FOOD QUALITY
A CHALLENGE FOR NORTH AND SOUTH

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As a past Secretary General of IAAS (1964-65), it is an honour and a pleasure to be asked to introduce this book. I congratulate the IAAS for taking the initiative to have the book prepared and for selecting such an important topic. When I was Secretary General, I was a student at the Royal Veterinary and Agricultural University in Copenhagen. At the time IAAS did not have either a permanent office or a president. The “office” followed the Secretary General and I have observed the growth of the IAAS with great interest. I am proud to have been associated with such a vibrant organisation.

Food safety is of critical importance for all, independent of income-level. However, unsafe food and unclean drinking water are particularly serious problems for the health of low-income people in developing countries, where they cause illness and death among millions of children and adults. In high-income countries, including the member countries of the European Union, food safety concerns have gained increasing importance in the public debate and policy-making, partly because of mad cow disease, dioxin in food and feed, increasing frequency and severity of illnesses due to contamination of meat and other food, because of other food safety concerns and partly because of consumer preferences for lower risks, the latter being closely correlated with increasing incomes.

In my opinion, assuring that all people have access to enough safe food to live a healthy and productive life, while protecting the environment from exploitation, is one of humanity’s most important challenges. About 800 million people are food insecure; they do not have access to enough food to meet their needs. More than a billion people suffer from micronutrient deficiencies, and every third preschool child in the developing world is malnourished. Between 5 and 10 million of them die every year from nutrition-related health problems. Some are malnourished and die because they do not get enough to eat, others die because the food and water they consume is unsafe. Food security and food safety must go together. However, high food safety standards may increase food prices and make it even more difficult for the poor, who typically spend 50-70 percent of their income on food, to get access to enough food.
Food safety standards are to a considerable extent a function of income level. Higher-income consumers, who spend 10-15 percent of their income on food, are likely to seek higher standards even when such standards make food more expensive and even when a higher standard reduces the risk very little. Such high standards were not considered appropriate by society 50-70 years ago, when incomes were much lower and the budget share going to food much higher. Similarly, the food safety standards now required by high-income countries may not be appropriate for low-income countries. Yet, with globalisation, uniform standards across countries are likely to become the norm. Whose standards should then be applied? This and many other important questions are addressed in this book, which I believe should be required reading for all who are interested in the world food situation.

Per Pinstrup-Andersen

Former Secretary General, IAAS
H.E.Babcock Professor, Cornell University, United States
Professor, Royal Veterinary and Agricultural University, Denmark
Food is like fine china.  
Not only is it expensive,  
but it must be handled carefully  
because of its fragile nature.

[From 'Maintaining Food Quality in Storage' on http://www.ces.uga.edu/pubcd/b914-w.html]

Economical and physical access to sufficient, safe and nutritious food is a basic human right that should be guaranteed to every human being. To assure a sustainable production of qualitatively satisfying food, it is needed that every one of us is aware of the problems involving food production from producer until consumer.

During the last years, more and more consumers, both in North and South, are concerned about the quality of the food they buy on the market and about the production methods used in food production. Is this scepticism justifiable and, if yes, what can be done to improve the food quality and the transparency of the food production chain? What is the influence of industrial food production on the availability of qualitatively good food for people in the South?

The influences on food quality can be situated in 3 domains: raw agriculture, food industry and policies.

Agriculture has gone through tremendous changes the last century, going to high input industrialised agriculture in the North and to large scale plantations in the South, although the population in the South still depends on low input, mixed farming systems. The decrease of transport costs and the liberalisation of world trade have not only increased the availability of foreign products, but also the world-wide competition has grown to an unseen level. What are the influences on the food quality in this competitive economy and of the urge of farmers to survive? What are the influences on food security in developing countries of this battle of markets?
Are the recent food crises, like BSE, foot and mouth disease, etc., consequences of the industrialisation of agriculture, with its subsequent specialisation and enlargement of scale? Are they due to the increased trade, which in general doesn’t contribute to a better transparency of the food system?

On agricultural level, some companies in the North claim that food security and quality problems can be solved by genetically engineering. Can GMOs really improve food security on earth? What are the health risks and the environmental risks of GMOs and can they be assessed with the knowledge and experimental results that we have at this moment? Are currently available GMO plants, taking into consideration the potential environmental risks, really needed, or are they just a profitable tool of some powerful multinationals?

An other aspect of modern mechanised agriculture is the exorbitant use of pesticides, which increases yield and improves the esthetical aspect of agricultural products, but raises questions about the sustainability in an environmental perspective, and about the health hazards for the farmers on one hand, due to application of these products, and for the consumers on the other hand, due to the presence of residues in the food.

An answer to this is sometimes claimed to be given by organic agriculture, as an alternative to conventional agriculture. Do biologically grown crops and animals have the potential to assure presumed sustainability and health guaranties? Can organic agriculture be a global alternative for conventional agriculture, or is it merely a utopian dream of some idealists in the wealthy North?

Because of the enormous explosion of urban population, food industry needs to cope with major challenges in the field of food conservation and the development of convenience food. Food safety measures can be divided in three classes, biological, chemical and physical food safety. All these aspects of food safety need to be fulfilled in the processing of natural resources into the final product destined for human consumption. What do these different aspects of food safety consist of and how can they be guaranteed in the food industry? How do food
companies apply technical and scientific innovations to continuously improve the product quality? What kind of guarantee can be offered by normative systems like ISO and HACCP? Are these processed food products as good for the consumers’ health as the food in earlier times, without any kind of additives?

Through specialisation and increased trade, the resulting food products are assembled of materials with a very diverse origin. Is it possible to track and trace where all constituents come from and what has happened with them in order to prevent major food problems like the dioxin crisis?

What is the opinion of the consumer after the recent problems in the food industry and are they right to use more locally produced ‘natural’ products because of a lack of trust in the industrialised food system?

In this increasingly liberalised world, the controlling and directional role of governments cannot be underestimated. What can policy makers in North and South do to guarantee food security for all? What are the advantages and disadvantages of the existing policies, and does a real solution exist? Do governments have the power to take measures to diminish the gap in life standard between rich and poor countries in this liberalised world ruled by powerful multinationals and industries?

How can government assure a safe food production, good for both human health and the environment? How can government organise the integrated chain management and what kind of tools are at its disposition to do this? What can be the role of labelling and organic agriculture in this matter, and what must be done for organic agriculture to make it realise its promising objectives instead of becoming a spurious unsatisfying solution that seems to be better for the consumers but does not change anything substantially in reality?

Nobody can survive without food, people do struggle for this source of life and power.

Food quality, a never ending challenge for you and me.
INTRODUCTION:
FOOD QUALITY: FROM FARM TO FORK...
AND FAR BEYOND

Food has always been a basic human concern. Even before the development of any agricultural systems, the daily search for edible, affordable and trustworthy food dominated human life. It was the agricultural revolution, thousands of years ago, that started a fascinating and utmost important evolution for mankind: from that point, people were able to actively influence their supply of food and conquer their own small part of independence from nature. Still, in these early days and ever since, food has remained the most important basic need for the large majority of people.

The development of retail activities and food processing during the last centuries, in particular in urban and western societies, combined with other industrial evolutions and the construction of a relatively high level of general welfare, slowly changed this situation. A large part of the population detached itself and even alienated from the primary food production, and food industry became a dominant player in the production-consumption chain. Unfortunately, this economic development turned out to be highly differentiated depending on climatic, economic, political, social and historical factors.

Therefore, at the beginning of the 21st century, a large part of the world population’s daily concern still is the difficult basic food production to feed and support the own family. At the same time, some western consumers’ only direct contact with the food chain consists of large-scale supermarkets where they buy convenience food that is advertised in million-dollar commercial campaigns. But still, whether only 10% or even 95% of people’s income is spent on foodstuffs, the quality of our food remains an extremely important daily concern for producers, retailers, consumers and policy makers.
Food security, food safety, food quality and quality food

As can be expected from the differentiated situation in the world, the notion of ‘food quality’ can vary considerably depending on the situation and the place of a person. A first interpretation of food quality could be its availability. Many scientifically supported studies demonstrate the fact that this world is producing enough food to feed the world. But these studies also stress that only a lucky minority of the world’s population is never confronted with food shortage in terms of quantity or nutritious quality. Some authors in this book will elaborate on this human tragedy. Indeed, the nutritional value is a very important property of food and is more often than quantity the major cause of malnutrition. The nutritional value is relatively easy to quantify since all the important food constituents are known and their effects are defined. Furthermore, there are only a limited number of nutrients divided into two classes, macronutrients and micronutrients, depending on the amount human beings need to live a healthy life. The determination of optimal nutritional value can be assessed by nutritionists and can be increasingly controlled by the food processing industry. Once this ‘quality’ of availability is guaranteed, the other basic concern is the absolute safety of food. The absence of harmful components or pollutants in the human nutrition is a universally important issue. Most consumers usually are in a situation of relative reassurance about food safety, fed by daily habits and a long-term absence of serious threats. However, this concern is extremely intensified whenever a society is confronted with a potential or real food hazard. Farmers, food industry, retailers and governments are mobilised and new and stronger precautions are taken at each of these occasions. These first two aspects of quality being reassured, there still is another notion of relative food quality, and this is based on hedonic components. Foods are materials that in their naturally occurring, processed or cooked forms are consumed by humans as nourishment and for enjoyment. Defining the hedonic value of food is rather difficult because such a definition must take into account all those properties of a food such as visual appearance, smell, taste and texture, which interact with the senses. These properties can be influenced by a large number of
compounds that in part have not even been identified. The optimal hedonic quality of food is mainly determined by the preferences of the consumer and a continuous concern for any producer.

A fourth and increasingly important way of approaching food quality is the valuation of the intrinsic values of food and food production systems. The production system of traditional African subsistence farmers is often interwoven with a person’s social position. In the Western world, people increasingly attach importance to the conditions under which the food is produced: the growing demand for animal welfare standards in meat production and a general concern about sustainable production systems are driving forces for new alternatives such as organic agriculture and short market channels.

The outline of this book

This book more or less follows the quality aspects throughout the food chain, from ‘farm to fork’ or from ‘stable to table’ as expressed in fashionable terms. And it even goes beyond that food chain by adding an important chapter on the interaction of policy and food quality.

A first chapter deals with the consequences of the demand for quality food on farms, and the daily application of these consequences in animal and plant production systems. De Smet et al. give some good examples on how animal breeding and feeding practices are closely linked to the final product quality. Aerts reflects on the consequences and the measures following a major food crisis like BSE. Wollny et al. stress the importance of the conservation of genetic diversity of farm animals in the South. A currently much discussed topic is the potential of biotechnology to cope with food problems in developing countries. Gheysen et al. and Spencer present prevailing and contrasting opinions on this issue. Another important aspect is the use of modern techniques like crop protection products, which is introduced by Duponcheel. In contrast with this, Schnug provides us with arguments to advocate organic production in developing countries.

The second chapter highlights quality issues connected to the intermediate actors in the food chain, from basic processing to retailing. The first paper from Vanderbeke deals with the effects of the introduction of GMOs on the feed industry. New possibilities but also
new problems arise in this primary sector. The integral management of food chains obviously is of great importance in modern and efficient industries, and Pereira et al. introduce a practical application for this in the fruit and vegetable chain, while Gellynck et al. and Moens broaden the scope on this issue. Zooming in on food quality research in industrial contexts, Rajkovic et al. offers a good example of an application of microbial food control techniques. Labelling and the renewed attention for short marketing chains are the topics of the contribution by Mathijs.

This latter aspect thematically bridges the second with the third chapter, where the focus is on the concerns and characteristics of the consumer. Indeed, this actor could be considered as the driving force of the food chain wherever in the world he lives. Miles opens the discussion with a paper on the aspect of human perception. Going one step further, the exactingness of the western consumer, incorporating more than just nutritional and security values to his food, is demonstrated by Demey et al. The African perspective, explained by Donkor, may seem much more basic, but includes many similar values as well. Dessein illustrates this with a case study from field research in Ghana, where cultural and social values are indissolubly connected with the local food production. The concluding paper of this chapter by Ramaekers deals with the basic nutritional and safety needs from a medical perspective.

The final chapter deals with the ways that governments and organisations can tackle difficulties in the food chain and problems in the international trade arena. Pinstrup-Andersen first gives a concise overview of possibilities for policy actions. Three practical examples are elaborated for developing countries: Loum discusses the transfer of technologies and their application on small-scale African farms; García-Marrimore and García-Marrimore and García-Marrimore and García-Marrimore describes examples of educational programmes in two different continents, and Hariyadi and Dewanto-Hariyadi stress the importance of communication in relation to possible food hazards. The last, but not the least important aspect, is international trade and its barriers. Gaskill outlines the US point of view in the current WTO biotechnology-related negotiations, while Vandeplas discusses the potential of biotechnology in fighting hunger. And concluding this book, Nguz describes existing trade problems based on food quality arguments and a possible solution, based on world-wide co-operation.
PART I
FOOD QUALITY AND AGRICULTURE
Integrating quality criteria for animal products and production systems: a complex challenge

Stefaan De Smet, Veerle Fievez, Katleen Raes and Daniel Demeyer

Department of Animal Production
Faculty of Agricultural and Applied Biological Sciences
Ghent University, Belgium

Email: stefaan.desmet@UGent.be
http://fltbwww.rug.ac.be/animalproduction

Research at the Department of Animal Production mainly involves monogastric and ruminant nutrition and meat science. Digestive physiology and rumen fermentation are the key areas of our research in farm animal nutrition. Carcass quality, meat quality, and meat fermentation are the research areas in the field of meat science. Both research fields are increasingly integrated, with current emphasis on the effects of animal feeding on the nutritional quality of animal products.
Abstract

Animal production is carried out in a large variety of production systems. Within the search for improved sustainability, optimisation of the quality of animal products and production systems receives increasing interest around the world, although to a varying extent. Using two cases from own research, a simple qualitative evaluation of a set of quality criteria is done. It is clear that evolutions in animal production and specific strategies may have contrasting effects on different quality criteria. Hence, there is a need for specific methodologies to quantify and to evaluate the overall quality of different animal production systems.

1. Introduction

Around the world, animal production is carried out in a large diversity of production systems, mostly in mixed land-based farming systems, allowing primary plant production to be upgraded to secondary production of milk, meat and eggs, and also providing several other services by animals. Animal products provide one sixth of human food energy and more than one third of the protein on a global basis (Bradford, 1999). It is clear that animal production differs considerably between developing and industrialised countries. In the former, food production is often not the only objective of animal production, and the use of animals relies to a large extent on the use of lignocellulose-based feeds in extensive, low-input low-output systems. On the other hand, mixed farming systems in industrialised countries evolved over the last decades to highly specialised animal food production systems, with uncoupling of animal and plant production in some systems, and aiming at maximising the production output at the animal and farm level. This involves large capital investments, the use of genetically selected animal types and large inputs of energy, concentrate feeds and chemical fertilisers. However, some drawbacks associated with the search for maximising the output in these systems are becoming evident (Rérat and Kaushik, 1995; Steinfeld et al., 1997). Indeed, the quality concept includes or should include more than strict production criteria. In a broad sense, the
quality of animal products involves safety (hygienic and toxicological safety), nutritional quality (chemical composition) and sensory and technological quality (various eating quality characteristics and quality for processing) (Demeyer, 1997). The quality of a production system can be evaluated using criteria related to environmental care (e.g. contribution to acidification, eutrophication and global warming), animal welfare and socio-economic issues (e.g. use of finite resources). Our department aims at integrating some of these aspects in its own research, as illustrated in a first case study. Still, these basic, analytical research results should be integrated in production systems, which should be evaluated as a whole, as illustrated in a second case study. However, evaluation at this level is confronted with a number of opposite results and conflicting interests. Finally, some general considerations regarding optimisation of the quality of animal products and production systems are made.

2. Case 1: Use of fish oil in terrestrial animal feeding

The fatty acid composition of animal products receives considerable attention to date (Raes, 2003). In industrialised countries, the increasing incidence of several civilisation diseases has been linked to dietary factors, including the large intake of saturated fatty acids (SFA) and the relatively low intake of n-3 poly-unsaturated fatty acids (PUFA). Hence, current human dietary guidelines recommend an increase in the intake of PUFA, especially of the type n-3, at the expense of SFA. Although this applies to the whole diet, optimisation of the composition of individual foods is also recommended since food habits only change slowly. In general, products of terrestrial animal origin are considered relatively high in SFA and low in PUFA, although this strongly depends on the type of product (milk being generally much lower in PUFA than meat or eggs), the type of animal (meat from ruminants being generally lower in PUFA than meat from monogastrics) and the animal’s ration. In monogastric animals, the fatty acid composition of the animal tissues and products is strongly related to the fatty acid composition of the dietary fat. In ruminants, however, modifying the fatty acid composition is more difficult due to lipolysis and biohydrogenation processes occurring in the rumen. In these processes, linoleic acid (C18:2n-6, LA)
and linolenic acid (C18:3n-3, LNA) are partly hydrogenated and converted to more saturated fatty acids after being liberated from the feed triacylglycerols or galacto- or phospholipids. For increasing the n-3 PUFA content in animal products, different feeding strategies may be applied. Much interest exists to date for an increased use of grass or grass products and linseed as sources rich in LNA. In the animal, LNA is incorporated in tissues and converted to the long chain n-3 PUFA eicosapentaenoic acid (C20:5n-3, EPA) and docosahexaenoic acid (C22:6n-3, DHA). However, this conversion is limited. Alternatively, fish oil is rich in EPA and DHA and is therefore an interesting direct source of long chain n-3 PUFA. It is striking that in aquaculture attempts are now made for economic reasons to replace fish oil by cheaper vegetable oils, whereas terrestrial animal agriculture aims at the opposite for improving the product quality. At our laboratory, the use of fish oil is evaluated at several criteria. Interestingly, beneficial effects for totally different quality criteria seem to coincide, although there are also some associated problems.

- By using fish oils in the diet of ruminants, EPA and DHA contents of animal products can be significantly increased. EPA and DHA are themselves less subject to lipolysis and biohydrogenation in the rumen compared to LA and LNA, thus allowing a larger flow to the duodenum and consequently to the tissues. In addition, the fish oil fatty acids seem to depress biohydrogenation of LA and LNA, giving rise to an increased production of a range of intermediates of this hydrogenation process (conjugated and trans C18 isomers). An interesting intermediate in this respect is cis9, trans11 CLA, originally called rumenic acid because of its natural occurrence in products of ruminants, and to which a number of positive health aspects have been attributed. Feeding fish oils to ruminants thus contributes to an improved health value of the products by increasing the long chain n-3 PUFA and the CLA content. On the other hand, increasing the CLA content of animal products seems impossible without a concomitant increase in trans fatty acids, with possible negative health implications, though not all trans fatty acids show these properties.

- Fish oils do not seem to depress fibre digestibility in the rumen; a problem often encountered when using large amounts of vegetable
oils rich in PUFA. On the other hand, the inclusion of fish oil in the diet may depress feed intake more than other fats because of taste aversion. Like vegetable oils rich in PUFA, fish oils are also potent methane inhibitors (Fievez et al., 2003). Methane serves as a hydrogen sink in the rumen fermentation processes, but is at the same time a loss of feed energy and is unwanted because of its global warming potential. Propionate is the alternative hydrogen acceptor that can be used as energy source by the animal, and a decreased methane production in the rumen is generally associated with increased propionate production. It is estimated that animals (mainly ruminants) contribute for about one-fifth to the global warming effect of methane. EPA and DHA seem to depress methane production relatively more than LA and LNA. Feeding fish oils to ruminants may thus positively contribute to environmental protection.

- A problem with feeding fish oil to farm animals is the increased risk of off-flavours and of reduced shelf life due to peroxidation of PUFA. The susceptibility to peroxidation is relatively greater for EPA and DHA than could be expected from the higher number of double bounds compared to LA en LNA. Hence, including fish oil in animal diets needs absolutely to be accompanied by a sufficient provision of anti-oxidants. However, the occurrence of a fishy aroma in animal products originating from animals that received fish oil can often not be totally prevented.

- The large scale application of fish oil feeding to farm animals is further hampered by the shortage and the associated relatively high cost of fish oil, also caused by the absolute requirements of larvae of some fish species for dietary long chain PUFA. In addition, feeding fish oil and animal fats in general to terrestrial farm animals is sometimes discouraged because of its somewhat unnatural character and for toxicological safety precautions. It should be mentioned that the long chain PUFA in fish originate from aquatic plant species, algae that have the capacity to elongate and desaturate LNA in considerable amounts. Hence, some algae may be interesting alternative sources of EPA and DHA for animal feeding. However, one can question the need for modifying the fatty acid composition of animal products in a more general context, if the average
consumer would follow the recommendations for regular intake of fatty fish. Another approach is the transgenic breeding of plant species for a specific fatty acid composition.

3. Case 2: Evolution of meat production in industrialised production systems

Using the evolution of meat production and sensory quality and fatty acid composition of meat in industrialised production systems as a case study, some of the consequences of increased productivity levels on several quality criteria will be illustrated. A summary is given in table 1. Increasing live weight gain and reducing body fat content of animals have been the major objectives in specialised meat production systems, mainly because of increased efficiency and lower feed requirements associated with protein vs. fat deposition in fast growing animals. Feeding strategies for this purpose make largely use of concentrates rich in cereals, protein sources and oils or oilseeds. Concomitantly, breeding programmes have shifted the genetic potential of farm animals for these traits, resulting in altered genotypes and in an enormous increase in production levels. This has provided the western society with ample, relatively cheap meat. However, far less attention has been paid to product quality except for safety aspects, although it is affected in many ways.

Selection for increased muscularity and growth of lean mass has been accompanied by a shift to more white, glycolytic muscle fibres at the expense of red, oxidative and oxido-glycolytic fibres. This results in faster glycolysis post mortem, affecting colour and water-holding capacity of meat. In extreme cases, this leads to aberrant sensory and technological properties, e.g. PSE meat in pigs and broilers (De Smet et al., 2002).

A lower carcass fat content is generally associated with a lower intramuscular fat content. Since fatty acids contribute to meat flavour, the extremely low fat content in meat of some modern animal breeds, although beneficial for human health, has clearly reduced the flavour of this kind of meat. On the other hand, the higher muscle mass of meaty
animals and the concomitant lower connective tissue content has advantages in terms of meat tenderness and yield of premium cuts (De Smet et al., 2002).

As mentioned above, the fatty acid composition of animal products deserves particular attention with regard to human health (Raes, 2003). The large use of concentrate feeds including cereals and oilseeds rich in linoleic acid and the reduced natural pasturing in intensive meat and egg production systems has shifted the fatty acid composition of these products to unfavourably high n-6/n-3 ratio’s. Hence, optimisation of the fatty acid composition of animal products is recommended, this being much easier to achieve in monogastric animals than in ruminants as outlined above. In addition, an altered feed fatty acid composition may equally affect animal health and metabolism similarly to the effects known in humans, e.g. possibly affecting reproductive performances.

Including pure PUFA-rich oils in animals’ diets for improving the intramuscular fatty acid composition has been shown to hold risks for meat oxidative stability, creating the need to supplement diets with anti-oxidants. On the other hand, grass as a complete feed is not only characterised by a desirable PUFA profile, it also provides sufficient natural anti-oxidants and meat from pastured animals combines improved fatty acid composition with satisfactory oxidative stability. Recent research in milk indicates that the botanical diversity of natural grasslands is accompanied by differences in the milk fatty acid composition. Similarly, the complex of plant secondary compounds present in more diverse pastures and feeds may yield additional benefits at present largely unknown, as well for improving product quality as for animal health.

As a result of the strong selection for improved lean mass and reduced body fatness, some extreme genotypes have appeared such as double-muscled cattle and stress-sensitive pigs. In general, it is becoming clear that the physiological limits of genetic selection have been almost reached in some cases, the widespread need for caesarean section of double-muscled calves being a very prominent example thereof. Low body fat stores in some extremely lean genotypes may impair female fertility and milk production. In males, highly muscled conformation is
clearly negatively affecting sperm production and quality. Although counteracted to some extent by improved management and veterinary practices, the high productivity levels of modern farm animals clearly increases the risk for the occurrence of metabolic diseases. In some way, it appears that high performance animals have fewer resources to rely on in case of stress and disease challenges (Rauw et al., 1998).

Since intensive meat production is mostly associated with raising animals in confinement, animal welfare may be compromised at several points, although it is obvious that this is an extremely difficult issue to address. Improved housing and husbandry practices have clear benefits, although not solving all problems, and extensive production systems may also face animal welfare problems. Evaluation of animal welfare across farming systems is hampered by the lack of knowledge and of consistent welfare indicators at this time. Similar arguments can be raised concerning the effect of high animal density husbandry practices on the risk and spread of pathogens.

The effects of high animal productivities on environmental issues are also difficult to address. By dilution of the maintenance requirements, highly performing animals show in general a lower emission of minerals, and in the case of ruminants also of methane, on a per unit of output basis. On the other hand, environmental pollution is of concern on a per land surface basis, and since intensive production systems are generally associated with a large number of animals per hectare, pollution problems are mainly prevalent in intensive landless meat production systems. In addition, intensive production systems require large inputs of fossil energy, also contributing to environmental damage.

This list of effects of intensive meat production is not complete, e.g. the effect of the large import of feed components from overseas on the north-south relationship was not addressed. However, it is obvious that focusing only on an efficient conversion of plant material in animal food products may compromise overall product and production quality at several points. More importantly, it appears extremely difficult to design optimal animal production systems that fulfil the whole set of quality criteria.
Table 1. Qualitative evaluation of direct (product) and indirect (production system) quality criteria for the evolution of intensive meat production systems

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<td>Selection for increased growth of lean mass</td>
<td>↓↑</td>
<td>↑ =</td>
<td>↑</td>
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<tr>
<td>Concentrate feeding of cereals and oilseeds</td>
<td>=</td>
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<tr>
<td>Raising animals in confinement and landless production</td>
<td>= =</td>
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</table>

↑, positive effects; ↓, negative effects; ↓↑, positive and negative effects depending on the trait; =, no large effects

4. General considerations

In many societies, animal agriculture has been producer-driven for a long time. It is now recognised that a shift to a consumer-oriented type of production is needed. Improving the quality of animal products in its broadest sense according to changing consumer demands becomes then more important. The above cases aimed at illustrating, from a technical background, the complexity and the interrelationships that have to be addressed when considering the improvement of the overall quality of animal production systems. As animal scientists, the authors want to make following general statements:

- It seems that basic, analytical research increases the complexity rather than providing practical guidelines for improving and integrating different quality aspects. Nevertheless, this type of research remains absolutely necessary to create new opportunities for animal agriculture. In research at the level of animal production systems there is a large need for application of new methodologies (e.g. life cycle analysis) to be able to comprehensively evaluate
different production systems. Most of the currently applied ‘quality systems’ do only allow to steer specific quality criteria (e.g. microbiological safety in HACCP) but do not allow to design optimal production systems that take into account most of society’s demands.

- It may be argued that integration of the various links of the animal food production chain in a ‘from farm to fork’ approach may help to solve some problems currently experienced in industrialised systems, while maintaining the benefits of high animal productivity. The renewed interest in western societies for food produced in a more natural way may help in this regard. It is hoped that developing countries in their attempts to increase animal productivity take into account these interrelationships, and become aware of the value of their animal food products of more natural origin.

