the likelihood of a heavy rain event.

* Consists of two shallow rip lines and a trail of straw mulch on the soil surface
* Replaces the use of contour drains
* No difficulties with trafficking ~ no ditch
* Works by breaking slope length, slowing water flow and promoting rapid infiltration
* 20-40 meters spacing between lines depending on slope, soil type, crop to be grown, organic matter levels, and the likelihood of a heavy rain event
* Requires 3-4 square bales of straw per hectare, 2ha /hr
* Installed on the contour.

##### Land Drainage

Drains are constructed and are important for carrying excess water off agricultural land.

## Soil Structure Decline

Information on cropping soils, deep ripping, drainage and Kraznozem (Ferrosol) to soil structure, growing green manure crops to improve soil structure, deep ripping and drainage.

### Deep Ripping

Deep Ripping is a very common practice. Here farmers and experts highlight many benefits from deep ripping soil. To get maximum benefits, ensure that a deep ripping operation is effective, farmers need to consider a number of factors:

* is soil moisture appropriate for deep ripping.
* is the whole paddock compacted or is it only gateways and headlands where compaction exists.
* how deep is the compaction.
* are the tines correctly spaced on your ripper.
* on investigation is the operation effective.

## Organic Matter Decline

The gradual decline in soil organic matter in Tasmania occurring under continuous cropping may leave soils more susceptible to damage and less resilient to stress.

## Acid Sulfate Soils

They are natural soils that contain sulfides (mostly iron sulfides), usually in microscopic form. Most of these sulfides were formed by bacterial activity (sulfate reducing bacteria) in underwater sediments over thousands of years. Sea water provides a ready source of sulfate sulfur for conversion to sulfides and thus extensive areas of ASS tend to be found on low-lying coastal margins once covered by sea water. As the river deltas and beach ridges advanced seaward and sea levels receded, the sulfur-rich sediments remained and today can be found in coastal plains, wetlands and estuaries.

## Irrigation

More careful use of water is necessary to ensure optimum use of the available water supplies. There are two basic ways of using water for crop cultivation: rain-fed farming and irrigation. Water is naturally applied to the soil through rainfall in case of rain-fed farming whereas irrigation involves the artificial application of water for agricultural purposes.

Effective irrigation is essential for the end-to-end growth process of the plant starting from seedbed preparation, germination, root development, nutrients supply, quality and quantity of yield. Ensuring uniformity is a prerequisite for maximizing irrigation. Though the quantity and time of supply depend majorly on the producer, the uniformity is taken care of by the irrigation system. It takes a thorough knowledge of equipment, system design, crop and its growth stage, root structure, soil nature and composition to finalize on the type of irrigation system to be chosen. The system chosen should minimize water loss, soil erosion, salt imbalances and leaf burns.

### Importance of Irrigation

Promotes more yield

* + - 1. Helps to maintain the yield in the absence of rainfall and other environmental stress conditions
      2. Lengthens the growing season
      3. Maximizes the uses of fertilizer application
      4. Increases the productivity of drylands
      5. Less dependency on supplementary feeding in grazing processes
      6. Improves the capital value of the land as well as establishes a market presence for unseasonal produce
      7. Results in greater returns

### Types of irrigation systems

Based on the way water is distributed throughout the field, the irrigation systems are classified into many types. Given below are some of the common types of irrigation systems:

|  |  |
| --- | --- |
| **Irrigation Type** | **Description** |
| Surface irrigation | This type of irrigation system works independently of any mechanical pump. Water distribution takes place along the gravity all over and across the land |
| Localized irrigation | A piped network is used to distribute water under low pressure to each plant |
| Drip irrigation | This type of irrigation is effective at minimizing evaporation and runoff as it is a localized form of irrigation wherein drops of water are delivered near the root region |
| Sprinkler irrigation | Overhead high-pressure sprinklers are used in this type of irrigation to distribute water from a central point in the field. Alternatively, sprinklers on moving platforms can also be used for watering |
| Center pivot irrigation | This is mostly used in flat areas especially in the United States. Water distribution is done using sprinklers that move on wheeled towers in a circular pattern |
| Lateral move irrigation | In this type, a series of pipes each with a wheel and sprinklers are used for irrigation. The pipes are operated either manually or mechanically. This system is considered economical but more laborious |
| Sub-irrigation | This is used more often in areas with high water tables. A system of pumping stations, canals, gates and ditches are used for distributing water |
| Manual irrigation | As the name suggests, the irrigation of this type is through manual labour and watering cans. |

## Soil Sampling

The correct procedure for collecting soil samples to ensure consistent & reliable results. The following soil sampling procedure was written in collaboration with the Upper Brumby Catchment Group. All of the steps will be applicable to all situations, except Step 3 which may vary depending on the circumstances.

1. Ask whether the lab you are using is accredited for the tests that you want done. The lab should have National Association of Testing Authorities Australia (NATA) and/or Australasian Soil and Plant Analysis Council Inc. (ASPAC) accreditation.
2. The results you get from year to year will be more consistent and comparable if you use the same lab each time.
3. There are a number of different sampling patterns that can be used to give reliable results for soil testing, including sampling a zig zag pattern across a paddock, walking a circle around a paddock, or randomly sampling a small area which is typical of the paddock. To return to the same place each time, establish defined transects across every paddock, and mark them using GPS and by painting fence posts. This transect line can be followed whenever the paddock is sampled.
4. No matter what method you use to collect your soil samples, it is important to avoid small atypical areas in the paddock, including changes in soil type, breaks in slope, fence lines, waterlogged patches and obvious stock camps. If the paddock is made up of large areas with different characteristics then these areas should be sampled separately. If using the transect method, some paddocks with two distinct soil types will require a transect line for each soil type. These will be tested separately. If they produce the same results the two transects can be sampled separately and the samples mixed together, giving one sample for the paddock.
5. Make sure you sample at the same time every year, preferably when you can be sure that the soil moisture will be the same, as differences in soil moisture can affect the results. The preferred time is usually spring or late winter.
6. Sample to the same depth every time the paddock is sampled (150 mm is standard for cropping, and should be used even during pasture rotations; 75 mm is standard for pasture). It's difficult to compare results from samples that have been taken from different depths.
7. The soil samples should be taken using a tube sampler, or spade. If an auger is used, care must be taken to avoid sample mixing.
8. For a standard paddock (approximately 20 ha) at least 50 individual cores should be collected. These should be mixed to form the sample for the paddock. As paddock size increases, so should the number of cores (e.g. for an 80 ha paddock you should collect at least 100 cores).
9. The cores should be spread out evenly along the transect (i.e. take 25 from the first half of the paddock and 25 from the second, spread out along the transect). Avoid taking samples from where there are dung or urine patches, or from where plant growth appears unusually good or poor.
10. The cores should be collected into a clean bucket (with no trace of fertilisers in it), mixed well and put into a clean plastic bag.
11. Make sure all samples are labelled clearly (some labs will supply labels for you).
12. Keep the samples cool (use an eski to store them in) and send to the lab ASAP.
13. If you have a GPS (and plenty of time!) you may wish to record the location that individual cores are taken from, and collect from this location whenever you sample.

## Soil Moisture Measurement

### Scheduling irrigation

To be used effectively, soil moisture sensors must be:

1. Used in an irrigation shift that delivers water evenly
2. Installed correctly and placed in an area which is representative of the crop being grown
3. Used in combination with other irrigation management information (soil moisture sensors only measure a tiny area of an irrigation shift):
   1. evaporation-based scheduling
   2. soil moisture monitoring
   3. grower observation.

### Sensor types

There are basically two groups of sensors:

1. Water potential sensors, such as tensiometers and granular matrix sensors
2. Soil moisture sensors that give a percentage or relative content of soil moisture.

### Water potential sensors

These sensors measure how hard it is to remove water from the soil, providing the best indication of available water for plants. Soil type and water content influence the suction pressure required to remove water from the soil, but a monitored sensor, which is recorded and graphed, will show the sharp fall that indicates water has become hard for a plant to access. Questions when choosing a water potential sensor:

1. Do they accurately read in the desired range for the crop in which they are used?
2. Do they react quickly enough to be useful for the crop being monitored?

The two most common types of water potential sensors are tensiometers and granular matrix sensors, such as gypsum block and watermark sensors.

#### Tensiometer sensors

Tensiometers (Figure 1) are the most responsive water potential sensor, and they require the most care and maintenance. There are two types of tensiometer tip: one is used in sands, and the other in clays and loams. Use the appropriate tip to see quick reactions to changes in water status.

Tensiometers work by measuring suction pressure at the tensiometer's porous tip. Water is drawn out of or into the tip, depending on water availability. This creates a suction pressure representing the suction force required for a plant to obtain water from the soil. Measurements can be done by manually reading a vacuum gauge, or automatically, using a logging pressure transducer. To maintain tensiometers, check for bubbles and refill the fluid used to create the vacuum within the tensiometer.

#### Granular matrix sensors

Granular matrix sensors pass a current across a porous media – usually gypsum – with the electrical resistance changing proportionally to the amount of water drawn in and out of the media. They are generally a low cost, low maintenance sensor. Once installed they often last many years without intervention.

The reactivity of granular matrix sensors to changes in water status is the biggest limitation to their use. Accuracy is somewhat poor and can vary greatly – between 10% and 25% of the actual measurement.

Most granular matrix sensors have low accuracy at low tension (0–10 kilopascals). This is an issue if the soil type being measured has limited plant available water and the crop is water sensitive, such as vegetables grown on the coarse WA sands and heavier clays.

Depending on the porous material and the construction of the sensor, the water seems to move in and out of these sensors slower than with tensiometers. There tends to be a lag in the sensor wetting and drying in response to the soil. The lag tends to be greater as the soil dries, as opposed to rewetting, and therefore may lead to an underestimation of plant stress on the drying cycle.

### Water content sensors

These sensors measure the water content of a soil using the time or frequency of a pulse travelling between or returning to electrodes. The most common types are capacitance and time or frequency domain. Most sensors are accurate within 2–3% of the actual soil moisture.

### Capacitance sensors

Capacitance sensors generally measure several depths at intervals of 10 to 20cm, and come in lengths from 40 to 180cm. Multiple depth measurement produces useful information on water movement through the soil profile and relative moisture content of the soil at different depths.

The limitation with most capacitance sensors is that they measure only a very small volume of soil outside the access tube or wall of the sensor. Correct installation must maximise soil contact and ensure water is not allowed to move preferentially down the outside of the sensor. If this occurs, the measurements will not reflect the situation in the undisturbed soil away from the sensor. The method of measurement means these sensors are affected by salts in the soil: salts increase electrical conductivity which means the sensor inaccurately overestimates soil moisture.

### Time and frequency domain sensors

True time domain reflectometry (TDR) sensors are very accurate, but require quite complex and expensive measurement equipment. A similar, less expensive alternative are sensors that measure using water content reflectometry (WCR) and time domain transmissometry (TDT).

This type of sensor generally consists of two or three metal prongs between 5 and 30cm long that are pushed into the side of a soil pit to measure the undisturbed soil. The measurement extends to about 3 to 6cm around the sensor, giving a larger volume of soil measured (0.3 to 8L).

With correct installation into undisturbed soil and the larger volume of soil being measured, data from these sensors will be more representative of the whole area compared to capacitance sensors. They are also less affected by salts in the soil.

Accurate estimation of water availability with time or frequency and capacitance sensors will only be achieved by calibration with soil tension measurements. If calibration is not done, estimation of water availability relies on interpretation of the change in curve produced by taking regular measurements and graphing them.

### Choosing a sensor for your farm

Choosing a soil moisture monitoring system can be difficult. Systems that deliver data to a website or your local computer are readily available and are a better option than a manually read sensor.

#### Suitability of a system

The following questions may help assess the suitability of a system for your farm:

1. Are you more concerned with available water (water potential) or the movement of water in the soil?
2. Do the sensors react well in the soil type and range of soil water in which the crops are being grown?
3. Is accuracy important? How sensitive is the crop being monitored? Will a delay in identifying the lower level of soil moisture and stress point result in yield loss?
4. Are you prepared to maintain sensors (e.g. check for air in tensiometers)?
5. Are the graphs or values easily understood and is support available to interpret the data from the system?
6. Is the system adaptable? If you change your mind about the type of sensor you want, will your logger take different probes?
7. Does the information automatically log to a computer system or does it have to be manually read?
8. If the system is web based, is the site reliable so you can depend on data being available when needed?

#### Guide to select Water potential Sensor

The below table provides the guide to selecting a water potential sensor according to soil and crop type

|  |  |  |  |
| --- | --- | --- | --- |
| **Soil and crop type** | **Tensiometer** | **Granular matrix** | **Gypsum block** |
| Coarse sand | Yes | No | No |
| Sandy loam, loam, loamy clay | Yes | Yes | Yes |
| Heavy clay | Yes | Yes | Yes |
| Vegetables and strawberries | Yes | No | No |
| Perennial fruit and table grapes | Yes | Yes | No |
| Pastures | Yes | Yes | Yes |
| Wine grapes | No | No | Yes |
| **Maintenance required** | Moderate | Low or none | Low or none |

#### Data Measurement Pattern

If soil moisture or capacitance sensors are preferred, the shape and pattern of data measured is most important. Base the purchase of these types of probes on the following criteria:

|  |  |
| --- | --- |
| **Pattern** | **Concern** |
| Copes with salinity | Is the probe likely to be affected by salts in the soil and does the probe still work in these conditions? |
| Repeatability | Will the reading be the same if soil moisture has not changed so graphs will be clear and simple? |
| Volume of soil measured | What volume of soil is the probe measuring? Is a larger volume desirable? |
| Temperature and salinity measures | Some soil moisture probes also measure temperature and electrical conductivity so would these be useful to track? |
| Ease of installation | What assistance is there to ensure proper installation, such as an instruction manual, video or demonstration? |
| Robustness | How robust are the probes? Are they likely to be damaged and can they be easily repaired? |

# 

# Other Ingredients for Agriculture Productivity

## Plant Nutrition

It is well known that the growth and development of the plant are majorly dependent on the availability of nutrients in the soil. Plants need a total of 16 elements for completion of a productive life cycle. There are two classes of nutrients based on the quantities they are required for the growth and development-macronutrients and micronutrients. They are macronutrients i.e., the ones that are required at higher concentrations of about 1150g per kg of plant dry matter and micronutrients that are required at a concentration of 0.1100 mg per kg of plant dry matter. Nevertheless, both of the nutrients are significant for plant growth and metabolism.

### Types of Plant Nutrition

##### Macronutrients

As the name suggests, macronutrients are required in larger quantities by the plant. Macronutrients are again classified into

* Structural nutrients: Carbon, hydrogen and oxygen that build the organic molecules of the cell. They represent the non-mineral class of macronutrients
* Primary nutrients: Nitrogen, potassium and phosphorus which comprise about 75% of the mineral nutrients of the plant. They are required for the proper functioning of plant enzymes and other biochemical processes
* Secondary nutrients: Calcium, magnesium and sulphur are classified as secondary nutrients

##### Micronutrients

Micronutrients are required by the plant in lesser quantities yet, essential for the plant growth and survival. They play a key role in the metabolic activities of the plant. They include boron, zinc, manganese, iron, copper, molybdenum and chlorine.

### Functionalities of Plant Nutrition Types

The functions of each of these are given below:

1. Boron: It is required for the formation and strengthening of the cell wall, flowering, fruiting and pollen germination. Deficiency leads to reduced seed and grain production
2. Zinc: It helps in photosynthesis and growth regulation. Its deficiency would lead to slower maturity and reduction in the size of leaf
3. Manganese: Manganese plays an important role in photosynthesis and nitrogen metabolism. Delayed maturity and early leaf drop are the consequences of manganese deficiency
4. Iron: Energy transfer, nitrogen reduction and fixation are key functions of iron. Iron deficiency causes yellowing of leaf
5. Copper: Copper is responsible for photosynthesis, grain production and cell wall strengthening. Copper deficiency results in yellowing of leaves and stunted growth
6. Molybdenum: Molybdenum is essential for pollen formation and nitrogen fixation and its deficiency leads to reduced fruit and grain growth
7. Chlorine: This micro-nutrient helps in osmosis, photosynthesis and ionic balance. With chlorine deficiency, there is reduced plant growth and decreased resistance.

## Agrochemical

Agrochemicals play a key role in increasing agricultural productivity by protecting crops from insects, pests, fungi, weed, rodents etc. Owing to their benefits, they have been used indiscriminately, raising concerns over their usage. Nevertheless, they are indispensable in agriculture to maintain productivity as the population is exponentially increasing and so is the demand for food. Hence there is a need to employ a policy for the management of the agrochemicals to encourage their judicious use.

