International Journal of Emerging Engineering Research and Technology
Volume 7, Issue 6, 2019, PP 1-11
ISSN 2349-4395 (Print) & ISSN 2349-4409 (Online)

Contribution of Chemical Engineers to Enhance Agricultural Revolution to Stimulate Economic Growth for Nation's Development

Davies, Oluwadabobomi O.G.* and Obayomi, Kehinde .S

Department of Chemical Engineering, Landmark University, Omuaran, Kwara State, Nigeria.

***Corresponding Author:** Davies, Oluwadabobomi O.G., Department of Chemical Engineering, Landmark University, Omuaran, Kwara State, Nigeria, Email: oluwadabobomigrace@gmail.com*

ABSTRACT

The contribution of chemical engineers to enhance agricultural revolution to stimulate economic growth for nation's development cannot be over emphasized. Chemical Engineering is the bedrock of agricultural development and its neglect is a potential threat to the future survival of any country. Chemical Engineering is a growing area, a field that was practically non-existent in Nigeria 20 years ago especially in Nigerian Universities. Chemical Engineers have been driven increased technological development and agricultural revolution to stimulate economic growth for nation's development. Chemical Engineering has a major contribution to make to the required advances in sustainable farming and food production, in sympathy with the environment. It combines other engineering skills and innovation that takes a strongly multidisciplinary approach to agricultural problems. It has contributed to enormously for national economic development in the area of food production, reducing spoilage, giving foods greater shelf life, employment opportunities, industrial development, sustainable agriculture, enhance quality of life of farmers, advanced food processing technology, innovation in food purification, genetically modified foods, sterilizing and packaging perishable foods, natural resources conservation, reduction of drudgery in agricultural work and food security. New technology developed in controlling pests and weeds enhanced the optimization of chemical application, through novel atomization and improved spray handling, ensured target coverage and efficacy is optimized and losses to the environment reduced. The involvement of chemical engineers in research and innovation contributed to better agricultural productivity and sustainability in the developing and developed countries, through fresh insights and implementation of enhanced agricultural systems and technologies

Keywords: *Revenue, Food Production, Technology, Equipment, Sustainability*

INTRODUCTION

Agriculture as a sector play key roles in sustainability and profitability in food business. It involves interdisciplinary teamwork of other sectors; one of them is Chemical Engineering. Prior planting, disinfectant of seeds are conducted using chemicals, and also inputs such fertilizers, herbicides, pesticides are essential for crops production. The involvement of Chemical engineering into agriculture, more food is produced and the variety and type of food increase. It means there will be more food in the economy than what is needed for consumption. Agriculture used to be the largest contributor to the Gross Domestic Product in Nigeria prior independence; the sector engaged the highest number of labour, caused the country to earn foreign currencies, and made the country renown in the internationally (Ayanda and Ogunsekan, 2012).

Many a time's harvested products are sometimes treated with chemicals for preservation before being processed. Most of the perishable crops like fruits and vegetables require chemicals to ripening and preservation. Chemical Engineers have been described as the unsung heroes of a crucial industry. Farmers are the one sustaining the world's food supply, they depend majorly on the proficiency of interdisciplinary teamwork, who designs and implements essential farm machines, processing, infrastructures and other resources. Economic growth of a nation is a positive change in the level of goods and services produced by any country over a certain period of time.

A nation with sustainable economic growth will enhance national income, positive impact in employment rate and eventually improve living standards of the citizen. This study was carried out to consider beneficial contributions of

chemical engineering to Agricultural Revolution to stimulate economic growth for nation's development. This study was done by review literature examine the relation between Chemical Engineering and Agricultural Revolution in order to stimulate economic growth and development of a nation.

What is Chemical engineering?

Chemical Engineering involves several types of activities. Chemical Engineering is a key discipline for agriculture to convey global food security thereby enhanced productivity. They also use their creativities to influence various areas of technology by conceptualizing and designing processes for producing, transforming and transporting materials. Chemical Engineers make these possible by carrying out several experimentations in the laboratory that brings these materials to full scale production. Chemical Engineers work in manufacturing, designing machines and plants. They ensure that the processes run smoothly and in the most economical way possible. Most times Chemical Engineers are referred to as **Process Engineers**. Chemical Engineers are involved in the creations and manufacturing of different products, such as pesticides, insecticides, herbicides plastics, paper, dyes, medicines, polymers, fertilizers, petrochemicals, clothing and even many foods.

