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Review

A model for education and promoting food science and technology among high school students and the public

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A model for education and promoting food science and technology (FST) as a career among high school students and the public is proposed. Important as FST may be, there has been a general down trend in the number of students enrolling for the course in the institutions worldwide. This is not unconnected with the "home economics/catering" image perception of the discipline by the public. The efforts of some developed countries in reversing this trend were reviewed. The USA, UK, Australia and Canada have put activities in place to this end, hence their stride in food security. If developing continents like Africa will overcome food insecurity, deliberate effort should be geared in making sure FST as a discipline/profession, receives the proper image and boost in enrolment. The proposed model uses the food chain to make a distinction between FST and other food-related professions such as home economics, hospitality management and nutrition/dietetics. FST operates at the secondary stage (processing and distribution) of the food chain closer to the farm gate, providing its end product (food) for other professions while targeting the public. All the other food related disciplines operate at the tertiary stage (retail) directly with the consumer while depending on the product of FST. The core business of the food industry is the product, process and the company, with FST directly involved in all of these areas. The model also highlights the involvement of FST in these areas as well as the need for industry-academia partnership.

Key words: Food science and technology, image, home economics, dietetics, nutrition, food chain.

INTRODUCTION

Food is not only our most important need, but the food industry is the largest of all industries, employing tens of millions of people in all areas such as growing, fishing, processing, transportation, storage, preparation, inspection, distribution, sales and marketing (Vieira, 1996). Food science and technology (FST) is the timeliest and the most relevant professions of our time. It is one of the most important because it is the device by which we can control the availability, nutrition, and wholesomeness of food; the one commodity that is critical to human survival. It is timely because we are in an era of significant technological advances and with these advances come a need for an understanding of the way our food is grown, harvested, transported, stored, processed, packaged, inspected, distributed, advertised, marketed, sold, displayed, prepared and served (Vieira, 1996; Jideani and Jideani, 2008).

Important as FST may be, there has been a general down trend in the number of students enrolling for the course in educational institutions worldwide. Larick (2005) reported that in the USA, there has been a drop in the student enrolment at the bachelor's level in the biological/agricultural sciences since 1997. According to the US Department of Agriculture, there will be a shortage of graduates with food, agricultural and natural resources degrees in 2010. Such degrees include technical sales, representatives, food quality assurance

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Abbreviations: FST, Food science and technology; **IFT,** Institute of Food Technologists; **FSTs,** food scientists and technologists; **AIFST,** Australian Institute of Food Science and Technology; **CIFST,** Canadian Institute of Food Science and Technology.

Table 1. A three-pronged approach to promote food science in U.S. high schools*

Programme	Content
1.Multimedia kits a. Science teachers	 1. Scientific 2. 6 experiments- 2 biology (osmosis and food safety); 2 chemistry (polyols and titration); 2 physics (packaging and viscosity). 3. 4-segment video, 3 scientific segments containing an overview and history of food science, food safety, and food chemistry; 1 segment focused on food science careers. 4. Youthful poster to arouse student interest in food science.
b. School counselors	1.Career Information 2. Extracts of 9 IFT members were used to create segments describing what food scientists are and how the individuals found and prepared for their careers. 3. Interviews from members of the IFT Student Association. 4. Poster describing what food science is, as well as what it is not. 5. IFT approved undergraduate food science programs. 6. Typical coursework in a food science program. 7. Scholarship information and a summary of a 2003 salary survey.
2. " Food Science Ambassador" Program	1. IFT members complete a brief indicating their interest in speaking with or visiting teachers, students, and counselors to discuss the field of food science or give a demonstration.
3. "Train the Trainer" Programme	1. Local area high school teachers and IFT members were invited to participate in a hands-on learning experience using experiments.

*Adapted from McEntire and Rollins, (2007).

