

### Introduction

This paper provides a concise introduction and summary of IMP Aust Ltd ('IMP') and the Great Land product (patent pending). Great Land is Australian designed and manufactured and was launched in November 2012. Great Land is in early stages of commercialisation.

### Executive summary

Great Land is a biological product based on genome interactions between six Plant Growth Promoting Bacteria ("PGPB") and plants and soils. These bacteria were selected based on the genetic understanding of the proteins (enzymes, catalysts, bacteriocins etc.) they deliver to the plant and soil to stimulate plant growth.

Great Land technology has little to do with soil bacteria per se. Great Land bacteria are just the delivery mechanism for the genes (and gene products) that are required to successfully promote genomic interactions between plants and microorganisms. The design of Great Land comes from a better understanding of the genes required to influence nutrient uptake pathways, pathogenic responses, growth promoting hormones and plant stress cycles.

Based on research in the field of microbiomics which has evolved in the last five to ten years in the biotech sector, the importance of various bacteria is quite different to conventional (or even non-conventional) agricultural thinking. This has implications for traditional nutrient theory.

Great Land has been designed to work in several ways including:

- a) Solubilising locked soil nutrients
- b) More efficient nutrient delivery to plants via additional and superior uptake pathways
- c) Production of plant growth hormones
- d) Introduction of a range of anti-microbial attributes that suppress many key plant pathogens.

Production has been established on sound biotechnology principles and procedures which achieve consistent reproducible results. Even though Great Land is a live product (shelf life approximating 6 months), it is very robust and requires no problematic handling or application protocols.

As a liquid, Great Land can be applied as a ground spray and also through irrigation. Great Land is NASAA certified organic as an input for organic production; however it has not been compromised to achieve certification. It is organic by default.



### Further information

#### **Product category**

The production and sale of plant growth microbial products in Australia (and internationally) are divided into two distinct camps.

- a) Agbiotech businesses whose product efficacy is based on peer reviewed results, supported by independent, replicated trials. Product quality is standardised and dependable, ingredients are known and identified. JumpStart® by Novozymes (a phosphate inoculant), is a contemporary example.

The product category is recognised by its highly controlled fermentation process. One objective of fermentation is to produce concentrated, pure strains of Plant Growth Promoting Bacteria (PGPB). These products are not brews or potions.

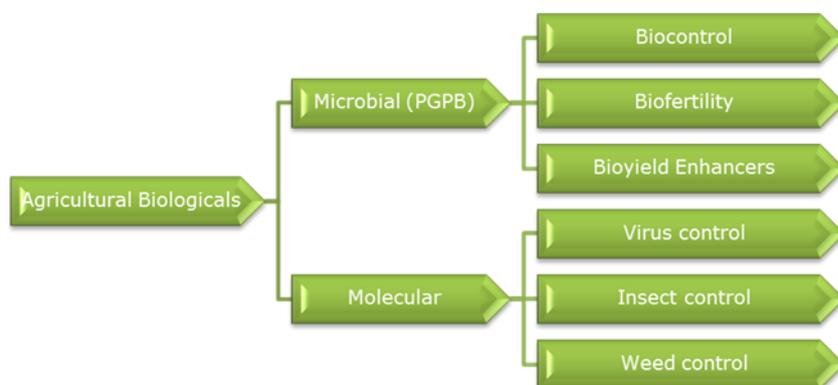
Bayer Crop Science has adopted the term 'Biologics' for the product category, while Monsanto has settled on 'Agricultural biologics'. They have defined their own sub categories to some extent. Monsanto's product set is reproduced **Figure 1** below.

- b) Products based on philosophies rather than science. These businesses are renowned for employing evangelistic sales approaches supported by circumstantial testimonials. There has been a large number of these products come and go, and no doubt there will be many more. This this product category is often referred to as EM's (an acronym for Effective Microorganisms).TM21 is a relevant example.

Agbiotech businesses have to educate the market on the distinct differences between science based products and others. Reputable, replicated, independent trial data is the first step.

Great Land is a high quality agricultural biologic, and more specifically, six purposefully selected, compatible, PGPB genomes.

**Figure 1: Monsanto Agricultural Biologics product categories**



### **PGPB and Microbiomics**

It is not the bacteria as such that matter; it is the genetic material they contain, and how these genomes interact with plants.

PGPB are defined as *plant bacteria that exert beneficial effects on plant growth and development*. They represent many different genera known to colonise soils, seed, roots, and other plant material.

A huge range of bacteria colonise plants. Many of these are pathogenic, but PGPB provide the host with essential services such as nitrogen fixation, solubilisation of minerals such as phosphorus, synthesis of plant hormones, direct enhancement of mineral uptake, and protection from pathogens. PGPB's may protect plants from pathogens by competing with the pathogen for an ecological niche or a substrate, producing inhibitory chemicals, or inducing resistance in host plants to the pathogen.