Chemical Engineers strive to advance production efficiency, design new equipment or modify the original equipment, conduct or supervise research for developing novel products, improving products or finding uses for the company's products. Sometimes they develop or upgrade automated systems to control measure or blend chemicals that feed into the production line. In some plants, Chemical Engineers prepare production cost estimates or actual production reports. Chemical Engineers design processes and equipment for large-scale manufacturing, plan and test production techniques and byproducts treatment, and direct facility operations. Chemical Engineers are responsible for developing procedures for the safe handling of chemicals and teaching those procedures to workers who handle the chemicals or work with equipment using the chemicals. They carried out tests on procured chemicals to ascertain qualities meet specifications, and they also test what the company produces for qualities assurance. They ascertain that operations relating to chemicals or by-products comply with standard regulations and laws as regards to environmental hazards.

Chemical Engineers adopt Ingenious application of scientific principles applied to invent, design and operate industrial chemical plants, build, sustain and advance structures, equipment, devices, systems, materials and chemical processes. Emergent employment opportunities for Chemical Engineers in the agricultural sector, energy and oil industries attributed to increase population, energy efficient and alternative energy sources. Their expertise in clean up or prevent pollution, safely dispose of toxic wastes, or manage a sewage treatment plant cannot be overemphasized. In fact, scores of companies preferred to hire services of Chemical Engineers to occupy various positions in environmental engineering, biotechnology and pharmaceuticals industries.

Manufacturing of drugs such as synthesize hormones, medical and surgical supplies they are engage. Many at times Chemical Engineering jobs overlap with many other fields. For instance, they are actively involved in designing and manufacturing computer parts and other electronics, and work closely with Electronic Engineers. They employed nano particles to purify contaminated groundwater and also work with other scientists in the area of DNA for gene and stem cell therapies (https://www.sokanu.com/careers/chemical-engineer)

Branches of Chemical Engineering

Many a times, Chemical Engineers are referred to as "Universal Engineers" due to their knowledge base and abilities are so broad. There is a diverse range of branches in Chemical Engineering as a discipline which involves (https://www.quora.com)

- Process Engineering and Design
- Advanced systems for Water Treatment and Distribution
- Computer Aided Process Plant Design.
- Environmental and Pollution Abatement Engineering
- Biochemical Engineering
- Pulp and Paper Engineering
- Oil and Gas Engineering
- Petrochemical Engineering
- Safety Engineering
- Reservoir Engineering
- Pharmaceuticals and Cosmetics

Job descriptions for Chemical Engineers

- Development of new and improved manufacturing processes through research
- Provide safety measures for those working with dangerous chemicals
- Inventive in processes for separating components of liquids and gases, or for generating electrical currents, through controlled chemical processes
- Design and plan the layout of equipment
- Carry out series of tests and monitor the performance of processes throughout production
- Identify and correct troubleshoot problems with manufacturing processes
- Appraise equipments and processes to guarantee compliance with safety and environmental regulations.
- Determine the costs of production for management.

AGRICULTURAL REVOLUTION IN ECONOMIC GROWTH AND DEVELOPMENT OF A NATION

Agricultural sector plays a crucial role in the process of economic development of any country. It is backbone of an economy which provides the basic ingredients to mankind and now raw material for industrialization. It contributes to the economic prosperity of developing and advanced countries. The economic history of many developed countries showed that agricultural prosperity contributed considerably in fostering economic advancement. The leading industrialized countries of today were once primarily agricultural while the developing economies still have the dominance of agriculture and it majorly contributes to the national income (http://www.economics discussion.net). The following are the roles of Agriculture to economic development.

ROLE OF AGRICULTURE REVOLUTION IN ECONOMIC DEVELOPMENT OF A NATION

Agricultural sector plays a crucial role in the process of economic development of any country. It is backbone of an economy which provides the basic ingredients to mankind and now raw material for industrialization. It contributes to the economic prosperity of developing and advanced countries.

The economic history of many developed countries showed that agricultural prosperity contributed considerably in fostering economic advancement. The leading industrialized countries of today were once primarily agricultural while the developing economies still have the dominance of agriculture and it majorly contributes to the national income (http://www. economics discussion.net). The following are the roles of Agriculture to economic development.

Source of Food Supply

Agriculture is the basic source of food supply of all the countries of the world. Due to fast growing population in developing countries and its rapid increase, the demand for food is on the increasing at a fast rate. Any failure in agriculture to meet the rising demand of food products, it is found to affect adversely the growth rate of the economy. Raising supply of food by agricultural sector has, therefore, very importance for economic growth of any country.