professionals and individuals to develop nutraceuticals (Goecker et al., 2005; BLS, 2010a). In the UK, applicants for food science degree courses have been halved in the last decade. Numbers of food scientists in North America showed a fairly sharp decline over the last five to ten years. Similar drops are seen in Australia, South Africa and elsewhere (Floros, 2008). In some institutions students who could not be absorbed in the courses of their choice are made to register for FST with little or no knowledge of what the discipline involves. But why is there such a problem? (1) Lack of motivation from high school students because they do not know who a food technologist is and what career opportunities exist; (2) parents, teachers and the public in general have poor perception of FST. There is a general "home economics/ cookery/catering" image of FST by the populace; (3) FST in general is not currently regarded in appeal and remuneration compared with some other disciplines. "Fewer food scientists' means industry is not able to fill positions" (Floros, 2008). According to Floros (2008) "it is trying to fill in gaps with other disciplines, like chemists, physicists, biologists, and engineers, but with this approach, there is only so much that can be do". The implication extends beyond the food industry to the food regulatory environment and academia. Furthermore, FST as a profession is under attack (Floros, 2009; Scott-Thomas, 2009). Floros (2008) attributed the reason to current economic situation leading to reduced funding in food technology, proliferation of movements such as slow food and the organic lobby, which has added to the perception that FST is about "messing with consumer" food. Our objective was to review some strategies that has been adopted, the implication of the downtrend to Africa and to propose a model to differentiate between FST and allied disciplines (home economics, nutrition/ dietetics and hospitality management) as a tool for promoting FST.

GLOBAL CONTEXT OF FST PROMOTION

Many organizations in the FST community have undertaken many programs to try to improve the public awareness and public understanding of FST. The Institute of Food Technologists (IFT) adopted a three-pronged approach to improving the image of FST in the U.S. (Table 1). The first was targeting the food scientists of the future through IFT Discovery Education Program, launched in 2006 providing lots of information to over 18,000 high schools. Two multimedia kits were mailed to 18,000 U.S. high schools in 2006. One of the kits contained scientific information for science teachers and the other career information for school counselors. Details of the content of each kit are outlined in Table 1. The second approach was creating a community of young professionals, getting them more involved and establishing them as ambassadors for IFT. The final approach was putting the IFT Student association to task to bring others into the profession (McEntire and Rollins, 2007; Floros, 2008). Concurrently with IFT activities is an explosion of television cooking shows making cooking appear more interesting to young people. Floros (2009)

reported that more students have come into food science; however, it is not clear whether the kids coming are interested in the science or just the cooking.

The UK food and drink sector skills council in 2006 warned of a serious shortage of food scientists and technologists (FSTs) employed in the food processing industry, with one in four vacancies for FST positions classed as 'hard-to-fill' (Nexnet, 2009). The BBC commissioned some activities to make easy the science behind food as a way to inspire the next generation of food scientists (Rastall, 2009).

The Australian Institute of Food Science and Technology (AIFST) convened in 2007 to gather information from delegates on the future needs and priorities in the education of FSTs in Australia and how these needs might be met. They identified barriers to achieving ideal FST education as (1) lack of motivation of high school students, (2) changing financial and political environment for FST programs, (3) poor industry input into education programs and FST courses not seen by universities as financially attractive. Among the key actions identified is to improve the image and promotion of FST by targeting careers information to students at high schools and at first year of a tertiary course who have to undertake courses in or related to FST; prepare and market well a comprehensive package for the target groups; AIFST to work with state education departments to prepare specific units of food based tasks that can be slotted into school curricula at appropriate levels (AIFST, 2007).

Canadian Institute of Food Science and Technology (CIFST) reported that the public awareness of food science is low (CIFST, 2009). Food Science Ambassador Programme was organized to primarily increase public awareness of food industry and of FST, to help high school students become better educated consumers of food. The secondary goal was to encourage more students to enroll in Canadian undergraduate food science programs and become food science professionals with needed skills for the Canadian food industry. Their strategy involved inviting food industry professionals to deliver talks and laboratories on FST in local high and junior high schools. Presentations were geared towards illustrating the role of the three basic sciences: physics, chemistry and biology as applied in FST. The scenario is not different in South Africa and other African countries. Under the technical skills clusters, food technology occupation has been identified as an occupation in demand (scarce skill) in South Africa according to the 2006 skills audit and workplace skills plans/annual reports 2006/2007 (WRSETA, 2008). Skills shortages involve jobs that are unable to be filled or have considerable difficulty in fulfilling vacancies for an occupation. Skills gaps involve existing employees who do not have the required qualifications, experience and/or specialized skills (Turner and Seemann, 2008). FST can be classified as an occupation where skill shortage and gap exist globally. Presently, there is a major concern in world food supply and the main response to this world problem is more likely to come from FST innovation (Turner and Seemann, 2008). FST has positive impact on the health and well-being of the world through the ready availability of good quality food. Rastall (2009) stated that over the next decades, tens of thousands of skilled food scientists will be needed to respond to the challenges faced in feeding the world safely and healthily. Hence, if there is any time to intensify efforts to getting more young people into the profession, it is now, especially so for Africa. It has been proposed that Africa is the only region in the world where the number of hungry people and malnourished children will increase in 2020 (Rukuni, 2002).