Selected references


BSE: humans, animals and economy

Stefan Aerts

Centre for Agricultural, Bio- and Environmental Ethics (CABME)
Katholieke Universiteit Leuven, Belgium

Stefan.Aerts@agr.kuleuven.ac.be
www.kuleuven.ac.be/cabme

Stefan Aerts graduated from the K.U.Leuven in 2002 at the Faculty of Agricultural and Applied Biological Sciences. His Master’s dissertation focused on the molecular and biological issues of BSE and the BSE crisis. He is currently working with the Centre for Agricultural, Bio- and Environmental Ethics (CABME), preparing a Ph.D. in Applied Biological Sciences.
Abstract

Many aspects of BSE are still not fully understood. Many of these can have implications for public health. E.g., it is not known how early in the incubation period prions can be detected. So, infected animals may still enter the human food chain. As BSE in sheep can be transmitted via blood transfusion during the incubation period and BSE in sheep closely resembles vCJD, safety of blood transfusion between humans is uncertain. Weighing economic and social impact of the measures against animal welfare and public health is and will remain difficult.

Introduction

BSE is one of the transmissible spongiform encephalopathies (TSEs) or so-called ‘prion diseases’. This is a group of invariably fatale neurodegenerative diseases, caused by a novel infectious agent. They are present in a sporadic, genetic or infectious form. Other members of this family are the well-known Creutzfeldt-Jakob disease (CJD) and scrapie, a TSE in sheep and the first TSE to be identified (in 1732). The agent of these diseases has long been unknown to scientists. Many of the unusual aspects of the prion diseases cannot be caused by a bacterium or by a virus. The most striking property of the agent is its extraordinary resistance to physicochemical or biological inactivation. This by far exceeds that of conventional pathogens. The main theory about the nature of the agent is Stanley Prusiner’s “Protein Only Hypothesis”, the prion theory (Prusiner, 1982). In this hypothesis, the agent is believed to be a single protein, albeit one with several unusual properties.

The discussion in this paper evidently implies acceptance of the causal link between BSE and the new variant of Creutzfeldt-Jakob disease (vCJD).

We will start with a brief introduction to the biological and molecular aspects of the TSEs. This will be necessary since most of the discussion later will be based on these rather technical matters. During this overview, we will point out the different areas where there is still considerable uncertainty. A more detailed discussion can be found in Aerts (2002).
Biological background

The agent

The development of each TSE is accompanied by the conversion of a normal cellular protein (PrP) to a proteinase resistant protein with different physicochemical properties (PrP\textsuperscript{Sc}). This cellular protein is present in many tissues, but the highest concentrations can be found in the central nerve system (CNS), i.e. the brain, the brainstem and the spine. Depending on the type of TSE, presence of PrP\textsuperscript{Sc} will be limited to the CNS (e.g. BSE in cattle) or PrP\textsuperscript{Sc} can be found throughout the body (e.g. scrapie). PrP is located on the outer surface of the cell.

Up until now, no one has been able to reliably determine the function of PrP in the body. Several functions have been proposed, but scientists often find that PrP knock-out mice have a normal development and behaviour (e.g. Büeler et al., 1992). This lack of clearly identifiable function contrasts with the observed strong conservation of the PrP sequence between different mammal species (e.g. Bamborough et al., 1996). Such a strong conservation would suggest an important function for PrP\textsuperscript{C} and neuropathological damage could then be a consequence of the loss of that function after infection. On the other hand, it is possible that this damage is caused by the accumulation of PrP\textsuperscript{Sc}, even if PrP\textsuperscript{C} itself has no function. For both possibilities, there is data either way.

Although we know that conversion of PrP\textsuperscript{C} to PrP\textsuperscript{Sc} and accumulation of PrP\textsuperscript{Sc} are highly correlated with the development of a TSE, the precise conversion mechanism is not yet know. We do know that PrP\textsuperscript{Sc} itself has an important role, maybe as a ‘template’ for converting PrP\textsuperscript{C}. Some, but not all, experiments indicate that other factors might be needed for the conversion (e.g. Telling et al., 1995). None of these factors have been identified at this time. Next to PrP\textsuperscript{C} and PrP\textsuperscript{Sc}, there are other forms of PrP (e.g. Hegde et al., 1998). It is unknown whether these are important in the development of a TSE.

An important, but puzzling property of prions, is the existence of different prion strains. Unlike conventional infectious agents, a prion has no genome. Nevertheless, it contains the necessary information to propagate several different strains; each of these strains has several typical features (e.g. incubation time, accumulation pattern). Most prion diseases have a distinct prion strain, but e.g. scrapie can be caused by 22
different strains. The BSE strain is distinct from all these scrapie strains and from the three CJD strains, but is considered identical to the vCJD strain. Unfortunately, the same prion strain can cause different disease characteristics in different host species. At this time, it is unclear which is the molecular basis of these different strains. It could be due to differences in conformation or post-translational modification. How the different strains propagate, remains a question.

We briefly mentioned before that prions have an extraordinary resistance to inactivation (e.g. Brown et al., 1990 and Taylor, 2002). E.g. even dry heat of 360 °C during 1 hour cannot eliminate all BSE infectivity. The conventional production conditions of meat and bone meal (MBM) are evidently not capable of deactivating all prions. These are however conditions that eliminate virtually all other pathogens and deactivate almost any other protein.

**Infection and disease**

Susceptibility to infection with prions can be dependent on the host genotype. In sheep, there is a whole range of different genotypes with different sensitivities to prion infection (Hunter, 1997). In cattle, no such influence of genotype has been observed. In humans on the other hand, all vCJD patients were methionine homozygotes at codon 129 of the PrP gene (NCJDSU, 2003).

The infective dose for cattle-to-cattle infection with BSE is still under investigation. Oral inoculation of a calf with 0.1g of infected tissue will produce 100% morbidity. The infectious dose for infection between species will be higher than for intraspecies infection. This is a consequence of the so-called species barrier and something that can be found with most diseases. It is impossible to exactly know the size of this barrier without experiments on humans. The size of the species barrier depends on prion strain, donor species, acceptor species, infection route, etc.

There are several theoretical routes of infection. Not considering intracerebral (i.c.), intraperitoneal (i.p.) and intravenous (i.v.) inoculation (commonly used in experimental work), infection can occur orally or vertically (dam to calf). Other – hypothetical – routes of (horizontal) infection are often classified as being a possible “third way”
of infection. None of these have been identified yet. Even maternal transmission is still under discussion.

An important problem in dealing with TSEs, in research as well as in field conditions, is the long incubation period. BSE in cattle has an average incubation period of 4 to 5 years. This period is influenced by age at infection, infection dose, infection route, etc.

**BSE epidemic**

The major vector for infection during the BSE epidemic was without doubt contaminated feed. The rendering of infected cattle carcasses induced a cycle of oral infections that caused an exponential increase in BSE cases in a very short period of time. This enormous increase and further development of the BSE epidemic is illustrated in figure 1.

![BSE incidence in UK](image)

**Figure 1. Incidence of BSE in the UK**

The epidemic reached a peak around 1992-1993 with over 35,000 cases per year. After that, incidence fell due to the measures taken – from 1988 on – in response to the epidemic. A very detailed overview of the
BSE epidemic, the specific situation in the UK and the measures taken, can be found elsewhere (BSE inquiry, 2000).

At this time, many European (and some other) countries have had cases of BSE. In these countries, the epidemic started later (imported from the UK), so also the peak and the subsequent decay followed several years later. A crucial point was the banning of the use of MBM for the production of animal feed in 1996. In most countries, this prevented the recycling of infected tissue before very large numbers of animals were infected.

Public health

Let us now take a look at the most important threats to human health that are still left due to the BSE epidemic.

The major route of possible infection is – as mentioned before – consumption of infected tissues. Several protective measures have been put in place. The tissues that have the greatest risk of being infected (Specified Risk Material, SRM) are removed from every cattle carcass, which is then tested for BSE. When positive, the carcass is destroyed, along with the neighbouring carcasses in the slaughterhouse and the entire herd (or cohort) from which the cattle originates.

There are several tests certified for use, each of these had a 100% sensitivity and specificity in the validation procedure. More tests are currently undergoing these procedures (E.C., 1999 and E.C., 2003). During these validation procedure however, BSE infected tissue was used from clinically ill cases. It is thus impossible to know how early in the incubation period infected animals can be detected. Since the major build-up of PrP\textsuperscript{Sc} is located in the last part of the incubation period, it is more than likely that some infected animals still enter the human food chain, albeit with small amounts of prions present. It is difficult to assess whether this poses a threat to public health, since we do not know the exact infective dose. In any case, the SRM of these animals will be removed before these enter the food chain.

Two studies have indicated that intraspecies transmission of experimental BSE infection in sheep can be carried out by blood transfusion during the incubation period (Houston \textit{et al.}, 2000; Hunter \textit{et al.}, 2002). Experimental BSE in sheep closely resembles the
characteristics of vCJD. This is an indication that blood transfusion between humans might be unsafe if a substantial number of people are infected with vCJD, but are still clinically normal.

A last issue of concern is the possible presence of BSE in the small ruminant population. The British sheep and goat herd was fed on the same MBM as the cattle herd. Experimentally, it has been shown that sheep are susceptible to infection with BSE. Thus, it seems possible that BSE is present in the small ruminant population, at least to a certain degree, although, at this time, there is no confirmed case of BSE under field conditions. There are some complicating circumstances that have to be taken into account (E.C., 2002a). When scrapie develops simultaneously with a BSE infection in small ruminants, BSE will be masked and cannot be easily identified at this time. Furthermore, BSE in sheep behaves in many ways like scrapie, meaning that it will be present in virtually all parts of the body, including urine and faeces. It is clear that this can be a serious problem if BSE appears to be present in the small ruminant population, in the UK or abroad.

**Humans, animals and economy**

It is often said that ‘the (financial) cost is of no importance when trying to protect public health’. It is difficult to assess the total economical cost of the BSE epidemic, but it is without doubt astronomical. E.g. in Belgium, in 2002 the budget for the BSE tests alone was € 33 million. Thirty-eight cases of BSE were detected that year. The costs for destruction of SRM etc. are not included in this budget and no routine testing is done on small ruminants at this time. There are still many other factors that attribute to the enormous economic cost, e.g. the culling of infected herds, the loss of confidence in animal production/agriculture, loss of export, … If BSE is confirmed in small ruminants and the measures taken in response are based on the measures taken for cattle, then the consequences for public health and economy could even be greater than that of the original BSE crisis itself, due to the specific properties of BSE in small ruminants.

To this great economic cost, we can add the social impact of the crisis itself and the measures that were taken in response to it. This impact
will not be limited only to producers and consumers that were directly affected (infected herd, vCJD patients, …) by BSE. It is of course difficult to find a balance between avoiding loss of human lives and keeping economic costs as low as possible. An extra difficulty is communicating this decision to the public clearly, without inducing even more anxiety. There are always two sides to every risk. On the one hand, the one that is often the easiest to see, are the possible consequences when something happens, *in casu* when someone is infected with BSE. On the other hand, the probability that something will happen, is just as important. This second factor is often difficult to assess and even more difficult to explain to a non-specialist public. As a result, it is easily left out of the (public) debate.

The BSE epidemic in cattle is apparently over its peak, even in most low-incidence countries, so it may be time to evaluate the measures that are currently in place in the EU and the different member countries. Is it e.g. still necessary to cull the entire herd in which an infected animal is found? An open expert debate will be necessary here, on all relevant levels. This will evidently have to take into account all the relevant data, including the different uncertainties that still exist.

We will not go into the discussion on animal welfare and animal rights, but it is clear that this can (and probably will) be something that has to be taken into consideration. Apart from purely ethical considerations on the culling of millions of animals, these measures are rapidly losing support with the general public.

**Table 1.** The four GBR categories as defined by the Scientific Steering Committee.

<table>
<thead>
<tr>
<th>GBR status</th>
<th>Risk for one or more infected animals in herd</th>
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<tbody>
<tr>
<td>GBR-I</td>
<td>highly unlikely</td>
</tr>
<tr>
<td>GBR-II</td>
<td>unlikely but not excluded</td>
</tr>
<tr>
<td>GBR-III</td>
<td>likely but not confirmed or confirmed,</td>
</tr>
<tr>
<td></td>
<td>at a lower level</td>
</tr>
<tr>
<td>GBR-IV</td>
<td>confirmed, at a higher level</td>
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Now, will all this have consequences for international trade between the EU and so-called “third countries”? European cattle, cattle products and MBM have been exported to these countries (in North and South)
during and before the BSE epidemic. Can we or can we not expect of these countries to implement the same safety measures? It’s clear that this would be very difficult (if not impossible) for the countries that already have a vulnerable economy. On the other hand, it would be foolish – and unfair to our own farmers – to import possibly unsafe products while putting strong restraints on domestic production.

The EU has taken a very pragmatic position in this matter. A Scientific Steering Committee advises the Commission on the Geographical BSE Risk (GBR) of different countries (or regions) (SSC, 2002). This classification permits a differentiated approach to different countries. A similar framework is prepared to assess the Geographical BSE Risk when BSE in small ruminants becomes a reality (or probability) (E.C., 2002b). All this information is freely available on the EU website. In table 1 we give an overview of the different categories. All non-European countries (except Japan) have a GBR-I or -II status. All European countries have GBR-III, the UK and Portugal have GBR-IV. In short, most “third countries” have everything to gain with this approach.

This novel and balanced approach seems a good framework and could be very useful in many other areas of international politics, especially those that need extensive risk assessment.

**Selected references**


NCJDSU (National Creutzfeldt-Jakob Disease Surveillance Unit). (2003), Tenth annual report 2001, online at http://www.cjd.ed.ac.uk/ accessed 08.05.2003


The conservation of animal genetic resources to facilitate food security and poverty alleviation

C.B.A. WOLLNY¹, M.G.G. CHAGUNDA², G.L.H. DOSSA³ AND T.N.P. GONDWE¹.⁴

¹Georg-August University of Göttingen
Institute of Animal Breeding and Genetics
Section Animal Husbandry and Breeding in the Tropics and Subtropics
Göttingen, Germany

²Department of Animal Health and Welfare
Danish Institute of Agricultural Sciences
Tjele, Denmark

³Projet d'Appui à la Gestion de la Recherche Agricole Nationale/GTZ,
Institut National des Recherches Agricoles du Benin (INRAB) and
Regional Extension Offices, Cotonou, Benin

⁴University of Malawi
Bunda College of Agriculture
Lilongwe, Malawi

Email: cwollny@gwdg.de
http://www.uni-goettingen.de
Abstract

Diversity of animal genetic resources is essential to achieve food security. More than 2 thousand million people are directly dependent on farm animals worldwide. Demand for animal products in developing countries will more than double in the next 20 years and is bigger than for cereals. Today, even a small increase in the consumption of animal products would reduce child mortality and facilitate cognitive development. Lack of know-how, inadequate breeding policies and wrongly designed development projects are major constraints. Under different ecological and economic conditions farm animals have a major role to play to sustain the livelihood of people in developing countries.

1. Introduction

The Convention on Biological Diversity (CBD) has brought attention to Animal Genetic Resources (AnGR) issues. The Food and Agricultural Organisation of the United Nations (FAO) implements a ‘Global Strategy for the Management of Farm Animal Genetic Resources’. It has been recognised that farm animals play a vital role for the world’s rural poor. Multi-purpose keeping of domesticated animals is central to the livelihoods of many of the poor in rural areas of the developing world. However, a third of approximately 6000 described breeds of more than 40 domesticated farm animal species are at risk of extinction, the majority in developing countries (FAO, 2000). Traditional breeds kept by pastoralists and farmers in marginal areas are well adapted to climatic extremes. They are tolerant to many of the diseases that plague modern breeds. They can survive without expensive feeds and inputs, and live and reproduce under harsh conditions. Low quality vegetation, crop residues and industrial by-products are converted into meat, milk, eggs, fibre, fertiliser or fuel. This function, however, is only one aspect. For the farmers and pastoralists, they also represent a source of cash income, a source of draught power and transport; a form of savings (a walking bank account); a buffer against crop failure and other risks, a means of employment; a way to access and use common land or community forests; and a support for community networks and culture.
In large areas where crops or vegetables cannot be grown, keeping farm animals is the only way people can survive. The extinction of locally adapted breeds directly threatens the livelihoods of people in these areas.

2. Food security, food quality, poverty and sustainable livelihoods

Food security is an evolving concept. The FAO (2003) defines food security as a condition in which ‘all people at all times have both physical and economic access to the basic food they need’. It is access, above all, which features in current policies for food security: access to natural resources and land, to education, water, credit, to seed supplies, technology and inputs, and access for women and children. In his definition of food security, Quashigah (2002) defined it as ‘good quality, nutritious food, hygienically packaged and attractively presented, and available in sufficient quantities all year round and located at the right places at affordable prices’. It is this last element of affordability that links food security to poverty. Poverty may be defined as a condition of a person or a group of persons whose means, monetary or otherwise, do not permit them to obtain the commodities and services necessary to attain a minimum acceptable level of economic well being. There is an inherent relationship between food security, poverty and food quality although Oltersdorf (2003), argues that food security is only a precondition but no guarantee for nutrition security.

World-wide diversity of AnGR is essential to achieve improvements in food security according to expected needs in different agro-ecological environments. The animal species important today for food and agriculture production are a consequence of processes of domestication that have been continuing for almost 12,000 years. Animal genetic diversity allows farmers to select stocks or develop new breeds in response to environmental change, threats of disease, new knowledge of human nutrition requirements, changing market conditions and societal needs, all of which are largely unpredictable. What is predictable is the future human demand for food. The prediction is based on the rate of population growth, urbanisation trend, changing life style patterns and income growth. This need will be felt most in developing countries.
where 85 percent of the increases for food demand are expected (Delgado et al., 1999). This ongoing livestock revolution is in sharp contrast to the saturated markets of industrialised countries. The predicted increase in demand for animal food products in developing countries offers potential benefits from rapidly growing markets but also risks due to strong competition.

Farm animals contribute to the livelihoods of more than two-thirds of the world’s rural poor and to a significant proportion of the peri-urban poor. Small farm animals are often the only assets of the poorest of the poor. AnGR also play many other important roles in people’s lives. They contribute to food and nutritional security; they provide transport and on-farm power, their manure sustains soil fertility; and they fulfil a wide range of socio-cultural roles. The optimised utilisation of well-adapted local farm animals offers the poor, including the landless, a rare opportunity to improve livelihood and income. Animal food products such as meat and milk are concentrated sources of high-quality protein, vitamins and minerals. When children consume even modest amounts, these products help to alleviate poor growth, poor cognitive development and impaired physical health. Although livestock keeping is not universal panacea, if animals are managed properly within an adequate agricultural system, they can be an important lever for reducing poverty and boosting the economy in developing countries (ILRI, 2003).

Conservation of domestic animal diversity is the total sum of all operations involved in management of animal genetic resources, such that these resources are best used and developed to meet immediate and short-term requirements for food and agriculture, and to ensure the diversity to meet possible long-term needs. Genetic diversity, which is expressed and can be measured as phenotypic and genetic variation is the prerequisite for farm animals to cope with future demands and climatic changes. This is why conservation of AnGR is so important and can be managed in-situ or ex-situ. In-situ conservation is the active breeding of animal populations for food production and agriculture, such that the diversity is both best utilised in the short term and maintained for the long term. Operations pertaining to in-situ conservation include performance recording schemes and development
(breeding) programmes. *In-situ* conservation also includes ecosystem management and use of AnGR for the sustainable production of food and agriculture.

In Malawi, one of the poorest nations in Africa, for example, native poultry breeds are kept by 95% of all households in rural areas and are often the only tradable asset in drought periods. In addition native chickens play important social functions in the entire life cycle of the people (Gondwe *et al.*, 2002). There is traditional breeding management practiced aiming to maintain the various phenotypes. Despite the diverse functions, deaths and predation are contributing substantially to off take and these are constraints to utilising chicken resources. Causes of deaths are ranging from parasite infestation to accidents and theft.

Effective mitigation strategies to minimize such constraints would contribute to usable traditional, nutritional and financial outputs. Conventional top-down development and animal husbandry improvement programmes often collapsed due to insufficient involvement of stakeholders and insignificant participation of farmers (Wollny *et al.*, 2002).

**3. Indigenous livestock and their adaptation to the local environment**

A consistent contribution has been made by animal production to human needs under different environmental conditions. The adaptation of species and breeds to a broad range of environments provides the necessary variability that offers opportunities to meet the increased future demand for food of animal origin and provides flexibility to respond to changed markets and needs. The majority of breeds are found in developing countries but many have become extinct or are at threat. By far the greatest cause of genetic erosion in AnGR is the growing trend of global reliance on a handful of modern breeds best suited for high input-output needs of industrial agriculture. In designing sustainable breeding programmes and management decision support systems in developing countries, which would result in sustainable improvements in the livelihoods of small scale resource poor livestock
keepers, a key aspect is to understand genotype x environment interactions. In practical breeding this simply means that farm animals can only be selected within the prevailing production environment. That is why it is so important to seriously consider both the present and future breeding programmes of all species and breeds in the context of the changing environments. In a competitive market, a breed of farm animals survives only if it is superior in at least one trait of economic relevance. Indigenous breeds have emerged in specific natural habitats and production systems over time. Unfortunately, little is known about the adaptive value of such populations and their functional role in crop-livestock production or other production systems.

Research by Dossa (2002) in Benin has shown that the Djallonké goat and sheep is the breed traditionally kept in the Sahel area. Djallonké animals are very small-bodied (dwarf) with short ears and a strong head. In sheep, the tail is short and fairly thick at the base, the male have a heavy mane. Djallonké are attributed outstanding characteristics, for instance their adaptation to infested tsetse fly environments (which results in trypanotolerance), their tolerance to heat stress and their foraging capability. Goats are more popular than sheep and the Djallonké goat is given a stronger cultural value than Djallonké sheep. However, sheep are used for certain sacrifices and religious purposes. From a cultural point of view the existence of the native breeds are essential to society in Benin. These cultural requirements are a genuine reason and an incentive for the conservation of Djallonké goat. Calculation of costs and benefits has shown that maximising profit is of minor importance. A conceptual framework, therefore, includes direct and indirect uses and cultural values in addition to output related traits.

For the efficient allocation of manpower or financial resources a decision-making framework based on simple criteria might be helpful in the absence of objective data derived from long-term recording or in-depth studies. Within an agro-ecological zone, for example, the risk of extinction of a population, the presence of unique traits such as adaptive behaviour, disease tolerance or good mothering ability, cultural and historical values of a population, and the critical role of the population in crop-livestock systems, could be assessed by a representative group of stakeholders. The application of a simple scoring model for each criterion, e.g. ranging from ‘very high’ to ‘non-existent’, and its weight
can be used to establish an aggregate score. This information would provide primary information on the relative importance of populations within and between species and would allow direct farmer participation and ownership of a future breeding programme. Distorting subventions, previous extension messages or donor dependencies, however, could bias the outcome of such an exercise. This requires a critical review of the assumptions made and further independent analysis.

4. Factors contributing to genetic erosion

The irreversible losses of genetic diversity reduce our opportunities for future developments. Although local breeds may carry genetic material of immense value, they face the risk of extinction for several reasons. Among these reasons are:

• Indiscriminate crossbreeding
• Civil strife and warfare
• Epidemics
• Lack of adequate breeding policies
• Lack of infrastructure
• Lack of promotion of desirable attributes (traits)
• Lack of sufficient understanding of local knowledge and values

The breeds native to particular agro-ecological zones are often well adapted to the local conditions characterised by climate, feed resource base and disease exposure. The breeds are rarely thought to be perfect in all respects and improvements in productivity are desired. A shortcut to genetic improvement is to introduce the characteristics of a new breed by crossing it with the indigenous breed. Crosses between different breeds are likely to have a larger proportion of heterozygous gene combinations than the parental breeds. The chance to lose an existing specific and unique gene combination within an indigenous population, therefore, increases through uncontrolled crossbreeding. Indiscriminate crossbreeding and continuous substitution of indigenous breeds has been identified as one of the major threats to the conservation of indigenous breeds (Wollny, 2003).

Comparative studies show that indigenous or local populations are able to produce efficiently in harsh environments. In several African
developing countries, efforts to launch crossbreeding programmes to establish dairy cows for distribution to smallholder farmers date back to the late 1950s. In Malawi, for example, after forty years of substantial governmental and international donor support approximately 8000 crossbred cows of various grades of Holstein-Friesian x Malawi Zebu produce on average less than 1000 kg per cow per year. An evaluation of the performance of Malawi Zebu, an indigenous genotype and its crosses on smallholder dairy farms, indicate that when the ecological and economic conditions are taken into account, native cattle are more efficient. The results suggest dependencies between genotype and management level under the prevailing smallholder conditions in Malawi. If no labour costs are included (a situation typical of smallholder dairy production when family labour is used and no other opportunity exists) the gross margin analysis indicates that the native Malawi Zebu cow is the most efficient genotype in a low-input low-output system (Mwale et al., 1999). It is highly recommended to maintain the Malawi Zebu as a genetic resource and promote its utilisation.

Reviews of hundreds of other studies in various farm animals confirm antagonistic relationships between traits of production and adaptation. The simple goal to maximize output, e.g. through crossbreeding or supply of subsidised inputs is not sustainable and often not beneficial to the producing farmer in the developing country. The optimisation of the prevailing production system through the implementation of appropriate community-based management programmes including improved housing, feeding, health care and appropriate breeding policies appears to be the most successful strategy to improve productivity.

Wrongly designed improvement programmes or formulated policies, which are communicated ‘top-down’, could misguide farmers into economic traps of ‘no return’. The promotion of high yielding dairy cows, for example requiring high inputs, is misplaced in areas or countries that are far from established markets and have no suitable infrastructure like cooling facilities and all-weather access roads. Another example of misplaced promotion is pork. On the market, grading is based on lean meat while the local people in the villages prefer meat with high fat content for energy. A breeding programme
based on wrong assumptions of the market goals and objectives would be detrimental to the farmer. The importance of poultry and its utilization in interaction with traditional practices in chickens has been demonstrated in countries of Southern Africa (e.g., Malawi, Zambia, Zimbabwe) and South East Asia (e.g., Vietnam and Indonesia). Research to validate phenotypic observations through application of biotechnological methods is a new and exciting way in farm animal characterisation. Work is completed or ongoing in small ruminants in Tanzania, Benin, Indonesia and other countries and clearly shows the existence of locally adapted and specific breeds. The design of adequate community-based management programmes requires the understanding of the production system in order to mitigate constraints and promote productivity through existing practices. The utilisation of farm animals integrated in various production systems is the only way forward to conserve the diversity of native farm animal species and breeds. It must be highlighted, however, that the lack of trained human resources, infrastructure and baseline knowledge about the available breeds constitute serious difficulties in many developing countries to establish and implement such plans.

