

Challenges of food availability, policy and implementation and the role of CSIR agricultural sector in Science, Technology and Innovation in Ghana

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Abstract

New developmental issues that contributed to the recent increases in food commodity prices globally include new global and national policy initiatives, changes in the global agri-food business due to increasing agricultural costs of production and several other factors. Globally, food-price inflation is socially and politically sensitive because as a basic necessity, its absence results in hardships for many lower income consumers especially in the face of declining annual growth rate in the production of aggregate grains and oilseeds. Projections suggest that food prices are likely to remain high in the next few years with high prices expected to affect most developing country markets. In Ghana, inadequate research/extension linkages have affected food production volumes. The challenge of food availability in Ghana is multifaceted and is a microcosm of the entire Science and Technology (S & T) challenge facing the country. This paper discusses challenges of food availability in Ghana from both national and global perspectives, and the role of CSIR agricultural sector in Science, Technology and Innovation policy and implementation in Ghana. Recommendations of policies and implementation strategies are also discussed.

United Nations Millennium Development Goals

The 8 goals and 18 targets of the September, 2000 United Nations Millennium Development Goals (MDG) seek to eradicate extreme poverty, achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability and develop a global partnership for development.

The millennium development goals directly impacting on food are the eradication of extreme hunger and poverty (Goal 1), so as to halve the proportion of people living on less than one dollar a day and also halving malnutrition; promotion of gender equality and empowerment of women (Goal 3), in addition to eliminating gender disparity in primary and secondary schooling; reduction in child mortality (Goal 4), thus cutting the under-five death rate by two-thirds. Today 850 million people are food insecure. Achieving food security requires adequate food availability, access, and use (World Development Report, 2008).

The Global Food Outlook and Challenges in the Food Sector

New developmental issues that contributed to the recent increases in food commodity prices globally include new global and national policy initiatives, changes in the global agri-food business due to increasing agricultural costs of production resulting in slower growth in food production, rising energy prices, reduced agricultural research and development by governmental and international institutions, depreciation of the US dollar/ growing foreign exchange, biofuel

production from food crops, high cost of fertilizer, drought/severe weather conditions in 2006 and 2007 in some major grain- and oilseed-producing area; holdings by major food-importing countries; rising global demand and falling supplies of food; and changing food consumption patterns and preferences with increased meat consumption that demand more grains meant for human consumption being diverted for animal feed. Inclusive are policies recently adopted by some exporting and importing countries to mitigate their own food price inflation, trade policies and international developments.

Effect of increasing oil pricing on food commodity prices

Globally, food-price inflation is socially and politically sensitive because as a basic necessity, its absence results in hardships for many lower income consumers especially in the face of declining annual growth rate in the production of aggregate grains and oilseeds.

The annual growth rate in the production of aggregate grains and oilseeds has been slowing. Between 1970 and 1990, production increased to an average 2.2 % per year (FAOSTAT, 1974). Since 1990, the growth rate declined to about 1.3 %. Between 2007 and 2008, the hike in food commodity prices rose 52 %; but as of March 2008, there was surge in maize and rice prices due to increased oil pricing that caused the price of food commodities to further rise to 98 %. While the index for all commodities rose 286 % that for crude oil rose 547 %. Consequently, projections of USDA's 10-year agricultural plan for U.S. and world agriculture proposed a declining rate of 1.2 % per year between 2009 and 2017 (IFPRI Impact projections, June 2001).

The quest for biofuel (ethanol and biodiesel) production from staple crops which would otherwise serve as food for humans has affected the availability of food globally. For example, as sugarcane is used in Brazil for ethanol production, corn is used in the USA; while in China cassava and sweet potatoes are used. Whereas the European Union biodiesel is produced from rapeseed oil, Brazil and Argentina use soybean oil while Canada biodiesel is produced from rapeseed.

Energy policies affecting food processing and storage

The hike in food commodity prices rose 52 % between 2007 and 2008. Factors contributing to the recent increases include slower growth in food production, more rapid growth in demand, increased global demand for biofuels feedstock, adverse weather conditions in 2006 and 2007 in some major grain- and oilseed-producing areas, declining value of the U.S. dollar, rising energy prices, increasing agricultural costs of production, growing foreign exchange, holdings by major food-importing countries, changing food consumption patterns and preferences (meat consumption vrs grains for animal feed), policies adopted recently by some exporting and importing countries to mitigate their own food price inflation, trade policies, weather and international developments (D'iaz-Bonilla, E. and Reza, L., 2000).