Awareness is a necessary milestone towards desired outcomes. Public awareness is a driving force, not a guarantee of desired outcomes (NAE, 2002). Notwithstanding, improving awareness will lead to the following long-term outcomes: increased global competitiveness; improved public policy; increased national security; a public more intelligently engaged in technology issues in food that affect their lives; an improved standard of living; and better prepared students in FST (Floros, 2008).

IMPLICATION OF FST EDUCATION FOR AFRICA

Most African countries are losing the capacity to feed themselves because per capital food production fails to keep pace with population growth (Rukuni, 2002). Most agricultural policies in Africa are focused on food production and not consumption (Rukuni, 2002). Food production issues are not as serious as wastage of agricultural produce. In most countries, wastage of agricultural produce occurs due to inadequate and sub-standard storage facilities, lack of cold storage, and shortage of food processing for value addition and to improve shelf life (Bamji, 2008; Aworh and Egounlety, 2009). For instance, it is estimated that about 50% of perishable food commodities including fruits, vegetables, roots and tubers and about 30% of grains including maize, sorghum, millet, rice and cowpeas are lost after harvest in West Africa (Aworh and Egounlety, 2009), and in sub-Saharan Africa, losses range from 5 to 60% (IUFoST, 2003). Low purchasing power results in households consuming diets that are high in fat and carbohydrate and not fruit and vegetables (Drewnowski and Specter, 2004; Tanumihardjo et al., 2008); a situation resulting in serious nutritional problems.

Food security at the household level is a balance between availability and access at all times, to adequate, safe, nutritious and healthy food that meets dietary needs, including the various micronutrient requirements, and food preferences of every segment of the population (Rukuni, 2002; Aworh and Egounlety, 2009). In this regard, there is a need for complementary food security policies that will increase the probability of food access by the vulnerable groups. In-appropriate food processing technologies, inefficient post-harvest handling practices and inadequate or lack of storage facilities, packing

houses and market infrastructure are some of the factors responsible for high post-harvest food losses; major factors constraining food and nutrition security (Aworh and Egounlety, 2009). The authors proposed solutions to food and nutrition insecurity in Africa as (1) Adequate funding of institutions involved in food research and development; (2) increase in the funding of education, science and technology; (3) promotion of small-scale food industries and rural development; (4) proper management of resources and a genuine and sustained fight against corruption. There is no doubt that FST has made and continues to make tremendous positive impacts on the quality of life in the industrialised countries of Europe, North America and Oceania (Aworh and Egounlety, 2009). Therefore, it is not out of place to propose that FST education is the hope of African nations in achieving food security. Furthermore, the objective of FST education is to provide broad-based training in FST and graduates that are well grounded in the art, science and technology of food preservation and to achieve national goals and objectives of industrialisation, self reliance in the food and beverage industries, reduce post-harvest food losses and promote national food security (Aworh and Egounlety, 2009). In addition, FST can directly contribute to food security through enhancement of nutrient density; for instance, increasing protein density of cereal foods by fortifying with protein concentrate or a legume; increasing micronutrient density by fortifying one or more vitamins and/or minerals (Bamji, 2008). Turner and Seemann (2008) puts it better "if food technology is confused with, perpetrated as, or diminished in curriculum and teacher education to that of predominantly 'class-room cooking skills', and at the expense of innovation and design, knowledge and skills, then the collective effect on society would be undesirable and risky. FST curriculum through food innovation and supply ideas will address effectively the food insecurity in Africa.

Presently, in Africa there are institutions offering training in FST. However, there is no commensurate increase in funding and in the teaching and research facilities. Funding in most nations is provided predominantly by government with very weak industry-academia link-ages. Furthermore, there is little or no interaction between food industry and institutions offering training in FST in most African nations (Aworh and Egounlety, 2009). This obviously has adverse consequences for FST education and food research development. Consequently, there is a need for food industries in African nations to partner with academic institutions offering FST training.