5. Proposal for a comprehensive internationally oriented interdisciplinary research programme

In addressing the complex problems of shrinking genetic diversity and increasing poverty and food insecurity the following research activities are to be implemented. This requires an interdisciplinary approach in a multidisciplinary team of researchers, who are willing to enter in agreements enabling farmers and other stakeholders’ participation:

a) Increased productivity of indigenous AnGR through developing and better utilisation of production, fertility, disease resistance and other adaptive traits for different environments. New measures of productivity taking into account the nutritional composition and contribution of animal derived products and their preferences have to be developed and applied. Characterisation and role of currently undervalued species such as indigenous breeds of buffalo, small ruminants and poultry will be included. Methods of quantitative and molecular genetics and socio-
economics will be applied to develop appropriate Livestock Information Systems complementary to past and ongoing activities. Emphasis will be placed on deriving suitable livestock recording schemes, with attached literacy and numeracy programmes, to improve on-farm decision-making and livestock performance within existing systems. The existing knowledge systems must be used as a starting point.

b) The development and initiation of participatory, community-based alternative breeding strategies for maximum benefit to smallholder farmers in rural as well as in peri-urban systems, thereby contributing to the better livelihood of livestock keepers, increased food production for urban populations, and sustainable use of both animal and environmental resources, are to be fully complementary to the existing or ongoing initiatives. Crosscutting issues have to be included e.g. a better understanding of the effects of HIV/AIDS on livestock production at the smallholder level is required. It will be necessary to reliably predict what will be the impact of HIV/AIDS on overall livestock production, community and national herd populations and, thus AnGR, of countries in 15 to 20 years when the epidemic is expected to reach its peak. The challenges are to develop simple, sustainable breeding programmes for indigenous breeds as well as effective control and use of modern strategies to avoid further erosion of genetic resources considering frame conditions.

c) Assess and evaluate existing livestock policies and develop new policies that enhance the opportunities for sustainable utilisation of indigenous AnGR. This can be achieved by the analysis of policy impacts on AnGR diversity. Also by capacity building and providing the organisation required for participatory approaches with the farmers, infrastructure and incentives for sustainable use and development of selected indigenous breeds. A major challenge is to investigate interdependencies between human and nature induced disasters and genetic diversity and to develop measures, strategies and tools to avoid or alleviate effects. There is an urgent need to learn from past experiences in order to develop long-term disaster risk management (DRM) strategies for monitoring and conserving AnGR in the future. The proposed research programme will help to fill the existing void in knowledge about how different types of disasters affect AnGR and its
direct linkages to sustainable livestock production in populations dependent on livestock for their livelihoods.

6. Conclusion

Loss of farm animal genetic resources raises the risk of loss of valuable resources, reducing the world’s ability to react to changing nutritional requirements, unforeseen diseases, natural disasters and threatening food security. Studies on indigenous poultry, small ruminants and cattle provide evidence that under different ecological and economic conditions locally adapted farm animals play a major role to sustain the livelihood of the majority of people in developing countries and have the potential to increase productivity in an efficient and environmentally friendly way. Decentralised, community-based group breeding activities applying standardised data recording schemes could be the best compromise in the lesser-developed countries to improve livestock and to conserve genetic resources. The indigenous genetic resources of livestock offer an enormous potential, which is not yet exploited. The conservation of such valuable germplasm should be regarded as mandatory for securing food for present and future generations.

References


Plant biotechnology: possibilities for developing countries

Godelieve Gheysen*, Marc Van Montagu and Nancy Terryn

Institute Plant Biotechnology for Developing Countries
Ghent University, Belgium
* also Department of Molecular Biotechnology
Ghent University, Belgium

Emails: Nancy.Terryn@UGent.be, Godelieve.Gheysen@UGent.be
Website: http://www.ipbo.rug.ac.be
Abstract

Food shortage in the developing world is not only due to insufficient food production but also to a complex set of political and socio-economical problems, such as unemployment and unequal distribution of food on world level. A higher local production of food will lead to an increased income of the farmers, which are still the majority of the people in the developing countries, and thus this can generate more employment in the rural areas and reduce urban growth. Biotechnology is one tool that can contribute to future food security if it benefits the subsistence farmers in developing countries.

1. Introduction

The fast population growth mainly in developing countries, located in tropical and subtropical areas, means an extreme challenge to our society, as the majority of the world population will suffer poverty, food and water shortage. To meet the demands of food and feed production, and to try to diminish the threat of water shortage, higher agricultural yields and a more productive use of marginal lands are a necessity (FAO: Status of Food and Agriculture 2000). Biotechnology could be one tool that contributes to future food security if it benefits agriculture in developing countries (Serageldin, 1999; Conway and Toennissen, 1999). Indeed, even in the context of a complex set of political and socio-economic problems, biotechnology could give results, if an increase in the productivity of agriculture in the third world, including subsistence farmers, could be achieved. A higher production will lead to an increased income for farmers, who are still the majority of the population in the developing countries, and this could thus generate more employment in the rural areas and reduce urban growth. Several examples of genetically improved crops that could benefit subsistence farmers are fruits with longer shelf life, food with improved nutritional value and in particular crops with tolerance to diseases or to abiotic stresses such as salt, drought, aluminium toxicity and low nutrient availability.
2. Present Agriculture

The high yielding agriculture of the US and Europe resulting in doubling of the production during the second half of last century was based on the introduction of hybrid seeds and an intensive use of fertilisers and pesticides. Since then, crop breeding favoured the selection of elite cultivars under high input conditions. The application of the principles and crops of the Green Revolution in developing countries had to rely on high yielding cultivars that became available from the “rich” world. This resulted in favouring a large scale and non-sustainable “industrial” agriculture.

The high yielding dwarf varieties that made the Green Revolution a success required a high input of fertilisers and pesticides. Over the years it became clear that this industrial agriculture causes quite some problems for the environment. The “dead zone” in the Gulf of Mexico now reaches 22,000 km². The Baltic Sea was in the summer of 2002 again infested by toxic micro-algae and cyanobacteria.

Another environmental problem is soil erosion. Reports that demonstrate the important loss of the fertile topsoils due to intense tillage increasingly become available. Gordon Conway clearly states that for the relief of poverty, it will be essential to develop a sustainable agriculture geared towards the subsistence farmers and not only introduce our industrial agriculture in the Third World. To do so, new approaches in crop development will be needed.

Another concern with our present agriculture is that the improved cultivars, even when they double yield in a country like India, bringing basic food security, actually did not alleviate poverty.

3. What has been achieved with biotechnology?

It was in 1983 that the first genetically engineered plant was obtained. A bacterial gene, conferring antibiotic resistance, had been inserted in a tobacco genome using the natural transformation capacity of the soil bacterium Agrobacterium tumefaciens. Nowadays the progress in plant biotechnology is enormous. For virtually all major and minor crops transformation procedures have been established. Many genes have been isolated and inspired by the Human Genome Program, the complete sequencing of the genome of rice and of the model plant
Arabidopsis thaliana has been accomplished (AGI, 2000; Goff et al., 2002; Yu et al., 2002). Recent developments, mainly in the field of functional genomics, like for example micro-arrays, will make it possible to understand the genetic and molecular basis of plants, which will have a positive impact on agricultural applications (DellaPenna, 1999).

In the middle of the nineties the first field production with improved crops, mostly engineered to contain traits of importance to large-scale agriculture, was undertaken. Now nearly 60 million hectares are planted with these transgenic crops, mostly in the US, Canada and Argentina. These include crops that are resistant to certain herbicides, or resistant to harmful insects. Indeed the introduction of an insect toxin (Bt) of a soil bacterium, Bacillus thuringiensis, is one of the first success stories of biotechnological applications for agriculture (Vaeck et al., 1987). Meanwhile different Bt proteins have been identified, each with its own specificity against certain insects. Approaches are being developed for resistance to fungi or bacteria. Disease resistant plants certainly hold promises for the developing countries where insect pests and pathogens are even a greater problem than in the western world. In addition the smallholder farmer often cannot afford the expensive sprayings with pesticides.

One example is papaya, where Asian scientists, united in the Papaya Biotechnology network, have developed genetically improved local varieties of papaya trying to fight the ring spot virus, a disease endangering the survival of papaya in Asia (see website http://www.isaaa.org/projects/SEAsia/Papaya.htm). The first tests are promising and after further field trials, this new variety will be distributed to farmers all over. Similar virus resistant papaya varieties developed by Cornell University and the University of Hawaii have saved papaya production in Hawaii (http://univrelations.cornell.edu/NewSciLife/ss-CRF.html).

Among the first generation of genetically improved crops are also fruits with longer shelf life. Although these are often seen as a luxury product for the Western consumer, it is clear that in the developing countries, with their problems of adequate cooled storage and transportation, fruits with a delayed ripening could prevent great post-harvest losses.
4. The next generation

Today the so-called second and third generation of genetically improved plants are being developed. Novel traits engineered in these plants also include so-called output traits, like improved nutritional value and altered composition of for example carbohydrates or oils. Improving nutritional value has a lot of potential for the poorest people in the developing countries. Almost 800 million people in the world are undernourished, but next to this, a large number of people also suffer malnutrition, meaning they are qualitatively underfed. Developing countries do not only need more food, they also need more nutritious food to sustain a healthy life. The development of high quality cereals and staple crops, rich in essential amino acids and micronutrients such as iron and vitamin A, are strategies that can be approached by agricultural biotechnology (Ye et al., 2000).

Another useful application for developing countries is the design or generation of crop plants tolerant to abiotic stress, being one of the most important factors limiting plant growth and crop yields. Poor farmers in the tropics often have their lands on marginal soils, having as penalty a low crop productivity due to abiotic stresses such as salt, drought, aluminium toxicity and low nutrient availability. Acid soils comprise around 40% of the world’s arable land, while low phosphate availability affects over 60% of the land currently used for agriculture. Because of a low pH these soils have a too high aluminium concentration (as the soluble form Al^{3+}) that is a limiting factor for a good productivity. The generation of crops with a higher tolerance to aluminium offers possibilities here. Studies have shown that the expression of organic acids can contribute to this (Lopez-Bucio et al., 2000).

On the other hand, already one third of our planet consists of arid and semi-arid regions, and this extends with more than 10,000 hectares each year. Even regions that may have sufficient rain on an annual basis, may suffer periodic droughts. Biotechnology can help the building of drought stress tolerant plant genotypes suitable for use on marginal lands (Garg et al., 2002). This would allow a higher crop performance with reduced use of environmentally troublesome inputs.

Health care and medicines are a known problem in developing countries. Often the local people cannot afford the expensive medicines they need. Plants in this respect could be a cheap mini-factory for some
medicines that are based on plant secondary metabolites. In addition plants can also be used to produce vaccines (Richter and Kipp, 1999).

5. Biotechnology oriented towards developing countries

Despite the fact that there are numerous possibilities to design genetically improved crops useful for developing countries, industry till now has shown little incentive. Possibly they don’t see a big market in the Third World, or have little experience with the crops cultivated there. However some fruitful collaborations, maybe more humanitarian than profit driven, between industry and institutes in developing countries, have been instrumental to obtain certain improved local crop varieties. The virus resistant sweet potato project of the Kenyan Agricultural Research Institute and Monsanto with support also of USAID is one example of this (http://www.isaaa-africenter.org/sweetpotatoes.htm). How transgenic plants can help to decrease deforestation is exemplified by the nematode resistant potatoes developed by the University of Leeds. Potatoes are the principal staple food for Bolivians, but if potato fields get infested by the potato cyst nematodes, yield losses amount to 40%. Because nematicides are too expensive and crop rotation is not efficient (nematode cysts survive in the soil for many years), farmers often see deforestation as the only solution to avoid potato infection. Scientists at the University of Leeds have expressed a rice protein in potato that confers resistance to this nematode pest, allowing subsistence farmers to continue growing potatoes on infested land without serious yield loss (Atkinson et al., 2001).

Another example that actually comes from Flemish research is on banana. Banana is very important for Africa as it is eaten as pancakes, mash, chips, bread and beer. However, disease and pests devastate this staple crop. One of the most terrible diseases is an airborne fungus called Black Sigatoka, denying the bananas the photosynthetic energy they need to grow. Prof. Rony Swennen in Leuven, Belgium has genetically modified banana to resist the leaf disease. Now these transgenic bananas are awaiting approval to be planted in a test field in Uganda.

(Read more at www.agr.kuleuven.ac.be/dtp/tro/Bananas_A4.pdf).
The Institute of Plant Biotechnology for Developing Countries (IPBO) is an initiative of Ghent University, under the impulse of Prof. Em. Marc Van Montagu. Its mission is training and technology transfer and plant research, orientated towards the needs of the developing countries. To answer the local needs of the developing countries, IPBO supports the transfer of know-how by training and joint research projects. The aim is not only technology transfer but also the stimulation of the developing countries in establishing their own competitive biotechnology research. IPBO has also its own line of research, focused on crops and problems of developing countries. Research groups focus for example on the transformation of grain legumes and the study of biodiversity (check the website www.ipbo.rug.ac.be).

Next to the IPBO research lab, an IPBO-Foundation, called “Plants for Development”, will be started that has as objectives to establish a network of laboratories and institutions in the industrialised and developing countries. This network is essential for an effective cooperation between North and South, on the one hand to determine the necessity of the development of improved crops, on the other hand for the implementation of research results in developing countries.

6. Conclusion

At the 2002 Johannesburg meeting the need for sustainable development and the importance for fighting underdevelopment have been well stressed. To obtain this progress, science and technology will play a major role. This was the statement of ICSU, the International Council of Scientific Unions and that is surely our opinion. Thorough social and economic changes in the developing countries will be needed, but these can only be realised if science and technology can put value into agriculture and create the necessary sustainable industry. Plant biotechnology can here bring the new tools to realise them. To assure that the advantages of biotechnology will reach those most at need of it, the industrialised countries should make it possible for the developing countries to be independent partners in this endeavour by transfer of knowledge and technology. Science is indeed one of the essential factors that can contribute to breaking the vicious circle of poverty and food insecurity.
References


Biotechnology and hunger in developing countries

STUART SPENCER

Centre for Agricultural Bioethics
Catholic University of Leuven, Belgium

Email: stuart.spencer@lancet.com
Website: http://www.kuleuven.ac.be/cabme/
Abstract

The biotechnology industry suggests that genetic modification will solve the problem of world hunger. This paper attempts to assess the potential of biotechnology to provide food for the growing world population by comparing the promises with the realities of genetically modified food crops. It also looks at the socio-political influences on the uptake of biotechnology and at the use of low-tech solutions in the developing world.

1. Introduction

Hunger is predominantly a problem in the developing world; biotechnology is essentially a development of North Atlantic technology. Can this western technology be used to alleviate Third World hunger? Genetic modification has received a hostile reaction from the majority of consumers in Europe, and increasingly in North America (European Commission, 2000a). This may not be surprising in countries where there is a vast excess of food, agricultural production is subsidised and science is blamed for problems such as mad-cow disease. Even many of the farmers who were expected to gain from the introduction of genetically modified crops have become disenchanted. Yet genetic modification has been suggested as the only way to feed the world (for example: Pinstrup-Andersen 1999; and www.ifpri.org/hottopics/needs_forms/102899.htm). Biotechnology might help overcome world malnutrition through higher yielding varieties; improved use of marginal land; pest or herbicide resistance; and nutritional enhancement.

Global food production is already sufficient to feed the world’s population; unequal access to food is the problem. How far can biotechnology circumvent the economic and socio-political problems to reduce hunger?

There are 800 million people in the world who are regularly hungry (UN/ACC, 1999) while the number for those who are malnourished is a staggering 23 thousand million – nearly half the world’s population. Along with the malnutrition comes disease. Lack of dietary iron means 2,000 million people are anaemic; vitamin A deficiency causes 180
million cases of blindness each year; and malnourished people are more likely to succumb to infectious diseases. As the world population is expected to increase to 8.5 thousand million by 2025, the amount of cultivatable land per capita decreases - making efficiencies in food production even more imperative. World food production has increased steadily, but there are now concerns that we may be nearing the limit to production using conventional approaches. Some have argued that biotechnology (The Alliance for Better Foods, 1999; Modern Food/Biotechnology: Facts and Figures. http://ificinfo.health.org/backgrnd/bkgn4.htm accessed 8.4.01) is the only way to overcome this barrier while others argue that the relative global value of the increased yields has to be balanced against the possible loss of biodiversity and the damage to the environment.

2. The use of biotechnologies

Increasing yields

High-tech solutions such as genetic modification might increase crop yields, though evidence for this is scant; the reasons for this may be many. Plant breeding and selection programmes over centuries have already produced varieties that have much enhanced yields. There is thus much less chance of being able to capitalise on wild strains with a mutagenic advantage in terms of yield. Although modern biotechnologies have not yet produced increased yields, very much simpler solutions have been identified that can quadruple yields without any obvious detriment to the environment or ecology. In Madagascar, it has proved possible to increase yields of rice from 3 tonnes to 12 tonnes per hectare by planting fewer seedlings but planting earlier, using less water and more compost rather than fertiliser (Pearce, 2001). Nobody has yet shown such remarkable increases in yields with genetically engineered crops – and certainly not with food crops. This approach could radically alter life in hungry regions. Such methods for increasing yields are available to all farmers at no cost, and have the advantage of increasing the amount of food available to the people who need it.
Improved tolerance of adverse conditions

The use of marginal lands provides one possible way of increasing food production – particularly in developing countries. This could be through producing plants tolerant to adverse conditions such as salty ground, cold and drought. Salt-tolerant plants have been suggested as a way of utilising coastal lands where high salinity prevents crop growth, however there is really very little extra land that could be made cultivatable using salt-tolerant plants. Perhaps more optimistic is the possibility of producing frost-resistant plants. Prolonged cold weather is an important factor in reducing food production in many of the cooler parts of the world with hungry populations (central Asia and the Andes, for example). Modification of food plants so that they can grow despite the cold might be able to lengthen the growing season and so increase yields. Perhaps because growing food was not easy, these regions are relatively under-populated and so increasing food production in these areas will not directly influence the nutritional status of many people. There are large areas of land where cold-resistant crops could be grown, providing the potential to increase overall world food supply, but the socio-political problems of distribution (vide infra) will remain. Increased production in sparsely populated regions will not feed the world’s hungry.

Drought resistant crops may be much more promising, and could be practical in regions with a high numbers of poor people. However, crops still need water for germination and, since most of a plant is water, for productive growth. A crop like maize uses 5 million litres of water per hectare in transpiration (Smersmud, J., Mansour, W., Hess, M., and Selker, J. Sweet corn irrigation guide. http://biosys.bre.orst.edu/bre/docs/sweetcor.pdf accessed 27.02.02) and it has been estimated that this can only be reduced by 5% if the crop is to be productive. Consequently, many experts believe that drought-resistance will be unable to increase yields more than marginally. The best that can be hoped for at present is that established plants will be better able to withstand prolonged drought — so that they will survive until the rains come.
Pest and herbicide resistance

At present the major commercial genetically modified crops are pest-resistant cotton and maize, and herbicide-resistant soy and oilseed rape (canola). These crops accounted for more than 90% of the area planted with genetically modified crops planted in 1999. More than half of the area of genetically modified crops is a herbicide-resistant crop where the major advantage is decreased cost of chemicals – an issue of little concern to most subsistence farmers among the world’s poor and hungry. Losses due to pests are a bigger problem in the developing world, and if such losses can be avoided then yields should increase. Pest-resistant cotton has produced considerable increases in yields, but the results for food crops are less encouraging. Studies in the west have generally shown lower yields from genetically modified crops compared with the comparable premier seed varieties (European Commission 2000b; Benbrook C. Evidence for the magnitude and consequences of Roundup Ready soybean yield drag from university-based trials in 1998. www.biotech-info.net/RR_yield_drag_98.pdf). If farmers in the developed world with all their technological advantages can’t get increased yields from herbicide-resistant crops, what chance have farmers in the Third World? This does not mean that there is no place for biotechnology for making improvements in food production. There has been some good work directed specifically at production in developing countries: nematode-resistant potatoes (Atkinson et al., 2001), fungus-resistant bananas (www.agr.kuleuven.ac.be/dtp/tro/bananas_A4.pdf) and virus-resistant papaya. Without belittling these useful advances, papaya is not a major food crop and for most of the world’s hungry the staple food is rice.

There has been much concern over possible ecological problems that may accompany the use of genetically modified crops. Genetically modified genes can spread by hybridisation into wild varieties (Wilkinson et al., 2000). The spread of herbicide resistance into wild plants will result in increased use of herbicide, so counteracting a benefit of such genetically engineered plants. As with rice production, simple, low-cost solutions for use in developing countries have already been found. They can at least equal the benefits shown by advanced biotechnological solutions.
Striga hermonthica (witchweed) is a major weed that reduces maize yields in Africa. Removal of Striga is labour intensive, but workers at the Kenyan Agricultural Research Institute (www.icipe.org accessed 9.4.01) have found that growth of Striga is inhibited by interspersing maize with another local plant, Desmodium. Such a strategy is at least as effective as applying herbicides, but is less costly, more ecologically friendly, and uses locally available products. Not only does this increase the yields of corn, but Desmodium is also a useful fodder crop for animals, so increasing total productivity per hectare. Such inter-planting of crops is a well-accepted strategy in many regions.

Pest-resistant crops could significantly increase yields, but their use may have important ecological considerations. Losey et al. (2000) caused considerable concern amongst environmentalists when they showed that pollen from genetically modified plants caused the death of caterpillars of monarch butterflies. Although this may perturb western ecologists, this is not likely to be an important consideration for the self-sufficiency farmer whose major concern is feeding his hungry family. Perhaps more worrying is the study by Hilbeck and colleagues (1998) who raised plant-eating insect larvae on genetically modified maize; when they fed these larvae to green lacewings, many of the lacewings died. Environmentally this is important because it shows the toxin can be transferred to other insects throughout the growing season. Agriculturally it is important because lacewings are a predator of other maize pests. Again, there are local, cheaper, and perhaps more ecologically friendly ways to deal with the problem of pests. Stem-borer is a major pest to maize production in Africa. The borer larvae eat into the stem of the maize plants, weakening them and reducing yields. Research in Africa has shown that the stem-borer larvae prefer eating some other plants to maize. Molasses grass produces a sticky substance that attracts the larvae and traps them; by contrast, Desmodium repels stem-borer. Planting such grasses amongst crops acts as a natural pesticide and improves yields by up to 70%, but does not indiscriminately reduce local insect populations – or have the costs associated with genetically modified seeds. Such techniques are easily applied and are more appropriate for use in poor rural areas compared with genetically modified pest-resistant strains that usually require knowledge of intensive cultivation techniques not common in Africa.
It seems, therefore, that even if genetically engineered crops can produce more food there are some major concerns over environmental issues. Furthermore, there are clearly alternative solutions with potential benefit and perhaps lower detrimental effects. Overall, therefore, genetically modified crops do not appear to be the answer to increasing yields and alleviating hunger through increasing crop production.

*Nutritional enhancement*

Genetic engineering offers a number of other possible benefits, for example nutritionally modified crops. One much-trumpeted success has been the development of the so-called Golden Rice that is rich in Vitamin A (Ye et al., 2000). Golden Rice, and other nutritionally enriched varieties of food plants, could eventually help alleviate marasmus, anaemia and vitamin deficiencies. If the seeds become genuinely freely available to the needy this could certainly contribute to improved health for those who eat the crops. However, not everybody will benefit from this.

The World Bank estimates that up to a third of the world’s hungry – more than 200 million people – live in India (www.worldbank.org/poverty/data, accessed 28.3.01), and the number is growing — particularly in rural India. Yet India produces more than 200 million tonnes of grain per year and has a food surplus. The Indian government wisely stores grain as a safeguard against poor harvests, but this is not readily available to feed India’s starving population (“Prowling tiger, slobbering dog” 17th February, 2001. p 82, and a supplement on India in the issue of 2nd June, 2001. “Grim reapers” pp14-16. www.economist.com). Less than 5% of India’s agricultural products are exported, so the excess crops neither generate income nor fill stomachs — the rural population in India remains hungry. This situation is not due to the logistics of moving the grain to the hungry. Even in the fertile and productive region of Kalahandi, people may die of hunger because they cannot afford to buy the locally produced rice that contributes to the country’s grain surplus (www.connectotel.com/gmfood/hi210700 accessed 21.1.01). The large numbers of people who cannot afford to buy rice will still suffer and die regardless of the nutritional advantages of Golden Rice they cannot
afford to buy. In this case hunger and malnutrition is a consequence of poverty and cannot be overcome by biotechnology.

3. Who gains? Who loses?

The introduction of short-stemmed, high-yielding varieties of rice, maize and wheat was technically successful and increased agricultural productivity; but unexpectedly and paradoxically this so-called Green Revolution also increased poverty and hunger (Macdonald, 1992). The seeds of the new varieties did cost more, required more irrigation, more fertiliser and more pest-controlling chemicals. Generally, the new varieties were more expensive to grow than the traditional crops (Macdonald, 1992). Consequently, only the richer farmers were able to profit from the opportunity. The poor farmers, who could not afford to benefit from the opportunity, became relatively poorer, sometimes to the extent that they lost their land and joined the homeless and unemployed. Some lessons have been learned from this unfortunate, but well-meaned, intervention, but it remains likely that it will be the richer farmers who will benefit from further technological advances (which, after all, do have to be paid for by someone) at the expense of the poorer. The costs of genetically engineered plants (royalties, seed costs, herbicides for increasing the yield of herbicide-resistant plants etc) have been estimated at up to 35% (European Commission 2000b) more than conventional sowings, and this will make the crops inaccessible to even more people.

Some evidence of the increasing gulf between rich and poor farmers may be seen in Brazil. Famine is perennial in Brazil, but El Niño-produced droughts exacerbate the situation and millions face starvation as a result. Genetically engineered soy beans for export are now being grown in Brazil, but this does not directly help the starving who are largely subsistence farmers who do not grow soy. In Brazil it is again the richer farmers, rather than the needy, who benefit from the new technology.

If modern biotechnologies were readily available without cost, more of the poor and hungry may be able to grow their own subsistence rations, but in a profit-driven situation the benefits will be largely gained by the rich, and the poor will still starve. The morality of increasing the
number of people suffering poverty and hunger for the benefit of a few should not be a difficult conundrum to wrestle with. On the positive side, *Bacillus thurinigiensis (Bt)*- resistant cotton has been a clear success, at least in terms of reducing losses due to pests. Consequently yields of cotton have increased. This may provide an apparent advantage to farmers growing *Bt*-resistant cotton and perhaps to the local economy in general. However the advantage is illusory, or at best transient, and exemplifies a general problem with the economics of genetically modified crops. In the first instance, as farmers in the developed countries are the first to use the *Bt* cotton, they are the first to profit from it. This does nothing to help the hungry populations in the developing world (Sen, 1981). Developing-world farmers whose income is based on production of cotton would have to compete with even more efficient western farming. In a second scenario, if *Bt* cotton were available only in countries with hungry populations then there might be some benefit to local farmers and, perhaps, a trickle down benefit to local economies. Unfortunately, human nature and capitalist economies being as they are, any benefit to the poor and hungry is unlikely to be realised, as increased profits will remain with the farmer. Thirdly, as the use of *Bt* cotton becomes more widespread, the relative advantages are lost and the market collapses under a glut of cotton, so decreasing returns and increasing poverty.