### Benefits Of Pesticide Use

Plant insects and pests incur a major loss to farmers worldwide every year. It has been estimated that insects destroy 15% of crops, disease pathogens and weeds around 13% each and pests during postharvest period damage 10% of crops. Agrochemicals help minimize this loss by protecting crops, increasing productivity and maintaining the quality of the produce. This also saves other costs such as labour and fuel which in turn lowers the prices of agricultural commodities.

Apart from their use in agriculture, agrochemicals are also used to prevent negative impacts caused to society in many ways. For example, trees and weeds growing under power lines, when left unchecked, would result in power outages. Herbicides are used to eliminate this growth. Also, herbicides are widely used to control unwanted vegetation along national highways, roadsides, in parks, wetlands and public areas to ensure public safety and convenience.

In food processing, insecticides are used in permissible levels to protect raw commodities and packaged groceries from insects infesting them during processing, manufacturing and packaging stages. Insecticides and rodenticides are widely used in places where food is stored. Insecticides, herbicides and pesticides are also used in the home for controlling insects, herbs and pests.

### Risks Associated With Agrochemical Use

There is as much risk associated with the use of agrochemicals as the benefits. First and foremost is the harm they cause to humans and the environment. Use of pesticides in agriculture is inevitable as discussed previously. However, their non-judicious use is posing a great risk to human health as well as the environment. The pesticide molecules are inherently toxic. And most of them are broad-spectrum in nature resulting in the emergence of resistant species. Hence it is essential to develop molecules with selective toxicity. Instead, their biological counterparts need to be discovered and applied to alleviate the toxic effects. Farmers need to be educated on the need-based application of agrochemicals to promote discriminate use of these chemicals.

### Strategies For Agrochemical Management:

Various strategies are suggested to effectively manage agrochemical use. Some of them are:

* Ensuring environmental and ecological compliance
* Identifying non-target species for each region and protecting them
* Mandating the monitoring of toxic remains in plant parts, animal-based food and environment
* Defining Good Agricultural Practices (GAP) for each crop with respect to the agrochemical usage
* Establishing Maximum Residual Limit (MRL) for each agrochemical
* Detoxification and degradation of chemical residues in the environment
* Emphasizing and educating about the occupational and consumer risks associated with the chemicals

## Pest Management

Diseases, insects, and weeds can cause costly and irreparable harm to livestock and crops. Methods to manage these problems include the use of pesticides or biological pest control. Integrated pest management (IPM) couples both methods and includes monitoring to reduce the overuse of pesticide applications.

### Importance of Pest Management

Damage from pests often results in vast economic consequences. They threaten the health of our nation’s vital agricultural, natural lands, and urban areas. Among the adverse impacts are:

* The infestation of farms, rangelands, and forests
* Obstructions to streams and waterways
* Damage to crops
* Loss of wildlife habitats
* Disease and quality of life impacts in populated areas

### Agrimaan’s Impact

Taking action to reverse pest infestation is essential to combating these adverse impacts. Our programs are working to reduce losses caused by insects, diseases, and weeds by providing services such as:

* Coordinating IPM efforts through regional IPM centres
* Promoting reduced-risk pest management
* Identifying appropriate and safe use of pesticides
* Detecting and researching new and persistent pests
* Developing alternative pest management strategies
* Involving social considerations into management systems
* Advancing detection, surveillance, rapid response, and recovery into pest management networks

## Agriculture Waste

Agricultural waste is defined as unwanted waste produced as a result of agricultural activities (i.e., manure, oil, silage plastics, fertilizer, pesticides and herbicides. There is increasing pressure to recover wastes from landfill and to utilise them on productive agricultural land. This trend is recognised as *Zero Waste Strategy*.

Agriculture Waste can be categorised into different groups such as

1. Crop Waste (Sugarcane, Paddy Husk etc)
2. Animal Waste (Animal Excreta, Animal Carcases etc)
3. Processing Waste (Packaging Material)
4. Hazardous Waste (Pesticides, Insecticides)

The avoidance of waste is the most important starting point in improving resource-use efficiency and minimising the potential impact of waste disposal. Though waste production is an inevitable consequence of economic development, any potential negative impacts also need to be avoided.

Agrimaan™ addresses these challenges by investigating the potential to recover wastes for productive use in agriculture. When wastes are re-used responsibly and beneficially they are correctly termed 'recoverable resources'. To shift the paradigm and regard wastes as recoverable resources, particularly for the agricultural sector, it is essential to demonstrate that the long-term impacts from re-using wastes are not detrimental to human, animal, plant or environmental health.

The three principles of our R&D Waste Management Strategy in Agriculture are:

* Reducing wastes produced by agricultural activities,
* Preventing long term degradation or restriction of land used for agriculture due to the application of wastes
* Assisting in the uptake and responsible use of wastes for agricultural production systems

### Agriculture Waste as Animal Fodder

Using agricultural waste as animal feed, fish feed, or as constituent in feed preparation is a waste to wealth initiative. However, many agricultural wastes are unsuitable for direct consumption by animals as they need to be treated mechanically and chemically to make them edible. Roughage and fiber residue are often low in nutritional value and need supplements to enrich them.

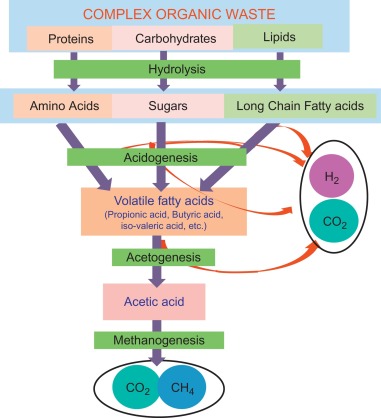
The deficiency of animal foodstuff in developing countries causes raw material to be imported with inherent high cost and reduction in animal production. Transforming some of these wastes into animal [foodstuffs](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/foodstuff) will help a great deal in overcoming this deficiency. These wastes have high fiber content that makes them difficult to digest. The size of the waste in its natural form might be too big or tough for the animals to eat. To overcome these two problems several methods were used to transform the agricultural waste into a more edible form with a higher nutritional value and greater [digestibility](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/digestibility).

Mechanical and chemical treatment methods were used to transform the shape of the roughage (waste) into an edible form. The further addition of supplements can enrich the foodstuffs with the missing nutritional contents. The mechanical treatment method consists of [chopping](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/comminution), shredding, grinding, moistening, soaking in water, and steaming under pressure. The mechanical method has been proved to give good results with high digestion by animals but they were never widespread because of high cost and therefore were unfeasible for small farms.

The chemical treatment method with urea or ammonia is more feasible than the mechanical treatment method. The best results were obtained by adding 2% ammonia (or urea) to the total mass of the waste. It is recommended to cover the treated waste with a wrapping material usually made from [polyethylene](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/polyethylene) at a 2 mm thickness. After 2 weeks (summer) and 3 weeks (winter), the treated waste is uncovered and left for 2–3 days to release all the remaining ammonia before use as animal feed.

### Building a Bio-based Solution with Agriculture Waste

Organic material in wastes, agricultural residues, wood and wood waste, aquatic plants, and algae can be considered as a good substrate for bio-H2 production. (Saratale et al., 2008). Biomass derived from plant crops, agricultural residues, and woody biomass are also being used for generating bio-H2 via both thermochemical and biological routes (Venkata Mohan et al., 2009b; Subhash and Venkata Mohan, 2014; Venkata Mohan, 2009). In order to make the organic fraction available for the bacteria, the cellulosic material requires an initial [pretreatment](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/pretreatment) step, which adds to the cost of the entire process. Unlike cellulosic materials, waste contains readily available carbon, thus making it a highly preferred substrate for bio-H2 production. Dark fermentation process is widely used for bio-H2 production as it is relatively less energy intensive and more environmentally sustainable due to its operational [feasibility](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/feasibility).



Despite the advantages, low substrate conversion efficiency, accumulation of carbon-rich acid intermediates, and drop in system pH impede upscaling of bio-H2 production (Pasupuleti et al., 2014). If these factors are optimized, then they can be the game changers, and H2 production at a practical scale in a cost-effective way and with high efficiency might become a reality.

### Composting from Agriculture Waste

Compost is the result of the natural rotting process that occurs with all organic material. The increasing suburbanisation of so many countries, plus the expansion of the nursery industry has produced a huge demand for compost. Compost is a valuable source of organic matter for soils and contains nutrients that are slowly available for plant growth.

Composting reduces the amount of wastes going to landfill and recovers valuable organic matter for our soils. Governments and businesses have seen these opportunities, and a whole new industry has been born - commercial composting. Commercial producers are simply speeding up the natural process of rotting. By creating the right environment, the rotting process of any organic material can, not only be accelerated, but also manipulated, to produce the desired results.

The basic ingredients of making compost are quite simple: - a supply of organic materials, microorganisms, moisture and oxygen. The last three are universally available and practically free, however, watering costs must be considered in every climate. Compost is a net user of water. So this enterprise is feasible anywhere in Australia. Organic material can be sourced from anywhere - garden or green waste, or animal manure are the usual sources but you can compost kitchen waste, sawdust and even paper. Successful producers in Victoria are composting green wastes, grease trap sludges, food wastes, sawdust, manures and wool scour wastes.

There are strict regulations governing the siting and operations of composting enterprises. Contact EPA Victoria for assistance early in the planning phase of a facility.

Depending on your method of production, you may also need to add some other materials such as gypsum, lime, dolomite and even soil. The other requirement is machinery.

Depending on the scale of production and the types of waste accepted, composting requires the use of heavy machinery. As a minimum, commercial scale operations require the use of a front-end loader to load, unload and turn compost. Screening equipment for the end product is also typical for most operations. Finally, you need microorganisms to do the composting. These occur naturally so all you need to do is provide the right environment to encourage the right types of microbes.

#### Production

As mentioned before, making compost is basically speeding up the natural processes of rotting of any organic material. If it is done properly, you can minimise the loss of nutrients into the air and so enhance your end product. Like every production process, the quality of your compost largely depends on the quality of the organic materials that you start with.

There are many aspects to quality compost such as its organic matter content, nutrient content, C/N ratio, salt content and suitability for use with particular plants. The Australian Standard for composts, soil conditioners and mulches (AS4454-1999) is the industry standard for determining compost quality.

The two most critical factors to consider when mixing organic materials are the C/N ratio and moisture content.

#### C/N ratio

The ideal C/N ratio is about 25-30:1 - that is, the composition of the raw material has about 25-30 times as much carbon as nitrogen. If there is too much carbon relative to nitrogen, composting is slowed down or even practically stopped completely. If there is too little carbon relative to nitrogen, there is a loss of the nitrogen (as ammonia gas) producing unpleasant odours and a loss of valuable nutrients.

Examples of C/N ratios of commonly used materials are: animal manure (5-12), weeds (20), leaves (60), lawn clippings (20), paper (170), straw (100), pine needles (70), sawdust (450), and seaweed (25). Seaweed is interesting in that it can be used, so long as you wash off the surface salt before adding it to the compost heap. If nitrogen levels need to be boosted, it is preferable to add other organic materials that are high in N (eg. manures, grass clippings), but inorganic fertilisers such as urea can also be used.

#### Moisture content

The next thing to consider is the moisture content. The optimum moisture content for composting is between 50 and 60% on a wet weight basis (ie. 50% = 50 g water in 50 g dry matter). Below 40%, the compost is too dry for the microorganisms to work at maximum efficiency. Above 60% there is a high risk of odours developing because of a lack of oxygen in the compost.

#### Temperature

Temperature also is important. The composting process naturally produces heat, which helps the microbial activity, but you don't want it to get too hot, otherwise these microbes slow down. When temperatures exceed 65 C the activity and diversity of microrganisms drops off markedly. The most rapid composting occurs between temperatures of 45 and 55 C. In colder areas, you may need to insulate the heaps in winter to retain the warmth. Heaps that are too small (eg. < 1 m3) will not heat up. Heaps that are too large become too hot and are at risk of catching fire. The optimum size of a heap depends on the materials being composted, space and equipment available (see below). The correct temperatures are also important in getting rid of the many pathogen, parasites and weed seeds that may be in the compost.

#### pH

Composting can occur at a broad range of pH. Adjustment may only be necessary if the starting materials are extremely acidic or alkaline, or if a certain pH range was required in the end product. Also, there is a greater risk of loss of nitrogen as ammonia causing odours when the pH exceeds 9.0.

#### Composting systems

The most common form of composting is the windrow system. Organic materials are placed in windrows of varying dimensions depending on the waste being composted, space available and equipment used. For manure based operations, the recommended size is around 1.5 m high and up to 2.5 m at the base. For green wastes, heaps can be as high as 2.5 m or more and 4-5 m at the base. The length of windrows only depends on space available, and can vary between 20 and 100 m. Windrows are turned by either front-end loader or specialised windrow turners. Turning is used to mix the compost, control temperatures and moisture and provide the aeration needed for composting. Capital outlays for windrow type systems are relatively small (unless a concrete pad is installed), but operating costs can be high because they are usually labour intensive.

Some types of wastes are more difficult to handle and must be composted with specialised aeration and leachate control equipment. These systems can be very expensive, and may not be an option outside urban areas. Another simple and cheap option is the passively aerated windrow or pile system. In this system, pipes are laid on the ground and the heap is formed on top. The pipes extend outside the heap to provide adequate airflow to the compost. A layer of finished compost is placed over the pile to reduce the incidence of odours. This system does not require turning. This system has been used to compost manures, but careful preparation and monitoring is required to ensure success.

#### Marketing

Markets can vary from home gardeners, nursery suppliers, topsoil manufacturers, landscape suppliers, supermarkets, potting mix manufacturers, local government and commercial horticulture. It is recommended that compost producers become certified to the Australian Standard for compost (AS4454-1999). Alternatively, compost producers may choose to get organic certification for their compost (eg. NASAA). Certification to one of these standards should give your product a marketing edge. Most producers are small and sell through local markets and outlets. However, there are opportunities with larger organisations but they will want a consistent product, regularly supplied and professionally packaged.

#### Composting Process Simulation

Simulation of the Composting process done (ref: <https://www.sciencedirect.com/science/article/abs/pii/0269748388901322>)

Separated cattle manure (SM) and grape marc (GM), and manure composts of these raw materials, were incubated in a composting simulator for 10 days. The effects of moisture content and addition of nitrogen on the rate of composting were measured in terms of oxygen consumption. Moisture content had a major effect on O2 consumption. The higher the water content, the higher was O2 consumption, which reached a maximum at 60–70% water content. Below 50% moisture, the microbial activity seemed to decline sharply. The O2 consumption was extremely low for the manure composts and was unaffected by the moisture content. No effect was recorded when nitrogen was added to SM. However, the addition of 0·25% (w/w) nitrogen to GM at all moisture levels increased significantly the O2 consumption, except for the mature compost. The most prominent effect of nitrogen addition was exhibited by GM that was composted at 60% moisture.

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# Agriculture Exposure and Risks to the Farmers

According to researchers of the National Cancer Institute, farmers due to long hours of exposure to sun, pesticides and other substances have higher rates of developing several deadly forms of cancer.

Evidence suggests that increased physical activity and lower rates of smoking among farmers contribute to lesser cancer incidence but agricultural exposures to microbes, sunlight, pesticides and other chemicals may increase the risk. Farmers are exposed to a variety of substances including engine fuels or exhausts, organic and inorganic solvents, chemical fertilizers, pesticides, welding fumes, mycotoxins and zoonotic microbes.

Other factors like genetic or medically induced immune deficiencies and agricultural lifestyle affect the health of farming populations. Farmers take on work of carpenter, mechanic, welder and pesticide applicators, getting exposed to many potentially hazardous substances. Agricultural workers, farmers or farm workers and their families may be exposed to potential carcinogens including pesticides, sensitizing agents and solar radiation experiencing higher rates of cancer. Women engaged in agricultural work and children living in agricultural areas may be exposed to different types and levels of cancer-causing agents. Wide range of exposures is possible depending upon the agricultural operation that varies from farm to farm.

## Types of Cancers due to Agricultural Exposures

Farmers appear to experience elevated risk for several cancers like non-Hodgkin’s lymphoma, leukemia, multiple myeloma, soft-tissue sarcoma and cancers of the brain, stomach, prostate, skin, and lip. Agricultural workers are at the risk of developing hematologic malignancies due to factors like zoonotic viruses responsible for human carcinogenicity in veterinarians, abattoir workers and meat inspectors; agricultural chemicals, for example, exposure to phenoxy herbicides increases risks of soft tissue sarcoma and malignant lymphoma; and agricultural farming involves lymphoproliferation as a result of the prolonged antigenic stimulus. Lymphohematopoietic cancers, melanoma, prostate and brain tumours have been also reported among agricultural workers. Commercial pesticides applicators and farmers have enhanced risk of developing lung cancers due to significant exposure to specifically four pesticides of chlorpyrifos, diazinon, metolachlor and pendimethalin. Mechanism of mutagenicity, immunotoxicity and hormonal disruption by pesticides potentially initiate and promote cancer.

