THE FUTURE OF THE WESTERN CAPE AGRICULTURAL SECTOR IN THE CONTEXT OF THE 4TH INDUSTRIAL REVOLUTION

Review: Food Design (Functional Foods)

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1. Technology Overview and Detailed Description

The term Functional Foods was first introduced in Japan in the mid-1980s and refers to processed foods containing ingredients that aid specific bodily functions in addition to being nutritious. Japan is the only country that has formulated a specific regulatory approval process for functional foods, referred to as Foods for Specified Health Use (FOSHU). These foods are eligible to bear a seal of approval from the Japanese Ministry of Health and Welfare. Currently, 100 products are licensed as FOSHU foods in Japan.

There is no official or commonly accepted definition of functional foods, however, there are those definitions which are prevalent in the literature, and which will be used in this report.

The European Commission on Concerted Action on Functional Food Science in Europe (FUFOSE) proposed a working definition of functional food, namely:
"A food that beneficially affects one or more target functions in the body beyond adequate nutritional effects in a way that is relevant to either an improved state of health and well-being and/or reduction of risk of disease. It is consumed as part of a normal food pattern. It is not a pill, a capsule or any form of dietary supplement".

Another definition[1] provided in the literature is:
"A functional food is, or appears similar to, a conventional food. It is part of a standard diet and is consumed on a regular basis, in normal quantities. It has proven health benefits that reduce the risk of specific chronic diseases or beneficially affect target functions beyond its basic nutritional functions".

A third definition[2] used for the purposes of this paper is:
"Natural or processed foods that contains known or unknown biologically-active compounds; which, in defined, effective non-toxic amounts, provide a clinically proven and documented health benefit for the prevention, management, or treatment of chronic disease."

Classification of functional foods
Functional foods can be categorised into 3 groups:
I. Functional foods that naturally contain a component that offers additional benefits to the consumer.
II. Processed foods in which a component is added to the food to give it additional benefits
III. Food in which the nature of the functional ingredients has been altered.

Technologies used to develop functional foods
Technologies used to develop functional foods can be classed into 3 categories, as shown in Table 1 below.

Table1: Technologies for functional foods[3]

Technology	Examples
Technologies used in traditional food processing	Formulation and blending, cultivation and animal breeding techniques
Technologies to prevent the deterioration of active compounds	microencapsulation, edible films and coatings, vacuum impregnation
Nutrigenomics	Personalized functional foods

2. Application Examples and Case Studies

Practical examples of a functional food are the following[4]:

- a natural food such as fruit or grain which may or may not be modified by plant breeding or other
- technologies (e.g. lycopene-enhanced tomatoes, vitamin E-enriched vegetable oils, vitamin A-enriched rice);
- a food to which a component has been added (e.g. a spread with added phytosterols);
- a food from which a component has been removed or reduced (e.g. a yogurt with reduced fat);
- a food in which one, or several components, have been modified, replaced or enhanced to improve its health properties (e.g. a juice drink with enhanced antioxidant content, a yogurt with added prebiotic or probiotic).

Using the definitions above, specific examples of functional foods are the following[5], [6]:

- All-bran cereals - a good source of insoluble fibres; scientifically demonstrated to be linked to
- a reduced rate of colon cancer.
- An apple, which after several studies, has shown that it can prevent some types of cancer – proven health benefits in, say, a new variety
- Two per cent milk with added vitamin D – milk is a good source of calcium, shown to reduce the risk of osteoporosis.
- Orange juice fortified with calcium – orange juice itself is not a functional food (it is an enriched food), but the presence of calcium makes orange juice fortified with calcium, a functional food.
- Omega-3 fatty acid enriched milk – these fatty acids have been shown to control hypertension and lipid metabolism. In amounts high enough to render health benefits, they allow for milk enriched with these fatty acids to be defined as a functional food.
- Margarine with plant stanols esters - plant stanols esters inhibit intestinal absorption of LDL-cholesterol, and therefore lower the level of LDL-cholesterol in the blood, and therefore reduces a risk factor (LDL-cholesterol) for a specific chronic disease when consumed on a regular basis and in normal quantities as a spread.