Pre-Requisite for Raw Material

Agricultural development is necessary to enhance the supply of raw materials for the agro-based industries particularly in developing countries. The shortage of agricultural goods has its impact on industrial production and a consequent increase in the general price level. It will slow down the growth of the country's economy.

Provision of Surplus

The advancement in agricultural sector gives surplus for increasing the exports of agricultural products. In the earlier stages of development, an increase in the exports earning is more desirable because of the constraints on the foreign exchange situation needed for the financing of imports of basic and critical capital goods.

Shift of Manpower

Previously, agriculture engaged a huge number of labor force. Agricultural development allows the drift of manpower from agricultural to non-agricultural sector. In the initial stages, the diversion of labor from agricultural to non-agricultural sector is more significant from the point of view of economic development as it eases the load of surplus labor force over the limited land.

Helpful to Reduce Inequality

In a country which is predominantly agricultural and overpopulated, there is greater inequality of income between the rural and urban areas of the

country. To reduce this inequality of income, it is necessary to accord higher priority to agriculture. The prosperity of agriculture would raise the income of the majority of the rural population and thus the disparity in income may be reduced to a certain extent.

Generate Effective Demand

The growth of agricultural sector tends to increase the purchasing power of agriculturists which will help the growth of the non-agricultural sector of the country. It will provide a market for increased production. In developing countries, it is well known that the most of the people depend on agriculture.

Reduction in Economic Depression

During depression, industrial production can be stopped or reduced but agricultural production continues as it produces basic necessities of life. Therefore, it continues to develop effective demand more importantly during adverse conditions of the economy.

Means of Foreign Exchange

Most of the developing countries of the world are exporters of primary products (agricultural produce). These products contribute 60 to 70 per cent of their total export earnings. Therefore, the capacity to import capital goods and machinery for industrial growth depends significantly on the export earning of the agriculture sector. If exports of agricultural goods fail to increase at a sufficiently high rate, these countries are forced to incur high deficit in the balance of payments resulting in a serious foreign exchange problem.

Contribution to Capital Formation

Developing countries need large amount of capital for its economic advancement. In the initial stages of economic progress, it is agriculture that displays a significant source of capital formation.

Employment Opportunities for Rural People

Agriculture gives employment opportunities for rural people even though the commercial farming is not quite engaged in developing countries. It is an essential source of livelihood.

Beneficial Contributions of Chemical Engineering to Agricultural Revolution

Chemical Engineers have contributed immensely to the grow of agricultural especially in the developing countries of the world.

Roles of Chemical Engineering Agriculture Revolution for Economic growth and Development of a nation

Some of the major contributions that can be ascribed to Chemical Engineers in boosting the agricultural revolution to stimulate economic growth involve:

- Invention of fertilizers, pesticides, and herbicides that protect and enhance fruit and vegetable growth;
- Development in food processing and packaging that enhances taste, appearance, and nutritional value and improving safety, convenience, and shelf life.
- Advances in technology that gives sterilization techniques to keep food against deterioration and people against food-borne illnesses.

Massive private and public investment in crops genetic improvement built on the scientific advances made in the developed world for the major staple crops such as wheat, rice, and maize and adapted those advances to the conditions of developing countries (Bouis, 2000). The developing world experienced an extraordinary period of food crop productivity growth over the past 50 years. The rising success stories of agricultural productivity growth in recent decades show that (*i*) agricultural development has shifted significantly and (*ii*) investments in research to address the crops, animals and constraints relevant to agriculture yield high returns In the developing economies, growing private sector interest in investing in the agricultural sector has created an agricultural revolution (Otsuka and Kijima, 2010)). Supermarkets are fast spreading across urban areas in growing economies and encouraging national and multinational agribusiness investments along the fresh produce value chains in the developing such as Nigeria countries (Jayne *et al.*, 2010). Traditional staple crops are diversifying into high-value horticulture and livestock production (Byerlee *et al.*, 2009).

Private sector has also made considerable investments in other commercial crops production for fiber and biofuel (Pray, 2001). These positive developments, interregional differences in food productivity persist in many emerging economies. Rising demand for feed and technological advances in breeding for stress tolerance crops and animals could result

in a revitalization of agriculture. Chemical Engineering thus directly and indirectly impacts on agriculture which helps in making it a productive and sustainable means to meet the increasing demand of human beings. It offers assistance in every level of agriculture making it a closely related stream to agriculture. The role of Chemical Engineering in agriculture is gaining importance with the increasing demand for agricultural outputs.