Varying agricultural exposures influence cancer risk in different ways with patterns indicative of occupational factors and farming lifestyle. The types and levels of exposures have shown evidence to suggest the strong association of risk of developing leukaemia among farmers. Leukaemia among dairy and poultry farmers suggest the involvement of zoonotic viruses while pesticide usage is associated with crop production. Pesticide applicators and farmers have higher rates of prostate and ovarian cancer while crop-duster pilots have higher rates of skin cancer. The associations regarding Hodgkin’s or non-Hodgkin’s lymphoma, soft-tissue sarcoma, multiple myeloma and cancers of the brain, stomach and prostate is unclear. The high rate of physical activity associated with farming lowers the incidence of colorectal cancer. Farmers, farm-workers and ranchers because of excessive exposure to UV radiation are at greater risk of developing skin cancer and need skin protection by usage of sunscreen, sunglasses and full clothing.

Reports suggest high consumption of plant-based foods has a preventive role in cancer. Increasing evidence suggests organic agriculture eliminates the use of synthetic pesticides and chemical fertilizers to create conditions favorable for high yields and provide a healthy work environment.

# Farmers Ecosystem

## Farmer Profiling

Farmers are the main actors in this entire supply chain management. However most of the time, it is difficult to quantify their needs and the value they can bring to society if they get the required tools and techniques to produce the high-quality items on time within budget. To understand their persona well, it is important we go through the following subsections:

A farmer is a person engaged in agriculture, raising living organisms for food or raw materials. The term usually applies to people who do some combination of raising field crops, orchards, vineyards, poultry, or other livestock. (Wikipedia)

Farmers can be grouped into different segments:

|  |  |  |
| --- | --- | --- |
| **Farmer Type** | **Approx Land Size** | **Additional Information** |
| Small Time Farmers | 1-2 ha land |  |
| Medium Farmers | 4-6ha land |  |
| Large Farmers | above 6has |  |
| Landless Farmers | No land in his or her name |  |
| Marginal Farmers | Less than 1 ha land |  |

## Farmer’s Growth Strategy

Every farmer is a business in one sense. Their primary objective of this work is to cultivate something to earn and support their family. However, this is not enough. Farmers have got their own aspirations and desire to earn more and provide all the required amenities to themselves and their family members as compared to other professions like IT industry, Banking and others. There is evidence that farmers who had adopted the innovation and partnered with the right stakeholders, have changed their lifestyle and changed their profile. For example, [Australia](https://en.wikipedia.org/wiki/Australia) is a major agricultural producer and exporter, with over 325,300 employed in agriculture, forestry and fishing as of February 2015. Agriculture and its closely related sectors earn $155 billion-a-year for a 12% share of GDP. Australia leads the world with 35 million hectares certified organic, which is 8.8% of Australia's agricultural land.

Similarly, many farmers around the world look to Israel as a model of how to manage and flourish in conditions of water scarcity and a hotter, drier climate. Drip irrigation is the flagship technology, but they also consider seed breeding, choice of crops, use of protected agriculture in greenhouses and net houses, and scheduling irrigation based on data gathered in many different ways. Israeli precision drip irrigation — and associated data-analytics technologies – are critical tools for farmers facing a drier, hotter world. While many farmers in India have adopted drip irrigation, the challenge is to find a creative business model that can make this and other technologies accessible and affordable to the smallest of farmers

Agriculture is the largest source of livelihoods in India. 70 percent of its rural households still depend primarily on agriculture for their livelihood, with 82 percent of farmers being small and marginal. In 2017-18, total food grain production was estimated at 275 million tonnes (MT). India is the largest producer (25% of global production), the consumer (27% of world consumption) and importer (14%) of pulses in the world. India's annual milk production was 165 MT (2017-18), making India the largest producer of milk, jute and [pulses](https://en.wikipedia.org/wiki/Pulses), and with the world's second-largest cattle population 190 million in 2012.[[153]](https://en.wikipedia.org/wiki/Economy_of_India#cite_note-153) It is the second-largest producer of rice, wheat, sugarcane, cotton and [groundnuts](https://en.wikipedia.org/wiki/Peanut), as well as the second-largest fruit and vegetable producer, accounting for 10.9% and 8.6% of the world fruit and vegetable production, respectively.

However, India still has many growing concerns. As the Indian economy has diversified and grown, agriculture's contribution to GDP has steadily declined from 1951 to 2011. While achieving food sufficiency in production, India still accounts for a quarter of the world’s hungry people and home to over 190 million undernourished people. Incidence of poverty is now pegged at nearly 30 percent. As per the Global Nutrition Report (2016), India ranks 114th out of 132 countries on under-5 stunting and 120th out of 130 countries on under-5 wasting and 170th out of 185 countries on prevalence of anaemia. Anaemia continues to affect 50 percent of women including pregnant women and 60 percent of children in the country.

As per the FAO (Food and Agriculture Organisation) of the United Nations, Improvements in agriculture performance has weak linkage in improving nutrition, the agriculture sector can still improve nutrition through multiple ways such as:

* Diversifying production of crops
* Empowering women
* Strengthening agricultural diversity and productivity
* Designing careful price and subsidy policies that should encourage the production and consumption of nutrient-rich crops.
* Diversification of agricultural livelihoods through agro-allied sectors such as animal husbandry, forestry and fisheries has enhanced livelihood opportunities, strengthened resilience and led to considerable increase in labour force participation in the sector.

## Farmer Interaction Strategy

Interaction strategies are tactics, techniques, or approaches to communication, collaboration, support, and feedback that are used to support teaching and learning.

Increase your reach by utilizing different types of mediums and integrating different technologies. For example, you can host a radio program that’s geared towards educating farmers on a new technique.

You can ask them simple yes or no questions and have people that think yes call a certain number and people who think no can call a different number. This allows you not only to get information on how well you’re disseminating information but can also be used to gather contact information on farmers who might be interested in a specific program or service.

### Create Interactive Program

Increase your reach by utilizing different types of mediums and integrating different technologies. For example, you can host a radio program that’s geared towards educating farmers on a new technique.

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### Segment Target Audiences

Segment your target market of constituents into different categories based on their demographics, psychographics, and the preferred response action. By targeting them with different messages you are better able to raise their interest and elicit the response you seek.

For example, you could divide farmers into the type of crop they specialize in, their farm size, and their farming sophistication and send different messages to small corn farmers and large corn farmers, even if they’re in the same geography.

This is advantageous because you may want the small farmer to get further information from an ag inputs seller before they try something, while the large farmer may just need a reminder to do the target action. Making the messages as relevant as possible to different groups will increase the adoption/response rates.

### Utilise Existing Network

In communities there are already existing networks that can be utilized. Often there are key influencers within a community that when identified can become great resources for programs. Farmers already have networks that they share information with and can use to get advice on farming.

For example, the Digital Green project has farmers share training videos with their networks and they found that just sharing the videos started discussions on who the leaders in ag practices were within their communities and people wanted to be able to learn from other farmers successes

### Reduce Cost to Farmers

One of the best ways to ensure farmer participation is by creating partnerships with telecommunications companies in order to make interactions with farmers through phone and SMS inexpensive for the farmers and organizations. An example of ways to do this is through utilizing something like a beep system where calls aren’t ever actually answered so charges aren’t accrued, however, some companies will provide certain services at low or no cost.

The rapid advancements in technology are making it easier and easier to reach more farmers, but a large number of technologies out there can also become overwhelming. By tailoring messages and programs to specific groups to ensure they aren’t receiving unnecessary information will make tech adoption and agricultural improvements more sustainable in the long run.

The best way to do this is by continued engagement with your target group, redefining what your goals are for different segments of your target group, and keeping the costs down for farmers.

## Farmer Organisation Profiling

Mapping helps to build a clearer picture of existing FOs (Farmer Organisations) both nationally and within specific project target areas. It can then support the identification and selection of FOs to be included in projects. Profiling helps to assess FOs selected as partners, for example in terms of strengths that can be built on and weaknesses that need to be addressed so that services provided for members and links to market opportunities can be improved, with an impact on their income. Profiling usually consists of: (i) qualitative description; (ii) SWOT analysis; and (iii) quantitative analysis based on indicators for each assessed category

### Steps for the profiling

There are multiple steps to perform for profiling:

* 1. Broad *Mapping*

Broad mapping collects the following information:

* + - * + General characteristics of the country, with a focus on its agricultural sector.
        + Overview of FOs in the country: history, trends, typology, level of organization.
        + Analysis of the positioning of FOs in the agricultural development arena: how and where do FOs interact with other public and private stakeholders?
        + Strategic orientations that illustrate the main issues regarding the organization, structuring, service provision and positioning of FOs in their environment.
  1. Detailed *Mapping*

The objective of detailed mapping is to identify FOs that projects can establish partnerships with. The process has elements in common with profiling because the FOs mapped usually undergo broad assessment. Detailed mapping can also produce an assessment of the level of maturity of FOs, which can also be used as the basis for an M&E system and a capacity-building plan. The information to be collected includes:

* + - * + Name, contact, history (date created, initiated by whom).
        + Type/level of organization, geographical coverage.
        + Membership (number, type, ratio women: men), the existence of legal status, institutional functioning (structure, internal bodies, decision-making processes).
        + Objective/mission and range of services provided (economic, social, trade union/political).
        + Partnerships, relationships with other stakeholders (local authorities, public services, service providers and other private sector entities) and support organizations (NGOs, donors, etc.).

### How do we perform profiling?

The profiling process should be adapted to meet the needs of each situation but is generally based on the use of a questionnaire. Profiling can be done: (i) during a design mission, to assess an FO broadly; or (ii) during implementation, to assess the maturity level of an FO. It can be also used as an M&E tool for projects. There are several steps to be performed:

Step 1: collect information through interviews with FO staff and leaders. The questionnaire and list of documents to be checked are provided in the appendix.

Step 2: fill in the rating grid to assess the maturity level of the FO (see scale below).

Golden rule! If the grid is to be used as part of the profiling process at the design stage, it can be used as it is. However, if it is to be used for M&E purposes, it is recommended that you share it and discuss it with FO partners in advance.

### Maturity Assessment of Farmer Association (FO)

Assessing FO maturity levels on a scale of 1 to 4

* 1 = The FO has done nothing in this area
* 2 = The FO has started operating in this area
* 3 = The FO has evolved considerably in this area but still needs improvement
* 4 = The FO has evolved well in this area and needs no improvement

### Key Criteria for the selection of Farmer Organisation (FO)

* Governance, democratic functioning, transparency (respect for internal democracy, transparent accounting, members aware of FO activities, farmers pay their dues);
* Targeting: equal access for women and youth, specific responsibilities assigned to women;
* Good organizational development (all members aware of medium-term project activities, quality of balance sheet presented to the general assembly, including self-evaluation of activities and sources of income, an indication of debts, and well-prepared minutes of meetings);
* Effective participation of women in decision-making processes; Diversification of activities; Good use of resources and funds.
* Inclusiveness: FOs open to new membership and/or willing to provide services to non-members Efficiency and effectiveness of the economic services provided by FOs (bulking functions, input provision, training)
* Sustainability potential (good use of resources and funds, management of internal funds, diversification of activities, membership, business approach, etc.).
* Refer the Appendix1: Questionnaire for use in FO profiling process

## Farmer Segmentation

Agricultural extension to farmers in India assumes similar needs and aspirations. Research reveals there are in-fact many variances between farmers. The farmer segmentation tool enables the researcher or implementer to identify different clusters of farmers with similar characteristics. By better understanding specific farmer characteristics, more effective extension service delivery models can be targeted.

### Understanding Buying behaviour for Segmentation

There are 5 types of buying behaviours which define the customer segmentation as follows:

* Convenience – Producers in the Convenience segment choose input suppliers based on their location and service.
* Performance – Producers in the Performance segment choose input suppliers based on the quality of products and information and consider which product will perform the best.
* Service – Producers in the Service segment choose input suppliers based on the level of service and information from the local dealer.
* Balance – Producers in the Balance segment consider all input supplier criteria to be of equal importance.
* Price – Producers in the Price segment choose input suppliers simply based on price.

### Segmentation Approach

The approach combines quantitative and qualitative aspects to understanding the diversity of farmers within a community. On-farm resources are identified as well as a farmers’ level of entrepreneurship and willingness to invest in their priority crop. The farmer segmentation process identifies differences in farmers’ ability to invest in Good Agricultural Practices. Being able to consider the farmers capacity and willingness to implement certain practices informs the design of more manageable sets and sequences of practices.

### Farmer Segmentation Methodology

A mix of quantitative and qualitative data collection methods are used: focus group discussions (FGD) are used to collect qualitative data, and questionnaires are used to collect quantitative data. Through FGDs structural indicators (such as land or labour) along with functional indicators (such as motivation and training) are identified and prioritized by the farmers. Further discussion exposes sub-categories of the indicators which in turn informs the identification of specific farmer groups within the community. Finally, short structured questionnaires are administered to the original farmer group to capture quantitative data validating the FGD findings.

This kind of methodology informs the design of contextually specific and targeted extension support to smallholder farmers Identifies specific farmer groups with a desired characteristic Increases smallholder farmer adoption of good agricultural practices.

## Farmer’s Value Proposition

A value proposition is the benefit of a product or service to a customer. It is a blend of economic and non-economic returns and spans both the long term and short term. It is not only the specific product or service, but also the entire interaction a customer has with the company in the course of purchasing and using those products or services.

Some common differentiating factors are:

* *Best quality* - you offer something better than your competitors
* *Best value* - this doesn't always mean least expensive, but rather offering a better "bang for the buck"
* *Scarcity* - you offer something that's unique or hard to find
* *Luxury* - you offer something that people don't need but they want to satisfy themselves
* *Necessity* - you offer something people need and can't do without

### Concept of 5 “As”

* 1. **Advantage**

what value the product or service has over the competitors?

* 1. **Accessibility**

1. How distribution, manufacturing and logistics will impact the customers who are actually getting your products or services?
2. Can the farmers get the product or service when they need it?
3. The supplier must be able to deliver the product or service to the customer:
   * + 1. Within resource constraints (e.g. time, costs, and labor).
       2. Under given market conditions.
       3. When the smallholder needs it to be available. Because farm products have sensitive timing aligned to seasons and markets, this must be factored into the operations plan.
4. Market assessment information (see Who and Where is Your Customer), specifically where the target customer makes purchases, should be used to determine an effective distribution plan. Are purchases made:

* When a representative visits the community or farm?
* In the market town center on occasional visits?
* At aggregation points, such as a milk cooperative or grain collective?
* From agro-dealer networks?
* On a mobile device, such as for service delivery?
* There are two sets of information to consider when constructing a distribution plan:

1. Who distributes the product?
2. Where the product is distributed?



1. Timing is critical and hence it is important to plan your product to go to market. Consider these questions and answer those approximately:

* How much training time does your product require?
* How much installation time does your product require?
* How long does it take to get your product from distribution point to the customer?
* How long does it take to sell your product?
* How long does it take to transport your product to the point of sale?
* How long does it take to package your product?
* How long does it take to manufacture your product?

1. Total Days: Add the previous rows together. This is the total number of days from the time your product or service beings its lifecycle to the time the customer is able to use it
2. Finally, take the total number of days and subtract it from the day that your product needs to be in use by the customer to determine the first day of your logistics.
   * + 1. Can these timelines be met?
       2. What processes and costs will need to be re-engineered to meet these timelines?
       3. Are there ways to reduce any of these timelines?
       4. You will likely want to add some buffer time to account for any interruptions or unexpected events.
   1. **Adaptability**
3. Customisation of the product or services for the particular segment and how it fits with the behaviour and culture of the target customers.
4. Is the product or service – and accompanying support – tailored to meet the unique needs of the target customer and the context in which the customer lives and works?
5. Adapting a product or service to the smallholder farmer customer requires understanding what the market and customer needs, then customizing the product or service to meet these needs and conditions. Finally, the delivery of the product or service must be considered as well and adapted to this context. we can use the following methodology:
6. Questions to consider for adaptability:

* What are the smallholder’s critical needs in relation to the product or service being considered, that if not addressed, would significantly impact his/her livelihood or productivity?
* How can these needs best be addressed and what are the alternatives?
* How can the risk of adopting the product or service be reduced through a comprehensive market offering (e.g. training included with the product).
* smallholder farmers prefer lower-risk solutions over the alternative, even if they cost more, particularly when these solutions help address a critical need.
* The entire offering to the customer – not only the actual product or service – must address the smallholder’s needs. This may include training or post-purchase service.
  1. **Affordability**

Affordability is the price of the product or service including the season considerations. Does the farmer have enough money at the right time to purchase the product or service?

Affordability encompasses the price of the product or service in relation to the income of the target customer and the timing of the payment for it, relative to the cash cycles of the target customer. By using affordability strategies such as pay-per-use or bundling, the upfront cost of a product or service can be reduced, thus improving the prospects for customer uptake. Alternatively, financing can be offered in conjunction with the product or service to enable access to a good that is unaffordable if purchased in a lump sum. Reference the Affordability & Financing playbook for further options.