There are other ways in which the potential for genetic modification to worsen life in the developing world is greater than the potential benefits. For example, the development of genetically modified banana plants to allow it to be efficiently produced in non-tropical regions would have disastrous consequences for many Caribbean and Latin American countries whose economies are dependent upon banana exports. Similarly, if crops such as cocoa and coffee could be genetically modified so that they could be grown profitably in the USA, it would devastate economies in developing countries. In our high-tech, profit-driven society such scenarios are far from unlikely.
4. Conclusion

There is sufficient food now to feed the whole world, what’s lacking is the political will. In the near future political, economic and social influences make substantial improvements in food distribution to the hungry unlikely to happen. Although there are some possibilities for genetically modified plants to improve the general living standards in some developing regions, most of any (putative) advantages of genetically modified crops are likely to accrue in the west and the effects on alleviating world hunger will be minimal. In summary, there seems little prospect that biotechnology can reduce global hunger and, indeed, it could make the situation worse by increasing third world poverty.

Selected References


The use of crop protection products as part of sustainable agriculture.

ANN DUPONCHEEL

Communication Manager for Phytofar
Phytophar, the Belgian Association of the Industry of Crop Protection Products in Brussels

Email: aduponcheel@fedichem.be.

Phytofar has 18 member companies and in excess of 2500 employees in Belgium. Phytofar works with a wide range of initiatives to achieve high-quality farming production under healthy and environmentally friendly conditions.
For additional information, please visit the website: www.phytofar.be
Abstract

Crop protection products play a major role in the development of an agricultural system that is safeguarding ever-increasing parts of the world’s population against famine and malnutrition. However, as the years have gone by, attention in the industrialised countries has shifted away from food security to food safety. In the European Union, food safety does not only mean hygienic end-products, free from any harmful residues, but also products and production processes that are safe for people, animals and the environment. Both the crop protection industry and the farmers take their responsibility very seriously in this debate. Government plays an influential and supervisory role.

1. Sustainable development

Agriculture has subscribed to the world-wide concept of more sustainable development. This means that the production process and hence also the technique used for crops, including the crop protection products needed, have to fit in with it too. The notion of sustainability dates from the 1987 Brundtland Report that formed the basis for the United Nations Conference on the Environment and Development (UNCED) held from 2nd to 14th June 1992 in Rio de Janeiro, Brazil. The Rio Conference, as it has since become known, put forward a world plan for the 21st century, called Agenda 21. Agenda 21 lays down policy measures designed to achieve more sustainable development in order to meet the requirements of the present, without threatening the supply needs of future generations.

Typically, sustainable development has to meet three conditions at the same time, specifically in terms of economic, ecological (environmental) and social matters. In all countries, both in the North and the South, and at all levels of policy, both internationally and locally, the notion of sustainable development has to be taken into account. This is also spelled out in so many words in the European Union treaty: sustainable development must be included in all areas of policy in Europe, hence also in European agricultural policy. With its ‘Approaches to sustainable agriculture’ (COM(1999)20) and ‘Indicators for the integration of environmental aspects in the common agricultural
policy’ (COM(2000)20), the European Commission has already laid down the guidelines. And in the area of sustainable developments in agriculture, plant protection also has to be economically, ecologically and socially accountable.

2. Modern forms of plant protection

Modern methods of plant protection are not the magic answer in themselves. They each have their strong and weak points. As a result, modern plant protection tries to achieve a balanced mix of measures and brings together the various elements of modern plant protection methods into an integrated whole. This is called integrated pest management. The crop protection industry fully supports the development of integrated pest management in farming and horticulture that also includes the use of organic pest control methods.

2.1. Integrated pest management

Integrated pest management is a rational form of plant protection that uses a judicious combination of organic, genetic, chemical and technical crop protection methods. Hence it is a form of plant protection that involves the carefully thought-through and restricted use of products that protect plants. This is done to ensure that the damage done to crops remains below an economically viable threshold, while stimulating to the maximum the development of natural enemies of the harmful organisms. This new trend in plant protection is justified both from the viewpoint of economic cost-effectiveness and in terms of food safety and protecting the environment.

However, integrated pest management is not straightforward. Indeed, a dynamic and flexible plant protection system such as this makes use of the most advanced scientific knowledge and technology in agriculture. The strategy is based on preventative measures, a thorough knowledge of the make-up of the plant health problems that occur, the regular checking of crops in the field and compliance with the Codes of Good Agricultural Practices. In addition to knowledge about weeds, plant diseases and insect infestations, manufacturers also need to be up to date
with the available products, their operating spectrum and how they work.

2.2. Codes of Good Agricultural Practices

Codes of Good Agricultural Practices are imposed by the European Union. All member states are required to develop Codes for each country or region that are suited to specific production conditions. These Codes are then submitted to the European Commission for approval. The Codes contain useful tips, techniques and recommendations that help to enable individual farmers and market gardeners to abide by basic environmental quality requirements. There are a number of different Codes, each dealing with one specific area of production. The Codes of Good Agricultural Practices, Crop Protection Products for example, do not only contain general principles for plant protection as well as dealing with safety tips and the reduced use of crop protection products, but they also feature recommendations for each crop (corn, pasture, potatoes, cereals, sugar beet, fruit-growing, strawberries, vegetables, ornamental plants). The member states and/or regions are then required to encourage compliance.

2.3. Precision farming - A look into the future

A look into the future shows us the immense possibilities opened up by integrated pest management that provides a mix of all available modern technologies for achieving sustainable agriculture. Precision farming applies plot-specific fertilisation and plant protection techniques. Indeed the examination of yield records confirms that the crop yield potential and hence the required fertilising and plant protection methods are not the same across an entire plot of land. Yet these days, this is not taken into account. The whole plot of land is given the same treatment. This means that the dosage may be too great in one particular part of the plot, and too small somewhere else. Precision farming, with the help of modern communication techniques, can provide a solution for this by refining the entire production process. For example, it may be known that weeds always grow in particular areas of the field. To identify these
spots, optical techniques have been developed, such as the use of image processing. Identifying and/or locating patches of weed can then be done during weed treatment or beforehand. In the latter case, a ‘weed map’ is created based on the spectral analysis of aerial photos of the plot of land. The data is then fed into the sprayer unit that is fitted with a GPS device. Using weed maps has demonstrated that depending on the plot of land, a 40% saving in herbicides can be achieved with corn. Similar techniques are being developed for the detection and location of plant diseases because we also know that diseases occur in patches, which means it is usually excessive to treat the whole plot of land. Research is continuing. Some parts of precision farming are ready to be put into practice. And they can be fitted in with the integrated farming production method.

3. Chemical crop protection products

3.1. Legislation relating to crop protection products

Europe
Crop protection products are some of the most regulated substances in Belgium and also in Europe. The products used to protect crops have been subject of increasingly strict legislation for more than fifty years. The European Directive concerning the placing of plant protection products on the market (91/414/EEC) is aimed at providing strict legislation, particularly in the area of toxicity for humans, animals and the environment. The Directive requires the crop protection industry to provide all the information needed about the active agents in their products so that the user, the consumer and the environment can be better protected. To be able to market these products, each active substance used in a particular product has to be registered at European level. Such a registration is required to ensure that the active agents used comply with a whole series of toxicology and eco-toxicology tests. The costs involved for the research required at European level will soon be up to 125 million EUR for each active substance.
The European Directive also imposes the obligation of obtaining national registration before a retail product can be brought into circulation.

**National**

A registration file for every crop protection product has to be submitted in each member state where the product is intended to be marketed, owned or used. To obtain this registration, each product has to go through a whole series of technological tests that enable a thorough knowledge of the product to be gained, including the possible way the product might behave in the food chain and the environment. Consequently, crop protection products are subjected to more studies than any other chemical product. They have to meet even stricter conditions than medical drugs.

As a result of this strict legislation, the crop protection products that are on the market today can be applied without any danger for the user, provided they are used for the purpose for which they were registered. This is because their presentation (packaging, formulation), their application and the equipment with which they are applied meet the very strictest requirements.

### 3.2. With the necessary care for food safety

**Acceptable Daily Intake**

Different tests that have to be conducted before a crop protection product can be introduced into the market are related directly to food safety. Details about the product must be known in the short and long term. In practical terms, both short-term (90 days) and long-term studies (2 years) are carried out with regard to possible chronic toxicity. The toxicology file is also required to provide a definitive answer about any possible effect on reproduction and any possible mutagenic and/or carcinogenic effect of the product.

The aim of all this research is to define the quantity at which no discernible effects are obtained - the ‘No Effect Level’, or NOEL. Using this quantity as a base, it is then possible to define the ‘Acceptable Daily Intake’, or ADI. The ADI is the quantity, based on the available data
and weight in kilograms that a person can take on a daily basis throughout their life without causing any discernible effects. To determine this amount a safety factor of 100 and sometimes even 1000 is built in. This means that the quantity that has ‘no discernible effects’ is divided either by 100 or 1000. The safety factor is 100 for a 2-year study, 500 for a 90-day study and 1000 if there is the slightest doubt. In no other sector such a high safety coefficient is used.

**Maximum Residue Limit**
To achieve safe food, a package of food is used as an assumption. The MRL or ‘Maximum Residue Limit’ is calculated on the basis of the Good Agricultural Practices and is set within the acceptable degree of risk derived from the acceptable daily intake of the substances concerned.

To do this, we take an adult person and a common ‘basket’ of food. The maximum threshold of residues is never allowed to exceed the acceptable daily intake amount. A further safety margin is then added to that, because children and someone who is ill have different eating habits or may display greater sensitivity. If the limits were based solely on the ADI, they would have to be higher in many cases. The MRL is, as it were, the tolerance threshold of residues in food that legislators have laid down on the basis of scientific research. No product may be used in the European Union (EU) for which no MRL has been established. This makes the MRL a trading standard and not a health standard. It enables exporting countries to trade in crops internationally and assures importing countries that the crops have been treated correctly in the country of origin. The same MRLs are not always used in different countries, which makes it difficult - and sometimes impossible - to make accurate comparisons. The crop protection industry is also fully supportive of the European Commission’s proposal to harmonise legislation to come into effect at the beginning of 2005.

**The ‘precautionary principle’, an additional safety factor**
In contrast with the United States, the European Union applies the ‘precautionary principle’ to its food safety policy as well. The application of this principle is not new. It is part of the concept of sustainable development. The European Commission has laid down a number of guidelines because there was a lack of clarity about how the
principle should be applied, both inside and outside the EU. The principle is applied when a provisional objective scientific evaluation indicates that there are sound reasons for fearing that there might be possible harmful effects for the environment or for the health of humans, animals and even plants that are incompatible with the high levels of protection that the EU has set. Here once again the European Commission is proposing that assessing whether an ‘acceptable risk’ for society is predominantly a political matter, knowing that there cannot be zero risk, how much one might want there to be. Using the precautionary principle as a basis, a decision can be taken not (yet) to make a ruling on the registration of this or that product or method, or at least not to introduce any binding measure until there is greater clarity as to the possible consequences.

**Food safety: a practical example**
The acceptable daily intake (ADI) of a well-defined residue from an insecticide on fruit and vegetables in Belgium is 0.05 mg/kg live weight and the maximum residue limit (MRL) of that product is set by law at 0.1 mg/kg for fruit or vegetables. An adult person weighing 60 kg will, applying the safety factor of 100, need to eat more than 3000 kg of fruit and vegetables every day before getting into the danger zone. For a child weighing 10 kg, this would amount to a daily consumption of 500 kg of fruit and vegetables. This example demonstrates that in terms of food safety in the whole of the European Union and more specifically in Belgium, the risk threshold has been set very high indeed.

**Residue controls**
All member states conduct on-going checks into residues of crop protection products in foodstuffs. The European Union monitors the national inspection systems, and as a result of the various efforts made both by farmers and crop protection industry, there has been a further clear-cut reduction in breaches of the permitted maximum residue limits (MRL) in the past few years. For Belgium in 2001, for example, breaches of the maximum residue limits laid down were only observed in 3.7% of cases, which in view of the application of extremely high safety factors, in no way represents a hazard for public health. Finally, it has to be said that the method used for preparing food is a further form of protection. Research indicates that when food is being prepared, most
of any residues still present, which are already below the statutory limit, is reduced significantly further. Rinsing, boiling, blanching and other cooking processes ensure that food that is already safe becomes even safer.

3.3. The crop protection industry accepts its responsibility

Production processes are becoming increasingly integrated. This also applies to the food production process. In its ‘White Paper on Food Safety’ the European Commission has also opted for an integrated food safety policy from ‘ground to mouth’, from ‘farm to fork’. As part of this policy, everyone has to accept his or her part of the responsibility involved. After all, the government alone cannot be responsible for everything and more. There are the various links in the production chain that must manage and control their production processes in such a way that they monitor themselves and make adjustments where necessary. The task of government is to monitor the monitoring. The chemical industry and more specifically the crop protection industry is just one of these links in the food production process. It has taken the responsibility upon itself to monitor the whole process. The crop protection industry is constantly working on the development of new, selective crop protection products for which the quantity required can be reduced significantly and, in conjunction with the manufacturers of spraying machinery, new techniques are being developed to ensure that crop protection products are applied as responsibly as possible. The industry is also convinced of the importance of Good Agricultural Practices, the application of which plays a fundamental role in reducing residues to below the permitted thresholds. The communication campaigns run by the crop protection industry will continue to stress this point, and we continue to work closely with farmers to support the optimum use of crop protection products.

This is because crop protection products play an essential role in the context of healthy food. According to the Food Information Department of the European Council, people should eat 40 different types of food and predominantly a whole range of fruit and vegetables. The availability of such a range depends partially on the use of crop
protection products that are able to ensure a balance between price and quality.
Organically grown crops in the South - challenges and implications

EWALD SCHNUG

Director and Professor, Head of Institute
Institute of Plant Nutrition and Soil Science
Federal Agricultural Research Centre
Braunschweig, Germany.

Email: pb@fal.de
Abstract

Food quality is an issue of increasing public interest. The subject targets not only the content of nutritional compounds, health promoting or otherwise beneficial substances and features, but more and more the way food is produced. Organic farming and conventional, industrialised farming show fundamental differences from agricultural, environmental, social and economic point of view. One measure to achieve a high food quality on a holistic level is the implementation of organic farm production systems. The holistic approach of organic farming makes it a particular challenge to improve rural life in southern countries.

1. Food Quality and sustainable development

The aspect "food quality" has many different facets, which are closely related to the political and economic situation of a country. During starvation periods the main parameter for the quality of food is exclusively the supply of the body with sufficient energy, helping it to survive and stay alive. During war times virtually man has eaten anything, no matter how disgusting, without thinking about contaminations or how it was produced. Under these constraints it is simply the quantity, which reflects the quality of food. Agricultural policies focus on supporting farmers to run their operations at maximum output without view to quality and environmental impacts, respectively. In comparison, when people have free access to food the concentration of nutritional factors is a main quality parameter. This explains the explosive consumption of highly concentrated food such as sugar and meat in post war communities while the former major energy supply by fat and vegetables is drastically reduced, because their consumption is weighed emotionally so that substituting them can be regarded as a way of coping with starvation periods. For instance potatoes and cabbage were characteristic crops which were largely consumed during war and starvation periods in northern Europe and rape oil is still evaluated as low quality fat in Germany because of war memories.
Consequently, if food security is warranted in a society aspects of personal life quality and individual life span in the context of food consumption gain relevance. This implies that essential compounds such as vitamins and minerals, or energetic factors (bio-dynamic products) and hazardous contaminations with inorganic (heavy metals) or organic (e.g. pesticides, mycotoxins) pollutants are important quality criteria. With increasing welfare the technological quality of food is another quality parameter. Corresponding consumer demands are acknowledged in the EU quality standards for vegetables and fruits, which solemnly concentrate on size, shape and colour. The quality of peas for instance is supposed to increase the bigger and greener they are (Root, 1980).

The perhaps most demanding level of food quality involves the way food is produced and which can be attributed as "process quality". On this level not only the benefits for the own organism are questioned, but also the impacts agricultural production has on other ecosystems and organisms involved in the production system (e.g. animal welfare). This means that food quality is no longer an issue which can be controlled by analysing the product itself, rather it requires a holistic approach to evaluate all factors involved in its production. At this level defining and controlling food quality becomes a real difficult matter and a serious problem with view to the common understanding of science. It was Galileo Galilei (1564-1642) who stated “measure what is measurable and make measurable what is not measurable”. A basis of our science is the measurement of physical parameters. Thus it is not surprising that applying traditional chemical analysis for biodynamic products that claim to have a specific, energetic quality, failed to determine differences in crop quality (Finck, 1979).

When in the 1970's organic farming was brought up as an alternative to conventional production, the active stakeholders of food production launched extended campaigns for comparing the quality of conventional and organically grown products with the result that in general common production techniques delivered at least equal or even better quality than organic systems (Woese et al., 1997). Considering the higher price of organically grown products, organic farming was therefore dismissed as being no alternative, even suspected that customers are fooled (Finck, 1979). The fatality of this conclusion becomes evident by the following, simple comparison. Assuming that the same scientists who compared
conventional and organically grown food would be in charge to conduct a similar comparison on the products of the German car industry, this would be disastrous for the economy as from viewpoint of functionality and performance no much difference is left between the products of different brands, but still people accept a significant higher price for a Mercedes than for a Skoda. Like food, cars are a commodity (an indicator for this is for instance the rapid vanishing of small manufacturers), but despite this fact the car industry has very well managed to keep a diversity of brands of the same product. The (well paid!) differences between different brands of the same product are hardly measurable by means of physical methods and are deep in the world of expectations and imaginations. Selling a product’s image is in many cases the true source for sustainable profits in business and unfortunately agriculture failed to adopt this principle at much earlier stages.

There are only two occasions on which the human body is penetrated voluntarily: through feeding and sex. Both actions contain issues of pleasure and imagination, but in case of food the trend goes in opposite direction. The introduction of fast, processed and frozen food in the 1950s had a lasting impact on dietary habits and caused a significant increase of diseases such as obesity, type II diabetes, high blood pressure and heart disease (Kimbrell, 2002). Additionally, all efforts were made to lower the prices of foodstuff with a climax to a situation where the product prices hardly cover the production costs (Anon, 1980) and customer demands are ignored (Friedman, 1999). Under such circumstances it is not surprising that issues of food quality are under strong pressure in favour of factor efficiency for which repeated disasters in agricultural production give sad evidence.

Wendell Berry (2002) gives a clear view to the real problem of our "modern" agriculture: "We currently live in the economy and culture of the one-night stand. Industrialism has provided us innumerable commodities, amusements, and distractions, but these offer us little satisfaction. Instead we suffer ever-increasing alienation from our families, our communities, and the natural world. There is another way to live and think: it's called agrarianism. It is not so much a philosophy as a practice, an attitude, a loyalty; and a passion - all based in a close connection with the land. It results in a sound local economy in which
producers and consumers are neighbours and in which nature itself becomes the standard for work and production."

Organic farming is not only a way for an environmentally sound production of high quality food, but with its holistic approach to all factors involved in the production it is also a challenge to build up customer desired images on food, not at least because of the way they are produced. An argument often used against organic farming is that is not an adequate production system with view to food security. In this context Kimbrell (2002) points out that "world hunger is not created by lack of food but by poverty and landlessness, which deny people access to food. Industrial agriculture actually increases hunger by raising the cost of farming, by forcing tens of millions of farmers off the land, and by growing primarily high-profit export and luxury crops". Kimbrell (2002) concludes that the only solution to problems related to industrialised agricultural production is a return to sound organic agricultural practices.

2. Challenges of organic farming

Today's common agriculture causes a number of general problems like health problems caused by pesticides or antibiotics, hormones etc. used in animal husbandry, environmental problems caused by pesticides and agrochemicals, pollution caused by animal manure and organic waste products, diminished bio-diversity in ecosystems, including agricultural production. The negative impact of farm chemicals on the whole system has been recognised as early as 1876 by Friedrich Engels: "Schmeicheln wir uns nicht so sehr mit unseren menschlichen Siegen über die Natur. Für jeden solchen Sieg rächt sie sich an uns" and later by Rachel Carson who wrote that "The chemical war cannot be won, and a life is caught in its violent crossfire".

Some problems of Green Revolution agriculture are of particular importance for developing countries such as decreasing productivity, more pests, resistance against pesticides, low profit for farmers, food safety, deforestation, soil degradation resulting in low cost efficiency of inputs, inefficient use of natural resources, limited water resources,
foreign exchange problems, environmental requirements from export markets, limitations in market access, marginalised small farmers, urban migration leading to poverty and slums, social and cultural degradation, threatened food security and food sovereignty.

Organic farming is a well defined production concept (Schmidt and Haccius, 1998) which provides practical solutions to all these problems (see table in annex) and therefore meets the demand for "sustainability" best as outlined by the Brundtland Commission (1997) which stated that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

According to Cierpka (1999) “The aim of organic farming is to serve mankind in developing a most sustainable kind of agriculture: starting point is a healthy and living soil, the basis for healthy plants and animals, all aiming to produce quality food and at the same time taking care of the environment”.

More than its contribution to healthy food, organic farming has a strong impact towards the sustainable development of future societies: "A healthy farm culture can be based only upon familiarity and can grow only among a people soundly established upon the land; it nourishes and safeguards human intelligence of the earth that no amount of technology can satisfactorily replace. The growth of such a culture was once a strong possibility in the farm communities of this country. We now have only the sad remnants of those communities. If we allow another generation to enhance and embolden the possibility now perishing with them, we will lose it altogether. And we will not only invoke calamity - we will deserve it" (Berry, 2002).

3. Implications of organic farming

Organic farming implies not only a change in the production method on a farm, but also a change in the way of thinking by the people involved. As principles of organic farming are rarely taught in agricultural schools and universities, the successful implementation of organic methods implies a well functioning service and advisory system. Markets for organic food are just developing and their growth depends to a great
extent on successful marketing strategies. This all makes organic farming an ideal field for co-operative initiatives, an example for such an initiative is given in section 4. A common argument against organic farming is that it abandons the results of modern agricultural research and thus resembles a stepping back in history. But quite the opposite is the case: with the improved understanding of biological and physiological processes we are now able to maintain for instance plant health with "soft" nutritive measures rather than with "hard" pesticides as the example of SIR (Sulphur Induced Resistance) shows (Bloem et al., 2003). The motto for future research in organic farming is "to replace chemical aid by physiological know how".

4. Organic farming in the South - The SEKEM Example

The Rome Declaration on world food security "reaffirms the right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger" (World Food Summit, 1996). A major argument against organic farming is that it wouldn’t be able to feed the steadily increasing world population and thus it may be an extravagant option for rich countries in the North, but never for the poor in the South. As mentioned in section 1, it is not a continuous increase of crop productivity that will feed the world in future, but a rethinking in such way that small farming businesses are re-established by political measures that do not depend on high input costs for seeds, fertilisers and pesticides. The implementation of organic farming on these farms will be a vital contribution to food security and food quality in the South.

According to IFOAM (International Federation of Organic Farming Movements) (2003) "organic farming is currently practised in more than 120 countries. In a number of European countries (Austria, Sweden, Switzerland) organic farming now accounts for around 10% of the farmed land. Italy leads the way with over 50,000 certified organic farmers. Australia has the largest area of land converted with 1.7 million certified organic hectares. Hundreds of thousands of farmers in the developing world practise organic farming. "The origin of IFOAM members in 2002 were 6% from North-America, 17% from Latin-
America, 42% from Western-Europe, 8% from Africa, 7% from Central and Eastern Europe and 20% from Asia and Oceania.

A story of successful implementation of organic farming is the example of SEKEM in Egypt. The SEKEM (which means vitality from the sun) initiative started in 1977 on 125 acres of desert land 60 km northeast of Cairo. SEKEM claims "a holistic vision, encompassing economic, social and cultural endeavours with the main aim to develop the people". From the beginning SEKEM was dedicated to bio-dynamic methods of farming, which were used to produce a wide variety of crops and medicinal plants for local and export markets. It didn’t take long before SEKEM began to diversify into cotton production, herbal medicines, textiles and food processing. A steadily increasing group of bio-dynamic farms in Egypt have served as the base for a modern development of Egyptian agriculture. More than 150 farms, comprising more than 2,000 hectares are now converted to bio-dynamic production methods. The philosophy of SEKEM integrates the economic, social and cultural spheres of life in all aspects of its work and therefore its employees are empowered to realise their full potential as responsible and capable members of society.

An important step in the implementation process was the founding of the NGO Egyptian Biodynamic Association (EBDA) in 1990, which promotes organic farming and provides advisory services to the farmers. Agricultural consultants work with the farmers during the transition periods, supporting them in the phases and tasks of cultivation - helping them to implement the bio-dynamic methods. The farmers and agricultural engineers are trained in regularly organized training seminars and workshops.

5. Conclusions and outlook

Organic farming is a solution for many of the ecological and sociological problems modern agriculture caused during the past 50 years.

Karl Marx (1844) lamented the alienation of work from man. But the process of alienation has also taken place in many other sectors of human life and last but not least also in food production and food
Consumption. Increasing consciousness of lost values makes people seek for authenticity: "Authenticity will be the buzzword of the 21st century. But what is authentic? Anything that is not devised and structured to make a profit. Anything that is not controlled by corporations. Anything that exists for its own sake, that assumes its own shape" (Crichton, 2000). Transferred to agricultural production this means that there is a future for "authentic" food rather than designer food or alien nutrient sources processed from artificial raw materials derived from industrial enterprises. With its holistic approach organic farming provides such authenticity and bears the great challenge to revitalise the role of agriculture as a provider of food and social development.

The conclusions of this contribution end with the dedication to A. Kimbrell's outstanding book "Fatal Harvest": "To the agrarian mind, which is the only mind capable of rebuilding the culture of healthy soils, water cycles richness and diversity. May it multiply in future generations so they can recoup what has been lost and create farms and economies that are sustainable, humane, and beautiful. And to wildness, that essential quality whereby nature in all her wisdom unfolds with a genius that can only be manifested by undomesticated, unhumanised and unmanaged large portions of the landscape."

References


World Food Summit (1996) Rome declaration on world food security. 13-17 November 1996, Rome, Italy

This table was copied from the IFOAM website where its present president, Gunnar Rundgren states that this “is a table for problems where organic agriculture may be a solution or part of a solution. It should be noted that there may be other solutions that could deliver the same results as organic farming. One of the main features of organic farming is how well it integrates a number of important issues, which means that even if there are other solutions to each individual problem below, there is no other solution that to such a large extent is addressing most of the problem facing rural communities at the moment. Apart from ´problems to be solved´ there may be other good reasons to introduce organic production. These are more related to opportunities. The most obvious opportunity is consumers’ demand. The personal satisfaction of the farmer can be another one” (Rundgren, 2002).