EFFECTIVE PARTNERSHIP FOR FST PROMOTION FOR AFRICA

Gillies (1998) defined partnership as a voluntary agreement between two or more partners working cooperatively to achieving a set of shared outcomes. The shared outcomes in this case is to see FST education and training alive and thriving for the reason stated by Rastall (2009), that "the work of food scientists and technologists touches so many aspects of our relationship with food. Careers in food science will have a positive impact on the health and well-being of the nation, through the ready availability of good quality food. Future food scientists will be the guardians of the safety of the food we eat. They will be working on food security, conduct research on how the food we eat impacts on our health as well as advising food companies on the development of new products linked to optimal nutrition". FST institutions in most African countries enjoy the partnership of the government in terms of funding. However, partnership with the food industries is not so prominent. Down trend in FST impacts the food industry which directly impacts on any country's economy.

The food industry in Africa consists of the large foreign-backed companies and the medium-scale, the small-scale and the very small scale (as small as one person) enterprises owned by indigenous operators (Ladipo et al., 1986). Large-scale food industries financed through joint ventures with equity and loans from national and international financial institutions (multinationals) have a unique role to play in promoting FST through employment generation, value-added processing and training of skilled manpower. Small-scale food industries that involve lower capital investment and reliance on locally produced raw materials leads to rural development and agro-industrialization. These industries are vital to solving the problem of imbalance between the rural and urban areas and reducing post-harvest food losses and improving food availability (Ngoddy, 1988; Igene, 1992; Aworh, 1994). The activities of these industries will be halted if human capacity is compromised due to shortage of professional and technical skills needed; because employees skillful in food processing, preservation and packaging are required to deliver safe, nutritious, affordable and tasty food products to the consumer (IUFoST, 2003).

Napoleon et al. (2006) reported that in the US, many of the front-line workers within the food industry are non-degreed high school graduates. Majority of all workers in the US food industry are in the production environment as front-line supervisors, managers of production and operation, bakers, slaughters and meat packers, food batch makers, inspectors, testers, sorters and samplers. Other non-degreed employees occupy positions in the transportation sector and in service occupations as fast food and counter workers (BLS, 2010a). These employees do not necessarily need degrees in food science; however, they have a direct impact on efficiency of production within a company, on quality of products produced and in delivery of safe foods to consumers. An analysis of the training needs in food security by the South African Development Community shows that all sectors of the food processing and delivery system require

Table 2. Beneficial knowledge and skills for employees in the food industry[1].

Knowledge and skills	Content
Workplace and food safety	1. Workplace safety regulated by OSHA 2. Food safety regulated by USDA and USFDA 3. Good manufacturing practice (GMP)
Food and production systems	1. Knowledge of food systems from harvest to packaging 2. Knowledge of flow of materials in a production line 3. Knowledge of unit operations 4. Higher level of understanding about different processes.
Mathematical skills	1. Mathematical skills, understanding volume, proportions, percentages, measurements, net weights and so forth.
Professional skills	1. Technological competence 2. Cultural awareness 3. Work ethics

[1]Adapted from Napoleon et al. (2006).

human capacity development. A strong preference for all types of informal training such as on-the-job, mentoring and informal study for senior, mid and junior level employees was observed (IUFoST, 2003). Basic training in the concepts of food science and an awareness of food system will help increase employment opportunities and enhance productivity of employees (Napoleon et al., 2006). This scenario necessitates two-fold partnership between the industry and the academia; while the academia provides the much needed research and training opportunities and technical education to meet food industry needs, the food industry will provide grant support to the universities for research and promotional activities to attract more students into the discipline and facilitate the transfer of research results from laboratories to the marketplace.

A baseline study on South African graduates from the perspectives of employers indicate that there exists gap between employer expectations and higher education outcomes which has to do with proactive task-directed engagement and the application of knowledge (Griesel and Parker, 2009). Most employers desire a more formalized relationship between leaders of higher education and leaders in business; higher education-business association that will address these gaps on an on-going basis. Napoleon et al. (2006) outlined the current training needs and performance targets for non-degreed employees in the food industry (Table 2). Four major themes indicated as beneficial knowledge and skills for employees working in the food industry include workforce and food safety training, knowledge of food and production systems, learning and applying mathematical skills and professional conduct. The institutions offering FST education will develop integrated curriculum modules that will address the growing needs of the food industry and facilitate the development of employment skills required to function and prosper in the global economy. Food industries desire employees to “hit the ground running” (Napoleon et al., 2006; Griesel and Parker, 2009). That is, it will be ideal for employees to enter the job with basic awareness and knowledge of safety training, which could then be expanded and customized for specific functions particularly to each company. Food and production systems comprise of a broad range of higher order knowledge and skills including factual knowledge, understanding and applying procedures, analyzing problems and formulating solutions. Students should be engaged in practical mathematical applications and in problem solving, using modules developed to more specifically provide a practical application of the principle of mathematics. Technological competence include the ability to work with computers and various software packages, including word processing, spreadsheets and specific technical formulation software. What was lacking in most of the employees is the necessary translation between getting data generated by the computers in the processing line and understanding the importance of the data. Most employers desire that the potential employees enter with the ability to cope with changing environments, specific to technology, culture and work ethics (Napoleon, 2006; Griesel and Parker, 2009). Hence, the role of FST education must take its place in producing thinking, responsive and intellectually well-grounded individuals, who are flexible and can readily adapt to new demands and challenges.