- Oats, soy, rice, wheat, maize, barley, Millets (*Eleusine coracana*), Fig (*Ficus carica*), Sorghum (*Sorghum bicolor*), Fenugreek (Methi), flaxseed, tomatoes, garlic, broccoli and other cruciferous vegetables, Pumpkin (*Cucurbita pepo*), *Cordyceps* mushroom, citrus cranberry (*Vaccinium macrocarpon*), wine grapes, Cocoa (*Theobroma cacao*), peanut, strawberry, fish, dairy products and beef are other examples of functional foods that have been extensively reviewed[7].
- Probiotics cultures with health benefits in the prevention of diarrhoea, constipation, lactose intolerance, urinary tract infections, cancer and irritable bowel syndrome (extensively reviewed in the literature[8]

3. Technology or Application Life Cycle: Current Status and Expected Development in 2020 and 2050

Table 2: Life Cycle

Technology Area	Current application in agriculture	Expected applications in agriculture by 2020	Expected applications in agriculture by 2050
Food Design	Products with less fat, sugar or salt without affecting the taste, structure and (eating) experience • Products with a different structure, e.g. less grainy or easier to chew • Products with a specific aesthetic attraction, e.g. smell, shape and colour, so that food becomes a different (eating) experience	3D printing may enable households to design their own food, and print it.	Units of nutrients (cubes, gel or powder) Personalised foods (based on nutrigenomics, which investigates the interaction between diet and development of diseases, derived from an individual's genetic profile)

4. Business Eco-System View

Food Design (Functional Foods) overlaps with:

- 3D printing
- 4D printing
- Genetics
- Synthetic biology
- Metabolomics
- Proteomics

5. Benefits and Risks

Benefits

The health benefits linked to functional foods are:

- Better early development and growth;
- Health maintenance (e.g. immune function, gastrointestinal health, mental health, health in ageing, physical performance);
- Reduced risk of obesity;
- Reduced risk of chronic diet-related diseases (e.g. cardiovascular disease, type 2 diabetes and metabolic disease, musculoskeletal disease)[9].

Risks/Challenges

- Developing a new functional food is an expensive process. Product development requires detailed knowledge of the products and the customers, which is why quantitative and qualitative marketing studies must be carried out before launching any product on the market.
- The food industry is risk averse, takes into consideration many variables to develop or reengineer functional products, such as sensory acceptance, stability, price, chemical, functional properties

6. Potential Economic, Social, Ecological and Political Developments and Impacts

Economic Developments and Impacts

Functional foods sell at higher prices and contain larger profit margins than conventional foods - retail prices of functional foods are typically 30 to 500% percent above the comparable conventional foods. The global market size has been estimated between US$30 and US$60 billion with Japan, the United States, and Europe as the largest markets. Developing countries have emerged as exporters to cater to the increasing demand in the developed countries.

Local demand in developing countries is on the increase, and so opportunities for players in the value chain from raw material producers and processors to retailers are also on the increase.

Developing countries such as South Africa, endowed with rich biodiversity and traditional knowledge of the health effects of certain indigenous plant species, supported by indigenous knowledge systems legislation can exploit this competitive edge.

Social Developments and Impacts

Farming (agricultural production) for the functional foods industry can benefit primary producers and rural communities. Poorer communities can benefit from growing functional food markets through the domestication of wild plant species, observing sustainable practices, as they interact with the private sector in contract farming arrangements, which may be extended to on-farm agroprocessing operations.

Ecological (Environmental) Developments and Impacts

As suggested above, functional properties of plants and animals can increase the value of otherwise rare plant species, which can contribute to biodiversity conservation, through the careful management of biological resources.

Political Developments and Impacts

Several policies and strategies exist in South Africa to support the functional foods sector. These are underpinned by the following:

- New Growth Path
- Industrial Policy Action Plan (IPAP)
- National Development Plan (NDP).