<table>
<thead>
<tr>
<th>Problems to be solved</th>
<th>Solutions / Positive measures</th>
<th>Relevance of organic farming</th>
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</thead>
<tbody>
<tr>
<td>Health problems caused by pesticides</td>
<td>No use of chemical pesticides</td>
<td>X</td>
</tr>
<tr>
<td>Antibiotics hormones etc. in animal husbandry causing health problems</td>
<td>Improved animal systems</td>
<td>X</td>
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<td></td>
<td>Integrating animals and crops</td>
<td>X</td>
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<td></td>
<td>Meeting needs of animals</td>
<td>X</td>
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<td></td>
<td>Alternative disease treatments</td>
<td>X</td>
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<tr>
<td>Environmental problems caused by pesticides and agrochemicals</td>
<td>No use of agrochemicals</td>
<td>X</td>
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<tr>
<td>Pollution caused by animal manure and organic waste products</td>
<td>Integration of animals and crop production</td>
<td>X</td>
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<tr>
<td>Problems to be solved</td>
<td>Solutions / Positive measures</td>
<td>Relevance of organic farming</td>
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<tr>
<td>Reduced animal density/self-sufficiency of animal feed</td>
<td>X</td>
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<td>No use of agrochemicals</td>
<td>X</td>
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<tr>
<td>No GMO crops</td>
<td>X</td>
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<tr>
<td>Diversified production</td>
<td>X</td>
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<tr>
<td>Diversity and greater number of crops</td>
<td>X</td>
<td></td>
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<tr>
<td>No use of agrochemicals</td>
<td>X</td>
<td></td>
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<tr>
<td>More varieties - no GMO crops</td>
<td>X</td>
<td></td>
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<tr>
<td>Integration of animals</td>
<td>X</td>
<td></td>
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<tr>
<td>Alternative fuels to wood</td>
<td>X? (biogas)</td>
<td></td>
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<tr>
<td>Changed agricultural practises</td>
<td>X? (on one hand OA emphasise trees, on the other hand it may lead to higher use of agricultural land)</td>
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<tr>
<td>Tree-planting for multiple use (fuel, N-fix, fodder, mulching, fruit)</td>
<td>X</td>
<td></td>
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<tr>
<td>Awareness of population</td>
<td>X (OA and OA consumption linked to higher awareness)</td>
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<tr>
<td>Erosion control measures</td>
<td>X (Erosion control in inherent in organic concepts)</td>
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<tr>
<td>Increase of organic matter</td>
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<tr>
<td>Diversification of production system, aorestation, agroforestry</td>
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<td>Better management, soil building, prevention, diversification, varieties, biological control</td>
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<tr>
<td>Problems to be solved</td>
<td>Solutions / Positive measures</td>
<td>Relevance of organic farming</td>
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<tr>
<td>Low profit for farmers</td>
<td>Reduced cost for production Diversified more market oriented production</td>
<td>X? (in situations with high input prices and comparatively low labour costs)</td>
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<td></td>
<td>Increased income</td>
<td>X (if special organic market is available)</td>
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<tr>
<td>Low cost efficiency in inputs</td>
<td>Improved management and technology</td>
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<td></td>
<td>Efficient use of local (or on-farm) production resources</td>
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<tr>
<td>Inefficient use of natural resources</td>
<td>Integration of animals and crop production</td>
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<tr>
<td></td>
<td>Nutrient balance calculations</td>
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<td>Nutrient planning over a rotation period or a production cycle</td>
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<td></td>
<td>Recycling of nutrients from society</td>
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<tr>
<td>Limited water resources</td>
<td>Less pollution of water</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Improve water capacity of soils</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Soil protection measures</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Aforestation, agroforestry, mulching and cover crops</td>
<td>X</td>
</tr>
<tr>
<td>Foreign Exchange problems</td>
<td>Increase exports values</td>
<td>X? (depending on if value of increased prices compensate potential loss in volume)</td>
</tr>
<tr>
<td></td>
<td>Decrease imports of inputs</td>
<td>X</td>
</tr>
<tr>
<td>Environmental requirements from export markets</td>
<td>Environmental certification</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Extension and capacititation</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Organisation of farmers</td>
<td>X</td>
</tr>
<tr>
<td>Limitations in market access</td>
<td>Get competitive advantage</td>
<td>X</td>
</tr>
<tr>
<td>Problems to be solved</td>
<td>Solutions / Positive measures</td>
<td>Relevance of organic farming</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td>--------------------------------------------------------------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>Get access to market information</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Marginalized small farmers</td>
<td>Increase of production</td>
<td>X? (if traditional farming is not optimal)</td>
</tr>
<tr>
<td></td>
<td>Reduced cost for production</td>
<td>X? (in situations with high input prices and comparatively low labour costs)</td>
</tr>
<tr>
<td></td>
<td>Increased income</td>
<td>X (if special organic market is available)</td>
</tr>
<tr>
<td></td>
<td>Improve technology</td>
<td>X (OA is cheap and accessible)</td>
</tr>
<tr>
<td></td>
<td>Farmers organisation Direct marketing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycling of nutrients from society</td>
<td>X? (depending on the quality of the waste products, awareness of society, cleaning processes etc)?</td>
</tr>
<tr>
<td>Urban migration leading to poverty and slums</td>
<td>Increase income in rural areas, and decrease money flow from rural areas</td>
<td>(X)</td>
</tr>
<tr>
<td></td>
<td>Organisation, capacitation</td>
<td>(X)</td>
</tr>
<tr>
<td>Local / regional development</td>
<td>Increase income in rural areas, and decrease money flow from rural areas</td>
<td>(X)</td>
</tr>
<tr>
<td></td>
<td>Increase infrastructure and organisation of rural areas</td>
<td>(X)</td>
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<tr>
<td>Social and cultural degradation</td>
<td>Vitalising old values or creating new values</td>
<td>X?</td>
</tr>
<tr>
<td></td>
<td>Increase self-reliance and status of rural areas and populations</td>
<td>X?</td>
</tr>
<tr>
<td>Threatened food security</td>
<td>Increase production</td>
<td>Long term higher, short time lower, depending on conditions</td>
</tr>
<tr>
<td></td>
<td>Availability of production resources</td>
<td>?</td>
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<tr>
<td>Problems to be solved</td>
<td>Solutions / Positive measures</td>
<td>Relevance of organic farming</td>
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<tr>
<td></td>
<td>Increase income</td>
<td>Depends on the conditions.</td>
</tr>
<tr>
<td></td>
<td>Stable production</td>
<td>X? (pests could cause fluctuations…)</td>
</tr>
<tr>
<td></td>
<td>Decrease input dependency</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Increase diversity –less risk</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Soil improvement – more resilience</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Optimal use of local resources</td>
<td>X</td>
</tr>
<tr>
<td>(food safety)</td>
<td>Limit un-safe food</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Increase consumer awareness</td>
<td>X</td>
</tr>
<tr>
<td>(food sovereignty)</td>
<td>Local production</td>
<td>(X)</td>
</tr>
<tr>
<td></td>
<td>Local seeds</td>
<td>(X)</td>
</tr>
<tr>
<td></td>
<td>Local inputs</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Increase consumer awareness</td>
<td>X</td>
</tr>
<tr>
<td>(social conditions)</td>
<td>Less gaps between poor and rich</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Democracy, transparency, participation</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Organisation</td>
<td>?</td>
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PART II
FOOD QUALITY AND FOOD INDUSTRY
Impact of GMO feedstuffs on animal feed business

DR. E. VANDERBEKE

Director R&D Aveve Group

Email: Erik.vanderbeke@aveve.be
www.aveve.be
Introduction

It is already more than 30 years ago that biotechnology was developed and started with industrial applications after 2 decades of technology development. Due to the detection of extra-chromosomal DNA in bacteria containing antibiotic resistance genes and the use of DNA restriction enzymes, the plasmid DNA technology could start its bright future as a basic instrument for DNA studies, gene isolation, amplification and gene cloning. Soon the pharmaceutical and fermentation industry developed genetic modification technology in yeasts and fungi, leading to new applications. All of these techniques became standard “tools” in almost every university lab that wants to be on the forefront of new inventions.

Today it is very difficult to imagine the end of this new technology that has proven to have great economic potentials in the field of medicine, agriculture, and in general in all human activities. Totally new industries have emerged and new possibilities are discovered almost every day. Biotechnology can be categorised into three types:

• red biotechnology = pharmaceutical and medical application;
• green biotechnology = agriculture and food applications; and
• white biotechnology = industrial applications (non food agricultural products).

However, besides the very positive attitude towards the technological possibilities, there is obviously the factor of human / consumer acceptance. This technology is very specialised and is the playing field of a happy few technologists, engineers and companies. The comprehension and acceptance by the general public seems to be a more difficult issue. Whereas the acceptance for red biotechnology is high for obvious reasons of life saving benefits, green biotechnology, especially with the aspects of food and environmental safety, encounters a prudent and reluctant consumer at least in western European countries.
This reluctance to GM organisms in agriculture and food also coincides with general change in thinking patterns. For instance a transition from “production” to “health” thinking, a “chemical” to “natural” thinking, a “back to nature” and “natural is safer” belief. Pure political motives cannot be excluded either. Recent “accidents” linked to food production, like the BSE and dioxin contaminations of food chains has probably also enhanced the GMO fears in the agricultural sector. The impact of pressure groups using this “fear” as a tool to upset public opinion is also important. The “perceived” economic dominance of large industrial groups using biotechnology also created a negative image. All these factors have slowed down considerably the production and use of GM raw materials and additives in the actual western world. Of course much of this is also linked to the growing distance between the agricultural production and the consumer.

**New characteristics of feed, raw materials and additives by the use of GM technology**

In agriculture, GMO technology mainly influences the characteristics of raw materials and the cost of additives.

The basics of plant genetic modification started at the State University of Ghent (Belgium) in the early 80s. Prof. Shell and Van Montagu studied a natural phenomenon of bacterial transformation of plants resulting in nodule or tumor formation. Their research showed that a bacterium *Agrobacterium tumefaciens* contained a special, very large plasmid (TI plasmid). This extrachromosomal DNA was transferred into the plant genome upon infection. This transfer takes place to mutual benefit of the bacterium and the plant and is seen as a “genetic symbiosis”. The basis of plant genetic modification is indeed a “natural” phenomenon of gene transfer across species barriers.

At that time nobody could imagine the impact this research and know how development would have onto today’s agricultural world.
Industrialisation of this agriculture-biotechnology started with companies such as Plant Genetic Systems (PGS) in Flanders. They were followed by large seed and agrochemical companies, who have integrated most of the smaller AG-biotech companies into their own business.

The main difficulties in plant genetic modification are still the limited host range of the original plasmid - technology from Agrobacterium and the regeneration problems within different plant species. New transformation technologies are now used. Examples are protoplast transformation, tissue / cell electroporation, silicon carbide fibre vortexing, particle bombardment (DNA shotgun technology), and others. The plant cell type and tissue type used for the optimal transformation and plant regeneration is still an issue of research. A large number of plants and micro-organisms (production of feed additives) can now be genetically modified, however, with different success rates depending on the species. The main target today resides in the level and tissue selective expression of the characteristics in the new target organism. Also interactions between gene expressions are important research topics nowadays, leading to the often-mentioned development field of “proteomics”.

As far as agricultural raw materials are concerned, the current GM-characteristics are mainly found in the field of agronomic traits. The primary targets of GMO technology in the agricultural sector were the enhanced efficiency of primary production of raw materials. As a result, the main characteristics of commercial GM-plant raw materials today can be found in the field of herbicide and pesticide resistance. Indirect positive effects for animal nutrition have been reported for this first generation of GM feedstuffs. It has been experienced that corn-borer resistant Bt-corn varieties are less sensitive to fungal infections, resulting in significant lower content of mycotoxins. The main crops are still soy, cotton, corn and rapeseed. Soy, corn and rapeseed are directly linked to animal feed production business. New GMO varieties of cereals are on the edge (2004) of being commercialised today.
The second-generation products aim to produce GM plant varieties with directly enhanced nutritional values for animal feeding (and for human consumption).

New characteristics in feedstuffs are for instance low phytate corn. Phytate is the natural organic P-binding storage form in plants. It has a low digestibility in animals. Low phytate corn leads to reduced phosphorus excretion. High oil corn (HOC) has a higher energy content for animal feeding, corn with higher amino acid content has a better nutritional composition, low lignin containing plants have a better digestibility of the polysaccharides, ...

Some of these GM-plants have already been developed as stable cultivars for commercial use. However, their acreage world-wide until now is still limited.

In the first place it is expected that developing countries will adopt more quickly these new plant varieties as they have acute industrial development and nutritional needs for their growing human populations. World-wide the production of GM plants has increased by 12% in 2003. In China more than 50 % of the cotton is of GM origin.

GMO technology also had an important impact on the feed additive business.

Enzymes and vitamins are today almost standard additives in animal feeding in EU. They have a positive influence upon the nutritional value of the animal feeds, on the animal performances, on the environmental impact as well as on the economy of animal production in general. Enzymes, vitamins and amino-acids are produced on large scale by specialized fermentation industry world wide.

The first generation GMO enzymes were mainly altered by deregulation of the expression level. It results in constitutive expression of the enzyme protein in the producing fungus. Homologous (original organism of the gene) as well as heterologous (new organism) expression systems are now used.

The first generation GMO enzymes were “substantially equivalent” to the non-GMO enzyme as only the production levels, production strains or production processes were altered by the GMO technology. The same enzyme protein is produced and purified by downstream processing.
The first GMO enzyme on the market in Europe was phytase from Gist-brocades. Gb is a fermentation company in the Netherlands and is now part of the large DSM-group that also owns the former NOVO and ROCHE specialities business.

Phytase is an enzyme from microbial origin that can degrade phytate. It makes the plant P stocks digestible for the animals.

Without GM-technology, phytase cannot be produced economically. The production (expression) levels in the GM fungi are 100 to 1000 times higher than the wild type production strains, making an economic application of this enzyme possible.

Other enzymes used in animal feeding like xylanases are increasingly produced by GM bacteria or fungi.

Only 15% of the fermentatively produced feed grade vitamins today are from GM bacterial origin. It is not clear if a transition to GM strains will have an effect on the prices at feed ingredient business level.

Second generation GM enzymes are now under construction. They aim to obtain enzymes with enhanced thermal stability characteristics during the feed production processes. Thermal steps in feed production can lead to substantial loss of the actual generation of added enzymes.

Also construction of GM enzymes with lower inhibition phenomena are today under development.

Finally some research groups have mentioned the development, cloning and production of enzymes in plants. This technology is known as “molecular farming”. It is seen as an alternative production mode to the fermentative production of enzymes and pharmaceutical important products.

However until today no such commercial raw material is available for the feed business (i.e. plants with cloned fungal or bacterial phytase).

**Environmental aspects related to GMO feedstuffs and additives**

The development of enzymes that influence the digestibility of phosphorus had a major impact on the environmental pollution in
Western Europe. Indeed, in countries and regions with intensive animal production the total phosphorus content of the mono-gastric animal feeds has been reduced by almost 40%. By using phytase the portion of digestible phosphorus could be maintained at minimum levels for optimal animal production. It can be stated that the phosphorus excretion into the environment by the use of phytase has been reduced by more than 30% during the past 7 years in intensive production locations in Western Europe. Through further optimisation of GM production strains the phytase production cost has dropped to a level that allows economic competition with feed phosphates on a world-wide basis.

The use of enzymes like xylanases and glucanases indirectly resulted in substantially lower quantities of manure production (lower N excretion). High levels of cereals in animal feeds can lead to digestion problems. These enzymes hydrolyse viscous polysaccharides from cereal origin. They reduce intestinal viscosity and enhance the digestibility of the feed.

For this reason, today, almost 90% of chicken feeds in Europe contain these kinds of enzymes in cereal based diets, piglets feeds around 30% and enzymes are increasingly being used in growing and finishing pigs.

Enzymes are also used as alternatives for antibiotic growth promoters in animal nutrition. The use of antibiotic growth promoters is expected to be totally banned in the EU in the near future. The substitution by enzymes will result in less environmental stress related to the use of antibiotics (possible resistance build up in agricultural environments). Indirectly the production of vitamins by GM strains seems to have a positive influence on the environmental aspects of fermentation, thus delivering an additive to the feed business with less environmental constraints.
Current situation of the European law on GMO and possible evolutions

Following the development of GMO technology, the first laws on the deliberate release of GM organisms into the environment were introduced end of the 80s.

The European laws on GMO are focusing today on two main criteria: safety (approval of the use) and free choice (labelling).

The first laws focused on the operation of GMO research facilities and the introduction of living GMO into the environment.

GM plants are subject to the normal toxicology evaluation on EU and local government levels and their impact on the environment have to be assessed.

So, let it be clear that new GM-plants have been well evaluated before their admission.

Due to the technical matter, these laws were not well known to the general public or even to the politicians.

Under the pressure of public opinion (and mainly pressure groups) as well as the EU parliament, opposition raised to the cultivation and use of GM plants in EU.

Despite original approval, a moratorium was installed on the cultivation of GM plants in the EU end of the 1990s. This moratorium had a large impact on new GM developments and the conduction of field trials in Europe. Today, for example, the number of field test has dropped to almost zero in Belgium and the Netherlands.

Processing and use of GM plants is still allowed legally. With respect to animal feeding about 12 GM varieties of corn, soy, rapeseed are taken up in the positive list of feed ingredients and as such allowed as feed raw materials.

Originally the international definition of “substantial equivalence” was accepted for additives and derived fractions, meaning that after purification the end product was not GMO.

Today a new EU regulation is under construction (expected end of 2003). Preliminary drafts state that a GMO product will stay GMO
forever. Non-GMO products will have to be distinguished by “hard IP”, which means that they must be collected through separate and traced channels.

Actually, still a matter of disagreement is the status of the end products of agriculture i.e. the animal meat, eggs, and milk from animals that have been fed GM ingredients or additives. Some groups want these products to be labelled as GMO.

Although no transfer of GM traits or DNA has been demonstrated into animal products, this still remains a point of strong controversy. DNA fragments of the raw materials fed to the animals can of course be detected in the gastrointestinal tract.

Concerning separation of GMO and non-GMO raw material channels, an accidental contamination with GMO up to a limit of 1% is actually tolerated. In this case labelling as GMO is not required. This limit of contamination is still under debate. Limiting this level to 0.5% or even zero tolerance still has strong political support.

There are positive signs that the strict moratorium on GMO cultivation in Europe will be lifted, but it seems that detailed GMO labelling of resulting food products will be enforced. Today enzymes, vitamins and amino acids are mentioned on the positive additives list for feed production whether or not produced by GM techniques. Each additive is screened individually for approval, after which their use in animal nutrition is allowed without GMO labelling.

**Consumer point of view and client demands**

Beside the strict GMO regulations coming up, there is a large demand for GMO free products from the large retail sector. As distributors fear negative impact of GM-foodstuffs on their sales, more and more “label products” and “animal production protocols” limit the degrees of freedom for the agricultural and animal feed producing sectors. For instance today all poultry feeds in Belgium are produced with a GM free label.
Federal research centres, federations and industrial groups have started debates with the political world and consumer groups.

**Impacts on organisational aspects of feed production and animal feed formulation**

As mentioned the public and retail demands for non-GMO feeds (free choice) results in complication of the feed production units. Beside the separate logistic needs of supply and reception of raw materials at the factories, also the stocks must be separated. When feasible, the production lines should be separated as well. Producing feeds on mixed feed production lines implies the use of cleaning batches between production batches to limit contamination by carry-over of GM traits in the non-GMO feeds. This type of feed production is characterised by higher costs and loss of capacity (efficiency).

In practice this often means that the number of suppliers of raw materials have been reduced substantially (i.e. only GM free soybean meal), leading inevitably to higher costs. Internationally the number of soy meal suppliers decreased from more than 10 to only a few and the quantity of corn by-products has been substantially reduced.

Of course the tracing and quality assessment also creates additional costs. GMO samples are taken in the port of origin, allowing GMO analysis to be worked out before reception of the ship in the national ports. Beside this the non-GMO protocols demand regular checks on “risky” raw materials. End products are sampled as well in regular sampling plans, leading to additional and costly qualitative and quantitative GMO measurements in external laboratories.

It can be estimated that the cost of non-GMO production is about 2.5 to 5% higher depending on the feed composition. For the GM-additives as stated previously, the cost and environmental impacts are positive as long as their use without labelling is allowed.
Leaving out these kinds of additives would create real problems for the actual formulation of feed compositions, as there exist no economic alternatives.
An integrated information system to improve safety and quality of fruits and vegetables

LUÍS DIAS PEREIRA, LUÍS MIRA DA SILVA, JOSÉ PEDRO SALEMA AND MIGUEL MIRA DA SILVA

Luís Dias Pereira
luisdiaspereira@sapo.pt
Final year student
Instituto Superior de Agronomia
Lisboa, Portugal

Luís Mira da Silva
lmbignolas@isa.utl.pt
Professor - Secção de Agricultura
Instituto Superior de Agronomia
Lisboa, Portugal

José Pedro Salema
jose.salema@agrogestao.com
Executive Director
Agrogestão-Consultoria em Meio Rural
Cascais, Portugal

Miguel Mira da Silva
mms@dei.ist.utl.pt
Professor - Departamento de Engenharia Informática
Instituto Superior Técnico
Lisboa, Portugal
Abstract

This paper proposes an information system architecture and a prototype implementation of an integrated traceability system to improve vegetable and fruit crops quality and safety control, focusing on the implementation of the component at the level of producers. This component of the system allows producers to register crop data (including sowing and harvesting dates, application of pesticides and fertilisers, irrigation and crop productivity), making it easier to store and share information required by retailers, auditors and certification authorities. The prototype presents a web interface and, allows retailers, producers and other parties, including consumers, to send and receive data over the Internet in order to share information amongst all parties. In addition, it can be used for decision support, e.g., to provide producers with aggregate information about their crops.

1. Food Quality and Safety

In recent years there has been a strong debate in the scientific and political arena about food quality and safety. Amongst the most important issues on this debate are the benefits and limitations of creating a single world-wide regulatory agency with specific legislation on food quality and safety standards. Together with this concern, several other issues have been raised, including:

- the objectives of governments’ food quality and safety programs;
- the attributes of efficient food quality and safety systems;
- the technologies that are needed to support food quality and safety systems.

Some of these issues have been discussed extensively in the literature, by Taylor (2002) in particular, on behalf of the following objectives:

- reducing food borne diseases;
- maintaining public confidence in food safety and food supply;
- forming an international leadership on food safety.

Although governments play an important role in reducing food borne diseases through the implementation of research projects, better regulation and formal education schemes, the main responsibility on
food safety rests in private hands. Nevertheless, companies are interested in a strict regulation system only if it can be implemented with an inexpensive traceability scheme. At the same time, retailers want their customers to be able to choose from a wide range of products knowing that those involved in the food chain have done everything that is possible to assure food safety (Taylor, 2002). Only in this way they can financially benefit from confidence in their products.

Despite the existence of food quality and safety legislation and control systems on a national level, no country today can guarantee that all food consumed within its borders has been produced according to the national quality and safety standards. Moreover, a large percentage of the food consumed in any country comes from abroad, making it impossible to establish reliable food quality and safety schemes at a national level. This is probably the main reason to create an international food safety program within the World Food Organisation (WFO), which will coordinate and assure food quality and safety worldwide.

Despite the limitations of food safety at national level, so far not much has been done at the world scale to improve this situation. In what concerns seafood, meat, poultry and juices, there is an international standard prevention scheme, the Hazard Analysis and Critical Control Points (HACCP) (Centre for Food Safety & Applied Nutrition, 2003), which is currently being adapted for other food sectors. However, this is possibly the only food safety scheme with world-wide recognition. Other standards, such as EurepGap (EUREPGAP, The global partnership for safe and sustainable agriculture, 2003), Assured Produce Scheme (British Farm Standards, 2003), etc, have been developed with a local or regional acceptance, but none is used on a global scale.

This situation is now slowly changing, with some large-scale prevention and traceability “farm to table” quality and safety systems for fruit and vegetables being developed and implemented in the European Union and the United States. With increased concerns of consumers and a growing interest of retailers, the need for integrated information systems to manage food quality and safety information could not be more opportune.
2. Current information system (IS)

We have designed an information system architecture for one of the largest food retailer chains in Portugal. The system deals with information at three different levels: producers, processing units (producers’ organisations) and the retailer chain. Eventually the information will be available for consumers as well.

A large part of the information managed by the IS already created and exchanged by the different agents of the supply chain: producers, producers’ organisations (processing units) and supermarkets. However, without the IS, information is exchanged by paper format, fax or Email as Excel worksheets. The IS supports digital exchange of information between the different agents of the supply chain and, more importantly, it supports digital integration of the departments within the retailer.

Figure 1 illustrates the current flows of information within the supermarket chain and between the supermarket chain and producers’ organisations (processing units).

![Diagram of current information flow]

Figure 1. Current information flow

As the figure shows, even within the supermarket chain most of the information flow was performed via paper or fax. In fact, only the orders from supermarkets to the logistic company and the quality
control of daily deliveries are processed automatically. Not only the information flow inside the *Business Unit of Fruits and Vegetables* are based on paper, but also contracts, contract rectifications, orders to processing units, and lot labelling was exchanged by fax or telephone.

The benefits of increasing the efficiency of data exchange within the *Business Unit of Fruits and Vegetables* and between this business unit and processing units are large:

- the system allows for processing the information in a faster way, while simultaneously improving data integrity within the business unit.
- it makes contacts with processing units much easier and possible to undertake in real time.
- it allows for better control of food quality and safety, which was the original objective of this project.

### 3. Proposed information system

Figure 2 describes the process of information exchange within the new information system, in which all flows are now digital except for the issuing of invoices. Invoices will also be issued electronically next year.

In spite of providing a more effective food control system through the improvement of information flows throughout the supply chain, allowing information to arrive faster and to be properly delivered and stored, a system which cannot go further than this would not be sufficient to assure better quality and/or safer food. To achieve this, the system must be able to manage data concerning food producing and processing along the supply chain, i.e., it must be a full traceability system. This requires collecting information at the level of producers (and producer’ organisations, when controlling processing).

The next part of this paper describes the software used by producers to store and provide information required to fulfil the requirements of a strict quality and safety control system for fruits and vegetables.
4. Producers’ module

Producers are provided with a software package in which they can enter, store, manage and retrieve all data regarding their fruit and vegetable crops. This software contains parameterised features, such as crops/varieties, pests, diseases, pesticides, fertilizers, and final products. The main reasons for supplying producers with these parameterised values are:

i) coding: when information from producers reaches the Business Unit of Fruits and Vegetables, the same codes have to be used for the same crops, fertilisers, final products,…

ii) control: the system provides information on whether the products used (namely pesticides) are legally authorised for the crops and pests or diseases for which they are used.

Producers introduce all the parameters concerning their fields and farms themselves. Once all the required parameters have been introduced, the software is ready to store all the information concerning each particular crop on each particular field. Each crop is associated with a variety, field area, sowing/planting date, estimated yield and harvest day (real yield and harvest day in case harvest has already occurred), and
fertiliser and pesticide applications dates, quantities and prescription numbers. This information enables full traceability, by linking products not only with a farm, but also with fields within farms. In this way, it is possible to manage all the information about crops and crop inputs in all fields.

The software used by producers is able to generate reports containing historic, statistically treated or aggregated data, such as average farm yields, usage of inputs, and deviations to the contracted harvest dates and yields. Historic data make it possible to track efficiency and productivity variations along the years. All these data are easily filtered by field, fertiliser/pesticide, crop, and sowing and harvest dates. This provides producers with useful information, which may help the adoption of the software at this level of the supply chain.

The information is introduced on producers’ PCs (or sometimes in PCs in the producers’ organisations, when this task is undertaken at a collective level) and sent via Internet to the Business Unit of Fruits and Vegetables. The Business Unit of Fruits and Vegetables uses this data for management activities and compiles data from all producers, in order to generate aggregated information and make it available back to producers (e.g. yield averages, pesticide and fertiliser use,…).