Achievements in Enhancing Food Production

The natural safety, convenience, availability, nutritional content, aesthetic appeal, and variety that characterize our food supplies are a feature of modern life. Through the concerted efforts of Chemical Engineers and others, the yields and quality of farm crops have increased greatly, and the industry manufacturing and packaging foods and beverages have grown into a lucrative business. Traditional food-related businesses comprise of small stores selling primarily fresh, locally grown foods with a short shelf life. Before modern engineering advances were widely adopted by the food industries, the variety of foods available at stores were determined by what was produced locally, seeing that transportation limitations determined the distance that perishable foods could travel.

Immense technological advancement in food production and processing were observed immediately after Second World War. This brought unique advances in the tools and techniques to enhance food safety, nutritional value and aesthetic appeal. Ingenious packaging options and sterilization methods were developed and also extending transportation distances and the shelf life of foods. The contribution of Chemical Engineering to know-how can be credited with improving the conversion of raw foodstuffs into safe consumer products of the highest possible quality. Chemical Engineers routinely develop advanced materials and techniques used for, among other things, chemical and heat sterilization, advanced packaging, and monitoring and control, which are essential to the highly automated facilities for the high-throughput production of safe food products.

Other key innovations in its history include conceive, design, test, and scale up revolutionary food-production and processing techniques. Dramatic advances in the scientific understanding and engineering techniques that enhances agricultural production and allow for the commercial-scale production of numerous processed foods through Chemical Engineers. Chemical Engineering unit operations and methodologies, developed for other industrial purposes, are employed by the food industries, involving drying, milling, extrusion, refrigeration, heat and mass transfer, membrane-based separation, concentration, centrifugation, fluid flow and blending, powder and bulk-solids mixing, pneumatic

Technological breakthrough

Technological change and innovations are important sources of structural change. Innovations lead to “creative destruction”, a process where agricultural business linked with old technologies decline and new sectors and firms emerge and grow (Verspagen, 2000). More productive and profitable agricultural business displaced less productive and less profitable ones and aggregate productivity in the economy increases. Over the years, technologies have been instrumental in the long-term rise in production of processed fruits and vegetables, dairy, meat and poultry, and seafood products, and enhance widespread distribution of such foods. The following are some of the most revolutionary improvements experience in food processing noted in the “Breakthrough of the Twentieth Century” by the Institute of Food Technologists (www.ift.org). The application of irradiation to control harmful bacteria in fresh and frozen poultry and meats, modified-atmosphere packaging began to be used widely and high-pressure processing was also commercially applied first to fresh packaged foods to kill microorganisms that cause spoilage without altering flavor, texture, or appearance were approved by U.S. Food and Drug Administration (www.fda.gov).

Crop protection

Crop protection is very important in agriculture. Disease affects plants and leads to delay in metabolic activities, stunted growth, shedding of flowers and fruits and at times cause death of the plant. The application of chemical control is the result of research. Despite the fact that, certain side effects are linked with some chemicals but it still remains most efficient ways of reducing pathogens. Fungicides are used to controlled fungal diseases. Bacterial diseases are controlled by particular antibiotics. Since viral diseases are difficult to eradicate special insecticides are used to control the insect vector transmitting the viral

pathogens. Laboratory researches have help in reducing animal disease which are detrimental to proper animal production. Chemical engineers are helping to protect crops against weeds, insects, and other pests. They have been involved in developing and synthesizing series of chemical compounds that function as pesticides to kill bugs as well as herbicides to kill weeds. Design of the industrial processes required to produce these compounds on a commercial scale was performed by Chemical Engineers. Pesticide efficacy, effectiveness and safety are being enhanced through new technologies and systems based on an understanding of fluid flow and dispersal in the natural environment.

Advances in chemical fertilizers

Farmers used fertilizer that produced scientifically in Nigeria for the improvement of their crop production. Various types of fertilizers have been produced such as nitrogen fertilizers to increase crop productivity that will stimulate economy growth. Presently, synthetic and organic fertilizers have been developed and these significantly increase crop yields. The use of organic and inorganic fertilizers improved food production as well as economic there boost agricultural revolution. This was made possible by applying the scientific knowledge acquired through Chemical Engineering.

Boosting the Attraction, Appearance and Taste of food

There have been a lot of inventions, positive development and success stories in the area of flavor, taste, texture, and appearance of food which have heighten consumers interest. Presently, a branch of Chemical Engineering is devoted to applying Science and Technology to enhance the taste as well as appearance of the food. A lot of researches have been carried out by Chemical Engineers are working closely with Food scientists to produce natural and artificial flavors and other food additives in large quantities. The unique, combined expertise of the scientists in this field has been directed towards the following:

- Improving food flavors and textures,
- Advancing nutritional value
- Enhancing the appearance of foods.