The type of grant support developed through industry partnership with university scientists as outlined by Schweigert (1987) is given in Table 3. African food industries could support the course of FST in Africa through gifts, grants-in-aid, project grants and contracts and new product development projects. The gifts are unrestricted and the most desirable since the departments can utilize the gifts for support of teaching, research and public service programs. An interesting aspect of the university - industry research partnership that will be of huge benefit to the small and medium scale industries in Africa is that linked to a food processing pilot

Table 3. Food industry research interaction with the universities.

Food industry research interaction
Gifts
Grant-in-aid
Project grants and contracts
Projects to develop new products
Pilot plant use

Source: Schweigert (1987).

plant associated with a FST department in a tertiary institution. Opportunity is provided for any food industry group to use specialized equipment in the pilot plant for contractual conditions. In this regard, the Department of Food Technology, Cape Peninsula University of Technology is constructing a state of the art pilot plant that will serve both as a teaching and research plant as well as assisting the need of the food industry. This is probably the first of its kind in Africa and will go a long way to boosting food security in South Africa and hopefully Africa as a whole.

FOOD SCIENCE AND TECHNOLOGY AND ALLIED DISCIPLINES

Table 4 outlines the concerns, challenges and focus of the food related disciplines; home economics, dietetics, hospitality management and FST disciplines. Family and consumer sciences or home economics is an academic discipline which combines aspects of consumer science, nutrition, cooking, parenting and human development, interior decoration, textile, gardening and other subjects related to home management Anon (2010). The content of home economics is a synthesis of the physical, biological and social sciences, the arts, and the humanities as they are applied to the improvement of family living. The aspects of family living that concern the home economist include: (1) Family relationships and child development; (2) consumption and other economic aspects of personal and family living; (3) nutritional needs in the selection, preservation, preparation and use of food; (4) the design, selection, construction, and care of clothing and its psychological and social significance; (5) textiles for clothing and for the home; (6) housing for the family, and equipment and furnishings for the household; (7) art as an integral part of everyday life; (8) the management of resources so that the values and goals of the individual, the family or the society may be attained (Fleck, 1974).

Nutrition is the provision of the materials necessary to cells and organisms (in the form of food) to support life. The diet of an organism refers to what it eats. Dietitians are health professionals who specialize in human nutrition, meal planning, economics, preparation, and so on. They are trained to provide safe, evidence-based dietary advice and management to individuals (in health and disease), as well as to institutions (Wikipedia, 2008a). For example dieticians might teach a patient with high blood pressure how to use less salt when preparing meals or create a diet reduced in fat and sugar for an overweight patient (BLS, 2010b).

Hospitality management is the academic study of the running of hotels, restaurants, travel and tourism-related business (Wikipedia, 2008b). Most jobs are in hospitals, nursing care facilities, outpatient care centre and offices of physicians or other health practitioners. Hospitality means dealing with people (Barrows and Bosselman, 1999). The industry depends on the provision of successful service as a means of generating revenue, that is produces a commodity that is not tangible and cannot be seen (service) to people. Hence, the essence of hospitality industry is people interaction resulting in a less standardized product and a less controlled environment. Whereas in the manufacturing operations, assembly line can be stopped or product defect dealt with at a time, the entire hospitality industry is in constant state of making and delivery products. The food and beverage manage-ment along with the management of accommodation and facilities is the significant defining element in hospitality education and practice that lends hospitality management its distinctiveness in terms of that which is additional to a general business curriculum (Brotherton and Wood, 2008).