The software also allows producers (or producer’s organisations/processing units) to establish prices and define contracts with supermarkets using a digital support, as described in Figure II. This procedure is done using a web interface, which is accessible both for producers and their organisations (or processing units). Users login by using their user names and passwords. By accessing their private area, producers can confirm their specific information. In addition, they have access to aggregated information (as explained above), which can be used for benchmarking.

Benchmarking information consists essentially of statistically treated data. Producers are able, for instance, to check data on average yields, yields per input units, or inputs used. Selected data about fruits and vegetable quality control that is undertaken at the supermarket level is
also provided on the web site, both to producers and the general public (i.e. to consumers).

The parts involved in the system described above are represented in Figure 3.

![Figure 3. The Integrated Information System](image)

The information system has been developed bearing in mind that the most important aim was to meet the needs of producers, retailers, and certification authorities, while simultaneously limiting the efforts required by all these parties in adopting and using the software. In order to achieve this objective, a pilot scheme will be developed with several producers and processing units, a retailer and a certification authority.

Results of this initial project suggest that although some producers and processing units prefer a more complex interface, with both bookkeeping and decision-making tools, the majority prefers a simple interface limited to the features that are necessary to put into practice
the traceability scheme. Following these results, the information system developed adopts a solution that consists of the most basic features, which can be easily integrated in any existing software. This is surely the best way to achieve a wide scale and long-term adoption of the system.

5. Conclusions

Although it is still to be implemented on a large scale, our experience up to this point suggests that the information system proposed here complies with the needs and requisites of all parties in the supply chain, without compromising their independence or data confidentiality. So far, and more specifically at the producers’ level, the following benefits of adopting the system can be pointed out:

- the system facilitates data recording and management, saving time, and allowing for better bookkeeping;
- the system provides producers with valuable information, allowing them to improve the use of inputs; benchmarking tools may increase producers’ competitiveness;
- information can be used by other parties (e.g. certification authorities); the system is easily scaleable and adaptable to other demands and other traceability or food quality and safety schemes (e.g. Organic, EurepGap,…);
- the system improves food safety and quality, increasing consumers’ confidence and adding value to food products.

If justifying the development of such a traceability scheme is not very difficult from the point of view of the whole supply chain (including consumers), or considering the value of information for a large supermarket chain, convincing producers that they can benefit from the adoption of an information system that controls their activities and give them extra work is not so easy. Nevertheless, initial results obtained with this project suggest that producers have a lot to gain from improving food quality and safety standards through the adoption of an integrated information system. In the particular case of this project, large efforts have been made since the beginning to include features in the system to make it more interesting from a producers’ perspective.
(e.g. benchmarking features). Further developments should also bear this in mind and, whenever possible, be implemented in partnership with final users.

**References**


Interactions in the food chain: towards integrated quality management

Xavier Gellynck, Wim Verbeke & Jacques Viaene

Department of Agricultural Economics
Ghent University, Belgium

xavier.gellynck@UGent.be
wim.verbeke@UGent.be
jacques.viaene@UGent.be
Abstract

A major challenge for today’s consumer-oriented food industries pertains to effective and efficient interactions with other stakeholders in the food supply chain. This paper addresses recent development in these interactions with consumers, retailers and public authorities related to food quality. Interactions with consumers are guided by principles relating to quality perception gaps, and the abstract and relative nature of quality from a consumer perspective. Targeted communication, labelling and quality function deployment are relevant tools. The relation between the food industry and the retailer is characterised by institutional innovation. Consumer requirements are translated too often in a reactive rather than in a pro-active way. The costs of food safety differ between companies. Given the EU regulation on traceability in the food chain, it is argued that exploring the benefits and costs of traceability in the food supply chain, could be an interesting topic for further research.

1. Introduction

The fundamental issue of marketing science is the fact that a positive relation exists between business performance and market orientation (Deshpande et al.; 1993; Dreher, 1994). The most commonly accepted definition of market orientation is the one put forward by Kohli et al. (1993): ‘Market orientation is the organisation wide generation of market intelligence, pertaining to current and future customer needs, dissemination of the intelligence across departments, and organisation wide responsiveness to it’. Working market oriented is especially relevant in highly competitive markets and markets characterised by a stagnating or even declining demand, such as traditional agro-food markets in Western Europe. As previous research illustrates, this has not always been the case in the agro-food business (Grunert, 1996).

Successful firms or chains in today’s competitive agro-food markets work more than ever before market oriented, with the ultimate goal to respond to consumer requirements or concerns and to maximise consumer satisfaction (Corstjens & Corstjens, 1995; Loureiro &
McCluskey, 2000). Agro-food quality and especially food safety get increased attention at consumer level. This increased food safety attention is enhanced by a set of food scares such as the use of growth hormones and growth promoters, the mad cow disease, the dioxin crisis and the foot-and-mouth disease. More recently, the discovery of acrylamide in food prepared at high temperatures further stresses the attention on health issues (FAO, 2002). In response to these concerns, both the industry and the public authorities concentrate on quality management in general and quality and safety assurance systems in particular (Shogren et al., 1999; Gellynck & Verbeke, 2001; Dickinson & Von Bailey, 2002).

The increased complexity both at consumer level (risk aversion and sensitivity) and processor level (risk management and communication) requires adaptation of strategies as well as of institutional organisation in the food supply chains with regard to quality management in general and quality assurance in particular. Within this framework, the paper focuses on changing relationships between the food industry on the one hand and consumers, retailers and public authorities on the other. The objective of the paper is to illustrate the basic principles about consumers dealing with food quality. Next, it is well known that the agro-food sector has not the reputation of always been working market oriented. In what follows, it is verified whether or not this is valid in relation to quality and quality management.

The structure of the paper is as follows. Section 2 gives an overview of the different concepts of quality management, focusing on quality policy and strategy. Section 3 establishes the link between the food industry and consumers. In section 4, we discuss the relation between the food industry and the retail sector, where we argue why a chain quality perspective is required, much more than a food company’s or retailer’s one. Section 5 provides some considerations related to the integration of consumer quality in the food companies’ quality management strategy. Section 6 discusses the economic impact of policy regulations on the business performance. Finally some conclusions are drawn and suggestions for further research formulated.
2. Quality Management

While there are many definitions of quality, all share the common assumption that quality is determined by the customer (Cortada, 1993), and hence should be defined from a consumer-oriented perspective. Quality definitions of this kind include the following aspects (for an overview of historical foundations of quality management see Luning et al., 2002):

- Continuous improvement (Deming, 1986);
- Fitness for use (Juran, 1989);
- Conformance to requirements (Crosby, 1979);
- A product that is most economical, most useful and always satisfactory to the consumer (Ishikawa, 1985).

Given these approaches, Schiefer (2001) defines quality management as the collection of the management concepts enhancing the improvement of processes regarding consumer orientation when delivering products or services.

In line with the principles of strategic management, which is about navigating the external environment in a way that makes the most of the firm’s assets (Saloner et al., 2001), we propose the following definition of quality management: ‘The process by which business operators adapt to the rapidly changing quality world around them, with a particular focus on the dimension of being proactive rather than reactive to external changes related to quality’. As indicated in figure 1, it is about quality strategy and policy, quality design and control, quality improvement and quality assurance. It is valid for an industry as a whole (e.g. food industry), a sector (e.g. meat processing sector). Quality policy relates to the broader concept of the general vision of an individual company, of a way of life. Quality strategy is linked with the allocation of people and resources in line with the targets at a horizon from five to ten years. Quality design both focuses on product and process development, with particular attention for the integration of consumer requirements, technological capabilities and present processes and products. Quality control concentrates on avoiding too much variation in raw materials, production and distribution. Quality improvement relates to the plan-do-study-act cycle (Deming, 1986) as the conceptual basis for continuous improvement activities. Quality
assurance includes the procedures to guarantee quality requirements (proactive) as well as the curative (reactive) procedures in case of problems (e.g. traceability).

Figure 1. Concepts related to quality management
Source: Adapted from Luning et al., 2002

3. Interaction between the food industry and consumers

Consumers occupy a very specific and crucial position within the food chain: they are both the ultimate target for products, services and information, and they are the starting point for a consumer-driven or market oriented chain organisation. A thorough understanding of consumer needs and their quality and safety perception is vital for being successful in today’s agro-food markets. The Total Food Quality Model as proposed by Grunert et al. (1996) integrates different aspects related to quality from the consumer perspective into one conceptual framework. The model assumes that expected quality is based on a number of perceived quality cues (either intrinsic or extrinsic). Intrinsic quality cues are related to the technological product specifications, which involve the physiological and biochemical/biophysical characteristics of the product. The technological product specifications
are also related to the product’s sensory characteristics, which mainly influence experienced quality.

With respect to quality from the consumer point of view three principles merit our attention. The first principle deals with the so-called perception gap, i.e. discrepancies between scientific and objectively measurable facts (like safety, quality or nutritional value from a technical point of view) versus human subjective perception of these facts. A perception filter between both worlds acts like a mirror, reflecting or dispersing some information (Wierenga, 1983). The result is that consumers perceive scientific realities (and related communications, e.g. about risk probabilities) differently depending on a number of factors like environmental, personal or situational characteristics. The second principle relates to the fact that quality is quite abstract whereas other product attributes are much more concrete. This is apparent e.g. when considering means-end chain analyses, where quality is mainly situation at the level of consequences or values, as opposed to attributes that form the basis of consumer motivational structures. In result, this relates strongly to the overall product image. The fact that quality is abstract and hard to verify explains why consumers tend to deduce quality from one or a few concrete product attributes, e.g. price or origin, or to transfer positive or negative images from one product to similar products. The third principle holds that perceived quality is relative. It means that a measure of quality perception, e.g. a score on a 5- or 7-point scale has no meaning in itself unless it can be compared with similar measures for other goods, in other situations or at other moments. Recognition of these principles is a key to understanding consumer quality perception.

Specific tools for down- and upstream interaction between the food industry and consumers have been developed. Downstream interaction is usually performed by means of communication, either through advertising or product labelling. Advertising has been shown to be effective, though with a five times lower rate than negative press (Verbeke & Ward, 2001), which is particularly relevant in the context of food quality and safety. Furthermore, recent developments relating to traceability in food chains include several opportunities for communication (Gellynck & Verbeke, 2001), since traceability
information may be used proactively in targeted communication with specific consumer segments, rather than opting for a defensive strategy of using traceability only in cases of safety or quality troubles. A typical upstream interaction tool pertains to quality function deployment; a planning tool with active consumer participation aiming at bringing better products to the market (Hofmeister, 1991). External market research and internal market intelligence system information provide insights in consumer needs and wants, which are to be translated in product specifications for optimum market orientation.

4. Interaction between the food industry and retailers

Retailers actively manage vertical relationships with their suppliers to enhance competitiveness and profitability by reallocating margins along the marketing channel or by extracting margin generating resources (Collins, 2002). This is illustrated by the development of private or retailer brands and the changes in the management of vertical relationships in the food chain. By developing such brands, retailers are exposed to additional kinds of risks in the marketplace associated with investments, perceived product quality and safety. Additional to these changes, new and adapted governmental regulations related to food safety (e.g. EU Regulation 178/2002 on food safety issues) are published. Both types of changes create increasing transaction costs at the level of the relationship between the food company and the retailer. It results in institutional innovation with the development of ‘voluntary’ quality assurance schemes, often accompanied by an official third-party certification. However, food companies often perceive this as a way to shift food safety costs away from retailers on to the suppliers.

One can wonder whether the introduction of ‘voluntary’ quality assurance schemes developed by retailers is motivated by the search for procurement management efficiency rather than by food safety and public health concerns. Concentration in the retail sector continues to increase and necessitate more suppliers to obtain the volumes for supplying the totality of the outlets. When suppliers present their products, the procurement manager has two criteria to evaluate the products, namely the quality and the price. The most difficult to
evaluate is the quality of the product since all suppliers argue that their product differs in quality from that of competitors. When a retailer manages to eliminate the discussion about quality and imposes the required quality attributes through quality assurance schemes, the job of the procurement manager becomes significantly simplified. Procurement management becomes limited to evaluating prices and verifying whether or not the specifications of the quality assurance scheme are respected. An important paradigm shift in business management relates to the fact that individual businesses no longer compete on an individual base or as an autonomous entity, but as supply chains (Christopher, 1998). It is expected that in the future successful companies will be part of a successful chain and that chains rather than individual companies will compete with each other.

5. Interaction between the food industry and public authorities

Several authors (Downey, 1996) believe that governmental regulations and more specifically in the case of the EU, regulations such as EU Directive 89/397 on food safety and hygiene standards, followed up by EU Directive 93/43 (Food Hygiene Regulation) and more recently the EU Directive 178/2002 known as the General Food Law, are the single most important factor contributing to the change in food quality systems in general and partnerships arrangements in particular. However, the introduction of new regulations does not always happen as smoothly as expected and often affects the competitiveness of individual companies, sectors, even member states or the EU as a whole. Anticipating the introduction of new food regulations does not happen quite often at EU level. In what follows, we discuss two main problems linked with the interaction between EU Directives on the one hand and quality management in the food industry on the other. It corresponds with differences in:

1) The capability of food firms to meet the new requirements and standards;
2) The way food processors are controlled and penalised, both at the national and international level;
Firstly, recent qualitative research results (Deroanne et al., 2002) illustrate clear differences among food companies in investments and costs related to food safety varying from 1.555 EUR to 26.165 EUR per full time equivalent per year in 2000. Consequently the capability of meeting new legislative requirements differs. These differences find their origin in several aspects:

- When a ‘quality philosophy’, like a way of life, is present in the company, the focus on quality in general and food safety in particular is much more at the centre stage than in the opposite case. It is often linked with the type of customers food companies work for. When working with retail chains, such ‘quality philosophy’ is much more present than it is in the case of the catering sector or smaller, traditional shops.

- The efforts made for food safety are greater in sectors characterised by higher food safety risks (microbiological contamination) such as the dairy, meat or fish sector than in other food sectors such as the chocolate or sugar confectionery.

- The efforts made for food safety are relatively more important in small enterprises (less than 20 employees) than in the larger ones (more than 100 employees). This is linked with the fact that larger enterprises benefit more from scale economies.

Secondly, the way EU Directives are translated into national legislation differs among the member states. These differences occur especially in the way the food processors are controlled and penalised, with consequences both on domestic and EU market. On domestic markets, some companies remain in business and continue to produce food products despite the fact that they do not comply with the regulations related to food safety (e.g. presence of HACCP plan). Such companies did not make the necessary investments, can consequently work with other costs structures and compete on the same markets. On international markets, food companies claim that differences in cost structures related to food safety exist between member states because of differences in the way food companies are controlled and penalised. The competitive position of food companies from member states where food authorities control and penalise more severely than in competing member states is weakened and not compensated by additional access to market as often claimed by advocates of rigid control.
6. Conclusions and further research topics

Gateways and vehicles for interaction between the food industry and other stakeholders in the food supply chain have been established. The major challenge is now to find out how to use them as effectively and efficiently as possible.

As it is expected that competition in the future will concentrate more and more at chain rather than at individual company level, we can agree with the suggestions for future research proposed by Omta et al. (2002):

- Which are the critical success factors for the design and control of chains?
- Which governance structures should be used to enhance the innovative potential of chains?
- How should firms share the costs and the benefits of their co-operation?
- How can the performance of a chain be evaluated quantitatively?

Based on qualitative research results, some hypotheses are formulated explaining differences between food companies in response to new food regulations. It would be interesting to test and validate these hypotheses through quantitative research techniques in order to obtain hard evidence. Moreover, the identification of the determinants of these differences would be an interesting topic for further research and could help in solving the discussion about falsified competition because of differences in food authorities’ actions.

The new EU General Food Law was published in 2002 and obliges food chains to introduce traceability (from ground to mouth) from 2005 on. The impact on the competitive position of EU food companies is unknown and according to our knowledge no studies investigated the distribution of costs and benefits along the food chain. This information could be useful to support of the EU position in WTO negotiations.
Selected references


Quality assurance in the Belgian food industry

Eva MOENS

Email: info@vegaplan.be
www.vegaplan.be
Integrated Chain Quality Management (ICQM) in the Belgian arable crop and horticulture sector

Since 1999 various professional associations from the vegetable/arable crop processing industry & commerce have been aware of their need for a closed system to ensure traceability, food safety and quality control all along the vegetable food chain.

The various sectors therefore sat together to develop a uniform system. In June 2000, their discussions led to the foundation of the “Concertation Platform for the Processing of arable Crops” (abbreviated as CPPC). The CPPC groups together a number of professional associations from the food industry with a mutual concern, namely the processing and commerce of vegetable produce. (The effective members include: FEVIA (Belgian Food Federation), Belgapom (Belgian potato industry), Belgrain (Belgian grain distribution), Bemefa (Belgian compounded feed industry), CBB (Belgian breweries), Cefi (Federation of Belgian chicory industry), the Federation of Belgian Maltsters, KVBM (Federation of Belgian milling houses), Subel (Federation of Belgian sugar producers), Vegebe (Belgian industry and commerce of raw vegetables), and VBT (the Belgian association of fruit & vegetable markets). Due to a lack of associations from certain sectors some other companies effectively became members: Algist Bruggeman (yeast), Amylum (potato starch), Cargill, Fuji Oil Europe, Vandemoortele (vegetable oils), and Citrique belge (citric acid). Almost all the members are associations and companies from the so-called “first transformation” with by-products that flow back into farming. Companies and associations from the second transformation (biscuits, chocolates, etc…) have smaller flows back into farming and are therefore not directly represented in the CPPC, but are associated via FEVIA, the Belgian Food Federation. The breweries are the only exception to this. They supply farming with pods as a by-product.)
Thanks to the planning of an Integrated Chain Quality Management (ICQM) system, this concertation platform wants to contribute to the development of a unique quality system throughout the vegetable food chain. In order to produce high quality and safe vegetable end products, all partners in the food chain have to contribute to the system; requirements and standards for production processes are necessary and external control is important. External control can be executed by the government or by independent control (certification) agencies. The basis for this system is auto control.

ICQM is based on a chain approach for the entire vegetable production:

ICQM is applicable for all partners in the chain and for all product flows.
In arable crop farming and horticulture rotation is applied. An efficient system of auto control can only be reached if all rotating crops – sugar beets, potatoes, vegetables, cereals, chicories, etc – are considered and if all stakeholders – the farmer and his suppliers, the processing industry, the fresh produce markets, the transport sector, trade & distribution, the consumers and the public authorities – are integrated in the system. Moreover, ICQM is applied on all product flows from agriculture and horticulture to the processing industry and backwards from the processing industry (co-products) to agriculture (mainly via cattle feed and soil).

The aim of the ICQM system is to guarantee "ICQM basis quality", including traceability, through the entire food chain. Each partner of the chain assumes their own responsibilities, which makes it possible to strive for an integral chain quality and traceability. The following scheme illustrates this chain approach:
The 4-letterword ‘ICQM’ endorses the chain approach and the aims of CPPC:

- **Integrated** signifies that a link is established between every single and responsible partner of the chain (function of their needs), so that the entire chain can be optimised. Each partner has to take up his own individual responsibility as well as contribute to the strength of the chain;
• The ‘Chain’ comprises all the partners in the food chain: suppliers, farmers, traders and intermediaries, the processing of basic raw materials and by-products, the processing of basic raw materials into end products, transport and storage, wholesalers, retail and the actual consumer;
• ‘Quality’ means that standards relating to product safety, product quality (both technical and nutritional), environment and health are pro-actively defined and met. Environmental concerns are fully integrated into the ICQM Quality concept;
• ‘Management’ includes planning, executing, controlling (=monitoring) and correcting

ICQM is based on auto control

The ICQM Standard is a key element in the ICQM System. The ICQM Standard describes the basic quality defined as: the legal and complementary (agreed per sector) requirements with relation to product safety, product quality and environment.

The ICQM Standard is an auto control system wherein the separate role of the producers (farmers, industry and suppliers) and the government is clearly defined. The producers are responsible for the safety and quality of their products (and services). The government is responsible for the setting of norms and standards, for inspection and control of the production processes and the products themselves.

This auto control system is based on:
(1) A documented production process (I&R: identification & registration),
(2) Guarantees for safety and quality (control systems following the HACCP principles and the Codes for Good Agricultural, Commercial and Production Practices),
(3) External independent control (government or official, independent control agencies (= certification instances)).

Via this chain system of auto control in the entire vegetable sector, one will meet the aims and requirements of the Belgian Federal Agency for Food Safety, concerning auto control and traceability for “all stages of production, processing and distribution of products”.

1. ICQM for primary agricultural production:

The ICQM Standard is developed for primary plant production by the concertation platform CPPC – AGROFRONT (AGROFRONT = association of Belgian Agricultural Organisations, representing the Belgian farmers: Algemeen Boeren Syndicaat, Boerenbond and Fédération Wallone des Agriculteurs). This bilateral approach guarantees the feasibility and efficiency of the system. The ICQM Standard describes the basic quality defined as the legal and complementary (agreed per sector) aims with relation to product safety, product quality and environment. Thus, the ICQM Standard includes the minimal requirements for the farmer to have access to the market.

(1) Identification and registration

The instrument for identification and registration on the farmer's level is the culture sheet. The culture sheet has to assure complete traceability. The gathered information on this culture sheet has to be relevant for the further chain and the administrative tasks for the farmer have to be reduced to a strict minimum. The information that has to be registered in the culture sheet also has to be based on hazard analysis and on the quality requirements with relation to the products and the production process. In principle, the culture sheet can be considered as the passport of the produced product and contains the unique identification of the producer and the produced unit as well as the necessary registrations during the agricultural process.

With regards to traceability (I&R), the farmer remains the owner of his data. Data transfer to other partners of the chain is clearly restricted to identification data of the producer, the culture or the parcel. The identification of farmers and parcels will preferably follow the rules of one, unique standard.

(2) Guarantees for safety and quality

The ICQM system is an auto control system designed to manage food safety and quality and is based on the principles of HACCP. The tools for the ICQM standard on farmer level are, at this moment, being developed within the concertation platform CPPC – AGROFRONT and consist of: a code for Good Agricultural Practices, a charter of
conditions/requirements and a checklist, including a culture sheet as instrument of traceability

- A code for Good Agricultural Practices contains detailed information for the farmer in order to satisfy in practice the charter of conditions/requirements. The code could thus be defined as it were as a reference book. The code describes specifically how one can meet all legal and sectoral requirements for the production of safe and quality food products, as well as environmental aspects. Moreover, the code contains culture-specific tips for production and how deviations can be recorded.

- In the charter of conditions/requirements all relevant norms to be met for the products and production processes in order to meet the requirements with relation to food safety, quality and environment, are stated. The charter of conditions/requirements is based on: (1) a hazard analysis, which makes culture specific modulation possible, (2) the quality requirements with relation to the products and production processes: legal requirements and per sector agreed requirements.

- The charter of conditions/requirements will be distilled into a checklist, in which the most important items of the charter of conditions/requirements are described. This checklist is to be seen within the context of external controls on the correct implementation of the ICQM Standard, but can also be used by the farmer during the implementation and maintenance of the requirements of the ICQM Standard.

The development of the code for Good Agricultural Practices and the charter of conditions/requirements are based on the product index card. The product index card, developed by the CPPC, integrates the philosophy of a HACCP plan in a simplified and complete format. The precautionary principle is fully integrated in this approach. Product index cards have been developed for potatoes, industrial vegetables, cereals, sugar beets and fresh vegetables and fruits.
The system will ensure the production of vegetable raw materials in a sustainable manner, with respect for the environment and guarantees for food safety, quality and traceability.

(3) **External control**
External control of the correct implementation of the system is an integral part of the ICQM auto control system. This independent control can be carried out directly by the Belgian Federal Agency for Food Safety or by an independent control agency (= official certification organism), which itself is recognised by the Belgian Federal Agency for Food Safety.

The ICQM System is a voluntary system. The ICQM Standard guarantees basic quality, as required by law, but meets also supplementary requirements (which are agreed per sector). The farmer is completely free to work according to this Standard.

*Management of the ICQM Standard:*

The management of the ICQM Standard will be trusted to the non-profit organisation named VEGAPLAN.BE.
VEGAPLAN.BE supplies information on the ICQM Standard and manages the addresses and status of companies using the Standard in a databank. Further, VEGAPLAN.BE will be responsible for the
recognition and training of the auditors - and this in a uniform, harmonised manner - as well as for the co-ordination and training of farmers and the industry. Finally, VEGAPLAN.BE will watch over the harmonised application of verification procedures with relation to sampling and analysis.

2. ICQM for the vegetable feedstock processing industry

The ICQM system is based on a *chain* approach: this implies that the processing industry also has to contribute to the system. The ICQM auto control system for the processing industry consists equally of (1) an identification and registration system, (2) guarantees for safety and quality and (3) external independent control (government or official certification organism).

(1) Identification and registration & (2) Guarantees for safety and quality

In the feed industry, several systems have been developed in order to guarantee quality and traceability (Good Management Practises, Good Hygienic Practices, HACCP, ISO,). Identification and registration are an integral part of these systems. Therefore, the ICQM Standard for the processing industry encloses on the one hand the optimisation and perfection of existing auto control systems and on the other hand an enlargement of these systems to their co-products.

One of the first CPPC achievements (December 2000) was the introduction of the **product index card**, in order to guarantee quality and safety assurance of *the co-products* (supplied by the vegetable processing industry) to the stockbreeding and dairy farming and the Belgian compound feed industry. Indeed, a lot of companies (processors of vegetable products) have (sometimes small) flows of co-products for the cattle feed companies (beet pulp, potato peels, grain pods). That is why a product index card has been introduced which integrates the HACCP philosophy (hazard analysis, establishing critical points, maximum values, corrective action, monitoring, and documentation). The precautionary principle has been fully integrated into this approach. The next step involves the development of the same instrument for co-products destined for agricultural soil.
In this way, all ‘flow backs’ (from industry to agriculture) are integrated in the ICQM System. Coupled with the commitment of the processors to buy products from ICQM-certified farmers, the entire ICQM-chain cycle of product flows is thereby closed.

(3) **External control**
The processing industry is equally liable to external control. Today, many processors are already certified by official controlling instances for their products with destination ‘human consumption’. This has to be enlarged for the other product flows. External control can be executed by the government (Belgian Agency for Food Safety) or by an independent control agency (official certification instances). One can find, on the website of VEGAPLAN.BE (www.vegaplan.be), a complete list of all processors (processing industry) of vegetable products that have signed up for and work with the ICQM System.

### 3. ICQM for suppliers

Extending the chain philosophy of the ICQM System, the suppliers have also been involved in this system. Quality and safety of primary plant products can only be guaranteed if the quality and safety of all supplied products and services is efficient. Therefore it was clear that consultation with suppliers was necessary to stay true to the spirit of this chain system.

Suppliers are classified as follows: (1) suppliers of products; seed, plants, chemical and organic manure and plant protection products and (2) suppliers of services: contract work, transport, commerce and distribution.

The ICQM auto control system for suppliers consists equally of (1) an identification and registration system, (2) guarantees for safety and quality and (3) external independent control (government or official certification organism).

**(1) Identification and registration & (2) Guarantees for safety and quality**
The consultation with the suppliers comprises two major points: (1) what guarantees can these suppliers provide in relation to quality and (2) what guarantees can be provided in relation to traceability of delivered services or products?
The consultation aims for an optimalisation of existing systems for quality guarantees and traceability for the suppliers and this as a function of its necessity, its manageability and the affordability. The suppliers gave their co-operation concerning the writing of a "white paper" in which the existing situation with relation to traceability and quality guarantee systems for their activities is described.