Some inventions have been in the areas of natural and artificial sweeteners and flavors. Foods in the recent times have also been improved through novel uses of different starches to advance texture and nutritional value.

Natural and Artificial Sweeteners

Refined sugar is developed mainly from sugar cane or sugar beets and has long accepted in the natural sweetener market. The commercial-scale production of refined sugar includes a series of chemical-engineering operations, which involve

- Milling shredded raw materials and mixing with water,
- Adding chemicals to adjust the pH level to control the acid content,
- Removing impurities,
- Crystallizing the sugar and drying it, and
- Treating wastewater.
- Currently high-fructose corn syrup, produced from cornstarch, has been used in foods and beverages. Production of corn syrup also needs many chemical-engineering operations, involving:
- Dry milling the corn,
- Reacting the cornstarch with enzymes, and
- Purifying by ion exchange.

High-fructose corn syrup is valued by food processors because it tastes sweeter than refined sugar and is produced as syrup, which makes it easier to blend into various foods and beverages.

Artificial sweeteners are modern chemical molecules that provide a sweetness level 500 to 600 times better than that of traditional sugar. They are widely valued and accepted by calorie-conscious consumers and diabetics who need to limit their sugar intake. Many of the chemical engineering expertise have improved the processes required to synthesize these compounds and produce them on a large scale production.

Starches

Starches from different sources are added into processed foods as a main source of nutritional carbohydrates. Starches are also regularly added to foods to act as thickeners, to improve stability, and to give a good “mouth feels” for the consumer. Chemical engineers have played significant role in effectively isolating the desired starch from cereal grain seeds, roots, and tubers. They are also accountable for engineering complex systems to produce user-friendly, free-flowing powdered starches in commercial-scale quantities.

Advancement in Sterilizing and Packaging Perishable Foods

Protective packaging systems are commonly used for products like fruits and vegetables and beverages. Prior, the advent of modern food-packaging technologies, foods available to consumers were limited to what could be produced and transported locally. Innovation of new packaging, Chemical engineers have offered opportunity to people everywhere to enjoy ample selection of foods. It is the responsible of Packaging engineers to design and optimise protective packaging systems that is sustainable. There have been synergies between Packaging engineers and consumers in creating and developing product's fragility and abreast of the supply chain and any environmental situations that can lead losses. Adoption of principles of engineering in packaging design and manufacturing is increasingly growing for developing optimal packaging systems for different types of products from pharmaceutical tablets to food systems. (https://www.ucc.ie/en/processeng/research/packaging/)

Sterilization in food-packaging operation is important. It is pertinent to sterilize foods to protect them against spoilage through oxidation, bacteria, and molds and this is a major bottleneck to engineering. Researches revealed the use of dehydration, smoking, salting, pickling, candying and the use of certain spices as a way reducing losses. Chemical engineers have made significant contributions to dipping spoilage and giving foods extend shelf life. These involves high-temperature pasteurization and canning, refrigeration and freezing, chemical preservatives. Innovative packaging techniques have been developed by chemical engineers to facilitate creating ample selection of fresher-tasting, longer-lasting foods, controls oxygen and carbon dioxide levels to slow ripening and to reduce spoilage. Some of the trendy packaging techniques are sterilization, vacuum packaging, and multilayered packaging. Multilayer packages enable heat sterilization right in the container. These specialized packaging enabled foods, fruits, seafood, and meat to be shipped over long distances and stored on the shelf for longer periods. These inventions have made products such as strawberries, mangoes, pear and kiwi fruit to be available in our markets year round.

Vacuum Packaging

Chemical Engineers have manufactured vacuum packaging to protect and preserved foods. The food is put into a gas-impermeable bag with air completely remove and the bag is sealed. This innovation reduces the oxygen level inside the bag so that microbes will not survive. Improvements on traditional vacuum packaging include controlled-atmosphere packaging and modified atmosphere packaging both of which indicate key chemical engineering breakthroughs in food processing.

Brick packs and Retort Pouches

The development of chemically sterilized brick packs is a avalanche contribution toward food safety and convenience. These multilayer packages are commonly utilized to package juice, milk, tomato sauce, and many other products to avert deterioration without keeping inside refrigeration. The innovative brick-shaped package is mainly manufactured from high-quality paperboard, plastic and aluminum. Flexible and laminated retort pouches are widely used for food preservation.