Food science is the discipline in which the engineering, biological and physical sciences are used to study the nature of foods, the causes of deterioration, the principles underlying food processing, and the improvement of foods for the consuming public. Food technology is the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe, nutritious, and wholesome food (Heldman, 2006). In practice, the terms food science and technology are often used interchangeably. Food science and technology is concerned with all technical aspects of food, beginning with harvesting or slaughtering and ending with its cooking and consumption. Examples of the activities of food scientists include the development of new food products, design of processes to produce these foods, choice of packaging materials, shelf-life studies, and sensory evaluation of the product with trained expert panels or potential consumers, as well as microbiological and chemical testing. FST therefore is a discipline in the science, innovation and design domain and not about the development of culinary skills and nutrition (Turner and Seeman, 2008).

Food scientists and technologists are specially trained to develop professional abilities, which are to be applied in the food industry. However, their expertise is essential in other areas such as raw material production, plant construction, legislation and government inspection, re-search and education, marketing, etc. A model of the food industry (Figure 1) comprise of the product, the process and the company. The core of the model is the food product which is the goal of food industry activities. Consequently,

Table 4. Food Science and Technology compared with other food related disciplines.

Discipline	Concerns	Challenge	Focus group
Food science and technology	All technical aspects of food beginning with harvesting or slaughtering and ending with its cooking and consumption.	1. Development of new food products 2. Design of processes to produce these foods 3. Choice of packaging materials 4. Shelf-life studies 5. Sensory evaluation of products with trained expert panels or potential consumers. 6. Microbiological and chemical testing.	Consuming public
Home economics/Consumer science	Study of human and material forces affecting homes and families and the utilisation of this knowledge for the benefit of mankind.	1. Serve more individuals and families and serve them more effectively. 2. Expand research and focus it on the needs of individuals and families. 3. Strengthen education for the profession.	Individuals and families
Nutrition/Dietetics	Human nutrition, meal planning, economics, preparation and so on	1. Provide safe, evidence-based dietary advice and management to individuals (in health and disease) as well as to institution.	Individuals (in health and disease)
Hospitality management	Practice of running hotels, restaurants, travel and tourism-related business	1. To provide the best amenities and comfort for guests.	Individuals in hospitality and tourism.

the study of the product, its composition, structure, quality and functions, is the core of FST discipline. The knowledge of the technological process systems and finally of the company system, is developed around this core. The study of FST is based on the study of the product, process and company resulting in the essential subjects for FST curricular outlined in Figure 1. FST is therefore a highly interdisciplinary applied science. It incorporates concepts from many different fields including microbiology, chemical engineering, biochemistry, and many others. Engineering ability is quite useful for aspiring food scientists (Vieira, 1996).

A coordinated campaign to improve public understanding of FST will require both short-term and long-term actions. The short-term focus should be on public awareness of FST through public relations and public affairs activities. Long term activities should focus on changes in the educational curriculum and improved teaching of mathematics and science in primary and secondary schools. If students are successfully engaged by mathematics, science, engineering, and technology in schools and their interest can be sustained through secondary school, the goals of having a more technologically literate populace and students educationally equipped to choose FST in higher institutions will be in hand. However, views of FST held by the public are based on information, misinformation, or lack of information, and it will take a generation to see the long-term positive outcomes. NAE (2002) is of the view that young people, beginning school, obviously, do not have these perceptions; and that they are clean slates and their perceptions can be molded more easily.

MODEL FOR PROMOTING FOOD SCIENCE AND TECHNOLOGY TO NON-PROFESSIONALS

An aspect of food common to all the food related professions is the food chain. In this article food chain refers to the path food takes from the primary producer (the farmer) to the consumer (the final link in the food chain). The 1900 food chain comprises of food raw materials (products of plant and animal husbandry and fishing) consumed as 'fresh' produce, processed into foodstuffs, or into ingredients for processing. These fresh and/or processed foods were essential commodities going on to wholesale markets, subsequently to retailers and the consumer, with little packaging or branding. Some raw materials or ingredients were stored prior to processing (Welch and Mitchell, 2000). Opportunities exist in the food chain for product loss through spoilage and spillage (IUFoST, 2003). Food chain became more complex by 1999 (Welch and Mitchell, 2000) to reduce post-harvest losses by introducing value added post harvest systems to stabilize food for effective food delivery. Processed food and ingredients are subjected to further processing to yield a range of more complex foodstuffs designed for specific niche markets. These changes resulted in increases in the range of available products and the ease of use by consumers.