Annexure 1 illustrates the alignment of Food Design (Functional Foods) with the key policy mandates of DAFF, articulated in the NDP, and APAP, and illustrates where Food Design (Functional Foods) and possibly technologies of the future may be used to support the delivery of the South African governments proposed interventions as articulated in the APAP.

7. Conclusions

The IFT (Institute of Food Technologists) Expert Panel[10] made recommendations in support of the continuation of functional foods development, some of which are listed below:

- **Expand research into traditional nutrients, other bioactive food components, and the intersection of**
- **genomics and molecular nutrition.** Continued basic and applied nutritional research must further explore the roles and mechanisms of action for traditional nutrients, by encouraging the intersection of disciplines such as genomics and molecular nutrition.
- **Expand research on biomarkers and physiological endpoints** using research efforts
- **Use or establish generally recognized as efficacious (GRAE) panels to evaluate health claims and streamline the regulatory approval process.**

- **Allow product labelling and health claims to accurately reflect the scientific data without triggering drug status.**
- **Indicate the degree of scientific certainty for approved and qualified health claims.**
- **Develop incentives for companies to invest in functional food research and development. I**ncentives such as a period of exclusivity or tax incentives would encourage food companies to pursue functional food development as a profitable venture, to counter risk concerns around cost of changes to manufacturing infrastructure.
- **Use health claims on food labels as the foundation for consumer education regarding dietary components for health,** by promoting the use of accurate claims on food, which go a long way towards consumer acceptance. This will involve the clear communication of potential benefits of functional foods by basic and applied scientists in academia, government and industry.

Other authors[11] made the following on functional foods in developing countries.

- Developing countries can enjoy the benefits of the functional food sector through partnerships between research centres, private entrepreneurs, and indigenous communities. Through these partnerships, options for producers are expanded, provided there is sufficient scientific proof to support health claims made, which itself aids in successful marketing to the consumer.
- Developing countries should intervene at the national level to exploit opportunities to supply the domestic market, and export markets.
- Further studies must be undertaken by developing countries to identify critical bottlenecks in production systems and facilitate competitiveness
- Opportunities for smallholder farmers to produce functional foods should be explored
- In South Africa, the National Research Foundation (NRF) has spear-headed Indigenous Knowledge Systems (IKS) research and application. The NRF has developed and IKS Funding instrument, whose is to contribute to the sustainable economic development of South Africa and the African continent in matters of IKS.

8. Synthesis and key trends from the

Challenges and success factors for developing countries[12]

An appropriate regulatory framework must be in place

Most countries lack suitable regulatory frameworks to facilitate the market development of functional foods. Such a framework would consist of production, sales, certification, and advertising of functional foods, as well as enforcement guidelines. The purpose would be to ensure that there is open competition and innovation.

The underlying science must be solid

The development and marketing of functional foods requires appropriate research expertise, to address the market's need for scientific evidence and proof of functionality, as well as an increase in the number and types of food with functional properties. This scientific expertise includes compound identification, understanding the physiological effects of these compounds, bioavailability, food preparation requirements and clinical trials. Time, finance, and skilled scientists are inevitable, and partnerships between formal science institutions and indigenous communities are recommended, as illustrated by South Africa's Biodiversity Act.

Demand must be understood

The market will define what regulations, actions, and science are needed in the producing/ exporting country. This market information should penetrate the value chain of the product development process, for decision-making and coordination of efforts, in support of harmonizing regulations between trade (production and export) countries. This becomes increasingly important for countries such as China, Russia, and Brazil who supply their domestic markets with functional foods.

Supply must be understood

A sustainable management plan for biodiversity resources of developing countries is important to avoid dramatic reductions in plant populations and interference in the dynamics of local biodiversity, coupled with climate change influences.

This sustainability question should be supported by intellectual property rights protection laws for new products developed in-country with equitable benefit-sharing between local communities and developers of the products, as well as with foreign bioprospecting entities.

Factors that enable a successful marketing of functional foods include consumer awareness (how diet and personal health are related), consumer preferences, the levels of disposable income, the presence of an organized retails sector, and the level of market maturity for new products.

End Notes

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