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Excellence in Research and Development

Agricultural Research Council

Policy on the Applications of Biotechnology

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1 October 2015

1. EXECUTIVE SUMMARY

The Agricultural Research Council (ARC) was established in terms of the Agricultural Research Act, 1990. Primarily, the mandate of the ARC is to conduct and drive research and technology development in order to transfer of scientific solutions and information to the agricultural sector in South Africa.

As a leading organisation in the development and application of technologies to agricultural problems relevant to commercial, emerging and small-holder farmers within both South Africa and the African continent, it is essential that the ARC identifies and utilises the most appropriate and effective tools to ensure:

- the efficiency and stability of food production systems;
- the protection of crops and livestock against biotic and abiotic stress (drought, diseases, pests) both in production and in storage of products;
- the safety and quality of food products;
- the efficient use and protection of environmental resources (including biodiversity) such as soil and water in agricultural production; and
- the protection of the environment, crops and livestock and consumers from harmful effects of chemical and biological entities in the food production system.

To achieve these aims, the ARC is committed to the use of the regulatory frameworks for the development of new biotechnology tools, and their application in the improvement of crops and livestock for sustainable agricultural production in South Africa, and the sub-Saharan African region in the long term.

Biotechnology includes a wide range of technologies, ranging from long established methods such as brewing and baking, technologies such as tissue culture and various methods for the clonal propagation of plants, the various technologies used for diagnostic tools, and the development of vaccines. More recent developments include a range of technologies in genomics, proteomics, metabolomics and phenomics which all use the generation and analysis of very large datasets from new high throughput analytical methods.

The genetic modification of plants and animals, resulting from the introduction of new genetic information into a species, has resulted in the introduction of new traits that can both improve agricultural production systems and improve food quality and safety. New technologies are now being developed and applied in plant and animal improvement, which result in precisely targeted changes in gene sequences, which will enable the improvement of crop and animal species in a highly controlled and specific fashion in the future.

The ARC Biotechnology Policy is to ensure the safe, effective, sustainable and regulated use of biotechnologies, to ensure the maximum benefit for farmers, processers, retailers and consumers of agricultural products. The Biotechnology Policy aligns with the strategic objectives which aims to ensure: efficiency and stability of food production systems; the protection of crops and livestock against biotic and abiotic stresses - both in production and in storage of products; the safety and quality of food products; the efficient use and the protection of environmental resources such as soil and water within agricultural production; and the protection of the environment, crops and livestock and consumers from harmful effects of chemical and biological entities in the food production system. This will be achieved within the current legal framework governing biotechnology related activities and through the application of rigorous scientific methods, and the robust proof of food safety through the cost effective testing of new products in line with world-class standards and best practices.

2. INTRODUCTION AND BACKGROUND

Agriculture contributes over 25% of GDP and employs above 70% of the labour force in most African countries' economies. While these proportions are lower in South Africa, it remains the case that agricultural production and subsequent agro-processing are a critical sector of the overall economy and for employment. Agricultural productivity is constrained by a many factors including climatic (abiotic) stresses and pest and diseases (biotic stresses). The challenge is therefore to develop technologies that can overcome these limiting factors, and can be utilized by the whole farming community, from small-scale farmers who only have access to minimal external input resources, to larger scale commercial farmers who also need to lower production costs to compete in the global market. Such approaches can include the use of biotechnology, during production and subsequent processing of food, feed and industrial products from agriculture.

In Africa, biotechnology tools used in agriculture include tissue culture, molecular characterization, marker assisted selection, molecular diagnostics and to a lesser extent, genetic modification (GM). Currently tissue culture is applied in many countries for rapid multiplication of planting materials for vegetatively propagated crops such as coffee, banana, pineapple and root crops. Molecular characterisation, including marker assisted selection and diagnostics, are increasingly being employed and developed to address agricultural questions ranging from pathogen characterisation to the selection

of trait containing progeny and the identification of existing and new diseases, pests and pathogens. However, few countries have adopted GM for agricultural research and development of crops, livestock or vaccines, and there is only limited production of GM crops in a small number of countries at present.

However, the application of biotechnology, and particularly GM technologies, depends on the approval and implementation of appropriate biosafety regulatory systems to enable the approval of the movement and production of GM crops and animals within each of these African countries. In addition, there and regulations in place which provide for the control of the exploitation and export of biodiversity resources, to prevent the import of plant, animal and human pathogens and to provide for safety standards in the production of food. The ARC regards these as fundamental to the protection of the environment and food production systems, and provides important support services in the implementation of these regulations.

3. BIOSAFETY AND REGULATIONS

The primary enabling step in this process is the accession of countries to the Cartagena Protocol on Biosafety, and to date some among the 170 parties, including 53 African countries have ratified this Protocol, which regulates the transboundary movement of living modified organisms. This provides the key international framework, within which national biosafety systems can be implemented. In South Africa this is then governed by the GMO Act (1997), its regulations and subsequent modifications, as well as other acts including National Environmental Management: Biodiversity Act (NEMBA), the Consumer Protection Act and the Foodstuffs, Cosmetics and Disinfectants Act.