Old and new global food and nutrition problems

Previous global food and nutrition problems that affected millions of people in the world included hunger emanating from deficiency of calories and protein; underweight caused by inadequate intake of food and frequent disease; micronutrient deficiency caused by deficiency of vitamins and minerals; and overweight to chronic disease caused by unhealthy diets and lifestyle.

However the new global problems affecting world populations currently include biofuel caused by use of food crops for energy sources, oil problem caused by conflicts/wars, food pricing/production caused by reduction in available food crops; and disasters caused by multiple factors such as Tsunami resulting in death and displacement; erosion, earthquakes, floods, droughts and environmental degradation (UN/SCN, 2004; FAO, 2005a; Micronutrient Initiative and UNICEF, 2005).

The situation of food and nutrition problems in Sub-Saharan Africa is particularly dire with the number of hungry people increasing by 20% since 1990. This has been further worsened by increase in the population of the developing countries (80 % of the global total), and an increase of over 50 million per year. Asia has the highest absolute growth with 2.6 % population growth per year, while Africa has the steepest rate (Reezal, 2008).

A world of less poverty, greater food security, and a healthier environment is possible only with explicit policy steps in that direction. For example, from indications that political decisions/will expressed in the Maputo Declaration (2003) where African Governments undertook to allocate at least 10 % of their budgets to agriculture and rural development showed only one country in five has reached or exceeded the 10 % level (African Union report on implementation of the Maputo Declaration). Trends should also include important changes in the international trade of processed and high-value added food products from developing countries.

Projections in the global food sector

Projections suggest that food prices were likely to remain high in the next few years with high prices expected to affect most developing country markets. However, it is pertinent to note that although the food market situation differs from country to country, the uncertainty of future evolution remains very high (Sachs, 2008; www.SciAm.com/jun2008). Given the amount of uncertainty, the resilience of the world's food system will be severely tested in the next few years and policy-makers may have to return to thinking about food as a strategic asset and begin to modify food policies (World Economic Forum, 2008) to feed the current six billion world population.

High prices are likely to stimulate a supply side response where the market signals are transmitted to food producers who have capacity to increase production and, where existing transport and market infrastructure allow, to supply the market (FAO, 2008a). This may represent an important opportunity for promoting agricultural and rural development in many low-income countries like Ghana, provided an enabling policy environment and supportive measures are established quickly.

Factors underlying the current state of the global food markets appear to be the confluence of different forces which have created the unique developments that have been observed since 2006. Although some studies have attempted to quantify these factors, it is however difficult in this instance to quantify such factors which have contributed to these events. Among the most important factors are (FAO, 2008b):

1. The strengthening of linkages among different agricultural commodity markets (i.e. grains, oilseeds and livestock products) as a result of rapid economic and population

growth in many emerging countries. This trend is likely to continue and it will affect the market dynamics both in developed and developing countries.

2. The strengthening of linkages among agricultural commodity markets and others, such as those of fossil fuels;
3. Biofuels and financial instruments that influence not only the costs of production of agricultural commodities but also the demand for them.
4. *The depreciation of the US dollar against many international trading currencies:* Most agricultural commodity prices are quoted in US dollars and the significant decline in its value against many currencies over the recent years has had critical effects on certain developments in the agricultural markets
5. *Weather-related production shortfalls:* Poor weather in many countries whose agricultural output is dependent on the weather has adverse effects on food availability. For example the severe drought in Australia, one of the world's largest wheat producers, has cut into global wheat production.
6. *Stock levels:* Since the mid-1990s, there has been a gradual reduction in the level of stocks, mainly of cereals. This supply side factor has had a significant impact on current markets with global stock levels declining, on average by 3.4 % per year, as demand growth has outstripped supply. Production shocks at recent low stock levels contributed to setting the stage for rapid price hikes.
7. *Increasing fuel costs:* High energy prices have made agricultural production more expensive by raising the cost of mechanical cultivation, inputs such as fertilizers and pesticides, and also transportation of inputs and outputs (Joachim von Braun, 2008a).
8. *Changing structure of demand:* the growing world population is demanding more and different kinds of food. Rapid economic growth in many developing countries has pushed up consumers' purchasing power, generated rising demand for food, and shifted food demand away from traditional staples and toward higher-value foods like meat and milk. This dietary shift is leading to increased demand for grains used to feed livestock (Joachim von Braun, 2008b).
9. *Operations on financial markets:* Market-oriented policies are gradually making agricultural markets more transparent to the extent that they affect the decisions of farmers, traders and processors of agricultural commodities. The abundance of liquidity in certain parts of the world that reflect favorable economic performances, coupled with low interest rates and high petroleum prices, make derivative markets based on agricultural markets a magnet for speculators looking to spread their risk and pursue more lucrative returns.