The proposed model (Figure 2) uses the food chain (from farm to plate) to indicate the position of each discipline thereby clearly differentiating them. The food chain comprises of primary (farming), secondary (processing and distribution) and tertiary (retail) (Desjardins, 2006). The primary food processing is concerned with all

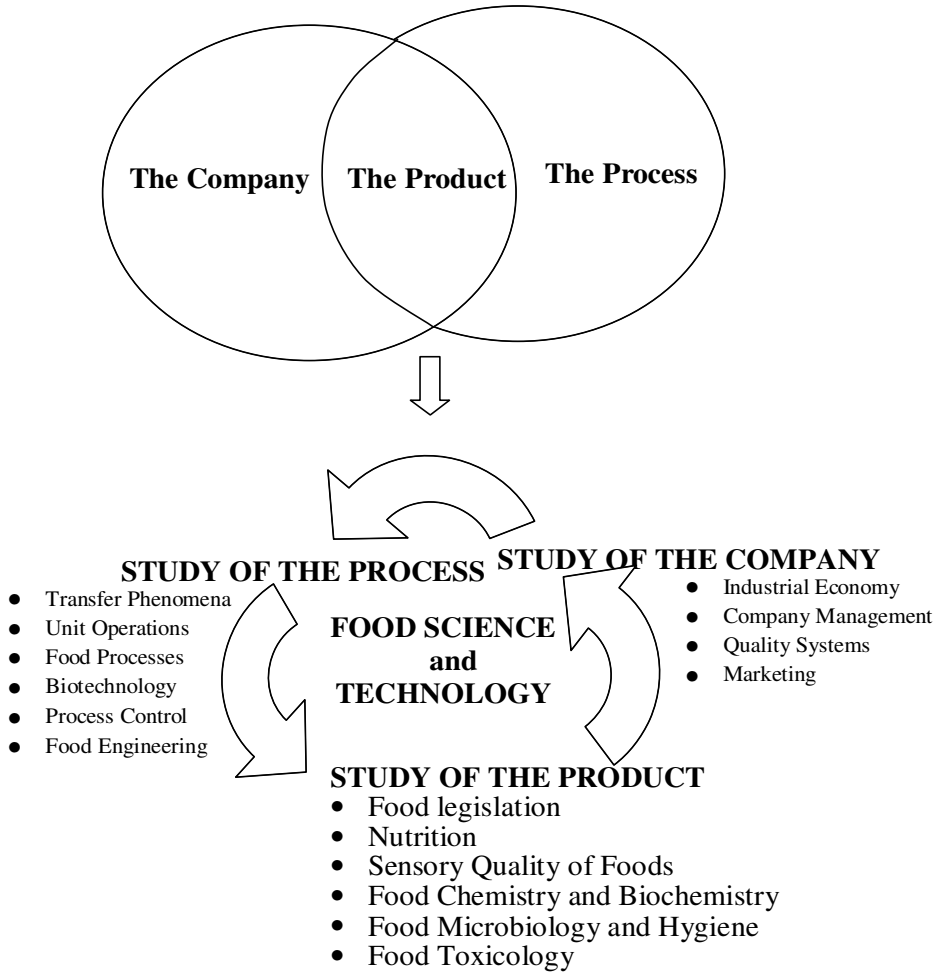

Figure 1. The model of food industry and components of food science and technology discipline

the manufacture of foods from agricultural commodity. All food materials are produced from farms (global food imports, greenhouses, commercial farms, local family farms or urban agriculture). As the fresh food leaves the farm gate it may be subjected to extended storage, prolonged transport, processed, portioned and packaged before supply to the market (Welch and Mitchell, 2000). The processing involves simple processing such as picking, trimming, washing, packing before distribution or distributed as fresh. The food may be distributed to stock-yard, abattoirs, storage facilities, warehouses, butchers, canneries, freezing facilities, marketing boards, food terminals, brokers, distributors and produce auctions.

The secondary food processing is concerned with the use of products from the primary industry as a raw material for further processing. The processing may involve preservation to increase shelf life, for example; pickling, canning, irradiation, freezing, drying, etc. yielding more complex foodstuffs. These changes have resulted in wide range of products available to the consumers (Welch and Mitchell, 2000).

At the tertiary stage through retailers (restaurants, institutions (hospitals, universities, schools), super-markets, small grocery stores, farmer/markets) the food gets to the consumers. Sometimes the retailers and even the consumers purchase directly from the farm.