(3) External control
Obviously, the suppliers are also liable to external control (carried out by the Belgian Federal Agency of Food Safety or by an independent certification organism that has been recognised by VEGAPLAN.BE)
General risk assessment of Bacillus cereus in processed foods

ANDREJA RAJKOVIC*, MIEKE UYTTENDAELE AND JOHAN DEBEVERE

Laboratory of Food Microbiology and Food Preservation
Faculty of Agricultural and Applied Biological Sciences
University of Gent, Belgium

*andreja.rajkovic@UGent.be
Abstract

Bacillus cereus is an important microbial hazard especially in cooked processed foods. The pathogenic character and the potential of some strains to grow at low temperatures and express single or combined virulence factors in food matrices or human intestines revealed a need for risk assessment studies that will provide an estimate of the risk to have illness or any other end-point as an outcome of the consumption of contaminated food.

1. Introduction

One of the aspects of food quality is the microbiological profile of the food fabricates indirectly influencing organoleptical (sensorial) characteristics of the food product and its shelf life. It is also the microbial profile that will primarily address the issue of the food safety. One should realise that there is a difference to be made between micro-organisms that are responsible for spoilage and those who represent a food safety problem. However, the difference is not always evident, as there are micro-organisms that may well fit in both categories. Among them Bacillus cereus is one of the most frequently involved bacteria in the spoilage of a wide range of different types of food. B. cereus, a spoiler, can also be a pathogen given the circumstances in which it may express some of its virulence factors for which then the safety limits have to be established in order to prevent foodborne outbreaks. B. cereus is repeatedly reported as a causative agent in food intoxications due to its spore forming character, heat resistance and possible toxin production. In the Refrigerated Processes Foods of Extended Durability (REPFED), which are generally produced using a mild heat treatment and kept stored between 4 and 7°C (with temperature abuse up to 10°C), it represents one of the most important microbial hazards. The assessment of the health risk posed by presence of B. cereus in REPFED requires essential knowledge on prevalence, strain characteristics and their growth in food matrices, thus it is also of essential importance for the HACCP application to know the potential for survival and growth of food-poisoning spore-forming bacteria. Moreover, estimation of the actual exposure level requires additional
information on consequent consumer behaviour, concerning transport, storage and preparation. Nevertheless, not only REPFED foods are susceptible for spoilage and involved in the food safety problems, but *B. cereus* equally endangers milk and milk products, farinaceous and proteinaceous foods. Due to a variety of food matrices that can host *B. cereus* and its spores, food borne outbreaks of *B. cereus* are known, both on the northern and southern hemisphere.

2. Risk assessment

The importance of risk assessment studies rises both from the virulence potential of *B. cereus* and the fact that sales and consumption of REFPED foods are generally rapidly increasing in many parts of the world. Being also a problem in farinaceous foods, such as rice, it is known as a potential threat for a large population on the Asian continent. Through this process an estimate of the probability and impact of adverse health effects attributable to potentially contaminated foods will be provided. The outcome of the process is thus a risk estimate (of illness), a measure of the magnitude of risk, based on current scientific knowledge and understanding. Risk assessment is only one element of risk analysis, an overall strategy that also includes risk management considerations and risk communication activities (Lammerding, 1997).

There are four cornerstones in the general framework for conducting food safety risk assessments (Codex Alimentarius Commission, 1999):

1. Hazard identification
2. Hazard characterisation
3. Exposure assessment
4. Risk characterisation
These steps represent a systematic process for identifying adverse consequences and their associated probabilities arising from consumption of foods that may be contaminated with *B. cereus* and/or some of its toxins (Lammerding and Fazil, 2000).

### 2.1 Hazard identification

*B. cereus* is a bacterium, causing more food poisonings than any other bacterium. Fortunately, most cases are mild, but there are strains that produce a lethal toxin, named the emetic toxin or the cereulide. *B. cereus* is considered Hazard Category 2 (capable of causing disease). Hazard of *B. cereus* presence includes both the presence of the organism itself and/or its toxins. The key to hazard identification will be the availability of public health data and a preliminary estimate of the
sources, frequency and amount of the hazard under consideration (Forsythe, 2001).

**General characteristics of *B. cereus***

The morphological and biochemical characteristics of *B. cereus* are well known and already described in detail (e.g. ICMSF 5). Therefore, none of this will be repeated here. However, it should be clear that *B. cereus* can be understood as a group of phenotypically similar, but genetically different micro-organisms comprising *B. cereus* sensu stricto, *B. mycoides*, *B. thuringiensis* *B. anthracis*, *B. pseudomycoïdes* and discussable *B. weihenstephanensis*. For the purpose of this text only *B. cereus* sensu stricto will be considered.

**Factors affecting the growth of *B. cereus* in foods**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Minimum value (°C)</th>
<th>Optimal value</th>
<th>Maximal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>4</td>
<td>30-40</td>
<td>55</td>
</tr>
<tr>
<td>pH</td>
<td>5.0</td>
<td>6.0-7.0</td>
<td>8.8</td>
</tr>
<tr>
<td>(a_w)</td>
<td>0.93</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

There are various factors that will influence the growth of *B. cereus* and all of them act in a synergistic or antagonistic way to each other. Temperature, water activity, pH and the atmosphere composition in the food package (if packed) are among the most important factors. However, it must be underlined that there is a wide variation in characteristics among *B. cereus* strains. The difference between psychrotrophic and mesophilic strains is not evident, but the spores of the former are generally more heat sensitive. The spore germination is also highly variable among *B. cereus* strains. There is, also, still only little knowledge on the influence of the pH compared to that of the water activity. These are just some of the facts that indicate the complexity of interaction among *B. cereus* and food matrices, which cannot always be compared to growth and survival in the culture media.
B. cereus toxins-characteristics, production, detection

There are several toxins produced by B. cereus that can be divided into two types according to the symptoms.

- Toxins causing diarrhoeal symptoms

This is a group of three toxins, which were all tested in rabbit ileal loop assay, for their diarrhoeal response. The hemolysin BL (HBL) and non-hemolytic enterotoxin (NHE) are actually protein complexes, each consisting of three protein constituents. In both cases the optimal toxic effect has been found when all three components were tested together. The third toxin from this group is a single protein, called enterotoxin T. In the food borne outbreaks related to B. cereus the highest incidence is due to the HBL and the NHE. Some reports suggest that 83% of the strains isolated from different food sources contain the gene encoding for one of the HBL components (Te Giffel et al., 1997). All of these toxins are unstable, inactivated by low pH and by the action of the digestive enzymes, thus indicating that the preformed toxin will not contribute to the illness, as it will be destroyed during the passage through the stomach.

There are two commercially available methods that can be used for detection of HBL (B. cereus enterotoxin reverse passive agglutination assay-BCET-RPLA, produced by Oxoid, UK) and NHE (visual immuno assay-VIA, produced by Tecra, Australia) in food samples or in culture supernatants. Both kits are based on the immunological responses between toxin (antigen) and antibodies that are provided in the kit. Although easy to use, both kits are with drawbacks of sensitivity, limited application for coloured foodstuffs and non-quantitative determination. They also react only with one of the toxin components. There are several other possibilities for the toxin detection (cytotoxicity, animal tests, gel diffusion), but the ongoing research should provide more user friendly and more reliable quantitative methods.

- Toxins causing emesis

The second type of the toxin is the emetic one, causing emesis in monkeys, also creating strong vacuole response in Hep-2 cells and
swelling of mitochondria acting as K-ionophore. Human sensitivity is not known, but it is possible that 10-50g of food contaminated with $10^8$ cfu/g of toxigenic B. cereus strain is enough to cause an illness. For the comparison: an intoxication dose of 9.8-12.9 µg/kg for Suncus murinus and 70 µg for one rhesus monkey (7-8 kg animal) is known (Agata et al., 1995). The toxin itself is a peptide of molecular mass 1.2 kDa, remarkably heat stable (121°C, 90’), pH stable (2-11) and trypsin insensitive. There are indications that it is a product of enzymatic synthesis rather than of gene translation and it is related only to H1 serovars of B. cereus.

Due to the small size of the peptide, it has no immunogenic properties. Therefore, not available immunological detection methods are available yet. However, there are some other ways, namely bio-assay on boar spermatozoa motility, cytotoxicity, animal tests (emesis in primates and Suncus spp.). Good indicators that the strain might be producing emetic toxin are negative starch hydrolyses reaction, negative BCET-RPLA and specific ribotype.

2.2 Hazard characterisation

Through this step a qualitative and/or quantitative estimate of the hazard effect (possibility, nature, severity and duration) on the health of the consumer is obtained. It gives an answer whether there will be illness occurring and, if so, what would be its characteristics. Three types of factors must be considered, namely pathogen, food-related factors and host (consumer)-related factors. For B. cereus characteristics such as spore-formation; conditions for toxin production (their incubation period, severity and persistence), tolerance to adverse conditions and psychrotrophic character of some strains must be kept in mind (Rajkovic et al., 2003). Emetic toxin is produced mostly at 12-15°C (Finlay et al., 2000) and oxygen tension (Finlay et al., 2002) together with food preparation methods (Agata et al., 2002) seem to play an important role for the toxin production. Symptoms of the emetic poisoning have an incubation period of 1-5 hours prior to nausea, vomiting and malaise (in immuno-compromised individuals symptoms may result in liver failure and death). Symptoms are normally resolved within 24h. HBL and NHE toxins are produced optimally at 30-35°C.
(Lund and Granum, 1997; Beecher and Wong, 1994), having an incubation period of 8-16 hours and being normally resolved within 12-24 hours. Other virulence factors such as phospholipase C and sphingomyelinase could also be understood as toxins in a broad sense. The interaction between the factors and their combination at a given moment will play a crucial role for determination of the hazard effect.

Dose-response relationship

To perform this part of the hazard characterisation, a sufficient number of data must be available through one source or a combination of sources: human volunteer studies, population health statistics, outbreak data and animal trials. The delineation of the end-point must be clear (infection, illness, chronic sequel or death). Results of food borne outbreaks indicate that a possible infection dose for the diarrhoeal syndrome is in the range of $1.2 \times 10^3$ to $1 \times 10^8$ cfu g$^{-1}$ of food; the median value around $10^7$ cfu g$^{-1}$ (Kramer and Gilbert, 1989); while for the emetic Granum (1997) suggests the range of $1 \times 10^5$ to $1 \times 10^8$ cfu g$^{-1}$ or viable cells or spores. However, one must realise that not every B. cereus strain expresses the same virulence, which is in this case manifested through the amount of toxin produced. The numbers of B. cereus required to produce detectable amounts of toxins are in the order of magnitude of $10^5$-$10^7$ cfu g$^{-1}$ or ml$^{-1}$ of food product. These amounts of bacteria present in the food would cause apparent spoilage, thus provoking rejection by the consumer.

2.3 Exposure assessment

The contamination with B. cereus and/or its toxins at the moment of consumption and the consumption patterns influence the exposure of consumers to the hazard. The maximum level that has no harmful effect on the consumer should be considered in the exposure assessment studies (epidemiological studies reveal the figure of $1 \times 10^4$ cfu g$^{-1}$) (Nottermans and Batt, 1998). Nottermans and Batt (1998) write about three methods for determination of the exposure, including surveillance testing, storage testing and
predictive models, underlining the necessity for estimation of exposure level at the moment of consumption. Surveillance testing is easily applicable for most of the foods and gives a picture of the level of *B. cereus* presence in food items. It is of concern that there were ready-to-eat products containing more than $1 \times 10^4$ cfu g$^{-1}$.

Storage testing combines the influence of time and temperature during storage in the households, prior to consumption. One of the studies in the Netherlands revealed that 11% of the milk consumed could contain *B. cereus* counts higher than $1 \times 10^4$ cfu ml$^{-1}$ ($1 \times 10^4$ cfu ml$^{-1}$ seem not to be harmful and therefore the probability to the exposure to higher counts is considered).

In both cases reliable detection and quantification methods must exist, which is at the moment lacking in the case of *B. cereus* toxins.

If in the predictive model limiting conditions for *B. cereus* growth are applied to calculate the corresponding counts of organisms in foods, the estimate will represent the worst case scenario, thus providing a possibility to evaluate the most important factors influencing the growth and the final counts. Using a range of values for the growth factors, a more realistic estimation can be obtained.

### 2.4 Risk characterisation

Using the information gained through the previously described steps, the final characterisation of the risk can be made, providing the finalisation of the risk assessment study. However, one must realise that the general risk assessment can not be of sufficient reliability, so it is recommendable to perform the study for a particular group of food products, or even individual products, that are similar to each other regarding the production process, storage and consumption patterns. The consumption patterns will be related to the whole population or certain target groups within the whole population. The information generated in this step, can be qualitative and/or quantitative, within a certain confidence interval.
3. Conclusion

The complexity of the risk assessment studies requires large numbers of relevant data to be collected and evaluated in order to fulfil all four steps of the study. When talking about *B. cereus* a few facts have to be kept in mind.

Large variations exist between different strains in limiting growth conditions, as well as in the amount of toxin produced (if produced).

There are two different types of poisonings, both requiring high number of *B. cereus* to be present.

Emetic toxin acts through the intoxication (preformed toxin), while diarrhoeal toxins act after being produced in the small intestine and the pre-formed form is not generally understood as a hazard.

Emetic toxin is highly heat stable, while diarrhoeal toxins are labile.

A product containing more than $1 \times 10^5$ cfu g$^{-1}$ of *B. cereus* should be considered hazardous.

In most countries the presence of *B. cereus* is regulated only in a few sensitive foodstuffs (e.g. baby foods).

References


Marketing food quality: the role of labels and short chains

ERIK MATHIJS

Associate professor in agriculture and resource economics
Centre for Agricultural and Resource Economics
Faculty of Agricultural and Applied Biological Sciences
Katholieke Universiteit, Leuven, Belgium

Email: erik.mathijs@agr.kuleuven.ac.be;
www.kuleuven.ac.be/aeeclo/index.html
Abstract

Many farmers face high costs and hence are not competitive without substantial government support. Focusing on a low-cost strategy is no longer an issue. New strategies have to focus on producing added value by targeting specific markets. This paper discusses how products can be differentiated to serve different market segments and focuses on the importance of transaction costs in marketing channels as the key driving force of how food supply chains are organised. Two distinct examples of marketing strategies in Flanders are provided: the Flandria quality label and the Atalanta cooperative as an example of short supply chains.

1. Introduction

Mainstream European agriculture is in crisis as many farmers face high costs and hence are not competitive without substantial government support. Focusing on a low-cost strategy is no longer an issue for many European farmers in general, and particularly for those in highly urbanised regions, such as Flanders. The latter face even higher land and labour costs. Traditionally, farmers in such regions have intensified their production, that is, they have increased the value added per hectare by applying more fertilisers or by producing high value added crops such as vegetables. However, also these markets are saturated and intensive livestock systems have negative impacts on the environment. Therefore, new strategies have to focus on producing added value by targeting specific market segments in which consumers are willing to pay a higher price for the higher quality offered (Mathijs, 2003).

The central question of this paper is whether farmers are able to follow these strategies and improve their situation. The next section discusses how products can be differentiated to serve different market segments and focuses on the importance of transaction costs in marketing channels as the key driving force of how food supply chains are organised. Section 3 discusses two distinct examples of marketing strategies in Flanders: the Flandria quality label and the Atalanta cooperative as an example of short supply chains. Section 4 concludes the paper.
2. Segmenting markets and marketing differentiated products

2.1 Serving different market segments

Without being complete the following criteria can be used to segment consumer markets (Kotler et al., 1999): geography (region, urban versus rural, climate); demography (age, gender, family size, family life cycle, income, profession, education, religion, ethnicity, nationality), psychography (social class, lifestyle, personality); and behaviour (purchasing behaviour, purchasing demands, user status, use intensity, loyalty, opinion, interest). All of these criteria can be potentially relevant for agricultural and food products. Consumer preferences and habits change rapidly and include the following trends (Mathijs, 2003):

- The (rich) consumer whose basic needs are fulfilled appreciates a more varied and sophisticated diet. As a result, the demand for diversity and new products, that are usually imported, increases;
- Consumption patterns diverge: one segment sees its welfare increasing and seeks additional value, while another segment gets poorer and seeks the lowest price;
- The population ages at an increasing rate resulting in shifts in the demand for food and in purchase behaviour;
- The participation of women in the labour market increases and family size decreases. Many consumers want to save time by eating out, eating prepared meals, having food delivered, etc.;
- Both the consumer that wants to save time and the consumer that is looking for ways to spend his free time buy more of their food in the supermarket. The purchasing process itself and the experiences and possibilities attached to the process become more and more important;
- Several food crises have made the consumer more conscious and alert for food safety. Many consumers want more information on the origin of their products or on the production process. Some consumers even prefer to buy food locally, for example directly from the farmer;
- An increasing segment of consumers consciously buys ethical or sustainable: organic, fair trade, animal welfare, etc.
All these criteria can play a role to segment food markets. Marketeers will try to identify segments, for example by techniques such as cluster analysis that combine different criteria to build a consumer profile. However, the use of consumer segments and profiles is limited, as the 21st century consumer is no longer one-dimensional: his purchasing behaviour becomes more and more complex. For example, he may buy cheese and butter at a discount store such as Aldi to eat it with the best wine bought in a deli.

2.2 Developing products for different market segments

Differentiation implies that products differ in certain attributes. Often people refer to differences in “quality”. However, there is no single definition of quality and different people understand quality differently. Attributes can be categorised into intrinsic attributes (e.g., colour and tenderness as objectively measured), extrinsic attributes (e.g., price, brand, packing, country of origin), experience attributes (e.g., colour and tenderness as experienced by the consumer) and credence attributes (e.g., health, environment, animal welfare). Another categorization is based on tacit and non-tacit attributes. Tacit attributes may refer to:

- the product itself: taste, form, colour, quality (i.e., fat, tenderness, composition);
- the production process to the extent that it results in a tangible difference, such as less residues by integrated or organic pest management;
- a service: a product may be delivered in a certain packaging form, tailored to the consumer’s demand, delivered at home, etc.

Non-tacit use criteria refer to how the product is produced (animal welfare, environment, organic), the image of the product or the producer (brand), the region of origin (regional identity or “terroir”), without the product being significantly different with respect to tacit criteria.
2.3 Marketing differentiated products in segmented markets

Differentiated products can be delivered in different ways to the markets they are developed for. A key point is that the attributes that differentiate these products are well communicated to the target consumer. For this, the different actors in the food supply chain have to coordinate their actions closely. In other words, the role of vertical coordination strategies increases with increasing product differentiation and market segmentation.

Vertical coordination is defined as the way supply chain actors are organised. Supply chain actors in a typical food chain include input providers (e.g., animal feed companies), farmers, food processors, wholesalers and retailers (or supermarkets). In fact a continuum of vertical coordination strategies exists ranging from *spot markets* in one extreme to *vertical integration* in the other extreme. In the case of vertical integration a single company owns and controls the entire production process. Between the extremes of spot markets and vertical integration are for example contracts, joint ventures, strategic alliances, etc. Contracts are the most widely used coordination strategy in the intensive livestock sector.

In most cases a certain actor initiates the coordination. In the intensive livestock sector this is called the *integrator*, usually an animal feed company or a slaughterhouse. Also food processors and supermarkets often play this role. Farmers can also take the initiative by establishing a cooperative to process their products (dairy), organise a wholesale market (auction in horticulture) or even sell to the consumer (coop supermarkets).

Different organisational arrangements yield different results for the farmer: it is very likely that the farmer captures a larger share of the rent in the case the marketing channel is an initiative of farmers rather than of other channel actors. But which factors determine which marketing channels are formed? Besides economies of scale and span, only those vertical coordination strategies will survive that will save the most on transaction costs. These are costs related to the transactions between successive stages in the supply chain (Young and Hobbs, 2002). Transaction costs consist of:

- *ex ante* search costs: costs made to find information on prices, quality attributes, potential buyers or sellers, etc.;
bargaining costs: costs made to draw up contracts, pay middlemen, etc.;

ex post enforcement costs: costs made to check whether the terms of transactions are being followed.

Three crucial trends influence transaction costs and will ultimately shape future supply chains (Hobbs & Young, 2000; Lahidji, 1998): changing consumer preferences, liberalisation and globalisation of food markets and technological progress. In the past, technology has improved packaging, processing, transport and storage. Two relatively recent innovations will prove to be extremely important for the future: biotechnology and information and communication technology (ICT). The potential applications of biotechnology are immense: improved product quality, adjusting plants to difficult circumstances, higher yields, resistance against pests and diseases, tolerance against pesticides, more efficient vaccination, quicker and more reliable diagnosis of animal diseases, traceability throughout the entire supply chain, etc. ICT allows collecting more information in supply chains to better understand the consumer’s needs, detect new trends and even sell on line.

These external drivers increase the transaction costs between the different actors in the supply chain. As a result, these actors have an incentive to increase vertical coordination to minimise transaction costs. In the past, most food products could be marketed without much coordination, because they were homogenous and standardised. In the next section, we discuss two examples of vertical coordination strategies in the Flemish vegetable sector.

3. Examples of vertical coordination strategies in Flanders

Product differentiation only works when the differences in attributes can be guaranteed and communicated to the consumer. For this, systems are established that define these attributes and organise controls on a regular basis (mostly by external evaluators). Central in these systems is the traceability of the products from producer to consumer. Four systems can be distinguished (Mathijs, 2003):

- Government protection: labels are assigned and protected by the government. For example, the European Commission prescribes the requirements for organic farming and regional
products.

- **Sector labels**: private labels that are initiated by the sector itself. In Flanders, integrated chain management exist for milk (IKM), pork (Certus), beef (Meritus) and veal (BCV veal). Also the Flandria label belongs to this group of labels. All these labels are actively supported by the VLAM, the Flemish Promotion Centre for Agricultural and Fisheries Marketing, a cooperation between the government and the private sector.

- **Distribution brands and labels**: supermarket chains commercialise a large share of what they sell through own brands or labels. Product specifications are drawn up by the supermarkets and define the minimum standards suppliers have to fulfil.

- **Direct contact with the consumer**: to minimise the distance between farmer and final consumer they may interact directly through on farm shops, farmers markets and other forms of short supply chains. Since the 1990s, new arrangements such as food teams and vegetable subscriptions emerged. The consumer engages himself to buy a certain package of food or vegetables from a group of farmers during a fixed period. These packages are distributed through central dispatch centres (see Verhaegen & Van Huylenbroeck, 2002, for an overview).

### 3.1 The Flandria label: a private quality label

The Flandria label has been established by seven Flemish auctions that have joined together in LAVA (Logistieke en Administratie ve Veiling Associatie, Logistic and Administrative Auction Association). The label was first used in 1995 for tomatoes and Belgian endive, later for most other vegetables and also for fruit. The label is private and voluntary and is part of a common brand ‘Milieubewuste teelt’ (Production with concern for the environment) also known as ‘De Groene Boog’ (The Green Bow) (see Figure 1, for the label’s logo).
The requirements to be able to carry the logo are described in product specific sets of production rules that are based on ‘Good Agricultural Practice’ (GAP), guidelines from the European retail sector (EUREP) and the principles of HACCP (Hazard Analysis of Critical Control Points). The Flandria production rules include prescriptions concerning production technology, crop protection, fertilisation, employees and environment, quality, hygiene, registration, traceability, control, etc. To assure the quality of the label, both the products and the procedures are being controlled.

Recent research based on a limited sample of 52 Flandria producers (Van den Bossche, 2003) shows the existence of two groups of producers: producers who participate because they feel rationally obliged (40% of the respondents) and producers who are convinced of the benefits of the label (36%). Nevertheless the majority of respondents is satisfied (70%) or without opinion (27%) concerning his participation. An important bottleneck for the majority of producers (80%) is that the label is insufficiently known by the consumer. Almost 70% of the respondents think that they are more dependent of the buyer, while almost all respondents find that they have not enough to say in what is going on in the supply chain.

3.2 The Atalanta cooperative: a short supply chain

Several reasons explain the relative success of short supply chains (Feenstra, 1997; Gilg & Battershill, 1998; Halweil, 2002; Kloppenburg et al., 1996; van der Ploeg et al., 2002; Renting et al., 2003; Westgren, 1999):
• More and more consumers prefer locally produced and marketed food, as they are convinced by the superior quality of local products, concerned for food safety or because of moral persuasion (Nygard & Storstad, 1998).

• More and more producers realise they can no longer turn in the treadmill and look for alternatives. By eliminating some of the chain actors (wholesale and retail) the farmer can capture the rent of the added value he created;

• Governments (and most notably the European Commission) actively stimulate short chains in the framework of its rural development strategy. Short chains are considered in many countries (such as France and Italy) as essential elements in rural development (Marsden, 1998: Marsden et al., 2000).

The cooperative Atalanta has been established by 7 organic vegetable producers in 1997 in West-Vlaanderen (de Jong, 2003). Its objectives include the joint marketing of their produce, improve the relationships between the members, but also between the members on the one hand and consumers, traders and processors on the other. Presently, the membership has increased up to 25. Up to 16% of the produce, 28% of sales, is marketed through vegetable subscriptions. Other marketing channels include wholesalers, farms shops and restaurants. The cooperative marketing has been essential to make sure that the organic producers obtain a price that is sufficient to cover their higher production costs.

4. Conclusions

Marketing food quality can be done in several ways. Crucial, however, is that farmers producing extra quality are remunerated for their efforts. Quality labels are the most widespread instrument used for marketing food quality products. However, most labels are initiated by actors located higher up in the supply chain, such as food processors, supermarkets, wholesale organisations, etc. As a result, farmers do not perceive their situation to have improved. Recently, farmer-led initiatives have emerged that try to re-establish the direct link between producer and consumer. Such initiatives seem more successful to ensure
that the rent created by the extra quality actually accrues to the farmer. However, short supply chains are bound to be limited in size and scope.

References


PART III

FOOD QUALITY AND THE CONSUMER
Public Perception of Food Safety

DR. S. MILES

Institute of Food Research
Colney, Norwich

susan.miles@bbsrc.ac.uk
www.ifr.bbsrc.ac.uk

Dr. Susan Miles has been working as a Research Psychologist in the Consumer Science group at the Institute of Food Research since 1996. Her current research interests include: Public perception of food risks, optimistic bias, the impact of uncertainty on risk perception, risk communication and trust, and quality of life issues in food allergy.
Abstract

The public has become increasingly concerned about the risk from food, for a number of reasons. Regulators need to take account of both technical risk estimates and public concerns when managing risks associated with food safety. Thus, it is necessary to identify and understand public concerns. It is widely acknowledged that public risk perception is socially constructed and based on psychological factors. In this chapter, three issues that influence public perception are outlined: public reaction to uncertainty associated with food safety, public trust in risk messages about food, and the impact of optimistic bias on public risk perception and food safety behaviour.