Inventions in Convenience Foods

Chemical Engineers have recorded tremendous breakthrough development in packaging and this will encourage farmers to increase on the production. Prepackaged, frozen, fast-cook, dehydrated, and microwavable foods are among the success stories and positive developments that provide fast-paced modern lifestyle more palatable. Chemical Engineers invented food-processing techniques giving highly nutritious brown rice, wild rice, beans, and series of crop seeds to be cooked promptly without losing their nutrient-rich outer layers. They are largely responsible for the development of the many automated processes used to produce today's easy-to-cook convenience foods.

Frozen foods

A lot of researches have been conducted by Chemical Engineers who developed processes to produce frozen foods retaining their appearance, texture, taste, and nutritional content when thawed and cooked. Chemical engineers revealed that rapid-freezing processes aid thawed foods to maintain their freshness. The blanching of vegetables by rapid freezing inhibits the enzymes that lead to discoloration and bad flavors. It involves flash freezing pieces of food, which enables them to preserve their natural characteristics when thawed **(https:// www.aiche.org)**

Purification of Foods

Food purification during processing operation is imperative to removing contaminants for

instance salts, metals, bacteria, fungi, and pathogens and thereby improving food quality, safety, aesthetics and boosting diversification of consumer markets . Membrane-based separation systems, developed by chemical engineers, and have now turned out to be the purification methods of choice for many food processors.

Most food ingredients and processed foods contain unwanted contaminants, for example:

- Fungi, and
- Other pathogens.
- Suspended solids,
- Dissolved salts,
- Metals,
- Bacteria,

Membrane-based separation

This technique uses pressure during food processing to force unwanted impurities out through a semi permeable membrane. Semi permeable membrane materials developed by chemical engineers include cellulose acetate, ceramics, and polymers. Numerous physical membrane configurations have been devised to separate unwanted solids and dissolved compounds from foods and beverages on a commercial scale. Membrane-based separation provides significant cost and performance advantages compared with such traditional separation techniques as centrifugation, vacuum filtration, and sand or diatomaceous earth filtration.

Different kinds of membrane-based separators use reverse osmosis, microfiltration, ultrafiltration, or nanofiltration systems based on the size and structure of the membrane pores. The size of the pores determines the size of the solid particles or liquid droplets that can be removed. Chemical Engineers are continually striving to develop more advanced commercial designs membrane-based separation systems that are more efficient, effective and cost-effective.

Safety of Foods

Contamination by microorganisms is the most common cause of food-borne illnesses and deterioration. Chemical Engineers produced commercial-scale sterilization techniques like high temperatures, high pressures and vacuums, and preservatives. Nowadays irradiation is used to kill microorganisms without losing the food quality, appearance, or nutritional value.

Battling the bugs

Chemical Engineers have committed significant effort to developing and commercializing technologies to control such microorganisms like Escherichia coli, Salmonella, and other disease-carrying pathogens. Presently, United State of America is one of the leading countries of the world that their food supply is the safest in the world.

Traditional methods

Eliminating microorganisms from meat and poultry, seafood, dairy products, grains, fruits, and vegetables decrease spoilage and protect consumers from food-borne illnesses. Traditional methods have not been effective compared to the advanced technology being used presently. The efficient and effective any process must possess the following:

- Kill microorganisms in great numbers;
- Cause no damage to meat proteins and other constituents;
- Function effectively and economically in large-scale operations; and
- Not affect food appearance, taste, texture, color, or nutritional value.

Irradiation

United State of America Food and Drug Administration was the first to approve the use of irradiation to kill disease-causing bacteria and parasites and spoilage-causing microorganisms. Presently more than 40 countries have adopted the use of irradiation of food and agricultural products. The process was created through synergy between Chemical engineers and Food scientists for effective process.

Genetic modification

The crossbreeding of plants over many generations was once required to produce foods with more desirable or enhanced traits. Now with techniques developed by chemical engineers, genetic materials can be quickly and precisely transferred from one organism to another. The resultant gives stronger and more nutritional products.

Plants that have been modified genetically may be used to produce crops with

- High nutritional content,
- Better resistance to herbicide and pesticide damage,
- Improved resistance to disease,

- Certain desirable traits (e.g., faster ripening or delayed softening).
- Lowered allergenicity.