FST positions itself at the secondary (processing and distribution) part of the food chain closer to the farm gate, (Jideani, 2002) providing its end product (food) for other disciplines to use while targeting the public. All the other food related disciplines operate at the tertiary stage (retail) directly with the consumer while depending on the products from FST. For FST education to achieve its awareness campaign in today's political and economic climates, food scientists needs to be more politically active through the professional societies and as indivi-duals to advocate more government and private support of the discipline (NAS, 1994). After all, the global call to combat global warming came as a result of coordinated efforts by individual scientists and their professional societies who insisted on and proved the need for greater government participation. The future of FST and the level of support to be received for research, education and training depend greatly on our activities today.

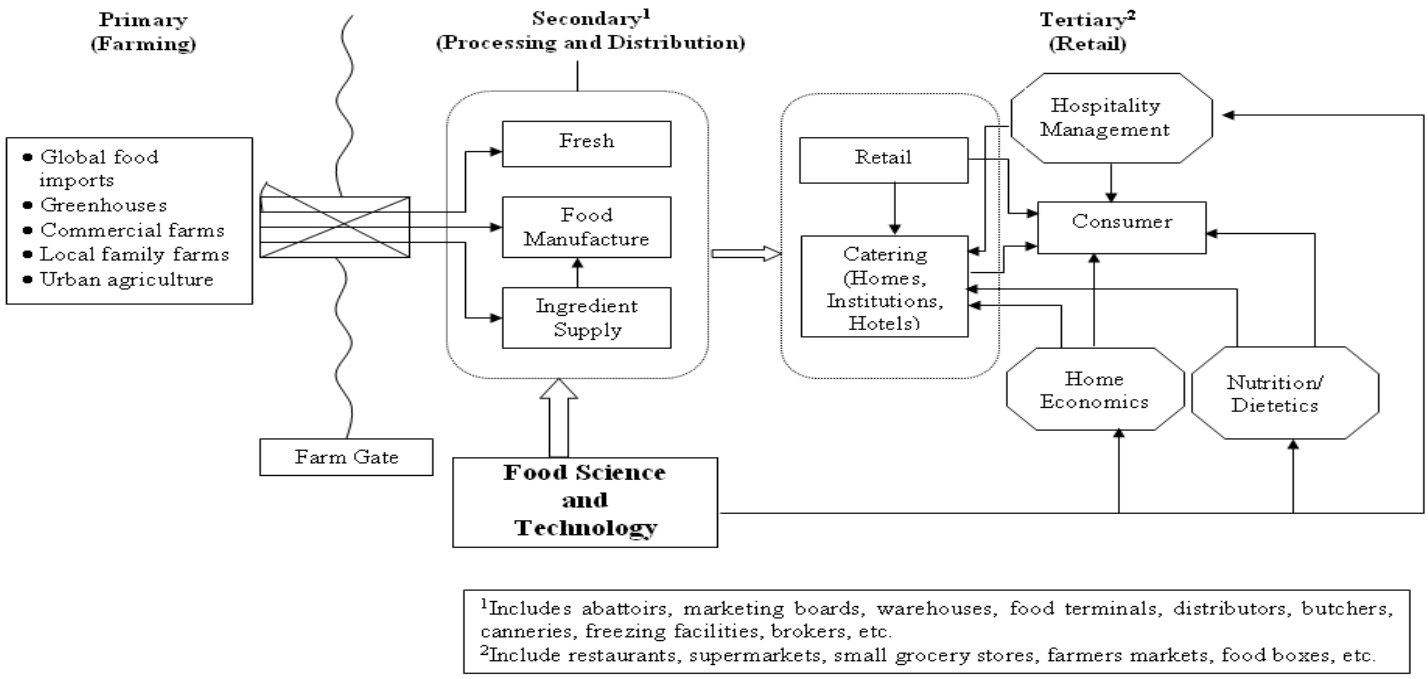

Figure 2. Proposed model for educating and promoting of food science and technology among high school students and the public.

CONCLUSION

The developed countries are putting systems in place to make sure their food industries do not stagnate due to shortage of well-trained, educated work force. The developing countries in Africa need to do more if they hope to overcome food insecurity. The proposed model in its simplicity will enable the poor image of food science and technology (FST) to be resolved and the proper understanding and objective of FST established among high school students, the public as well as the governments in African countries. A significant improvement in public awareness will require better coordinated efforts by FST organizations presenting consistent messages about the nature and value of FST.

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