Microbiomics is new branch of molecular microbiology studying the interactions of microorganism genomes and the environment in which they reside. Great Land development would not have been possible without recent advances in DNA technology.

### **Intellectual property**

Great Land intellectual property was created by Australians and is Australian-owned by IMP Aust Ltd (IMP). It is manufactured at IMP's biotechnology research & development and production facilities in Queensland, Australia.

IMP has successfully lodged an international PCT application and has a patent pending in Australia, New Zealand and the United States for the product.

### **Great Land incubation tests**

Incubation tests have been designed to forecast the potential of Great Land to positively influence nutrient availability, nutrient uptake, and carbon levels. The test also looks for increasing levels of available cations and trace elements.

Incubation testing includes important intellectual property.

### **What does Great Land do?**

- a) Increases nutrient availability e.g. Ca, P, N, Zn etc.
- b) Increases Carbon levels
- c) Noticeable increase in resistance to soil borne pathogens
- d) Increases survival rates and development of plant seedlings
- e) Increases resistance to stress e.g. water, heat etc.
- f) Increases crop yield, both quality and quantity
- g) Increases leaf nutritional content

### How it works

Great Land is not a 'fertiliser' in the traditional sense. It does not contain plant available nutrients in significant amounts. It contains genetic material (microorganism genomes), that respond to stimuli. These responses, in cohort or isolation, positively affect key plant growth conditions.

Great Land PGPB have also shown to improve plant tolerance to stresses such as salinity, metal toxicity and pesticide load.

Great Land was selected for specific genes which produce:

- a) Plant hormones such as Auxins, Gibberellins, Cytokinins
- b) Bacteriocins; anti-bacterial/fungal compounds
- c) Globular Proteins, which attract other bacterial/fungal species
- d) Enzymes which facilitate Nitrogen mineralisation; Transaminases, Transferases, Deaminases
- e) Utilization genes which solubilise phosphatases
- f) Exogenous enzymes which solubilise and utilize minerals e.g. Ca, K, Mg, Zn

How?

- a) Small amounts of the stress hormone ethylene (produced by plants) is a growth promoter, however in large amounts (stress responses) it inhibits growth. PGPB's are able to lower the levels of ethylene, reducing the plants stress response.
- b) Enzymes that catalyse deamination (the removal of an amine group from a molecule) are called deaminases. Important amines include amino acids. Amino acids are the building blocks of proteins. Deamination can increase the availability of plant available nutrients from organic proteins, a potential alternative to chemical fertilisers. Amino acids also play a key role in the transport and the storage of nutrients.

### Manufacture

Great Land is cultured under sterile conditions using fermentation techniques to produce single bacterial strains at high concentrations.

A small number of bacteria can become a large number of bacteria very quickly. Generation times for bacteria are measured in minutes or hours when provided with the right conditions. The liquid culture vessels (fermenters) at the production facility are used for this purpose. Bacterial cell concentrations reach in excess of  $10^9$  (one billion) per millilitre. This liquid culture forms the concentrate for further dilution to the final product for application in the field. Production is batched, as opposed to continuous.

Great Land batch production is reliable and consistent, meaning product composition is stable and results are repeatable. This aspect of quality control is essential for Great Land to preserve its classification as a premier agricultural biologic product.

Prior to release, further QA standards have to be achieved. Samples are taken for testing from 10,000 litre batches at the point of filling into either bulk or 1,000 litre IBC's. A 'viability' count is conducted to

ensure the batch has a minimum of  $10^6$  live bacteria per millilitre as stipulated on the label. In addition, random samples are taken for testing during storage before customer delivery. Batch records are held at IMP Biotech for tracking and diagnostic purposes.

**Figure 2: Biotech fermenters**



### Research continues

In the broader context of published, peer reviewed research, there is growing support for PGPB as a viable solution for reducing the dependence of crop production on chemical fertilizers. It is also recognised that the exact mechanisms of plant growth promotion by PGPB are not fully understood and there is still much scientists are yet to understand.

Great Land is a pioneering product in ag-biotech for the benefit of plant growth, without the known environmental and health risks associated with chemical inputs.

### Bio Control

At this point IMP makes no claims in relation to Great Land and bio control, however, IMP continues to invest in this area of research.

Research suggests PGPB can secrete substances that kill or prevent the deleterious effects of some microorganisms (bacteria, fungi) by:

- a) Limiting the availability of elements to pathogens
- b) Altering the metabolism of the host plant to increase its resistance to pathogen infection
- c) Competitive exclusion of plant pathogens.