The Ghana Situation and Critique of Ghana's Food Policy and Strategies

In Ghana we do not use biofuels, so we should not hide behind failures in our agricultural policy to blame biofuels and the global food crisis. The problem is the lack of ST&I policy to drive development in the country. Political decisions/will expressed in the Maputo Declaration in 2003, where African Governments undertook to allocate at least 10 % of their budgets to agriculture and rural development has not been adhered to strictly. Only one country in five has reached or exceeded the 10 % level as reported in the African Union report on implementation of the Maputo Declaration.

The problem of food insecurity seems to be a political one. For example in the 1990s, the Ministry responsible for Science and Technology was named the Ministry of Industries, Science and Technology (MIST) which was changed to Ministry of Environment, Science and Technology (MEST), then to Ministry of Environment and Science (MES), then to Ministry of Education, Science and Sports (MESS); with science sector being combined with two equally large sectors as Education and Sports overshadow the issues of S & T. Thus non-partisan commitment to S & T is recommended to effectively project issues related to Science and Technology. Presently however, the Ministry has been renamed MEST.

In Ghana where politicians have a four-year renewable mandate within which they want quick results from the electorate to showcase for further eligibility into office, political parties therefore do not embark on funding S & T because it requires longer periods for the manifestation of results. Strong commitment/political will from the corridors of power in Ghana towards S & T would be the avenue to ensure that constructive policies are implemented. Nobel laureate Amartya Sen once indicated that *'even small changes in food prices can push the poor into hunger and destitution: some of the greatest famines in history were caused not by massive declines in grain production but rather by losses in the purchasing power of the poor....due to poor policies.'* The race against hunger can be won, but only if the necessary resources, political will and correct policies are put in place (State of the World Food Insecurity, 2006).

The challenge of food availability in Ghana is multifaceted and is a microcosm of the entire Science and Technology (S & T) challenge facing the country. At present, science, technology and innovation has not been widely acknowledged as a very significant public policy issue in Ghana. Policy makers in Ghana have not fully recognized the importance of innovation to Ghana's competitiveness (Yawson, 2004).

There are several issues that need to be thoroughly explored. Methodology to assess Ghana's national innovation performance is necessary. Ghanaian policy makers need better knowledge of processes of innovation and technological change to assist Ghanaian firms to become more innovative, and consequently achieve greater international competitiveness. They also need to be advised on methods likely to stimulate innovation, and produce greater social benefits and more effective commercial outcomes from Research and Development (R&D) and other innovation investment.

Currently there is little data on investment by the private sector in S&T from which to draw any meaningful conclusions. The level is, at present, very low or non-existent. The developing Ghanaian industry imports technologies mostly embedded in production equipment and processes, with very few moving on to adapt and develop their own technologies. In the public sector, foreign donors are the major sources of technologies and the funding to adapt and develop some basic technologies.

Although many of the institutes run by government ministries are described as research institutes, it appears the immensity of their activities are scientific and technical services: that is not to say that there is no research and innovative activities being undertaken. Thus the Ghanaian national system of innovation is, at present, primarily an S&T services system. At this time the

primary policy interest must lie in considering S&T investment and in measuring S&T inputs and outputs.

In order to promote economic development and reduce poverty, a number of policies and programmes have been formulated for the Agricultural Sector since the early 1990s. These include the Medium Term Agricultural Development Programme (MTADP) and the Accelerated Agricultural Sector Development Strategy (AAGDS). In 2002, the Food and Agricultural sector Development Policy (FASDEP) was formulated as sector wide approach programme to provide a holistic framework for food and agriculture that will take cognisance of all on-going efforts and individual projects in the Agricultural Sector. FASDEP was based on the recognition that “Ghana cannot achieve its planned economic growth and poverty reduction without significant improvement in the performance of the agricultural sector” There is however, no STI policy frameworks of which these agricultural policies are embedded resulting in a critical disconnect.