**Questions to consider for affordability:**

* What percent of an annual income of the target customer does the product or service cost? Is this affordable or should the company revisit the design of the product or service to reduce the cost?
* How does the timing of the purchase align with the income cycle of the farmer?
* Does the farmer need to pay at the time of purchase or are credit terms available?
* What financing can be offered to assist with purchasing the product or service? Does the company have the internal capabilities or can it partner with financial institutions to offer credit?

**Key considerations:**

* Affordability strategies such as bundling and no-frills are generally used for lower-priced products and services; however, pay-per-use enables single-use of higher-priced equipment.
* Financing strategies are used for higher-priced items for which enough cash will not be available for purchase, but companies should offer after-sales service to ensure that the technology performs as advertised and that the customer is able to generate sufficient revenues for loan repayment.
* Establishing enterprises that rent or lease-to-own higher-cost equipment is another strategy that can be useful in increasing affordability.
  1. **Awareness**

Awareness is the method and channels for marketing the products and services. Does the farmer know about the product or service and what is the best way to tell him or her about it?

Awareness is simply how a company ensures the target customers know about the product or service. This requires a blend of the following and should be highly localized:

* Incorporation of elements of traditional marketing.
* An agent workforce that is trained and has proper incentives to educate users.
* Partnering with an organization that already has agents and farmer groups in the target areas.
* Brand ambassadors who will publicize the product or service.
* Finding influencers in communities to act as early adopters.

Most importantly in the smallholder farmer segment, effective awareness strategies require developing relationships and trust. A company must build relationships with its target customers, either directly or through agents. After initially building trust with the customer, it must be maintained through superior product and service delivery and follow-up.

### Channels

There are many communication channels available to companies to drive awareness among smallholder farmers. The most effective channels are those that leverage trusted community members and provide local demonstrations of the product or service. When deciding how to communicate with customers, the company should consider the profile of its target customers. Specifically:

* Literacy: customers’ ability to read affects how products, services, or training are delivered.
* Language: often there are many local dialects; choosing the correct one is necessary for comprehension and will also engender trust with customers.
* Technology access: ability to communicate by SMS, Internet, social media, television, and radio may vary among groups, so connectivity should be factored into marketing plans.
* In addition to the distribution points discussed in the accessibility section – all of which can also be used for awareness – there are a number of other effective communication channels. As with most marketing, there is a direct correlation between the price of a method per person and its effectiveness.
* Cost and Effectiveness of Advertising Channels



### Product Demonstrations

The value of demonstrations to reach the potential customer cannot be overstated in the smallholder market. Given the risk-aversion and mistrust of outsiders, demonstrations show the impact of the product or service and the positive difference it could make in customers’ lives. The smallholder gains trust by seeing the product function and by seeing results Demonstrations and training are often done at aggregation points (e.g. milk cooperatives or grain collection centres) and other areas where there is frequent traffic that can be easily viewed by prospective customers.

### Product Offering

AGCO and partner GSI offer small customizable metal grain silos to grain traders. They have capacity from 34 to 500 tons and additional space can be added on as needed, offering an appropriate postharvest storage solution for smaller-scale production. Financing is offered, including a discount from an NGO and 70 percent financing from the bank with proof of 50 percent collateral.

### Pre- and Post-purchase Support

Pre- and post-purchase support is important to ensure the product performs for the customer as advertised and that any problems are quickly addressed. A successful product experience leads to positive word-of-mouth about the company and product and increases the likelihood of both repeat purchases and new clients as these early adopters become an important part of the marketing campaign. Product performance and reliable customer support build loyalty to the company and product, reducing the threat of competitors. Customer support is also important when financing is involved by ensuring the technology provides the return on investment as advertised, thereby improving loan payback and lowering the risk of default for a financial institution. By successfully servicing early loans, banks will be more willing to expand future lending. Customer support and training is not always offered by the company itself. Third parties can be engaged in providing training and support, including social sector organizations, donor programs, and government extension agents.

## Skills and Education for Farmers

Farmers require ongoing education to stay aware of fast-moving developments in technology, science, business management, and an array of other skills and fields that affect agricultural operations. NIFA initiatives increase farmers’ knowledge in these areas and help them adopt practices that are profitable, environmentally sound, and contribute to quality of life.

Farmers — beginning and experienced — are critical to creating rural prosperity in the United States. However, farmers face unique challenges and require education and training to ensure their success.

Training helps farmers to incorporate the latest scientific advances and technology tools into their daily operations. The results of enhancing their operations with these tools increases efficiency and can also lead to:

* Less harm to the environment
* Reduced food contamination
* Reduction of the need for water and chemicals for crops
* Increased profits

More work needs to be done to demonstrate the value of digital technologies to the farmers. We know our farmers are innovators and we want to make sure they have the skills needed to make the most out of technology . Formal learning opportunities will help address this need for future farmers. However, there is also a need to upskill those already working in the agriculture sector. This will enable a faster transition toward digital farming practices so that the full benefits of technology can be realised. Agrmaan with the local Government will develop a program to address skills gaps in agriculture, with a focus on enabling the adoption and use of digital technology. This includes linking Agrimaan’s IntelliFarms with industry to demonstrate the capability of AgTech, and with schools to promote technology-based careers in agriculture.

# Crop Information and Related Details

## Commodities

List of commodities and relevant details are given below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Item Code** | **Item Name** | **Sub Item Name** | **Other details** |
| 1 | APPLE |  |  |
| 2 | ARHAR/TUR (RED GRAM) |  |  |
| 3 | BAJRA |  |  |
| 4 | BARLEY |  |  |
| 5 | CASTOR SEED |  |  |
| 6 | CHANA WHOLE (BENGAL GRAM) |  |  |
| 7 | COTTON |  |  |
| 8 | CUMIN |  |  |
| 9 | GROUNDNUT |  |  |
| 10 | GUAR SEED |  |  |
| 11 | JOWAR |  |  |
| 12 | MAHUA FLOWER |  |  |
| 13 | MAIZE |  |  |
| 14 | MASOOR (LENTIL) WHOLE |  |  |
| 15 | MOONG WHOLE (GREEN GRAM) |  |  |
| 16 | MUSTARD SEED |  |  |
| 17 | ONION |  |  |
| 18 | PADDY |  |  |
| 19 | POTATO |  |  |
| 20 | CHILLI | CHILLI-TEJA |  |
| 20 | CHILLI | CHILLI-334 |  |
| 20 | CHILLI | CHILLI-THAALU |  |
| 20 | CHILLI | GREEN CHILLIES |  |
| 20 | CHILLI | RED CHILLI-DRY |  |
| 21 | SHELLING PEAS |  |  |
| 22 | SOYBEAN |  |  |
| 23 | SUN FLOWER SEED |  |  |
| 24 | TAMARIND (WITH SEED) |  |  |
| 25 | TOMATOES |  |  |
| 26 | TURMERIC |  |  |
| 26 | TURMERIC | TURMERIC BULB |  |
| 26 | TURMERIC | TURMERIC FINGER |  |
| 26 | TURMERIC | TURMERIC CHURA |  |
| 27 | URD WHOLE (BLACK GRAM) |  |  |
| 28 | WHEAT |  |  |
| 29 | RAJMA |  |  |
| 30 | RAGI |  |  |
| 31 | LOBIA |  |  |
| 32 | BASMATI RICE |  |  |
| 33 | KUSUM SEED |  |  |
| 34 | SESAME SEED |  |  |
| 35 | PEAR |  |  |
| 36 | ANDARIN |  |  |
| 37 | APOTA |  |  |
| 38 | USK MELON |  |  |
| 39 | 39LE GRAPES |  |  |
| 40 | LITCHI |  |  |
| 41 | POMEGRANATE |  |  |
| 42 | BANANA |  |  |
| 43 | PLUM |  |  |
| 44 | PEACH |  |  |
| 45 | MANGO |  |  |
| 46 | ORANGE |  |  |
| 47 | CUSTARD APPLE |  |  |
| 48 | WATERMELON |  |  |
| 49 | LEMON |  |  |
| 50 | BOTTLE GOURD |  |  |
| 51 | BITTER GOURD |  |  |
| 52 | CUCUMBER |  |  |
| 53 | BRINJAL |  |  |
| 54 | CABBAGE |  |  |
| 55 | CAULIFLOWER |  |  |
| 56 | CARROTS |  |  |
| 57 | SWEET POTATO |  |  |
| 61 | SPINACH (Palak saag) |  |  |
| 62 | MUSTARD LEAF (SARSO SAAG) |  |  |
| 63 | CORANDER LEAVES |  |  |
| 64 | GARLIC |  |  |
| 65 | LADY FINGER |  |  |
| 66 | GINGER |  |  |
| 67 | BEETROOT |  |  |
| 68 | RIBBED CELERY |  |  |
| 69 | AJOWAIN |  |  |
| 70 | CORIANDER WHOLE |  |  |
| 69 | JAGGERY OR GUD | JAGGERY BROWN |  |
| 69 | JAGGERY OR GUD | JAGGERY BLACK |  |
| 69 | JAGGERY OR GUD | JAGGERY GOLD |  |
| 69 | JAGGERY OR GUD | JAGGERY BROKEN |  |
| 72 | CLUSTER BEANS |  |  |
| 73 | RIDGE GOURD |  |  |
| 74 | RADISH |  |  |
| 75 | SWEET CORN |  |  |
| 76 | KINNOW |  |  |
| 77 | CAPSICUM (Green) |  |  |
| 78 | RAW MANGO |  |  |
| 79 | GUAVA |  |  |
| 80 | JACKFRUIT |  |  |
| 81 | JIMIKAND (SURAN) |  |  |
| 82 | WHITE PEAS |  |  |
| 83 | PEANUT KERNAL |  |  |
| 84 | COCONUT |  |  |
| 85 | COTTON SEED |  |  |
| 86 | PONGAM SEED |  |  |
| 87 | NIGER SEED |  |  |
| 89 | SAL SEED |  |  |
| 90 | DRIED RAW MANGO SLICES |  |  |
| 91 | RAW CASHEWNUT |  |  |
| 92 | REETHA |  |  |
| 93 | BAMBOO |  |  |

## Quality Parameters

The following table provides the list of quality parameters used for certain commodities:

|  |  |  |
| --- | --- | --- |
| **Quality Parameter Name** | **Values** | **Description** |
| Moisture | (% by wt) |  |
| Foreign matter | (% by wt) |  |
| Other edible grains | (% by wt) |  |
| Damaged grains | (% by wt) |  |
| Weevil led grains | (% by count) |  |
| Uniformity | More uniform |  |
| Uniformity | Slightly less uniform |  |
| Uniformity | Less uniform |  |
| Luster | Normal |  |
| Luster | Medium |  |
| Luster | Poor |  |

# 

# Government Entities and Other Stakeholders

## Government Entities

### National Agriculture Market (eNAM)

### Small Farmers’ Agri-Business Consortium

### Mandis

### Unified Agricultural Marketing ePlatform

### Indian Council of Agricultural Research (ICAR)

### Krishi Vigyan Kendras Agricultural extension service

### KIRAN (Knowledge Innovation Repository of Agriculture in the Northeast)

### National Agricultural Innovation Project Nurturing entrepreneurship development among the farmers

## Government Schemes

### Pradhan Mantri Krishi Sinchai Yojana

### irrigation projects under AIBP

### Irrigation Fund in NABARD

### Sustainable management of groundwater resources

### Compost

### Pits for production of organic manure (MGNREGA)

### Soil Health Card

### Organic Farming Schemes

### Parmparagat Krishi Vikas Yojana

### Organic Value Chain Development in North East Region

### Unified Agricultural Marketing ePlatform

### Pradhan Mantri Gram Sadak Yojana

### BE 2016-17 towards interest

### subvention

### Prime Minister Fasal Bima Yojana

### dairying projects

### Nakul

### Swasthya Patra

### Pashudhan Sanjivani

### E-Pashudhan Haat

### National Genomic Centre for

### indigenous breeds

## Government Digital Platforms

### Nandi Krushi

### realmilk.co.in

## Government Policies (as of 2020)

* 1. Fertilizer Policy: <http://fert.nic.in/page/fertilizer-policy>

## Research Organisations

## NGO

# Supply Chain for Agriculture

A Supply Chain is a system of organizations, people, technologies, activities, information and resources involved In moving materials, products and services all the way through the manufacturing process come up from the original supply of materials to the end customers.

Supply Chain is the global network used to deliver the products and services from raw materials to end customers through an engineered flow of information, physical distribution and cash. Supply chain management starts with procuring raw material and delivering the final product to the customer.

A Successful supply chain requires appropriate decision-making related to the flow of information products and funds. Those are categorised as:

* Strategic Decisions: Yearly (long term)
* Operational Decisions: Daily or weekly (short-term)
* Tactical Decisions: Quarterly (Mid-term)

## Effective Supply Chain Management Benefits:

* Improved customer services
* Reduction of cost across supply chain
* Efficient management of working capital
* Efficient allocation of resources
* Optimised manufacturing schedule
* Efficient management of raw materials, work-in-progress and finished goods
* Increases efficiency in transactions between supply chain partners
* Improved customer supplier relationship
* Use of RFIs can inform the supplier when stocks in retail running low
* The retail Link system created by the retailer allows supplies to access sales data and other information on their products
* Retailer can replace their bar-code technology with RFID readers to reduce their labor cost

## General Terms

|  |  |  |
| --- | --- | --- |
| **Term** | **Description** | **Example** |
| Contract | A legally binding agreement between different parties | Lease Agreement for the land |
| Procurement | Procurement is the acquisition of goods or services in the right quality and quantity, right time, the right place from the right source. Types are:   1. Direct Procurement 2. Indirect Procurement    1. MRO    2. Capital Goods |  |
| Direct Procurement | Raw material and product goods  Quantity: Large  Frequency: High  Value:Industry Specific | Sheets for car body, Car paint |
| Indirect Procurement (MRO) | Maintenance, Repair and Operating Supplies  Quantity: Less  Frequency: Relatively High  Value: Low | Lubricants, spare parts etc. |
| Indirect Procurement (Capital Goods) | Capital Goods and Services  Quantity: NA  Frequency: NA  Value: NA | Machinery, Computers etc. |
| Inventory | Types:   1. Raw Material 2. Work in Progress 3. Finished Goods |  |
| Purchase Order | [Purchase Orders](https://paramountworkplace.com/nine-benefits-of-pos/) are official documents issued to your suppliers, and when accepted form legally binding contracts. Purchase orders detail the items a purchaser agrees to purchase at a certain price point. Among other information, the purchase order also outlines the delivery date, shipping arrangements and payment terms. |  |
| Requisitions | Requisitions are internal documents. A requisition is a form that an internal department or individual submits listing items it wants to order from an outside vendor. Once these [requests are approved](https://paramountworkplace.com/approvingthespend/), the organization issues purchase orders to suppliers for the requested goods or services. |  |

## Supply Chain Value

The difference between the final product’s worth to the customers and the effort the supply chain expands in fulfilling the customer’s request will be the supply chain value.

## Supply Chain Structure

Supply Chain has a structure and this structure is determined by the life cycle of a product and it's procurement lead time. Product life cycle refers to the lifespan of a product. For example, mobile phones have a lifespan of 3 years, cars have a lifespan of 5 years and fruits have a lifespan of 2 days. Procurement lead time refers to the time taken for a product to reach it's destination from the day it is ordered. For example if an order is placed on 1st August 2019 and the expected delivery date is 20th August, the procurement lead time is 20 days. Generally a long product lifecycle means decades and long procurement lead time means months. For example, the computer industry has a short product life cycle in procurement lead time, the automobile industry has a loan product life cycle in short procurement lead time and the aircraft industry has a long time and long product life cycle.

## Supply Chain Environment

There are 4 manufacturing environments based on supply chain structure.

1. **Made-to-Stock (MTS)** is an environment where products are delivered immediately As in the case of FMCG goods.
2. **Assemble-to-Order or (ATO)** is an environment where it takes about a week to deliver products. Delivery of computers is an example..
3. **Made-To-Order (MTO)**: it takes around 4 weeks to deliver products. For example of in case of ambulances and fire brigade
4. Finally in the **Engineer-to-Order (ETU)** environment, it takes around 8 weeks to deliver products as in the case of aircrafts.

In all these manufacturing environments, the supply chain steps remain the same. The only difference is the time taken to deliver the product to end users.

## Supply Chain Strategies

Supply Chain are governed by 2 strategies as follows:

### Pull System

Pull strategy refers to organisations producing and distributing only what and when the customers want it. The business needs to maintain a buffer stock.

In many cases, raw materials are kept in stock and then produced, designed and assembled as per the customer’s requirement. Cars or computers with their customised features are examples of the Pull System.