As stated above, South Africa has broad range of complex regulatory systems to manage biotechnology in agriculture and human health. The GMO Act is the primary regulation that impacts on the work of the ARC relating to genetic modification; this Act is managed by the Department of Agriculture Forestry and Fisheries (DAFF) through the office of the Registrar, and through the Advisory Committee (AC) and Executive Council (EC). The ARC functions in compliance with the GMO Act and the Regulations, and provides expert advice to DAFF within this framework for the recommendations and decisions of the AC and EC. The ARC further adheres to the other acts related to biotechnology activities, such as the Biodiversity act, where and as required for projects.

4. APPLICATIONS OF BIOTECHNOLOGY

Agricultural research and development remains one of the most effective tools for substantially increasing agricultural production in a sustainable manner. This requires approaches to improve agricultural productivity, reducing the negative environmental impacts of production, including reducing emissions of greenhouse gasses and the

release of nitrogen and phosphorus, increasing water use efficiency, and reducing waste at all stages in the food value chain.

While historically, global production of food has outpaced demand, the rate of increase in production is now slowing due to both supply and demand issues. People demand increased quantity, quality and diversity of food, and on the supply-side, historic yield growth has slowed or plateaued in recent years. In addition, there is increased competition for land, water and other natural resources. Climate change is also threatening production growth in many areas and new biotic threats keep emerging in both plant and animal production systems. Additionally, reducing the environmental impact of agriculture, including greenhouse gas emissions, may in future require new and innovative farming methods. Worldwide, biotechnology is used in research within this changing environment to address many, if not all, of these concerns.

The utilization of biotechnology-derived crops is already widely adopted by the local farming community. South Africa is currently the 8th largest producer of GM crops in the world. Currently genetic modified (GM) crops are limited to three commodity crops, maize, soybean and cotton, and two traits, insect resistance and herbicide tolerance. These crops have been developed by major biotechnology companies from the USA, and have used technology strategies that are widely described as genetic modification, or GM.

More generally, there are also a range of genetically modified vaccines and industrial microorganisms that have been approved for use in South Africa, and these bring a range of benefits over previous generation systems, with improved efficacy and specifically designed application. Currently, there are no genetically modified animals or insects in production in South Africa at present.

5. NEW TECHNOLOGIES AND TRAITS

The increasing demand on quality and quantity of crops, together with new pest and disease, all occurring in a changing climate, will necessitate that many more crops that will require improvement, either through traditional breeding or new biotechnology approaches. Additionally, the introduction of new traits for a wide range of abiotic (eg, drought, heat, salinity) and biotic stresses (viral, bacterial and fungal pathogens, and insect pests), resistant traits, will require the utilisation of new biotechnology tools to eliminate these threats and ensure sustainable production in many different agricultural systems. Similarly, biotechnology will be key in the improvement of animals particularly in those traits (e.g. fertility, feed efficiency and tolerance to external parasites) that have proved difficult to improve through conventional breeding.

One of the most promising new biotechnology tools, are termed "*Genome Engineering*". These new genome-engineering technologies introduce highly specific and targeted changes within DNA sequences, thereby enabling the introduction of exact changes in

the genomes of plants, animals, and microorganisms for application in agricultural systems. This technology enables the introduction of targeted, subtle changes in the genome, thereby allowing the generation of a specific new trait (new phenotypic trait) within the original organism. This ability to express a new trait in the identical genetic background of the parental organism, without the need of multiple backcross integrations used in classic plant breeding approaches or the use if antibiotic selection approaches, will allow faster cultivar development and additive trait incorporation into current optimised lines. Therefore, the possible production of genome engineered crops, animals, insects and microorganisms will provide the basis for the rapid development of well-characterized new variants of organisms, that have clearly defined and understood traits that can easily be tested for substantive equivalence with the parental organism.

The range of genetic changes that will become possible in the future, will be very wide, but will parallel those found naturally through the exploration of a diversity of genetic variation occurring in natural populations and germplasm collections. These will provide new traits for a wide range of needs in modern agriculture, including systems for more rapid plant breeding; improved productivity and biosecurity of crops and animals; improved food safety and quality; longer storage; and potentially the development of new industrial crops (for example to be used for bioplastics, or pharmaceutical production).

The traits that will be introduced in the future, will be to the benefit of producers, processers, retailers and consumers, thereby increasing the sustainability of production and the quality, safety and nutritional content of foods, and the diversity and value of industrial crops. Additionally, these traits holds potential for bridging the gap between the demand and supply of food.

6. RESPONSIBLE USE OF BIOTECHNOLOGY

The foundation of the ARC policy on the use of biotechnology is the safe, responsible and regulated use of technologies for the improvement of agricultural production and products in a manner that is in line with current local and international laws and best practises.

The strong regulatory system applicable in South Africa, together with future developments in the technologies available, and the evolution of the regulatory system for managing the use of new tools in the development of new traits, provides a solid basis for the safe application of biotechnology, especially in the areas of genetic modification of plants, animals and microorganisms.