Agricultural biotechnology is expected to contribute significantly toward poverty reduction and food security in Ghana through increased productivity, lower production costs and food prices, and improved nutrition. This is because much of public sector R&D has emphasized simple, low cost technology appropriate for poor farmers in the rain fed and marginal areas, despite human resource and financial constraints that hinder progress. Raising productivity could increase smallholders’ incomes, reduce poverty, increase food access, reduce malnutrition, and improve the livelihoods of the poor. This in turn will reduce farmers’ crop protection costs and benefit both the environment and public health. A real problem is how to provide adequate incentives for crop breeders to focus on orphan crops and adaptations to difficult environments, which are of greater interest to poor farmers. Unfortunately, to date Ghana has no working biotechnology policy. A comprehensive biotechnology and biosafety bill prepared by the National Biosafety Committee with support from the United Nations Environmental Program (UNEP) since 2004 has still not been implemented.

Another challenge to food availability in Ghana is the markets. There are serious and fundamental constraints on the operation of markets in Ghana at all levels. The vast majority of the constraints at the national level arise because of costs imposed on businesses by Government (Yawson *et al.*, 2006). Weak, inefficient administration by the public service translates into time, money, risk and inefficiency for individual businesses. This in turn affects Ghana’s competitiveness in global and regional markets.

The issues can be categorized as follows:

1. Poor service delivery to the private sector (for example poor road maintenance resulting in delicate crops for export either being damaged on their way to the airport/seaports; or even deteriorating due to delays in arrival at the designated time).
2. Too much bureaucracy (for example at the ports or when registering a business) causes undue delays.

Addressing constraints on the operation of markets at the national level is a critical area for Government intervention. Improving the operation of the market at a national level will improve competitiveness and thus enhance access to global and regional markets. Tackling constraints at the firm level, although important, will be of limited effect without at the same time tackling the systemic issues of the mal-functioning of national markets.

Inadequate research/extension linkages in Ghana: the role of CSIR agricultural research institutes

In Ghana, inadequate research/extension linkages have affected food production volumes to benefit both the farmers and populace. The role of such linkages is recognised under the Growth and Poverty Reduction Strategy II (2006 – 2009). However, the Government does not vigorously fund it. Previously more than 75 % of the country's farmers used improved crop varieties and agronomic practices released by agricultural research institutes of the Council for Scientific and Industrial Research (CSIR). The lack of support of research institutions by Government in the area of food production, processing and preservation to achieve food security has caused gross reduction in the projected annual quantities. Government's lack of subsidising some inputs eg fertiliser under the Ghana GPRS II (2006 – 2009) in order to increase productivity such as removal of all agricultural input subsidies for staple food crops has severely crippled especially the three northern regions and Ghana as a whole in food productivity and availability.

Science, technology and Innovation in CSIR agricultural-based institutes to mitigate current food crisis

Food related research institutions of the Council for Scientific and Industrial Research (CSIR) include CSIR-Food Research Institute (CSIR-FRI) which deals with processing and preservation of foods. Other food commodities are animals (CSIR-Animal Research Institute, CSIR-ARI), crops (CSIR-Crops Research Institute, CSIR-CRI), Oil Palm (CSIR-Oil Palm Research Institute, CSIR-OPRI) and cereals and grains (CSIR-Savannah Agricultural Research Institute, CSIR-SARI).

CSIR-Food Research Institute

In the area of reduction in child mortality CSIR-FRI through S & T has produced affordable high protein-energy foods for the low income group and the vulnerable groups of society. Weaning foods were also produced from affordable and available raw materials such as bambara groundnuts and soybeans as substitutes for more expensive imported formulations. Enhanced nutritional status of children through household utilization of technologies combined high protein and carbohydrate content of bambara groundnuts to reduce the rather widespread micronutrient deficiencies eg. Protein Energy Malnutrition (Hidden Hunger) in Ghana.