### Push System

Push strategy refers to organisations producing and distributing only what the customer wants and when the customer wants it. The company needs to maintain a buffer stock.

The traditional approach in the supply chain is to predict and forecast demand for the product. Based on these forecasts, the product is manufactured. Finished product is then distributed and sold to customers. About 80% of the time organisations use the push strategy which is why there are so many new products in the market

## Supply Chain Activities

1. Production Scheduling
2. Sourcing and Procurement
3. Inventory Management
4. Order Processing
5. Transportation and Warehousing
6. Customer Service

## Typical Supply Chain Flow:

1. Customer wants fruits and Vegetables, He or she goes to retail outlet
2. Retail outlet has got the products from its own warehouse or from wholesaler
3. Wholesaler or retailer for the products in their warehouse from the distributor
4. Distributor got the raw material from the manufacturer
5. Manufacturer got the material from the Suppliers
6. Suppliers for the raw materials from the Farmers

Refer this: <https://www.sciencedirect.com/science/article/pii/S026087741530056X#fig1> to design the supply chain model

### 

# Supply Chain Management: Decision Making Phases

An effective Supply chain requires appropriate decision making related to flow of information, products and funds. There are primarily 3 decisions making phases in the most effective supply chain management.

## Design Phase

**Design phase involves making strategic decisions**. These decisions are made periodically and have a major impact on organisational activities and results. organisations make strategic decisions about

1. locations and capacities of production and warehousing facilities
2. products to be manufactured and stored
3. mode of transportation to be made available along with different shipping legs and
4. types of information system to be utilised
5. For example a strategic decision with respect to selection of information systems in an organisation may be whether to select SAP Oracle as the Enterprise resource planning or ERP system.

## Planning Phase

**Planning phase** involves making tactical decisions. Planning Involves making short term decisions. They have short term impact on organisational activities and results. Planning must be done on the basis of the supply chain configuration decided in the design phase. Tactical decisions should align with the strategic decisions.

In this phase organisations must consider below factors, when making tactical decisions

### uncertainty in demand

### exchange rates and

### competition

In general, the purpose of the planning phase is to predict the future Requirements to balance supply and demand. The following points are few examples of planning:

### Matching expenses with income

### Saving per month

### Prioritise what to buy and what not to buy

### Ensuring you have enough to last for the month

However, Effective planning should cover:

### Trial Launch

### Procurement

### Inventory Management

### Launch, Manufacture and Distribute product

### Controlling Losses

Questions we need to ask to make tactical decisions:

### How many products are needed?

### What are the raw materials required

### How much capital, machinery and human resources are required

### Which inventory policies should be followed?

### Should you manufacture products on your own or liaise with vendors?

### Which locations are you going to get your suppliers from?

### What should be the time and size of marketing promotions?

### Planning is an important strategic aspect of effective supply chain management. It involves capacity management and demand management.

### Capacity Management

Capacity management is the process of determining production capacity needed by an organisation to meet the changing demands for its products. It includes planning for men & Machinery. There are two terms used:

1. *Capacity Available*: is the capacity of a system or resource to produce a certain quantity of output in a given time frame
2. *Capacity Required*: is the capacity of a system or resource, needed to produce a desired output in a given time period. The sum of all required capacities is called *Load*. it is the amount of work in the system.

### Demand Management

*Demand* is the need expressed by a customer for consuming a good or a service. There are two types of demands which are:

1. **Dependent Demand**: When a product’s demand is interwoven with the demand of another product. Automobile companies producing car tires to be fitted into new cars are dependent on demand.
2. **Independent Demand**: When a product’s demand is not interwoven with the demand of another product. Spare car tire is a type of independent demand and customers can use it independently.

*Demand management* Is the process of arriving at a realistic plan to determine the quantity of products that need to be produced to meet customer needs.

There are two major activities performed under Demand Management which are *Demand Planning* and *Demand Forecasting*.

#### Demand Planning

##### Demand Planning is the process of arriving at a realistic plan to determine the quantity of products that need to be produced to meet customer’s needs. The objectives of the demand planning are grouped as:

* *Short Term Objective*: to drive the production system with minimize inventory and maximise sales and service level
* *Long term objective*: To help in strategic decision-making related to:
  + Capacity Addition
  + Preparation of budget
  + Market focusThere are primarily two distinct techniques when it comes to the demand planning:
  1. *Roll-Up or Bottom-Up (by Demand Managers)*
     1. Planning and information of planning is collated at the grass root level and gradually percolated at the top of hierarchy
     2. For example, separate plans for the model of cars in different states can be drawn up first and then aggregated to arrive at total plans for the auto manufacturer
  2. *Forced Down (By Top Management)*
     1. Planning is made at the top level and gradually percolated to the grass root level
     2. For example, the top management of the company decides to increase market share by 10%. Hence total sales required to attain this goal may be divided into different models and geographics. Accordingly, the product and territory managers will be given targets and promotional plans will be drafted and released.

#### Demand Forecasting

Demand forecasting is the prediction of demand that is likely to arrive in future based on information and experience. Forecasts should be:

* Simple and flexible
* Acceptable by everyone in the organisation
* Based on information from valid sources
* cost-effective
* Error-free

If a forecast is made for the next one year, they should match the actual results during the entire period. Forecast is considered good when the expected demand is close to the actual demand. There are two main techniques for the demand forecasting:

* Qualitative Techniques

Subjective

Enough data points are not available

Based on market intelligence expertise displayed by experts

Used for long-term forecasts

* Quantitative Techniques

Based on facts

Numerical data is involved

Enough data points are available

Used for short-term forecasts

## Operations Phase:

Operations Phase Involves making everyday, planning decisions. For example, daily scheduling of machines in the manufacturing industry is a typical operational decision. It also involves logistic planning for the movement of goods. Decisions made in the operation phase are short term and based on individual customer orders and immediate impact on business. Supply chain configuration is considered fixed as planning policies are already defined

Since the goal is to effectively handle incoming customer orders on certain information is less than the operation space In the operations phase, organisations:

* + Allocate inventory to individual orders
  + Set and order fulfilment date
  + Generate a pick list at a warehouse
  + Allocate an order to a particular shipping mode
  + Set delivery schedule of trucks
  + Place replenishment order

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# Supply Chain Management Execution Phases

## Procurement Phase

Procurement is the acquisition of goods or services in the right quality and quantity, right time, the right place from the right source. Once the product is received, the supplier gets paid.

## Procurement Cycle

Typical procurement cycle starts from requisitions and ends with payment but in order to make this process effective, we can add a few other items like Reporting, Supplier performance and others.

Requisitions -> Purchase Order -> Receiving -> Invoice -> payment -> reporting -> supplier performance -> supplier management -> Quotations -> Catalog Content Management

### Typical questions to ask like Where to buy raw materials from and How to select supplier(s)? To answer these questions, lets understand the key building blocks of the Procurement Phase:

## Sourcing

Sourcing is a strategic process of procuring goods or services from suppliers to meet identified production requirements. For example, for automobile manufacturers, the process of buying or procuring steel for the entire plant is called Sourcing. Sourcing team is also known as the Purchasing team, supply chain management team or Merchandising team. Effective sourcing requires less efforts than marketing to achieve the same profit margin.

Main purpose of Sourcing are:

* support operational requirements
* Manage procurement processes
* Select, develop and maintain source of supply
* Develop strong relationship with functional groups
* Support organisational goals objectives
* Develop integrated purchasing strategies

### Sourcing Cycle:

|  |  |  |  |
| --- | --- | --- | --- |
| **Step No** | **Sourcing Cycle** | **Key Activities** | **Key Attributes to capture** |
| 1 | Receive and analyse purchase requisition | The sourcing cycle begins when a department raises a purchase requisition, with details on what, how much and when to buy. then , the sourcing department analyzes the requisition | Requisition No, Supplier Id, Department Id, Date of Purchase Requisition, Delivery Date, Account Detail  Quantity, Description with Price, Total amount for each item and Grand Total  Requisitioned by with the signature |
| 2 | Select Supplier | Involves selection of supplier who can supply the required material |  |
| 3 | Request for quotation | Once suppliers are decided, the sourcing department floats a request for quotation or RFQ to which supplier respond with their quotes, terms and conditions |  |
| 4 | Determine price | The sourcing department then fixes the final price using various methodologies such as; strip down castings and comparative quotes |  |
| 5 | Issue Purchase Order | Once the price is finalised, the sourcing team issues a purchase order PO that lists the terms and conditions of purchase and all legal clauses | Purchase Order Sample:  Company name, PO Number, PO Date  To: company detail  Ship to: Delivery location  Item Name, Material Code, Description, Quantity, Unit Price, Required Date, Total Amount  Sub Total, VAT, Freight and Grand total  Terms & Conditions  Authorised Signature |
| 6 | Follow up for timely delivery | The sourcing team follows up on the timely delivery of the products |  |
| 7 | Receive and accept Goods | The sourcing team receives and accepts good |  |
| 8 | Approve Supplier Invoice | The team approves the supplier invoice for payment and make the payment |  |
| 9 | Monitor Supplier performance | Sourcing also monitors suppliers performance in terms of cost, timely delivery and quality |  |

### Sourcing Forms

There are two methods of executing a sourcing plan and those are:

* 1. Tactical Sourcing
     1. Includes day to day operations in any organisation
     2. Is used for low priced products ordered in bulk
     3. Does not require a long-term relationship with suppliers
     4. Is not aligned with strategic goals of an organisation
  2. Strategic Sourcing
     1. Involves analyzing the future of sourcing in an organisation
     2. is aligned with the long-term organisation goals
     3. Entails planning organizational purchases
     4. Involved managing, developing and integrating with supplier capabilities
     5. Entails shortlisting suppliers

### Sourcing Classifications

#### Direct Sourcing

Purchase of materials that are part of the final product. For example, glass required for the car window is part of the final product that is manufactured and sold by the manufacturer.

#### Indirect Sourcing

Purchase of material that assists in production, however not a part of the final product. Product required to maintain and repair the actual product. For example, Ford used to mold metal into shape for making cars.it also includes the products that are required to maintain and repair the actual product. For example, the engine oil.

## Purchasing

Purchasing refers to the portion of the procurement cycle that is actively engaged in buying a product or service from a supplier. Think of purchasing as the transactional portion of procurement. If procurement is the subject, then purchasing is the verb. Tasks that directly relate to the process of how goods and services are ordered are part of purchasing while activities such as strategic sourcing and vendor contract negotiation constitute procurement.

Purchasing is a subset of procurement where the savings can really add up:

* + 1. Save money by [organizing, consolidating and optimizing purchases](https://paramountworkplace.com/5-ways-to-save-in-the-procurement-process/).
    2. Increase visibility with [requisitions](https://paramountworkplace.com/products-requisition-procurement/mobile-catalog-shopping-approvals/) and [purchase orders](https://paramountworkplace.com/products-requisition-procurement/enterprise-purchase-order-management/) that organize, identify and track purchase requests.
    3. Boost efficiency with tools including guided buying catalogs, [mobile requisitions](https://paramountworkplace.com/products-requisition-procurement/mobile-catalog-shopping-approvals/) and [automated approval routing](https://paramountworkplace.com/products-requisition-procurement/dynamic-rule-engine-approval-workflow/).

## Manufacturing Phase

**Objective: Meet customer demands efficiently and economically**

Manufacturing refers to the product of goods by deploying available resources in the supply chain. This phase focuses on questions like

1. How are products made?
2. How to ensure products are defect-free?

High Level Understanding of Manufacturing can be described as:

* Produced as per the specifications created under the planning phase. Process of converting raw materials into a semi-finished or finished product.
* Product involves creating the product for consumer use, based on specifications decided during the planning phase.
* Raw Material might go under multiple processes to create the finished product.
* Quality testing and sampling are done to ensure the quality is met.
* Packaged for freshness and avoid contamination
* Sent for distribution

### Activities within Manufacturing Phase

Manufacturing phase encompasses

* Inventory Control and Management
* Requirement Planning
* Push and Pull systems
* Factory Flow Dynamics
* Shop floor Control
* Production Scheduling
* Aggregate Planning
* Quality Control
* Manufacturing Flexibility and
* Manufacturing Strategy

### Manufacturing Types

Manufacturing Types include

* 1. Batch Processing
     1. Different parts of a product are manufactured separately and assembled together
     2. Example is Car manufacturing
  2. Continuous Processing:
     1. Product goes through a single cycle till its completion.
     2. Example is medical drugs

### Manufacturing Planning and Control (MPC) System

MPC refers to efficient management of flow of material, human resources and machines. There are multiple levels of MPC such as:

|  |  |  |  |
| --- | --- | --- | --- |
| **MPC Level** | **MPC Work Item** | **Technique Type** | **Description** |
| 1 | Strategic business plan | Planning | This is a long term plan that states what an organisation wants to achieve in the next 2 to 10 years. |
| 2 | Production Plan | Planning | It focuses on the quantity of each product to be produced; Desired inventory levels; Resources required and their availability. |
| 3 | Master Production Schedule (MPS) | Planning | It refers to planning for production of individual end items. It is more detailed than the production plan. Various input to MPC includes the productionPlan, Forecast for individual items, Sales Order, Inventories and existing capacity. |
| 4 | Material Requirement Plan | Planning | It involved planning, purchase and production of components used in making items in MPS |
| 5 | Purchase and production activity control | execution | It ensures that the production plan is executed as planned in the first four levels of MPC. This level is an execution technique. |

### Inventory Management

Inventory refers to materials in hand such as: raw materials to be used for production or finished goods ready for sale. Inventory management is the process of deploying and moving raw materials, work-in-progress or WIP (raw materials in midst of being converted to finished goods) and finished goods through the system

#### Types of inventory

* 1. In-Transit
  2. Raw Material
  3. Work-In-Progress
  4. Finished Good

#### Importance of holding inventory

* 1. Increases responsiveness to customers
  2. Reduces risk due to uncertainties in supply demand, capacity and material value

#### Inventory related costs

* 1. Holding or carrying costs: costs of storage, cost of capital, cost of **obsolescence**
  2. Setup or order costs: cost of generating purchase order

#### Inventory: Planning Techniques

##### Always Better Control (ABC)

* + 1. This technique puts emphasis on value and importance of products
    2. Items that are classified as ‘A’
       1. High in value
       2. Require stringent inventory control
    3. Items that are classified as ‘B’:
       1. Less valuable as compared to ‘A’ items
       2. Require good inventory control
    4. Items that are classified as ‘C’
       1. Low in importance and value
       2. Require simple control measures for inventory management

##### Fast Slow Moving and Non-Moving

* + 1. This techniques classification of products based on number of units or quantity, consumption value or usage and availability of products
    2. Inventory management for
       1. Fast moving product is top priority
       2. Slow moving product is medium priority
       3. Non-moving items are least priority

#### Inventory Tracking Mechanism

##### Periodic Review

* + 1. Stocks levels are high
    2. Scope of combining multiple orders to the same supplier as one order
    3. Reduces cost related to managing inventory records

##### Continuous Review

* + 1. Stock levels are low
    2. Provides scope of obtaining quantity discounts
    3. Incases the cost related to managing inventory records

## Distribution Phase

Distribution is the process of getting the finished products for the customers. Distribution Approach is decided in this phase:

Business needs to decide whether to sell their products directly to the customer, wholesaler, retailer or different marketing channels?

Key questions are

1. How will the products be delivered to customers?
2. Who will deliver products to customers?

Retailers can purchase goods directly from manufacturers or from wholesalers. Retailers then sell products to customers. Distribution Phase encomposses:

1. Logistics
2. Warehousing
3. Selling
4. Payment

### Logistics

Logistics is the process of planning, implementation and controlling flow and storage of goods and services. It helps in movement of inventory from one point to the other. Logistics Planning and controlling flow of goods to ensure required materials available at the required time.

#### Building blocks of the Logistics:

* Inbound logistics
* Material management
* Outbound logistics
* Reverse logistics

#### Types of Logistics

* Procurement Logistics
* Product Logistics
* Distribution Logistics
* Global Logistics

#### Transportation and Modes

* Mode of transport for a product is based on the lead time.
* Factors that influence the choice of transport mode:
  1. Transportation Cost
  2. Transportation Time
* Organisations that send products from one location to another are **shippers.** They decide on the delivery time of products and transportation cost
* Organisations that help in transporting products for other organisations are **Carriers**. They decide the transport mode to be used to deliver products to the assigned destination.