Genetic modification is a procedure for changing the characteristics of a plant or organism to produce better desirable traits. For many years these changes were done by natural selection. Presently, there are of genetically modified foods that are being produced using an artificial form of DNA called recombinant DNA (rDNA). In simplest terms rDNA with a positive trait is transferred into an organism without that trait to create the desired improvement. The first agricultural genetically manipulated product was produced in the United States using rDNA and was introduced in the 1990s. A longer shelf life tomatoes plant was produced. The tomato plant was genetically modified to produce less of the enzyme that makes tomatoes to ripen and soften. Many other rDNA-modified crops, fruits, vegetables and grains have been successfully introduced with improved traits.

Roles of a chemical engineer in the food production and processing industry

Food production and processing essentially involves chemicals such as stabilisers, preservatives, artificial colours and flavours. Thus, the service could involve research, quality control, production. A good number of chemical engineers preferred working in food processing industry. Chemical Engineering plays an important role in agriculture as lot of plant protection activities depends on chemical. Inputs such herbicides, fungicides, pesiticides, nematicides fertilizers are major inputs used in agriculture which are presently in chemical forms. Chemical Engineering plays a key role in formulating different formulas in such manner that are easily available to plants and are very effective though applying in minute quantities. They were design to reduce the residual effect to improve the quality of the products

Today everyone wants to become healthy but no time or space to store foods naturally. Most recently people wants convenience, variety, nutritional content, availability in the food supplies. Thus, use of chemicals is increasing day by day in the food industry. Every process of the food industry is using the chemicals to protect the foods from the nineteenth century. Food industry used some limited chemical engineering process such as vacuum packaging, quick freezing processes, and others in the 19th century.

Presently, technological development and transformation brought high-quality materials, advanced tools, and techniques for the safety of foods and their nutritional value. This industry is adopting every operations and techniques used by other industries for the production of safe food products like heat sterilization, drying, refrigeration, concentration, membrane-based centrifugation, separation, milling, blending, pneumatic conveying, fluid flow, process modeling, monitoring, and control, powder and bulk-solid mixing.

To give acceptable flavor, appearance, taste, texture, nutritional value, the safety of different foods use the cooking over the fire, steaming, smoking, fermenting, sun drying, baking, or preserving with salt or spices.

These processes are carried out by chemical engineers. More importantly, these approaches are enhancing the aesthetic appeal of food, made possible longer distance transport for the multi-seasonal availability of some foods, and extending the shelf life of the foods. It inhibits the microorganism that causes food-borne illnesses. To complete the processing, the food industry needs chemical engineer experts, geneticists, chemists, and other experts in Chemical Engineering that help them to provide safety to the foods.

The chemical engineering played a major role in the food industry that modernizes the food processing. This modern food processing enhances the quality of life for people associated with food allergies. For instance we have sugar-free alternatives for diabetics, zero fat in the cooking oil, and many others.

Non-thermal process technologies

Non-thermal technologies are used primarily for foods where heating is not a good option due to flavour, texture and colour changes. However, better foods may be produced with high nutritional value. Some of these modern technologies have been investigated, including:

- high frequency pulsed electric field;
- high hydrostatic pressure;
- ohmic heating;
- microwave heating/radio-frequency heating;
- ultrasonic processes;
- infrared heating (IR); and
- UV disinfection (UV).

Nutraceuticals Food Product

In recent times, idea of enhancing one's is health through eating rightly is increasingly attracting the awareness of both consumers and researchers. Some food products that imparts positively on nutritional benefits are being introduced into the food industry and are likely to appear in the diets of modern consumers. A nutraceutical product is different from a naturally healthy foodstuff intended to formulate products with enhanced health benefits. Nutraceutical products involve the separation and purification of health-promoting compounds from unhealthy mixtures. Some compounds have been researched upon and recognized as causative to the prevention of diseases (heart disease, cancer and osteoporosis), and the healthy performance of the body. For example antioxidants, vitamins, minerals salts, fibre, probiotics (ebifidis and acidophilus), omega-3 fatty acids, phytochemicals and proteins with specific functions (https://www.sciencealert.com/food-engineering-for-the-future)

CONCLUSION AND RECOMMENDATIONS

Agriculture in developing countries like Nigeria encountered with a growing set of challenges: meeting the demands of diet diversity generating from fast rising incomes; feeding fast increasing urban populations; accessing technologies without hindrance; and increasing negative implication of climate change. Advancing the best of scientific knowledge and technological breakthroughs is crucial to stimulate economic growth for nation's development. Establish agricultural innovation and production systems to meet today's complex challenges. Chemical engineers have contributed immensely to agricultural technologies, particularly seed-based technologies. This technology has experienced a tremendous acceptance for sometime among the commercial farmers.