Micronutrient deficiencies pose a vast global health problem in Ghana. Vitamin A deficiency, iron deficiency anemia, and zinc deficiency increase the probability of early death for children and women, impair IQ development in children, and lead to a large loss in quality of life, productivity, and economic growth in developing countries. Iron deficiency anaemia affects 70 % of non-pregnant women in India and almost 50 % in Sub-Saharan Africa. Vitamin A deficiency also affects the immune system of approximately 40 % of children under five years of age living in developing countries, leading to approximately 1 million child deaths every year. In some countries the impact is more severe; in India almost 60 percent of preschool children suffer from vitamin A deficiency (Micronutrient Deficiency and UNICEF, 2005).

Eradication of extreme poverty and hunger through R & D and innovations that relate to the processing and utilization of crops that constitute the livelihood of rural poor will help increase

food security and income for these people. Also these household-based technologies produce indirect positive effect of improved income that progressively reduces child mortality.

CSIR-FRI has over the years supported the establishment and development of small- and medium-scale food processing industries with the design and fabrication of appropriate equipment such as high performance hot air dryers, flour sifters, cassava graters, hammer mills, and other food processing equipment. This has helped various local food processing industries to establish their businesses whilst saving on imported alternatives to these equipment. Over 100 start-up and SMEs have benefited from the construction of the equipment either directly or through NGOs such as ADRA, TechnoServe, etc. On improved rice processing methods, CSIR-FRI has collaborated with the Department for International Development (DFID) to promote livelihood security for farmers in Ghana so as to boost production.

CSIR-FRI has adapted and fine-tuned the technology of glucose syrup production from cassava for the manufacture of biscuits and confectionery as well as its use in soft drinks manufacture, frozen fruits and other food products, as well as in the pharmaceutical industry. Over 100,000 metric tons of glucose syrup is imported annually into Ghana. Other food products include *fufu* flours, high quality cassava flour, fermented maize meal, and weaning foods. The local production, use and export of some of these products constitute a large saving on foreign exchange for the country.

To promote gender equality and empower women has been engaged in processing some crops and agricultural activities that are the sole preserve of women; eg fish smoking and cassava processing. Technologies developed to enhance production and processing activities will empower women with job opportunities, enhance their employment status and provide income. Some of the technological innovations are aimed at drudgery alleviation in production and processing especially for women. Ease of production and processing will promote gender equality as far as these activities are concerned. In the area of improved maternal nutrition and health, household utilization of some technologies have been developed and promoted. To ensure environmental sustainability, reduction in the use of wood as fuel in household processing of foods by technologies that reduce cooking time and therefore less fuel wood use (to reduce forest degradation) have also been introduced in Ghana eg. fish smoking.

CSIR-Crops Research Institute

CSIR-CRI has used research and development through S & T to develop new varieties of crops which are pest, streak and drought resistant and high-yielding which are released to farmers through the Ministry of Food and Agriculture (MoFA). For example, improved maize varieties include Quality Protein Maize (QPM) such as *Obatanpa* and *Mamaba* for human consumption. Streak resistant Yellow QPM for the poultry industry has been developed with a 79 % internal rate of returns (Aflakpui, 2006).

In the area of legumes, soybean varieties such as *Anidaso*, *Salintuya* I & II, *Bengbie* and CRI-*Ahoto* were developed. Groundnut varieties that are rosette resistant include CRI-*Azivivi*, *Jenkaar*, *Nkosour*, *Adepa*; *Kpanielli* and *Gusie Balin*. Cowpea varieties include *Adom*, *Asetenapa*, *Ayiyi*, *Apagbala*, *Vallenga* and *Marfo tuya*. High yielding, disease resistant rice varieties with a capacity of 5t/ha has been developed and which have comparable quality to

imported long grain rice. The *Sawah* system of rice cultivation which is ten times more productive is in use.

Root crops like high yielding, pest and disease resistant cassava varieties with high starch content (20 - 25 %) such as *Afisiafi*, *Gblemoduade*, *Abasafitaa*, *Agbelifia* has been developed by CSIR-CRI to support the Presidential Special Initiative (PSI) and for local consumption.

A pepper variety (*CRI-Shito Adope*) released by CSIR-CRI is processed into paste for export as Tropicana Pepper Paste, and has characteristic red pepper colour before and after packaging, with no artificial colours added.