### Warehousing

It is Important part of logistics and used to consolidate orders to reduce transportation costs. It helps to

* 1. Provide value-added processing
  2. Reduce response time

#### Warehousing Management System (WMS) helps to

* + - 1. Record receipt of inventory into a warehouse and register its shipment out
      2. Manage inventory of storage locations and products

#### Distribution Centre

* + - 1. Distribution Centre (DC) is a facility that stores inventory and ships finished goods and fulfilled orders to customers in a specific geographical area
      2. Types of DCs:
         1. Central DC (CDC)
         2. Regional DC (RDC)
         3. Local DC (LDC)

#### Third Party Logistics (3PL)

* + - 1. Third Party Logistics (3PL) is a firm that supplies and coordinates logistics across multiple links in logistics supply chain
      2. 3PL helps manufacturers to:
         1. Focus on their core strength
         2. Avoid investing on resources, vehicles, storage systems
         3. Manage logistics effectively

## Selling Phase

The cycle of events ends with the sale of finished products to the final customer. Everything is usually followed by the payment

### Marketing

The marketing concept is a business philosophy, guiding a firm toward customer satisfaction at a profit. Marketing is the process of meeting customer needs effectively, so companies that provide customers with the right product at the right price can increase market share. In a competitive marketplace, companies must also get other elements of their marketing, such as **advertising**, **distribution** and **sales**, right to stay ahead of competitors. According to the Harvard Business Review, a company with a high market share is a tempting target for actual and potential competitors. The drive to improve and sustain market share is therefore an incentive to improve marketing efficiency and effectiveness.

Marketing can design programs to help partners grow their own business and make it easier for members of the supply chain to work together. Marketing can help distribution partners benefit directly from the strength of a company brand. The brand differentiates a company from the competition when it communicates with potential customers. Marketing also can support resellers by driving business in their direction. This can be as simple as generating leads or running joint marketing campaigns. Reward programs encourage distribution partners to do more business with a company, while incentive programs can increase revenue for both parties.

Marketing provides an essential balance in supply chain management. It helps companies and their partners become more focused on customers rather than on the production process. By improving communications, support and collaboration, marketing helps increase supply chain efficiency and create a single extended enterprise with a strong competitive edge.

Given the role of marketing in the implementation of supply chain management, suggested by a cause-and-effect relationship between the marketing concept, a market orientation, relationship marketing, and SCM, Min (2000a) concluded:

The objective of marketing is creating exchanges, and the output of it is customer satisfaction.

The marketing concept consists of three pillars:

1. customer focus,
2. coordinated marketing, and
3. profitability.

#### Market Orientation

A market orientation is the implementation of that philosophy, forcing the firm to generate, disseminate, and respond to market information.

A market orientation also affects the management of a firm, interfirm relationships, and a supply chain. That is, a market orientation leads a firm to focus on market information generation, dissemination, and responsiveness to satisfy customers, coordinate its marketing efforts, redefine the responsibilities of each function, restructure its organizational system, and achieve superior business performance. At the same time, a market orientation provides an environment that encourages a firm in its efforts to develop, maintain, and enhance close relationships with other firms, organizational learning from other firms, and building commitment, trust, and cooperative norms in the relationships with other firms.

A market orientation is performed both inside and outside a firm to recognize and respond to customers’ needs, and obtain experiences, products, skills, technologies, and knowledge from outside the firm that are not available to other competitors.

A market orientation promotes the implementation of SCM. • Relationship marketing aims at establishing, maintaining, and enhancing either dyadic relationships or multiple relationships in a supply chain to create better customer value.

#### Relationship marketing

Relationship marketing helps achieve such objectives of SCM as efficiency (i.e., cost reduction) and effectiveness (i.e., customer service) through increased cooperation in close long-term interfirm relationships among the supply chain partners.

#### Impact of Marketing to Supply Chain Management

With the help of the marketing concept, a market orientation, and relationship marketing, SCM achieves competitive advantage for the supply chain and its partners by reducing costs and investments, and improving customer service.

A company with high market share can create barriers to entry, making it difficult for competitors to build their own share. A competitor would have to make a major investment in marketing to overcome the barrier, giving the market leader a strong advantage. Although high market share is a benefit to the market leader, it may also attract the attention of regulators concerned about lack of choice for customers. The company runs the risk of facing antitrust legislation.

A company with a large customer base can sustain its market position by developing new products that continue to meet its customers’ requirements. Companies in the information technology sector refer to their customer base as an installed base. Companies can then offer upgrades to customers who have existing products installed. The cost of switching and retraining employees in a new product means that customers are usually reluctant to move to a new supplier, according to the Massachusetts Institute of Technology.

## Payment Phase

Every purchase is followed by a payment. Payment can be cash, debit or even special vouchers or coupons. Payment for distributors or manufacturers is complex

### Finance

The financial implications of supply chain decisions, trends in supply chain costs, a financial model for evaluating investments, and concerns for financial and supply chain management are few drivers to implement the effective Financial Management process.

The potential benefits of improved supply chain management are stymied by the absence of activity-based financial data and the inability to link performance measurement with cost. Traditional accounting techniques do not provide accurate and timely information that informs the financial aspects of supply chain trade-off decisions.

Supply chain activities affect profit and loss statements, balance sheets, and the costs of capital. By controlling supply chain expenses, profit margins are improved. By continuing to shorten cycle times, cash flows are enhanced.

Significant opportunities exist for the competent supply chain manager to reduce expenses, generate better returns on invested capital, and improve cash flows. Superior supply chain performance can also produce the leverage and competitive advantage to increase revenues and the supply chain’s share of the market.

Capitalizing on these opportunities requires the ability to plan for and measure supply chain performance and to effectively communicate performance implications in financial terms. The supply chain manager’s ability to articulate the financial implications of exchanges between firms will continue to increase in importance.

Activity-based costing is not widely employed. Improved collaboration between finance and other business and supply chain functions is necessary to facilitate the process to develop Activity Based Costing. This collaboration should help to overcome the seemingly widespread inability of supply chain managers to articulate the costs and benefits of supply chain activities.

## Return Phase

Few questions:

1. How are products deployed, traced and tracked?
2. How is customer satisfaction monitored?

### Customer Service

Customer service is often cited as a key objective of supply chain management. However, only if service offerings create value for customers will they lead to behaviors that improve supply chain performance. To achieve this objective, it is important for supply chain managers to manage customer service strategically and develop supply chain capabilities to deliver services viewed as important by critical downstream customers.

To achieve supply chain objectives, customer service activities must be strategic in nature and must be designed based on an understanding of the service levels important to critical customers. The impact of service levels on customers should be understood and internal capabilities designed to deliver service levels that optimize the overall performance of the supply chain. The quality of the customer interface is likely to influence the level of trust and openness of information exchange between firms, which can contribute to a better understanding of the customer’s needs and improved performance of supply chain management activities.

It is important to measure customer service outcomes as perceived by the customer and understand which performance outcomes are most valued by customers at various levels of the supply chain. Customer service requirements and performance, as well as the influence of customer service levels on customer behavior, should be understood and monitored for both immediate and downstream customers in a supply chain.

Customer service is not the ultimate objective of supply chain management but rather an outcome of supply chain management that can create value for customers through improved efficiency or effectiveness. Creating value for customers superior to that created by competition is expected to result in greater customer satisfaction and competitive advantage and influence customers to behave in ways that improve the performance of the supply chain as a whole.

### Performance Measurement

Capitalizing on the opportunities to plan and measure key supply chain processes improves both single-firm performance and supply chain outcomes. Supply chain performance measurement is in its infancy but will increase in importance.

Supply chain activities are not adequately defined, measured, or improved and the research is largely single-firm focused, emphasizing internal efficiency over external effectiveness. There is an absence of multifirm performance measurement, or measures across the supply chain. Interdependent planning and governance structures do not appear to exist across firms. Supply chain members still appear to act largely as independent supply chain members, focused on self-interest.

Activity Based Costing, a critical performance measurement capability, is not widely employed. Potential benefits of improved supply chain management are stymied by the absence of activity-based financial data and the inability to link performance measurement with cost.

## Research & Development Phase

* Supply chain activities have a major impact on the capabilities and profitability of the supply chain and its member firms in new product development.
* Innovative and effective new-product development is important in the turbulent, highly uncertain business environment of the future.
* By collaborating with immediate customers and suppliers, R&D can significantly improve the new-product development process.
* By collaborating with customers’ customers and suppliers’ suppliers of the supply chain, R&D improves the new-product development process.
* Companies that are multinational in scope can benefit through globalization of the R&D process and collaborating with global supply chain partners.
* The concept of postponement, delaying final product configuration as close to the end consumer as possible, benefits greatly from collaborating R&D with supply chain partners.
* Speed to market or reducing the cycle time to develop new products can be improved significantly through supply chain R&D involvement.
* Flexible new-product development enables companies to incorporate rapidly changing customer requirements and evolving technologies through supply chain R&D involvement.

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# Technology Use for Farming

## Sensor Technologies

Remote sensors can be deployed on farms to collect data on variables such as temperature, rainfall, humidity, wind speed, livestock tracking, and plant and animal health. This information can be relayed to farmers, to save time and cost from manual monitoring, provide greater insight into farm performance and improve farm decision making.

## IOT (Internet of Things) use in Precision Farming

Also known as precision agriculture, precision farming can be thought of as anything that makes farming practice more controlled and accurate when it comes to raising livestock and growing crops. In this approach of farm management, a key component is the use of IT and various items like sensors, control systems, robotics, autonomous vehicles, automated hardware, variable rate technology, and so on.

The adoption of access to high-speed internet, mobile devices, and reliable, low-cost satellites (for imagery and positioning) by the manufacturer are a few key technologies characterizing the precision agriculture trend.

Precision agriculture is one of the most famous applications of IoT in the agricultural sector and numerous organizations are leveraging this technique around the world. CropMetrics is a precision agriculture organization focused on ultra-modern agronomic solutions while specializing in the management of precision irrigation.

The products and services of CropMetrics include VRI optimization, soil moisture probes, virtual optimizer PRO, and so on. VRI (Variable Rate Irrigation) optimization maximizes profitability on irrigated crop fields with topography or soil variability, improve yields, and increases water use efficiency.

The soil moisture probe technology provides complete in-season local agronomy support, and recommendations to optimize water use efficiency. The virtual optimizer PRO combines various technologies for water management into one central, cloud-based, and powerful location designed for consultants and growers to take advantage of the benefits in precision irrigation via a simplified interface.

## Agricultural Drones

Technology has changed over time and agricultural drones are a very good example of this. Today, agriculture is one of the major industries to incorporate drones. Drones are being used in agriculture in order to enhance various agricultural practices. The ways ground-based and aerial-based drones are being used in agriculture are crop health assessment, irrigation, crop monitoring, crop spraying, planting, and soil and field analysis.

The major benefits of using drones include crop health imaging, integrated GIS mapping, ease of use, saves time, and the potential to increase yields. With strategy and planning based on real-time data collection and processing, drone technology will give a high-tech makeover to the agriculture industry.

**PrecisionHawk** is an organization that uses drones for gathering valuable data via a series of sensors that are used for imaging, mapping, and surveying of agricultural land. These drones perform in-flight monitoring and observations. The farmers enter the details of what field to survey and select an altitude or ground resolution.

From the drone data, we can draw insights regarding plant health indices, plant counting and yield prediction, plant height measurement, canopy cover mapping, field water ponding mapping, scouting reports, stockpile measuring, chlorophyll measurement, nitrogen content in wheat, drainage mapping, weed pressure mapping, and so on.

The drone collects multispectral, thermal, and visual imagery during the flight and then lands in the same location it took off.

## Livestock Monitoring

Large farm owners can utilize wireless IoT applications to collect data regarding the location, well-being, and health of their cattle. This information helps them in identifying animals that are sick so they can be separated from the herd, thereby preventing the spread of disease. It also lowers labor costs as ranchers can locate their cattle with the help of IoT based sensors.

JMB North America is an organization that offers cow monitoring solutions to cattle producers. One of the solutions helps the cattle owners observe cows that are pregnant and about to give birth. From the heifer, a sensor powered by a battery is expelled when its water breaks. This sends information to the herd manager or the rancher. In the time that is spent with heifers that are giving birth, the sensor enables farmers to be more focused.

## Smart Greenhouses

Greenhouse farming is a methodology that helps in enhancing the yield of vegetables, fruits, crops, etc. Greenhouses control the environmental parameters through manual intervention or a proportional control mechanism. As manual intervention results in production loss, energy loss, and labor costs, these methods are less effective. A smart greenhouse can be designed with the help of IoT; this design intelligently monitors as well as controls the climate, eliminating the need for manual intervention.

For controlling the environment in a smart greenhouse, different sensors that measure the environmental parameters according to the plant requirement are used. We can create a cloud server for remotely accessing the system when it is connected using IoT.

## Robotics

Robotics are being introduced to the dairy, poultry and other farming industries. Applications include autonomous feeding and milking, egg collection and sorting, and autonomous cleaning. These technologies are reducing costs while helping early detection and treatment of animal health issues.

Less waste and higher yields are being generated by equipment programmed for variable seeding rates and depths based on soil property and moisture data, derived from satellite imagery. Digital infra-red light and heat sensors combined with drones are used to measure paddock crop health to inform decisions about irrigation, pest management, fertiliser applications and harvesting.

Integrated digital animal health sensors and electronic identification devices enable farmers to rapidly respond to animal stress or disease, increasing livestock production and improving livestock health.

## Nanotechnology

Nanotechnology entails the exploration and engineering of matter at the atomic and molecular level. At one-billionth of a meter, one [nanometer](https://nifa.usda.gov/glossary#N) is about how long a fingernail grows each second. A typical germ is about 1,000 nanometers in size. Conducting research at this level allows scientists to measure, control, and manipulate matter to change an object’s properties and functions.

### Importance of Nanotechnology

Scientists anticipate that research in nanotechnology will lead to an unprecedented understanding of matter’s fundamental building blocks, resulting in unlimited applications. These capabilities are expected to produce technological advances in a range of fields that affect agriculture, including food safety, processing, and product development. Applications underway include development of:

* Safer food packaging
* Reliable and cost effective alternatives to commercially available insecticides
* Devices to detect disease-causing proteins in cattle
* Methods for producing healthier chickens for human consumption

## Biotechnology

Agricultural [biotechnology](https://nifa.usda.gov/glossary#B) uses biological processes to develop technologies and products that address farming challenges. In the face of a rising world population, the agricultural industry is seeking solutions for how to produce enough food to feed more people. More than 17 million farmers around the world have turned to biotechnology to increase crop production, prevent pest damage, and reduce the impact of farming on the environment.

### Importance of Biotechnology

Advances in biotechnology have opened up new options for farmers responding to market needs and environmental challenges. Products and technologies created through biotechnology benefit consumers in a range of areas, such as:

* Improved nutritional value in foods
* Lower food costs
* Reduced pesticide use
* Less reliance on petroleum

## Bioenergy

One means of addressing global economic, social, and environmental challenges lies in creating a thriving [bioeconomy](https://nifa.usda.gov/glossary#B), a marketplace based on renewable [biomass](https://nifa.usda.gov/glossary#B), [bioenergy](https://nifa.usda.gov/glossary#B), and sustainable agricultural crops. Bioenergy encompasses all forms of renewable energy derived from biological sources, such as biomass (raw materials) from woody biomass, grasses, corn, soybeans, forest and agricultural residues. Biobased products, such as biodegradable plastics, may also be made from biomass.

### Importance of Bioenergy

Non-renewable energy sources are limited and, as demand grows, continue to contribute significantly to changes in our climate. The production of bioenergy and biobased products is valuable to the nation’s ability to create new jobs and promote rural prosperity. This sort of bioeconomy reduces our dependence on non-renewable energy. India can be a world leader in the production of bioenergy and biobased products that:

* Are economical to manufacture
* Create new economic opportunities
* Promote the sustainability of our natural resources

To achieve a sustainable bioeconomy, it is crucial that biomass production remain sustainable in three major ways:

* Economically
* Socially
* Environmentally

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# Business Strategy: Agrimaan™ Innovation Hub

## Research and Development (R&D)

IntelliForms form part of Agrimaan’s ‘innovation ecosystem,’ which delivers science and technology innovations through a ‘hub and spokes’ model. The ‘hub’ is the AgriBio Centre which delivers core capability, knowledge and innovation infrastructure in the plant, animal, and microbial systems biology, as well as ‘big data’ capability. State-of-the-art InteliForms create, test, and prove smart technology solutions for agriculture, in partnership with industry, at selected sites. IntelliForms provides a forum to understand on-farm technology integration and find new applications for AgTech. Testing the impacts of these solutions in a farm environment allows for a better understanding of the return on investment for AgTech solutions. IntelliForms also provides regional benefits by attracting AgTech businesses and the world’s best science across Victoria’s agriculture regions. A virtual IntelliForms will connect and display technology across the innovation ecosystem, enabling lessons to be quickly shared between industries.

## Startup Support

### Supporting Agritech entrepreneurs

Agrimaan startups are critical to innovation in agriculture. Startups can deliver new and creative ways of solving problems and improving farm performance. To support the Agrimaan startup ecosystem, Agrimaan will work with government agencies to keep the fund which provides support to AgriTech startups, including capital funding, pre-accelerator and accelerator programs.