There have been a lot of concerted efforts to use modern techniques to improve the flavor, texture, nutritional value, safety, appearance and overall aesthetic appeal of various foods involving cooking over traditional practiced of using fire, smoking, steaming, baking, fermenting, sun drying, or preserving with salt or spices. Presently, effective engineered approaches have been adopted by chemical engineers such as routinely add nutrients, improve aesthetic appeal (in terms of a food's flavor, texture, and appearance), enable longer distance transport, extend shelf life, and remove microorganisms that lead to spoilage and are responsible for food-borne illnesses. Modern food processing have improved the quality of life for people with food allergies (by removing or neutralizing the proteins and other substances that create allergic reactions in certain people) and for diabetics (by reducing sugar content and providing sugar-free alternatives.

REFERENCES

[1] Arndt C., R. Benfica, F. Tarp, J. Thurlow, R. Uaiene. 2008. *Biofuels, poverty, and growth: A computable general equilibrium analysis of Mozambique*. IFPRI Discussion Paper 00803. Washington, DC: IFPRI.

[2] Ayanda, I.F. and Ogunsekan, O. (2012). Farmers Perception of Repayment of Loan Obtained from bank of Agriculture, Ogun State, Nigeria. Journal of Agricultural Science, 3; 21-27...

[3] Brittaine, R. and N. Lutaladio. 2010. Jatropha: A Smallholder Bioenergy Crop, The Potential for Pro-Poor Development. *Integrated Crop Management* 8–2010. Rome, Italy: UN FAO

[4] Bouis, H. (2000). Improving human nutrition through agriculture: The role of international agricultural research. Food Nutr Bull 21:550–567

[5] Byerlee, D., Janvry, A.D, and Sadoule,T. E. (2009).. Agriculture for development: Toward a new paradigm. Annual Review of Resource Economics 1:15–31

[6] Byerlee, D, and Fischer, K. (2002) Accessing modern science: Policy and institutional options for agricultural biotechnology in developing countries. World Dev 30:931–948.

[7] Edwin, J. and W. Masters. 2005. Genetic improvement and cocoa yields in Ghana. *Experimental Agriculture* 41: 491-503.

[8] Fafchamps, M., B. Minten, E.and Gabre-Madhin 2005. Increasing returns to market efficiency in Agricultural Trade. *Journal of Development Economics* 78(2):406-42.

[9] Fischer, G,, Shah, M, Tubiello, F.N, and Van Velhuizen, H. (2005) Socio-economic and climate change impacts on agriculture: An integrated assessment, 1990–2080. Philos Trans R Soc Lond B Biol Sci 360:2067–208.

[10] Jayne, T.S, Mather, D, and Mghenyi, E. (2010). Principal challenges confronting smallholder agriculture in sub-Saharan Africa. World Dev 38:1384–1398.

[11] Otsuka, K, and Kijima, Y. (2010). Technology policies for a green revolution and agricultural transformation in Africa. J Afr Econ 19:60–76.

[12] Pray, C (2001) Public-private sector linkages in research and development: Biotechnology and

[13] The seed industry in Brazil, China and India. Am J Agric Econ 83:742–747.

[14] Shelf Life and Packaging retrieve from https:// www.ucc.ie/en/processing/research/packaging.

[15] Verspagen, B. (2000), Growth and structural change: Trends, patterns and policy options. Paper prepared for the conference on "Wachstums- und Innovationspolitik in Deutschland und

[16] Europa. Probleme, Reformoptionen und Strategien zu Beginn des 21. Jahrhunderts", Potsdam, 14 April 2000. First draft, April 2000.

[17] Branches of Chemical engineering retrieve on 6/4/2018. https://www.quora.com/What-are-the-sub-branches-of-chemical-engineering. Achievements in Enhancing Food Production | AIChE *https://www.aiche.org*

[18] http://entrance-exam.net/major-role-of-chemical-engineering-in-the-agriculture-sector/#ixzz5CA6JkLf1

[19] http://www.economicsdiscussion.net/economic-development/role-of-agriculture-in-the-economic development-of-a-country/4652

Citation: *Davies, Oluwadabobomi O.G. and Obayomi, Kehinde .S, "Contribution of Chemical Engineers to Enhance Agricultural Revolution to Stimulate Economic Growth for Nation's Development", International Journal of Emerging Engineering Research and Technology, 7(6), 2019, pp.1-11*