Yam varieties (*CRI-Pona*) produced have excellent taste, nice aroma, are mealy and resulting in multiple tubers are suitable for *ampesi* and *fufu*. Superior sweet potatoes varieties rich in Vitamin A to control deficiency disorders include *Okumkom*, *Sauti*, *Faara* and *Santom Pona*. The varieties are suitable for French fries, fufu and flour. Sweet potato starch produced also serve as either disintegrant (agents added to tablets to promote break up in aqueous medium), binder (agents that impart cohesiveness to tablets to ensure they remain intact after compression) and also as filler (agents that increase the bulk of the substance for convenient handling).

Plantain and banana varieties developed include *Apem hemma* and *Kwadu bempa* respectively; and are hybrids tolerant to Black Sigatoka disease. Manipulation Technique (BMT) for mass production of planting materials has also been developed to boost food production and enhance security.

CSIR-Oil Palm Research Institute (CSIR-OPRI)

The development of oil palm planting materials with 500 % increase in fresh fruit bunch resulted in over \$32 million savings in import substitution for germinated nuts. Between 1969 and 2002, over 160,000 ha were developed with CSIR-OPRI planting material with early warning system for leaf miner control. Resistant coconut varieties being developed to Cape St. Paul Wilt disease with modified controlled pollination system for the production of Vanuatu Tall seed-nuts and with pollen production estimated to save \$40,000 per year in pollen imports were reported. Management of beetles in young palms was also pursued.

CSIR-Animal Research Institute (CSIR-ARI)

Pigs and well-balanced grower-finisher diets for weaners using AIBPs (palm kernel cake) has been developed to increase meat protein diet of Ghanaians. These were cheaper than other commercial diets and resulted in increased growth rate and faster achievable slaughter weight (at least by 50 %) than other current methods. Formulated concentrate for dairy cattle showed milk yields of supplemented cows increased over 40 % of those not supplemented.

A feeding package for growing finisher cattle was also developed. Reduction in cost of mortality by 60 – 80 % has been effective through the control of large round worms in cattle. In the area of animal diseases, Newcastle vaccine which saves between 2.8 and 4 million birds annually was produced; with Gumburo vaccine providing life-long protection of chicken. Worm packs for the control of worms in small ruminants were also developed through S & T.

CSIR-Water Research Institute (CSIR-WRI)

Nile tilapia which grows 20 % faster than the wild stocks and a protocol for production of mudfish fingerlings leading to increased survival of juveniles has been developed by CSIR-WRI. A polyculture of mudfish and tilapia was formulated through ST&I for maximum output. Also through S&T and Innovations, traditional technologies have been upgraded to reduce environmental pollution of rivers and streams from waste from palm oil, coconut oil processing and also from other industrial effluents.

CSIR-Savannah Agriculture Research Institute (CSIR-SARI)

CSIR-SARI has researched variously into cereals and grains which have been used to maximise production especially in the three Northern regions of Ghana.

Proposals/Way forward

Proposals for the way forward (Policy Responses to Rising Food Prices) are:

1. Protective policy measures designed to reduce the impact of rising world food commodity prices on our own consumers.
2. Certain exports must be discouraged so as to keep domestic production within the country.
3. Increase in domestic food supplies and restrain of increases in food prices.
4. Elimination of export subsidy on certain products.
5. Imposition of export tax on food commodities/Imposition of quantitative export restrictions on certain food commodities.
6. Ban on exports of some food commodities.
7. Reduction of import tariffs on certain commodities.
8. Subsidizing consumers by buying food commodities at high world prices and subsidising their distribution to consumers.

Recommendations of policies and implementation strategies

1. Encouragement of good governance and rule of law as prerequisite for development using S&T.
2. Adequate theory and practicals in Science education in primary, JSS and SSS should be pursued. Facilities for science education especially at the tertiary levels are outstretched so that practical work is limited and insufficient for any meaningful impact.
3. A critical mass of the Ghanaian youth must be well trained in the concepts of basic science. Capacity building in science educators and material support to schools such as the Polytechnics can be resourced adequately to become drivers of the economy.
4. Adequate funding from Government to Research Institutions. Now Donor agencies fund S &T issues more than Ghana Government.
5. Improved S&T will promote industrial growth in food processing.
6. Ghana needs a clear vision of S&T. Development of S&T Education (STE) policy required. Any policy on Science education must be reviewed regularly to take into account evolving trends in the food sector.
7. Create well resourced centres of excellence in S&T research.
8. Private sector must be encouraged to absorb science graduates for attachment.
9. Fabrication of food processing machinery should be encouraged by polytechnics and organised groups in the private sector.