### On-Form IoT Solution Adoption

Agrimaan will partner with the local government to deliver IoT network connectivity in each of the selected location(s) and will partner with participating farmers to select IoT solutions for trial. The trial will break down barriers such as lack of connectivity, digital literacy and capital to invest. The impact of IoT on farm performance will also be measured and will provide the agriculture sector with a clear rationale for investment in on-farm IoT. How will the trial work?

* IoT network deployment in selected location (s)
* Testing the AgTech market to discover on-farm IoT solutions for each of the four trial farm types.
* Agrimaan will partner with participating farmers to complete a digital farm plan and select IoT solutions to trial.
* Agrimaan will assess the impact that the IoT solution has on farm performance and profitability, and publish its findings.

## Empowering the Digital Government

The objective is to help the government use technology to streamline their processes and leadership in data management. Government also has a role to play in adopting digital technologies. As part of the On-farm IoT trial, Agriculture Victoria will look to make its agricultural data more readily accessible to researchers and other parties to spur innovation in the sector. Regulatory frameworks need to keep track with innovative farm businesses and processes. Government will actively work with industry and regulators to achieve this. We will also explore opportunities for regulators to use digital technologies to improve regulatory outcomes and reduce red tape for industry.

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# Business Strategy: Form Management Capabilities

Farm management, [making](https://www.britannica.com/technology/industrial-engineering) and [implementing](https://www.merriam-webster.com/dictionary/implementing) of the [decisions](https://www.britannica.com/topic/agribusiness) involved in organizing and operating a farm for maximum production and profit. Farm management draws on [agricultural economics](https://www.britannica.com/topic/agricultural-economics) for information on prices, markets, agricultural policy, and economic institutions such as leasing and credit. It also draws on plant and animal sciences for information on soils, seed, and fertilizer, on control of weeds, insects, and disease, and on rations and breeding; on agricultural engineering for information on farm buildings, machinery, irrigation, crop drying, drainage, and erosion control systems; and on psychology and sociology for information on [human behaviour](https://www.britannica.com/topic/human-behavior). In making his decisions, a farm manager thus [integrates](https://www.merriam-webster.com/dictionary/integrates) information from the biological, physical, and social sciences.

## Purchasing Capabilities

### Fertilizer Purchase

### Seed Purchase

### Crop chemicals Purchase

### Petroleum products Purchase

### Machinery Purchase and Leasing

### Repair Services

## Financial Management

### Finance Statements

### Profit and Loss Statements

Comparison of profit and loss statements over a period of years tells which resources have been most profitable and whether there has been an advance or decline in [net income](https://www.britannica.com/topic/profit).

### Cash-Flow Statements

A cash-flow statement shows the sources and uses of funds at given periods during the year. Such a statement provides a useful check on the accuracy of the farm’s other business records.

## Crop Production and Management

### Crop Scouting Management

Crop scouting is the process of precisely assessing pest pressure (typically insects) and crop performance to evaluate economic risk from pest infestations and disease, as well as to determine the potential effectiveness of pest and disease control interventions.

Efficiently capture information on crop health, insects, diseases and crop damage. Assess crop issues across all of your fields. Analyze scouting data to create timely and informed recommendations.

* Synchronize data to growers or other agronomists
* Collect in-field observation photos
* Scout by point or polygon
* Share recommendations
* Record field activities
* Enrol fields to receive in-season imagery for guided crop scouting and recommendation creation

### Crop disease Forecasting

AgrimaanTM will tie up with the Plant Pathology Services to provide critical disease diagnostics services for horticulture (ornamentals, nursery plants, amenity horticulture, turf, soil, fruits and vegetables), broadacre crops (cereals, canola and pulses) and pastures.

* routine plant disease diagnosis in plants, potting mix, soil and water
* nematode analysis of roots and soils for horticulture and broadacre crops
* plant virus identification
* specific disease testing for seed crops to meet export requirements
* plant pathogen testing to fulfil nursery accreditation and export requirements

### Precision Agriculture Management

This capability will have the following set of features:

* Scout crops for pest pressures and easily record and collect observation photos
* Create and share recommendation from the field
* Generate PDF reports and share via email or text
* Soil sample using a grid, zones, or previous soil sampling points
* View fertilizer and nutrient recommendations
* Send recommendations wirelessly using Raven Slingshot®
* Export data as a shapefile
* Receive rainfall estimates updated to the hour for each field
* Drive or draw new field boundaries
* Store and share data securely via the Agrimaan™ Platform

### Crop Insurance Support

Presently the following insurance products are offered by AIC.

* [Pradhan Mantri Fasal Bima Yojana ​](http://www.aicofindia.com/AICEng/Pages/PMFBY-OPERATIONAL-GUIDELINES.aspx)
* [Weather based Crop Insurance Scheme (WBCIS)](http://www.aicofindia.com/AICEng/Pages/Restructured_WBCIS.aspx)
* [Coconut Palm Insurance Scheme (CPIS)](http://www.aicofindia.com/AICEng/General_Documents/Product_Profiles/CPIS/CPIS.pdf)
* [Rainfall Insurance Scheme For Coffee (RISC)](http://www.aicofindia.com/AICEng/General_Documents/Product_Profiles/COFFEE-RISC-ENG.pdf)
* [Rubber Plantation Insurance](http://www.aicofindia.com/AICEng/General_Documents/Product_Profiles/RUBBER%20PLANTATION-ENG.pdf)
* [Bio - Fuel Tree / Plant Insurance](http://www.aicofindia.com/AICEng/General_Documents/Product_Profiles/BIO-FUEL-ENG.pdf)
* [Potato Crop Insurance](http://www.aicofindia.com/AICEng/General_Documents/Product_Profiles/POTATO-ENG.pdf)
* [Pulp Wood Tree Insurance Policy](http://www.aicofindia.com/AICEng/General_Documents/Product_Profiles/PULPWOOD%20TREE-ENG.pdf)
* [Varsha Bima / RainFall Insurance](http://www.aicofindia.com/AICEng/General_Documents/Product_Profiles/VARSHA-RAINFALL-ENG.pdf)
* [National Agricultural Insurance Scheme](http://www.aicofindia.com/AICEng/Pages/Present_NAIS_Features.aspx)

## Precision to Decision Agriculture

### Smart Management Decisions

Agrimaan™ SDM helps turn agronomic data into smart management decisions. With Agrimaan™ SDM data management features, you can create agronomic efficiencies in your program using the flexible record keeping all in one location.

It is the secure, easy way to organize, synchronize and standardize your precision agricultural data so you don’t have to second guess what was done in the past.

Use Summit Professional with FarmRite to optimize decisions and provide quick and easy service for growers to achieve cropping system goals. Synchronize data with colleagues and other agX® compliant applications.

Key Features:

* Access/share data
* Record keeping
* Reporting
* Variable-rate prescriptions
* Export to controllers

### Advanced Statistical Analysis and Information Processing (ASAIP)

With automation, Agrimaan ASAIP allows you to process more acres and produce cutting-edge information reports while increasing employee efficiency.

Agrimaan ASAIP provides advanced statistical analysis and processes information within minutes to determine inputs, performance and summarize critical information. You can customize and define agronomic equations and brand customisable reports. Used in conjunction with Summit Professional, FarmRite is the ideal solution for those who want to offer consistent decision-support products across their business with the flexibility demanded by growers.

Key features:

* 1. Fertilizer recommendations
  2. Variable-rate seeding (VRS) recommendations
  3. Multi-year yield analysis
  4. Automated data processing
  5. Branded reporting

### Geospatial Infrastructure for Integrated Precision (GIIP)

Agrimaan™ GIIP is a Platform as a Service (PaaS) for the agricultural industry that provides the necessary geospatial infrastructure for a community of integrated precision ag products and services.

Users with Agrimaan GIIP accounts are able to access Agrimaan GIIP compliant applications and share data with other Agrimaan GIIP Connections. AGIIP supports the features such as:

* **Standardization:** In order for multiple applications to collect and share data on a consistent basis, all data must be collected in a standardized format. This standardization includes reference data as well as spatial records, such as field boundaries.
* **Synchronization:** Synchronization with a central data repository ensures that all data collected is in adherence to Agrimaan GIIP standards and is available for sharing among Agrimaan GIIP compliant applications in a seamless manner.
* **Automation:** Once standardization and synchronization are in place, repetitive human interaction for processing data may be replaced with automated processing of pre-defined tasks.
* **Communication:** Seamless communication is necessary between all users who have an interest in a particular field. This communication is safeguarded by data-specific permission settings.

## Soil Management

### Soil Fertility Management

### Soil Moisture Measurement

### Soil Monitoring

### Soil Sampling

### Soil structure monitoring

Monitoring is an essential part of 'best practice' farm management to assess where you are currently (eg for benchmarking) and also to help you improve your performance. Monitoring can be done as part of a formalised Environmental Management System (EMS) or as a stand-alone part of overall farm management.

### Plant Nutrition Management

### Pest Management

* Coordinating IPM efforts through regional IPM centres
* Promoting reduced-risk pest management
* Identifying appropriate and safe use of pesticides
* Detecting and researching new and persistent pests
* Developing alternative pest management strategies
* Involving social considerations into management systems
* Advancing detection, surveillance, rapid response, and recovery into pest management networks

## Fertilizers Management

### Fertilizer Purchase by Farmers

### Fertilizer Demand Forecasting

### Fertilizer Fitness Assessment

### Fertiliser Monitoring

### Company Information Capture for Fertilizer Production

### Fertilizer Sale to Wholesaler Information Capture

### Fertilizer Sale to Retailer Information Capture

### Nutrition Wise Fertilizer Analysis

## Digital Agriculture

Digital Agriculture services provide rural data and analytics services to better predict and manage agriculture investment and commerce. Agriman™ Intelligence Platform offers complete coverage of Australian rural property, with scientifically supported, ground-truthed data and insights. Additional geographic coverage to come.

This is the heart of Agrimaan™ platform. It uses Machine Learning, Artificial Intelligence and Neural Networking.

### Connectivity

Appropriate connectivity is fundamental to digital agriculture with digitised farms needing widespread and reliable coverage.

### Digital Literacy

* + Many farmers have not had opportunities for practical learning and exposure to technology to identify the right technology options for their farm, or how to reliably use it.

### Cost and Investment Rationale

* + The value of digital agriculture has not been proven to farmers. Demonstration of return on investment is needed to boost adoption rates.

### Data Sharing

* + There is a lack of confidence in data privacy and security among farmers. Agreed data sharing protocols and governance arrangements are required to encourage the sharing of data across the value chain.

### Interoperability of Data Sets

* It is currently difficult for farmers to analyse data generated from multiple technologies. The ability to incorporate diverse datasets into a shared platform would allow farmers to gain greater insights and benefits from digital technologies.

### Digital Agriculture Services (DAS) Offering by Agrimaan™

* Potential Services
  + Rural Data
  + Global Insights
  + Models
* Potential Saas (Software as a service) based functionalities
  + Farmer Insight Hub
  + Rural Property Hub
  + Rural Valuations Hub
  + Climate Risk Hub
  + Commodity Hub
  + Rural Insurance Hub
* Potential Data Products
  + Rural AVM
  + CropID
  + Farm Productivity
  + Yield Forecasting
  + Yield Monitoring

#### Data Sources for Agrimaan™ DAS

DAS data comes from myriad sources including:

* + **Trusted Government Sources:** 
    - We harmonise, unify and continually refresh public data sources into a cohesive national data set.
    - Our sources included trusted public State and Federal government data, Bureau of Meteorology (BOM), Geoscience India, the Australian Bureau of Agriculture and Research Economics and Science (ABARES), PSMA and others. We also integrate the latest Valuer-General (VG) sales data, along with VG property data going back 12 years.
  + Unique Proprietary DAS Data:
    - We add and integrate new data in the form of unique, proprietary geo-referenced data layers using public satellite imagery and extensive agricultural ground truth.
    - These data layers include specific land and climate characteristics such as fire risk, drought stress, soil, land use, carrying capacity, slope and more for every farm in Australia.
    - We build in key agricultural and climate data, both historical and current, involving pasture and crop productivity metrics, topology, long-term rainfall deficit and most recently, Graincast metrics for forecast yields and crop identification.
    - Our integrated data sets include productivity scores – using earth observation, remote sensing, modeling, plant physiology and industry knowledge to measure the productivity of every farm and paddock in Australia every 17 days, going back 17 years.
    - DAS is continually integrating new proprietary data layers to enhance the value of its platform.
  + CSIRO Data:
    - Our data feed from CSIRO includes rainfall deficit at a farm level, flood risk, frost risk and much more.
    - Our remote sensing satellite and time series feed includes data from the present going back anywhere from 15 to 20 years.
    - Specific satellite sources include Landsat, MODIS, SAR and Sentinel 1 and 2. We also access Australia’s petascale Earth Observation Data Cube, as well as the Digiscape Future Science or Senaps Land software, APSIM and others.
    - Part of what makes the Rural Intelligence Platform™ so unique is it incorporates, integrates and applies the deep knowledge and domain expertise of CSIRO’s leading agricultural0……...2, water, climate and land scientists.

### Virtual Reality Farming Experience

Using Virtual Reality we beam people onto agricultural properties to help educate people where their food comes from and inspires them to consider a career in Agriculture. There are over 100 experiences covering a broad range of farming. The technology can be used for marketing, training, education, inductions, farm safety, OHS, asset management etc. Following features can be implemented:

* Helps educate people where their food comes from
* Inspires people to consider a career in Agriculture
* Used for marketing, training, education, inductions, farm safety, OHS, asset management etc
* We can integrate with <https://farmtable.com.au/accelerate-software/farmvr/>

## Agriculture Waste Management

### Compost Process Simulation

### Compost Production from Agriculture Waste

### Bio based Solution with Agricultural Waste

### Compost Selling

# 

# Business Strategy: Former or Grower Capabilities

## Farmer or Grower Management

### Farmer Profiling

### Farmer’s Land Information Capture

### Farmer’s Healthcheck

### Farmer Insights

## Farmer Organization (FO) Management

### Farmer Organization (FO) Profiling

# Business Strategy: Procurement Capabilities

## Sourcing Management

### Procurement Process Management

### Operational Process Management

### Supplier Management

### Quotation Management

### Price Decisioning

### Purchase Order Management

### Product Delivery Tracking

### Good Receipt and Acceptance

### Supplier Invoice Approval

### Supplier Performance Monitoring

## Purchase Management

### Purchase Optimisation

### Requisition to Purchase Order Tracking

### Guided Buying Catalog

### Mobile Requisitions

### Automated Approval Routing

# Business Strategy: Manufacturing Capabilities

## Manufacturing Planning and Control

### Strategic Business Planning

### Batch Processing

### Cox

### Production Planning

### Master Production Scheduling

### Material Requirement Planning

### Purchase and Production Activity Control

## Inventory Control and Management

### Inventory Planning

### Inventory Tracking

### Inventory Costing

### Raw Material to Work in Progress to Finished Good to In-Transit Tracking

## Packaging

### Requirement Planning

### Inventory Control and Management

### Packaging

## Production Handling

### Production Scheduling

# 

# Business Strategy: Distribution Capabilities

## Logistics Management

### Inbound Logistics Management

### Material Management

### Outbound Logistics Management

### Reverse Logistics Management

## Warehousing Management

### Distribution Centre Management

### Third Party Logistics Management

### 

## Selling Management

### Relationship Marketing Management

### Agriculture Product Sale for Wholesale

### Agriculture Product Sale for Retailers

### Agriculture Product Sale for End Customers

### Online Advertising

## Payment Management

### Activity Based Financial Data Management

### Linking Performance Measurement with Cost

### Finance Statements

### Profit and Loss Statements

Comparison of profit and loss statements over a period of years tells which resources have been most profitable and whether there has been an advance or decline in [net income](https://www.britannica.com/topic/profit).

### Cash-Flow Statements

A cash-flow statement shows the sources and uses of funds at given periods during the year. Such a statement provides a useful check on the accuracy of the farm’s other business records.

# 

# Business Strategy: Customer Service Capabilities

## Customer Service Management

### TBD

### TBD

### TBD

## Performance Measurement

### TBD

### TBD

## Customer Returns

### TBD

# 

# Business Strategy: Government Capabilities

## Farmers Help

### Kisan Knowledge Management System

### National Agricultural Marketing Portal

### Price Trend of Commodities

### Farmer's Storage

### Check statistical and analytical reports on agriculture commodity prices

## Soil Information

### Fertilizer Dosage for Crops

### Locate soil testing laboratory

### SMS Portal for Farmers

### Soil Health

## Insurance Information

### Pradhan Mantri Fasal Bima Yojana

## Seed and other Materials for Farmers

### Seed Dealer

## 

# Resources

# Course of Action

# 

# Motivation

# 

# Stakeholders

# 

# Locations

# 

# Assessments

# 

# Constraints

# Drivers

# Goals

# Principles

# Requirements

# Outcomes

## Agrimaan’s Value Proposition

The following value proposition canvas can be used:

* Optimisation of Inputs: Fertiliser, Seed, Fule
* Maximisation of output: Increase of yields
* Increase of Asset Utilisation: Machinery, animals, field usage
* Fact based decision making: Replacement, Investment, Changes, Labour
* Reduction of Admin Work:
* Reduction of Theft (fuel, fertilise, machine usage)
* Integrated Solution of all stakeholders
* Environment: Green Values: proof of purity, food traceability including substance used

In addition to the above value proposition, following business areas will be covered by AGRIMAAN:

|  |  |  |
| --- | --- | --- |
| Business Area | Pain Area | AGRIMAAN Solution |
| Organic Farming | Reporting & Inspection of Organic Farming | Farming data recording, Automatic record creation: material and financial flow |
| Traceability | From the seed (INVOICE REC., STOCKS) via field (CYCLES, FERT.PLAN) to the table (INOVICE ISS., STOCKS) |
| Cost control | Own Price Controlling: Cost Centres/ Analysis |

## AGRIMAAN’s Professional Services

AGRIMAAN boast specialised teams of experts that provide the following services:-

* Conduct Feasibility studies and landscaping research on new proposed farming projects
* Develop incubator programmes to monitor integrated growth of producers in becoming commercial enterprises
* Design marketing strategy to secure contracts for producers locally and in export markets
* Negotiate a package of inputs for the producers with banks, including insurances, provision of seeds, farming equipment and infrastructure
* Enter into separate contracts with individual producers based on the assessed need and set quality standards, production quotas; provide modern technology to monitor production, agree on prices and mark-ups with producers
* Forge partnership with suppliers of all farming inputs including tractors, manures and feeds in order to negotiate the best prices for our group of producers
* Assist cooperatives set up Agroprocessing Operations where all primary produce are processed to specification of the market in energy, food and textile sectors
* Attract Agro Processing companies to establish their processing plants in the Red Meat Industrial Hub and buy equity in the operations

### Agrimaan Investment Platform

This is a very innovative way to share equity among investors and farmers to provide a seamless succession solution which will be a win-win outcome for both retiring farmers and the next generation of farming families. Cultivate Farms will assist in helping the [retiring farmers](https://www.cultivatefarms.com/retiringfarmer/) to retain partial ownership, secure the best next generation farmer, ensure the farming operation is viable and provide ongoing business governance mentoring support to the farming enterprise to ensure the farm and the regional community thrives. The benefits to invest in this model are:

|  |  |
| --- | --- |
| **Benefit Point** | **Detailed Explanation** |
| Building equity for NextGen farmer | The incoming NextGen farmer is encouraged to acquire some equity which is a key desire, but usually out of reach, for many aspiring farmers across the country. |
| Attractive returns | Long term target of return of 10% p.a. comprising of approximately 6% of capital growth and up to 4% rental income |
| Robust Process | Firstly, NextGen farmers are vetted by Cultivate Farms and the retiring farmer before being matched onto the farm opportunity.  The AGRIMAAN platform is then used to list the properties and crowdfund the purchase price.  Investors can choose properties that interest them. Furthermore, 1 or more agricultural properties can be acquired by investors. |
| Opportunity to fractionally own the farm | Investors can participate in the fractional ownership of an agricultural property within the Next Generation Farmers Strategy which is then leased to both the retiring and aspiring farmer |
| Succession planning | The NextGen project provides a succession plan for retiring farmers to transition their farm to the next generation of farmers while seeing their farm scale to a higher level of productivity. |
| Facilitating a smooth transition | The retiring farmer will also retain some equity and stay farming in partnership with the NextGen farmer to ensure a smooth transition is achieved. |

# 

# Business Architecture

## Actors

### Farmer (Grower)

Farmer is the main actor in the overall business architecture. There are several use cases where Farmer is involved.

* Farmer grows Rice
* Land Information
* Farmer Profile Information
* Farmer’s Crop Information
* Process to request for processing (communication, alert and notifications)
* Integration is the key

### Processor

* 1. Manufacturer
  2. Regulator
  3. Shipper
  4. Retailer

### Consumers

#### Individual Customers

* + 1. Wholesales Customers

### Government Authorities

#### Local Administration

#### Regional Administration

### Farmer Association

### Farmer Cooperatives

### Customs

#### Custom

### Authorities

### Distributors

#### Prestides **Distributor**

### Government And Other Entities

### Ministry Of Environment

### Ministry Of Health

### Ministry Of Roads And Highways

### Ministry Of Veterinary Services

### Ministry Of Agriculture

### Agronomist

### Agronomists handle all kinds of agricultural projects from small to large high-tech farms with the help farmers to develop and implement practices ensuring economical and environmentally viable operations for the future.

### Agronomy is the scientific technology of using soil to produce plants for the purpose of food, fibre and fuel. Agronomists can work as farm managers, fertilizer and chemical store managers, lab and field technicians, crop management consultants, soil and water conservationists, inspectors or sales representatives for farm management services, financial institutions and food processing companies to perform land appraisal, soil testing or work in planning and managing positions in agriculture industry. Agronomist is a liaison between farmer and crop researchers to review research findings and to use knowledge to recommend solutions to farmers regarding new scientific developments in crop growing operations. Agronomists may be employed as plant breeders, plant pathologists and soil surveyors encompassing work in areas of plant physiology, plant genetics and soil science at research stations for federal and state government.

#### Roles and Responsibilities

### Agronomists are called crop doctors with a wide range of work concerned with the well-being and health of crops used for fuel, food production and land reclamation. Agronomists are scientists whose area of study is plants and soil in order to increase soil productivity; develop better cultivation, planting and harvesting techniques; improve crop yield, quality of seed and nutritional values of crops; and solve problems of agricultural industry. They are experts in the science of soil management for land reclamation and crop production to improve quality of seed and the nutritional values of crops. Agronomists conduct tests and are concerned with the practicing principles of soil management and crop production in fields. They conduct experiments to increase soil fertility and develop best methods for increasing crop productivity and quality. Primary duties of agronomists include, best way to use land after performing statistical analysis of data, measurement of soil salinity and nutrient levels for planting crops.

### Agronomists examine crops for the signs of disease, insect or pest problem, weed issue or problem with the soil. They think critically to solve problems concerning planting, cultivating, harvesting and protecting crops from pests, weeds and harsh climates.Agronomist work with farmers to conduct experiments and help to grow best possible crop with extensive knowledge of Agriculture, crop science,chemistry,biology, ecology, earth science, genetics and economics. They evaluate crop data collected; to find ways to improve the next generation crop. Agronomists compare results with scientific research journals and reference books to pinpoint the cause and find a solution. They present research findings to farmers to use the information for growing and harvesting agricultural products. Agronomists help farmers to manage crop planting and implementing efficient farming practices; improving crop efficiency and sorting any agricultural

### 

### Producer

### XYZ

### Retailer

### PESTICIDES RETAILER

### FOOD RETAILER

### Supplier

### RAW MATERIAL SUPPLIER

### Technology Partner

### United Nations Agencies

### United Nations Development Programmer

### United Nations Environment Programme

### United Nations Industrial Development Organisation

### World Health Organisation (WHO)

## Roles

## Functions

## Information

## Processes

## Services

Stakeholder/Actor/Role

Notes:

1. Crop Management
   1. Seed Supply to Grower
   2. Fertilizer Supply to Grower
   3. Lease or buy Equipments
   4. Soil Testing and Certification
2. Supply Chain is business capability
   1. Farmer sells Raw Material to Local Buying Agent
      1. Farmer and LBA Registration (interaction with registration system)
      2. Interaction with purchase system
      3. Interaction with payment system (payment to Farmer)
   2. LBA Sends Raw Material for Processing to processor (kept in warehouse)
      1. Inward/ Outward Lot detail
      2. Other details related to warehouse (challan, invoice, lot etc)
   3. Wholesaler give Purchase Order (PO) to supplier
      1. Interaction with Procurement/ PO System for PO Generation
   4. Work Order from Supplier to LBA
   5. LBA sends raw material to Shipper (Processing Facility/ Warehouse)
   6. Shipper sends material to Logistics (for shipping) - IOT enabled
   7. Shipment Tracking (IoT enabled)
   8. Supplier shared the copy of Work Order
   9. Logistics sends material to Wholesaler (external Logistics system)
   10. Supplier sends invoice to Wholesaler
   11. Distributor sends material from Wholesaler or Retailer
   12. Quality Checks (Certification)
3. Agro Manufacture
   1. Production of Crop
   2. Testing of Soil
   3. Seed quality management
4. Agro Resources
   1. Irrigation
   2. Plat Nutrition

soil moisture measurement and monitoring decision support system

## PRODUCTS

# Application Architecture: Application Collaboration

## Application Collaboration1

# 

# Application Architecture: Application Components

## ACSS (Agrimaan™Crop Scouting System)

Efficiently capture information on crop health, insects, diseases and crop damage. Assess crop issues across all of your fields. Analyze scouting data to create timely and informed recommendations.

* Synchronize data to growers or other agronomists
* Collect in-field observation photos
* Scout by point or polygon
* Share recommendations
* Record field activities
* Enrol fields to receive in-season imagery for guided crop scouting and recommendation creation

## APAM (Agrimaan™ Precision Agriculture Management)

APAM will have the following set of features:

* Scout crops for pest pressures and easily record and collect observation photos
* Create and share recommendation from the field
* Generate PDF reports and share via email or text
* Soil sample using a grid, zones, or previous soil sampling points
* View fertilizer and nutrient recommendations
* Send recommendations wirelessly using Raven Slingshot®
* Export data as a shapefile
* Receive rainfall estimates updated to the hour for each field
* Drive or draw new field boundaries
* Store and share data securely via the Agrimaan™ Platform

## ASDM (Agrimaan™ Smart Data Management)

Agrimaan@™ SDM helps turn agronomic data into smart management decisions. With Agrimaan@™ SDM data management features, you can create agronomic efficiencies in your program using the flexible record keeping all in one location.

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  2. Variable-rate seeding (VRS) recommendations
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## ADSP (Agrimaan™ Data Sharing Platform)

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Users with Agrimaan DSP accounts are able to access Agrimaan DSP compliant applications and share data with other Agrimaan DSP Connections. ADSP supports the features such as:

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* **Synchronization:** Synchronization with a central data repository ensures that all data collected is in adherence to Agrimaan DSP standards and is available for sharing among Agrimaan DSP compliant applications in a seamless manner.
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* **Communication:** Seamless communication is necessary between all users who have an interest in a particular field. This communication is safeguarded by data-specific permission settings.

## ASMMMS (Agrimaan™Soil Moisture Measurement and Monitoring System)

## AgSCMS (Agrimaan™ Supply chain Management System)

AgCMS is termed as Agrimaan Supply Chain Management System. This consists of following modules:

1. Procurement Management



## ADA (Agrimaan™ Digital Agriculture)

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     13. Yield Monitoring

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     4. Part of what makes the Rural Intelligence Platform™ so unique is it incorporates, integrates and applies the deep knowledge and domain expertise of CSIRO’s leading agricultural, water, climate and land scientists.

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## ACMS (Agrimaan Crop Management System)

AGRIMAAN’s Crop Management System uses the latest agricultural irrigation technology to help you to:

1. Reduce Cost & Increase Yields
2. Get more out of available water supply
3. Use exactly the right amount of nutrients for your crop

### AIMS (Agrimaan Irrigation Management System)

Using AGRIMAAN’s irrigation management system to manage the irrigation and nutrient needs for your agricultural crops will enable you to **accurately monitor and analyse your operations** so that you can confidently plan what changes need to occur to achieve the best results. Optimising and applying water and nutrients to your crops exactly when they need it will result in healthy, resilient plants that thrive rather than struggle.

### ASMMMS (Agrimaan Soil Moisture Measurement and Monitoring system)

* collects automatically logged data from sensors, including but not limited to; flow meters, soil moisture probes and weather stations.
* It is designed to be hardware independent, clients can use their existing sensors without the expense of installing new equipment.
* Covers different characteristics of each of the sites (e.g. field, orchard, park, playing field) so that the information and recommendations it provides are accurate and relevant.
* It helps protect the soil and surrounding environment, saves resources such as water, nutrients and energy and improved plant yield
* Configurable features include soil and crop characteristics, water budgets, irrigation system details, and weather data sources.
* collect and analyse data from all of these sources and then provide information on future irrigation needs to keep predicted soil moisture in defined optimal zones.
* Make informed decisions to increase or decrease irrigation to ensure plants are provided with optimal water and nutrients to meet their needs.

Sample Dashboard features:

1. Site Locations
2. Health Summary
3. Water Usages (sitewise)
   1. Actual vs budgeted
   2. Forecast Soil Moisture Summary
4. Alerts & Notifications
5. Nutrients
   1. Planned vs Applied (Cumulative)
   2. Planned vs Applied (week wise)
6. Weather Information
   1. Rainfall (mm)
   2. ETo
   3. Max Temp (Celcius)
   4. Min Temp (Celcius)
   5. Max Humidity (%)
   6. Min Humidity (%)
   7. Windspeel (k/s)
7. Google Map for the land which is then linked to available equipment, including weather stations, flow meters and soil moisture probes

### AFM (Agrimaan Fertiliser Management)

* Supports fertiliser planning, logging and reporting functionalities.
* automatically include irrigation water nutrient loads for fertiliser planning, and reporting of usage against budgets.
* This has clear benefits for recycled/reclaimed water projects, but also for any fertilised fields where savings can be made by considering background water nutrient load.

## APPLICATION EVENTS

## APPLICATION FUNCTIONS

## APPLICATION INTERACTIONS

## APPLICATION INTERFACE

/v1/agrimaan/farmers/{former id}

/v1/agrimaan/farmers/{former id}/lands

/v1/agrimaan/farmers/{former id}/

## APPLICATION PROCESSES

## APPLICATION SERVICES

# DATA ARCHITECTURE

## LOGICAL DATA MODEL

FARMER ENTITY

|  |  |  |
| --- | --- | --- |
| ENTITIES |  |  |
| FIRST NAME |  |  |
| MIDDLE NAME |  |  |
| LAST NAME |  |  |
|  |  |  |

SOIL ENTITY

## PHYSICAL DATA MODEL

## DATA CAPTURE

### FARMER DATA CAPTURE

## DATA STORAGE

## DATA ANALYSIS

## DATA COLLECTION

## DATA MINING

* + 1. Big Data????

## DATA COMPRESSION

### Predictive Analytics

### Prescriptive Analytics

### Cognitive Analytics

# TECHNOLOGY ARCHITECTURE

AGRIMAAN PORTAL INFRASTRUCTURE

WEB SERVERS

APP SERVERS

BIGDATA AND ANLYTICS INFRASTRUCTURE

REPORTING INFRASTRUCTURE

MIDDLEWARE PLATFORM

DATABASES

TOOLS

IMPLEMENTATION AND MIGRATION

WORK PACKAGE

DELIVERABLES

Watson Decision Platform

Watson Decision Platform for Agriculture is a new platform comprising artificial intelligence (AI), internet of things, and cloud solutions that together generate “*evidence-based” insights*. It’s available as a managed service offering and part of IBM’s new collection of [prepackaged tools](https://www.gurufocus.com/news/744155/ibm-largest-ever-ai-toolset-release-is-tailor-made-for-9-industries-and-professions) pretrained for customer service, human resources, manufacturing, and marketing use cases.

key factors that might affect crop yields, such as soil temperature, moisture levels, crop stress, pests, and diseases

Functionalities are:

1. Crop Price Prediction
2. Trend Analysis (Crop Diseases)
3. Disease Detecting Computer Vision Algorithm
4. Agriculture Analytics
5. Satellite Imagery
6. Weather Data
7. Census Data
8. Land Use
9. Business Locaton Data

In Brazil, its researchers built a prototype — the [AgroPad](https://www.ibm.com/blogs/research/2018/09/agropad/) — which uses AI and a mobile app to analyze soil and water samples. And in Kenya, IBM partnered with [Twiga Foods](https://www.ibm.com/blogs/research/2018/04/ibm-twiga-foods/) to test a blockchain-enabled microfinance lending platform for farmers and food vendors.

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# Appendix1: Questionnaire for use in FO profiling process

Refer this document to detail out: file:///Users/sa298306/Downloads/Module1\_FO\_Profiling\_web.pdf

Operations

1 - Land Preparation • 2 - Seeding & Planting • 3 - Irrigation • 4 - Fertilization • 5 - Weeding • 6 – Pest Control • 7 - Harvesting • 8 - Transportation • 9 - Other Expenses • 10 - Rent • 11 - Total of cost include rent

Wages and Production Inputs

1- Wages Labor • 2- Draft Animals • 3- Machinery • 4- Seeds Cost • 5- Manure • 6- Fertilizers • 7- Insecticides • 8- Other Expenses • 9- Total of cost without rent

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