10. Development of solar energy technology for food preservation eg grains must be funded by Government to ensure sustainability.
11. Agricultural subsidies must be introduced to help producers of foods
12. Trade restrictions must be reduced.
13. The benefits of economic growth must be spread more fairly among all levels of Ghanaian society
14. Budget should provide increased resources for agriculture (Maputo declaration) and rural development, including water resource management and programs for education, health, and employment for poverty reduction
15. Donors must vigorously and frequent/timely monitor progress of the African Union's peer review mechanism under NEPAD (New Partnership for Africa's Development) of the Maputo declaration.
16. Public and private sectors of the economy must be involved in the food situation, innovation and research system. eg increase in supermarkets due to increasing urbanization.
17. Increasing price of energy results in rise in cost of farmers' inputs, processing, and transportation causing high food prices.
18. Investments are needed in the five key drivers—rural road construction, education, clean water provision, agricultural research, and irrigation
19. strengthening governance of the food and agriculture system at the global, country and local levels to translate the new initiatives of 2005 into action on the ground
20. scaling up public investment for agricultural and rural growth,
21. taking targeted steps to improve nutrition and health, and
22. creating an effective global system for preventing and mitigating disasters.
23. producers of food crops must respond by increasing the area allocated to crops during the coming decade
24. Increase in agricultural research and development by governmental and international institutions/Investment in agricultural research
25. Better policies and increased investments—not only in Sub-Saharan Africa, but also throughout the developing world—can greatly improve food security for millions of people

In response to the food price crisis:

1. The World should heed the call of United Nations Secretary-General Ban Ki-moon and also Kofi Annan to fund a massive increase in Africa's food production, finance the needed and already available technologies e.g. high-yield seeds, fertilizer, small-scale irrigation etc. This new African green revolution would initially subsidize peasant farmers' access to better technologies and cause at least doubling grain harvests. The funding would also help farm communities establish long-term microfinance institutions to ensure continued access to improved agricultural inputs after the temporary subsidies end in a few years.
2. The U.S. should end its misguided corn-to-ethanol subsidies, given world demand for food and feed grain.
3. The world should support longer-term research into higher agricultural production. Unfortunately, the U.S. administration is proposing to sharply cut the U.S. funding for

tropical agriculture studies in the Consultative Group on International Agriculture Research.

4. The world should follow through on the promised Adaptation Fund announced last December 2007 at the U.N. Climate Change Conference in Bali, to help the poor face the growing risks to food production from increasingly adverse climate conditions. Trade in and export of value-added processed and high-value agricultural food products should be encouraged instead of exporting the raw materials

Interaction between farmers, scientists and media

Media is a powerful communication tool. Food and agricultural problems would be better solved if dissemination of results from research, development and innovation are disseminated to farmers through interactions and media publications and seminars. Access to communication is paramount to improving the quality of life and providing access to farmers of research findings so that the public can understand research results, examine the evidence critically and make informed decisions. Through various information, education, and communication (IEC) strategies ranging from exhibitions, production of leaflets and posters as well as radio interviews and also e-group to promote sharing of science-based agricultural information among members farmers, RD&I issues can be disseminated. Organization of study visits and writeshops for the media will also be useful. Policy issues should include guiding S&T to benefit the food unsecured poor in developing countries.

The present international consensus is that in the next 30 years, the world population will swell to over eight billion or slightly more (Reezal, 2008). Partnership of researchers, donors and farmers in the use of biotechnology to increase world food output and reduce food insecurity by improving crop yields and reducing crop loss would be beneficial. Such policies would help developing country farmers buy and implement new technology and enhance biotechnology's ability to improve food security (<http://www.bic.searca.org>).

Bill Gates stated that 'the poor do not need computers; they need food, clean water, and health care. Yes, but they also need education, jobs, and—if they are among the millions of the world's poor and malnourished who live in rural areas—opportunities to produce enough food at a reasonable cost and without degrading the natural resources needed by their children and grandchildren. Is modern information and communication technology (ICT) irrelevant to these needs?' (Per Pinstrup-Andersen, 2001).

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