Introduction

The public has become more concerned about risk in recent years, including the risk from food (Pidgeon, 2001). There are several possible explanations for this. Firstly, public trust in the regulation of the food supply has suffered a decline. Whilst the introduction of regulatory bodies such as the Food Standards Agency in the UK has gone some way to counter this, it is still recognised that trust in Government and the food industry is low. This is likely to have a negative effect on reaction to communications from regulators. Secondly, the public may have little experience or knowledge of new, technological hazards (such as genetic modification and food irradiation), nor any context in which to place them. Thirdly, public concern is influenced by well publicised food scares, such as Salmonella in eggs in the late 1980s, BSE in beef in the mid 1990s, dioxins in meat, and the emergence of E. coli O157:H7. Food scares about a particular food can have a wider impact than simply on the perception, sale and consumption of that food. Consider the impact the BSE scare had on public attitudes towards genetically modified food in the UK. Whilst changes in public perception towards beef, mostly strongly illustrated by purchasing behaviour, were transitory the BSE crisis had a lasting effect on perception of genetically modified food (Hunt and Frewer 2001; Miles and Frewer, 2001). Furthermore, it has been argued that the handling of the BSE crisis has had an enduring impact on trust in regulators (O’Brien, 2000).
It can be argued that people want two types of information about food: information about the product (such as the ingredients and the nutritional composition), and information about any potential risks. This necessitates the provision of information about risks associated with food to the public. It is generally accepted that there is no such thing as ‘zero risk’ when evaluating different potential hazards; the key is to identify the acceptable level of risk. However, when assessing the acceptability of risk, one has to consider both the actual risk and the perceived risk.

When thinking about the risk associated with any food hazard, people are unlikely to have statistical information about illness or death rates to hand. Nor are they likely to have access to personalised information about their risk from a food hazard. So, they have to make inferences based on what they remember hearing or observing about the hazard. Whilst there is some question about whether there truly are differences in perception between experts, and members of the general public, it is recognised that in the past, the public’s perceptions about various safety issues have been dismissed as ‘irrational’. However, psychological research has indicated that the public’s beliefs are merely different, and has led to recognition that they are equally valid. This research demonstrates that factors such as whether the effects of a hazard have a personal impact are seen as involuntary, uncontrollable, unnatural or potentially catastrophic determine public perception of potential hazards. Furthermore, concern is higher for hazards that are dreaded or worried about, judged to be new and unfamiliar and to affect many people (Sparks and Shepherd, 1994; Fife-Schaw and Rowe, 1996; Slovic, 2000). People’s attitudes, and self-protective or risk-taking behaviours have their root in psychological factors such as these, rather than in the technical risk estimates provided and used by experts.

There are two key reasons why one needs to consider public perception of food safety. Firstly, risk regulators’ perception of what the public is concerned about regarding a given food safety issue may be far from the actual concerns of the public. If this is the case, then risk messages based on the risk regulators’ perceptions may be ignored. Risk
regulators need to ensure that food risk communication is relevant and salient to the general public, by identifying and focusing on the actual concerns held by the public. In addition to increasing uptake of the message, the public will see that their concerns are being acknowledged and dealt with, which has implications for public trust. Secondly, public acceptance of any new food technology will be a major determinant of how successful this technology is. It will be up to the consumer whether or not they purchase the products of any new food technology. In addition to the economic impact of public rejection on the various sectors of the food industry, there may be other negative effects. For example public rejection of food irradiation in Europe has led to the potential food safety benefits of this technology being lost thus far.

**Uncertainty**

To enable people to make informed decisions about their food choices it is necessary to include information about any uncertainty associated with potential food hazards in communications. In the past, there has been an assumption that not only does the public view uncertainty in a different way to experts, but also that the public does not understand uncertainty, and will not accept it, resulting in uncertainty not being communicated to the public (Frewer et al., 2001). However, there is evidence with respect to BSE that failure to communicate information about uncertainty can have a negative impact on public perception and trust in regulators (Eldridge et al., 1998). Furthermore, the public has had experience of responding to uncertainty with regard to food (e.g. with respect to the 1996 BSE crisis and genetically modified food). Thus, they are aware that uncertainty can exist in food risk information, and that it might be attributable to a variety of causes, including scientific disagreement, or uncertainty about whether the risk will change in the future.

Uncertainty about food safety is viewed one of two ways (Frewer et al., 2001). Most people see uncertainty as being caused by deficiencies in the present state of knowledge, for example through conflicting evidence or incomplete information. Here, uncertainty is viewed as a transitory state, due to a ‘change’ in the status quo (i.e. if new research
becomes available). It is expected that the uncertainty will be resolved over time, as a result of action on the part of the Government. Furthermore, people expect to be informed of any uncertainty as soon as it is identified and of the actions being taken to resolve it. They also want the means to make an informed choice about their exposure to the potentially hazardous food should it still be present in the food chain. Other people believe that uncertainty is due to the suppression or withholding of information from the public by Government, the food industry, or both. In this case, people believe that these sources are knowledgeable about the hazard and its associated risks (in other words, there actually is no uncertainty), but this information is being hidden for some reason. This is related to public concerns about their lack of ability to take informed control of their own actions, which leads to anger towards the source believed to be withholding the information.

Public response to uncertainty in risk messages is dependent on the food safety issues under consideration. For example, when risk regulators communicate uncertainty about the risk to health associated with genetically modified food and pesticides, people are more concerned than when the uncertainty is associated with food safety issues like BSE or Salmonella food poisoning. Such variation is related to differences in perception between these food safety issues. For example BSE and food poisoning are seen to be highly personally controllable. In contrast, people do not believe that they can control their exposure to genetically modified food and pesticides; furthermore, they believe that it is society’s responsibility to protect their health from these potential hazards (Miles and Frewer, 2003). Hazard dependent differential responses to uncertainty about food safety can be further illustrated by considering the real world examples of BSE and genetically modified food. In response to the perceived uncertainty associated with BSE in 1996, a number of different behaviours were observed. For example, some people stopped buying and eating beef, others changed their beef purchasing behaviour in terms of buying less beef or buying what was viewed as better quality beef, some people purchased more beef as a result of the fall in beef prices, and others didn’t change their behaviour at all (Frewer et al., 2001). People were able to undertake these different behaviours because the risk was associated with a clearly identified group of products, and purchase choices were under people’s own
control. Unable to do this with unlabelled genetically modified soy, people would be reliant on regulators to ensure their safety. Thus, if regulators were uncertain themselves about the safety, or if there was uncertainty due to scientific disagreement, or uncertainty about the risk in the future, then this would likely lead to increased risk perceptions and reduced acceptance by the public.

Subsequent to the 1996 BSE crisis Government reports on, and in response to, the BSE Inquiry have recognised the need for more open food risk communication with the public and clear acknowledgement of any scientific uncertainty about the safety of food where it exists. Furthermore, the importance of ensuring that consumers have the information they need to make informed food choice decisions under conditions where there was uncertainty has been acknowledged. The need to identify and communicate any uncertainty associated with food safety is increasingly being recognised, even as it becomes evident that this is what the public wants. Whilst we may yet be unclear as to the best way to communicate this information, or the specific impact it will have on public perception of food safety, this is not an excuse not to inform the public.

**Trust**

As described earlier, public trust in food safety regulation has fallen. Distrust in industry, government and other regulators may have an impact on public response to risk acceptability and risk communications. When evaluating messages they have received, people may consider the context in which the information is presented, as well as, or instead of, the information content itself. Thus, sometimes, people may judge communications purely on the basis of whether or not they trust the communicator. It has been suggested that trust is particularly important when people’s ability to make decisions and take action is limited (e.g. due to lack of knowledge or control over the hazard) (Siegrist, Cvetkovich and Roth, 2000); a situation that characterises technological food issues such as genetically modified food. The public must confer responsibility for control of the application of such
technologies onto regulators. If they do not trust these regulators then they are bound to feel concerned.

However, we should not assume that simply being trusted is enough to ensure effective risk communication and risk acceptance, which would imply that we need to focus all our energies on building trust. There are a number of issues to take into account (Miles, 2002). Firstly, it is necessary to distinguish between trust in the information source and trust in the information itself, as the same information attributed to both a trusted and a distrusted source can be equally well received if it is based on salient, consumer held concerns. It is important to ensure that messages address the issues that are important to consumers. The focus should be on getting the message right. Secondly, trust in a given information source is not static; it can rise and fall over time. Thirdly, there is an expectation that certain sources will provide information about particular topics, and if they do not, this is likely to lead to suspicion. For example, whilst in the UK public trust in Government sources can be low, they are a popular choice for receiving food safety information as people expect to receive information about risks associated with food from the Government. Finally, related to this, there is a distinction between whether an information source is trusted, and how popular it is, in terms of whether people use it to get information. Use of various information sources is affected by the topic being communicated. For example, doctors are a trusted source of information because people believe that doctors will tell them the truth. But they may not be the preferred source of information for some specific potential hazards, for example, genetic modification of food, because people believe that other sources will be more expert and will have more knowledge about the topic. It cannot be assumed that just because an information source is highly trusted to provide information about one topic it will be as trusted for another topic. Those communicating with the public about food safety need to ensure that the various facets of the trust, public perception and hazard acceptability interplay are acknowledged. It is important that the right people are communicating the best information, in the most suitable fashion for the target audience.
**Optimistic bias**

As previously stated, people are rarely given information about their own risk from a potential food hazard. Instead they have access to information about risk to people in general, from which they have to infer their own risk status. This can lead to a difference between people’s perceived personal risk, and their actual risk. Research indicates that people tend to believe they are less likely to experience negative events and more likely to experience positive events, compared to other people. This bias is known as ‘optimistic bias’. Optimistic bias is not found for all hazards. For example, people think that they are less likely to suffer food poisoning than other people, but, they think that they are as likely to suffer from high blood pressure as anyone else (Weinstein, 1987). However, where it does exist optimistic bias can cause problems when the Government or other such organisations try to give the public information about food hazards. People showing optimistic bias may ignore recommendations in risk messages (e.g. not eating undercooked eggs to protect against Salmonella food poisoning), believing that these messages are aimed at people more vulnerable than themselves. They may also fail to take actions to protect themselves (e.g. thoroughly cooking chicken to avoid food poisoning), believing that they are less likely to be affected by a hazard than others. However, if these people really are as likely to suffer negative consequences from a hazard as others, then by not taking appropriate self-protective behaviour they may be putting their health at risk (Miles and Scaife, in press; Miles and Frewer, 2003).

Risk communicators and health promoters need to be aware that the people with whom they are communicating regarding these food related hazards, may believe that they are less at risk than other people and so not attend to the information. Taking optimistic bias into account will make it more likely that those who are at risk from a hazard are made aware of it, know the appropriate precautions, and take these precautions.
Conclusion

Whilst every effort is made to ensure the provision of safe food, the public may encounter risks to their health through their food consumption. However, somewhat regardless of the level of actual risk associated with any potential food hazard, it is important to consider the public’s perception of the risk. Research indicates that public perception of food safety is driven by a number of psychologically determined factors, and it can be influenced by associated issues such as the presence of uncertainty, comparative risk perception and trust in risk regulators and other information sources. To ensure good relations between the public, the food industry and food risk regulators, it is necessary to identify and address the public’s concerns.

Acknowledgements

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References


Consumer versus producer expectations and motivations related to “superior” quality meat in Belgium

VANESSA DEMEY, WIM VERBEKE, XAVIER GELLYNCK AND JACQUES VIAENE

Department of Agricultural Economics
Ghent University, Belgium
Abstract

This study reports findings from an exploratory study on consumer and producer expectations of “superior” quality fresh meat in Belgium. The aim of the study is to investigate how Belgian consumers perceive “superior” quality and to confront the consumer expectations with the producer motivation to supply “superior” quality meat. In the first phase, consumer and producer beliefs, attitude and behaviour towards quality of fresh meat were established. In the second phase consumer motivation to buy “superior” meat and the motivation of producers to engage in the production of “superior” quality meat were investigated. The insights from this exploratory research yield hypotheses about differences in consumer’s and producer’s view on “superior” quality meat. Ultimately, the findings of consumers and producers are to be confronted in order to obtain an integrated vision on “superior” quality meat.

Introduction

Both the supply and demand side of the food chain are continuously in evolution since producers and consumers react to external trends and changes in society. Agricultural producers for instance have to cope with competitively low producer prices, an increasing gap between themselves and the end users of their produce and an image at risk of being damaged by breakdowns wherever in the food chain. Consumers are concerned because of several food safety crises or animal health issues (hormones, BSE, dioxin, foot and mouth disease, avian influenza) and increasingly question the safety and quality of their food (Verbeke, 2001). Quality has become a key word for producers as well as consumers (Vannoppen, 2002). An important note in this respect is that food quality can be defined in a number of ways, depending on who is providing the definition. Whereas producers and processors commonly define quality in technical or technological use attributes (e.g. yield), the wholesale dealer and the retailer may prefer quality definitions based on visual attributes (e.g. size, form, colour). Government officials are involved in regulations concerning health aspects (amount of contaminants). Consumers on their side are interested in many aspects
such as taste, freshness, appearance, nutritional value and food safety (Lassen, 1993; Wandel and Bugge, 1997; Jongen et al., 1999). During the last years consumers also attach increasing importance to the extrinsic quality attributes such as respect for animal welfare and environmentally friendly production (Gale et al., 1999; Bernués et al., 2003). Most of those newly emerging quality attributes are so-called credence attributes, i.e. product characteristics that can neither be directly perceived nor verified by consumers. Instead, people have to put trust in the presence of these attributes, e.g. through confidence in personal communication, labels or controlling organisations.

In this paper the perceived quality approach is chosen and used to investigate consumer and producer expectations towards quality in the specific case of meat. This approach analyses product quality from the viewpoint of the consumer, making quality a subjective assessment dependent on perceptions, needs and goals of individuals (Steenkamp, 1989). The European Commission (2003) defines the prime conditions for food quality as the compliance with legally established standards (food safety, the environment, animal welfare), while other aspects of quality are optional. This leads to the assumption that a distinction can be made between "basic" quality (compliance with legal standards) and "superior" quality (extending quality beyond standards). Hence, in the remainder of this paper, “superior” quality is used to denote quality beyond mandatory legal standards. The objective of this study is to investigate how Belgian consumers perceive such a “superior” quality for meat, and to confront the consumer expectations with the producer perception of “superior” quality.

**Research method**

The data of this study are obtained from qualitative research, i.e. a relatively unstructured, exploratory research methodology based on small samples of both consumers and producers. It provides the fundamental understanding of people’s language, perceptions and values in relation to the subject of investigation (Malhotra, 1999). The findings of qualitative research provide insights in trends, yield research
hypotheses for further quantification, and should hence not be regarded as conclusive.

In the first part of the study focus group discussions were conducted with Belgian consumers. The objective was to explore perceptions of meat quality. Four focus groups were conducted with 8 participants each. All respondents were female and the main responsible person for food purchasing within their household. Consumers were only allowed to participate if they were responsible for shopping for food and consumed fresh meat at least 3 times per week. The group discussions were led by an experienced moderator, based on a discussion guide that listed the issues to be covered. Table 1 shows the composition of the groups.

On producer side the first part of the research consisted out of 12 depth interviews. These interviews were conducted with Belgian livestock producers. The objective was to uncover their beliefs, attitude and feelings towards fresh meat and quality oriented livestock production. Like focus groups (cf. consumer research), depth interviews are an unstructured and indirect way of obtaining information. Unlike focus groups, depth interviews are conducted with individual respondents (Malhotra, 1999). During the interview a topic list served as guide. Farmers were selected for participation when their livestock production system fitted into a "superior" quality initiative. Producer’s characteristics are shown in Table 1.

Table 1 Respondent’s characteristics, phase 1 (exploratory research)

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<thead>
<tr>
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<th>Flanders</th>
<th>Wallonia</th>
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<tr>
<td><strong>Consumer research</strong></td>
<td></td>
<td></td>
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<tr>
<td>Focus groups (n=4)</td>
<td>8 persons - age: &gt; 55 year</td>
<td>8 persons - age: 40-50 year</td>
</tr>
<tr>
<td>Respondents (n=32)</td>
<td>8 persons - age: 25-35 year</td>
<td>8 persons - age: 25-35 year</td>
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<tr>
<td><strong>Producer research</strong></td>
<td></td>
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<tr>
<td>Depth interviews (n=12)</td>
<td>Beef: 1</td>
<td>Beef: 3</td>
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<tr>
<td></td>
<td>Pork: 3</td>
<td>Pork: 1</td>
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<td>Poultry: 2</td>
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The second part of the consumer research was based on the means-end chain theory and the methodology of laddering, i.e. a technique for conducting depth interviews in which a line of questioning proceeds from product characteristics to user characteristics (Malhotra, 1999). This technique allows gaining insight in how product characteristics and their perceptions are linked to consumer values. It uncovers the motivations and argumentation of logics consumers rely on to justify their decision-making (Vannoppen, 2002). Interviews were conducted with 50 Belgian consumers, distributed over different types of "superior" quality initiatives. The consumers were recruited at the different types of shops (e.g. farm or butcher shops selling meat from specific “superior” quality oriented initiatives). For the second part of the producer research, the same technique was used as for the consumer research. Interviews were conducted with 50 Belgian producers, who were selected upon criteria of participation in different types of "superior" quality initiatives.

In the following the main results of the discussions and the interviews will be presented. The general findings are illustrated by using “verbatims”, which are translated from Dutch or French directly from the interviews with either consumers or producers. Although these statements originate from individuals, they have been carefully selected to reflect the different viewpoints that emerged from the discussions or interviews.

**Exploratory research findings**

**Consumer expectation of “superior” quality meat**

Discussions with consumers about food consumption in general and meat eating habits in particular revealed that consumers consider meat by large as a traditional food. It provides lots of energy and is essential as a source of proteins. The negative aspect of meat is its price. Respondents consider meat as one of the more expensive food products, and in many cases even the most expensive bit of their daily dish. The three types of meat that are in the scope of this research (beef, pork and
poultry) are seen as "every day meat", together with veal. Other types of meat are reserved for more festive occasions (ostrich, wild boar, rabbit …).

The research shows that the perception of meat was different in the various age groups. The oldest age group possesses the memory of long gone days, where meat was the centrepiece of every meal. This traditional point of view, including nostalgia of the past, is exemplified by:

"In the old days men came home from a hard day of work and wanted to eat a big steak …"

"When we were younger, if you hadn't had a piece of meat, you hadn't eaten."

Nevertheless, concerns about their personal health (cholesterol, cancer,…) have led to changes in their eating habits. Despite loving meat, these respondents also claimed to eat much more fresh fruit and fresh vegetables as compared to a couple of years ago. In some cases, the daily portion of meat has even been reduced and sometimes has been replaced by fish. But from time to time they still long for the real taste of a good piece of meat:

"A good steak, no sauce, just the meat ..., it can taste so good, but I know it's not healthy."

For the younger consumers meat does not play such a dominant role in their eating habits. Although most of them report eating meat almost every day, they do not perceive it as an essential part of the meal. Lots of dishes are known were meat is only present in small portions (spaghetti, pizza,…) or where meat is completely absent (vegetarian dishes). The younger age groups consider meat as being a rather basic product and do not share the same appreciation for it as noted with the older age group. Convenience is what matters most for the younger consumers. Shopping and cooking have to go fast, since most of them live in households with double income. The following verbatims exemplify this point of view of younger consumers:

"Meat is just meat! What more can I say on the subject?"

"When I come home from work I do not want to spend hours in the kitchen"
While purchasing meat, all age groups base their decision on criteria like price, freshness and appearance. The older consumers buy more traditional pieces of meat like for instance “roast beef” whereas the younger generation chooses more preparations based on minced meat (meat mixtures like “brochette” or hamburger). All age groups judge the quality of meat on sensory characteristics (taste, tenderness, odour). The older group of consumers attaches most, though still relatively limited, importance to the origin of the meat. They link some regions in Belgium with a better way of producing meat and a better end product:

"Meat from the Ardennes tastes better."
"Where I live, you can't find a steak like the ones they serve at the Belgian coast. I know the meat they serve at the coast from my holidays. That meat always tastes better."

The older age group was the only group that seemed to have a good idea on how meat is produced. This was also the only group that is interested in receiving extra information on this topic (way of producing, handling, …). The younger groups have little knowledge on the production of meat and stated not to have time to read any extra information.

Elderly: "My supermarket gives me extra information on leaflets. I take these home, where I read them. If I have additional questions, I ask the butcher of the shop on my next visit."
Young: "Honestly, I haven't got a clue on how my meat is produced and I don't care either."

Based on the focus group discussions, it can be suggested that for the major part of the consumers their interest in quality is limited to the sensory characteristics of the meat. Further investigation of consumer awareness and interest in quality aspects of meat was made through analyses of the motivation of consumers who specifically buy labelled meat, actively search for a butcher who gives extra guarantees, or choose for a short supply chain and buy their meat directly from the primary producer. So for the second part of the research the focus was on consumers who already made an effort to search for "superior” quality meat.
All respondents who decided yet to buy “superior” quality meat agree that the sensory aspects of meat are utmost important. Most of all, people want to enjoy their meal. The distinct hedonic character of meat has yet been demonstrated in previous research (for an overview, see Verbeke, 1999). These aspects are linked with values like "pleasure in life" and "taking care of your family". Some respondents linked this eating quality with the way the meat is produced. 

"Since we all have to eat anyhow, it might as well taste good."
"Eating is one of the pleasures in my life."
"It gives me pleasure to see my family enjoy their meal."
"Meat from a chicken that could run around its whole life has more taste."

Next to the organoleptic quality, one of the major concerns of “superior” quality meat buyers is the perceived effect that food has on their health and that of their family members. Here the values "living a healthy life" and again "taking care of your family" play an important role. By choosing one of the alternatives described above, they try to get some guarantee on the healthiness of the meat.

"One does not know the long term effect that additives (like hormones) can have on our body."
"Health is the most important thing in life, without your health you're lost."

The consumers who buy labelled meat choose to do so, mainly to be reassured that this meat has undergone some kind of control. By doing so they try to achieve the value "security";

"Label stands for the assurance of control."
"I'm looking for meat with a certified clean image."

A label is also linked with better production methods (respect for animal welfare, care for the environment, …). This is mostly the case for organic label buyers. Here values like "protect the environment" and "respect for all living creatures" play an important role.

"I buy labelled food because I want to be sure I get meat that is produced in a proper way, with respect for nature."

In some cases the respondents made a link between the label and the origin of the meat. They stated to prefer meat originating from Belgium,
because they perceive this as being safer. This was connected with the value "security":

"I think at this moment Belgium has very strict rules concerning meat production. Therefore, I prefer buying fresh meat from Belgium."

Consumers who buy their meat in special butcher shops are looking for the same values as described above. They put their trust in the butcher, who gives them guarantees or information about the way meat is produced. Again the value "security" was found as the higher-order objective that is striven for:.

"We trust the organisation behind the shop, they guarantee good production methods."
"I know where my butcher buys his meat; I can show you the grasslands where the cows were grazing."

Logically, other aspects that apply to every butcher shop (good service, presentation of the goods, ...) are also important for consumers to buy at outlets with “superior” quality meat:

"Not only am I sure about the quality, but the service is great as well."

For the group of consumers who buy at the farm gate, direct contact between producer and consumer and their relationship of confidence, are perceived as a sufficient guarantee of “superior” meat quality. Here the value "security" was mostly combined with the value "social contact":

"I buy directly from the farm gate, I know the farmer, I know I'll always get good quality."
"It's important to know the people behind the product."
"I want to know where the meat is coming from."

Aside from the quality aspect, some of the respondents appreciated the price benefit linked with the system of short supply chain (e.g. volume discounts, less intermediaries). This can be associated with the value "economic well being":

"I get my meat cheaper then when I buy it in a shop and it's of better quality. Good deal!"
Producer perception of “superior” quality meat

As could be expected, every producer is convinced that his own production method leads to quality products. The interviews revealed that producers all pay attention to more or less the same production factors to obtain good quality meat. All producers agree on the importance of hygiene and good housing. The meaning attached to some of the other factors differs from one group to the other. All producers acknowledge the importance of the choice of breed. But where one group prefers a fast growing breed, the others defend a slow growing animal. On other factors linked with the breed (age of slaughter, percentage lean meat, …) different opinions also exist. Animal welfare is important for every farmer, but the way in which one integrates this in his production varies a lot. Other criteria are only used by one type of producers like label, point of sale, external control or working with well known partners.

These findings led to a classification of producers in three groups for the second part of the research: production aimed at specific supermarket sales (following supermarket’s prescriptions of quality standards), production following authentic or traditional methods, and production for sales through short market channels. Again the research focused on producers who already are involved in the production of "superior" quality meat.

The farmers from the first group generally choose to produce under a label upon request from their slaughterhouse, backed-up or enforced by a specific retailer. Most of the times the way of producing described by the retailers resemble very much the way of working they are already used to. Subscribing to the label is the logical next step in order to stay in business and guarantee market access:
"We could easily join the label with little adjustments to our way of working."
“Joining the label ensures that my livestock can be sold without delay when it is ready.”
The standardised way of working results in a product of nearly uniform quality. In this way the customer (the supermarket as well as the final consumer) knows what they will get:
"By following the same production standard we can all provide the same quality."

The emphasis is on the production of meat that is lean and tender, with a taste and colour that is appreciated by the consumer. Most of the producers acknowledge the fact that producing leaner meat leads to some loss of taste. In their opinion the consumer does not know the real taste of meat anymore.

"The consumer does not want to see any fat when he's buying meat."

"People do not appreciate a strong meaty taste. It's too powerful for them."

The producers believe that labels are a way of regaining the confidence of the consumer. For the producers themselves a label is an assurance they will be able to sell their products and / or get a better price. These decisions are made to achieve the value "economic well being".

An extra benefit from producing under label is the feedback of slaughter data. After every delivery the producer receives some information on the health status of his animals, which allows him to act accordingly and follow-up his production closely. Combined with the regular controls this entails opportunities for continuous improvement of the production process. These findings were linked with the values "profession satisfaction" and "economic well being":

"It's always good to check from time to time if you're still on the right track."

The production of the farmers in the second group could be categorised as production driven through a concern. The producers voluntarily choose to work in a less intensive production system. They opt for more rustic breeds, with slower growth rate (for example Limousin for cattle, Duroc for pork and Kabir for poultry). As a result the animals are slaughtered at an older age, which has distinct benefits according the producer. A lot of these production systems chose for free range animals. "Respect for animals" is the value that is achieved here.

Preference for authentic, less intensive production systems fit in the motivation to continue ancient traditions of meat production. This is strongly linked with the values "profession satisfaction". The producers are convinced this results in meat with more and better taste:

"Our animals get the time to mature, this results in a different meat."

"It's a whole different philosophy: producing in a traditional way."
"Meat from our animals has a real taste of meat."
"My animals walk around freely, it's more natural."

In most of the cases the meat is commercialised under a label that is often self-established small-scale. In many cases, reference is made to a specific region. The meat from these productions is sold in small butcher shops that work in the same spirit as the producer. Alternatively, this produce can be found as a "produit de terroir" in supermarkets. Some of these farms also have their own point of sale on their premises:
"For me it's important to know that the meat I produce is sold by someone who believes in the same values as I do."

The group that chooses to produce in a short supply chain mostly is motivated by the personal contact between producer and consumer. On the one hand the producer receives appreciation for his work. He knows his clients, which motivates him. Important values are "social contact" and "professional satisfaction". Furthermore, the personal contact allows producers to develop a relationship of respect and trust with the consumer:
"The personal contact makes it all more humane."
"Knowing that your work is appreciated makes it all worthwhile."
"I find it important to communicate the way we work here on this farm."
"The consumer wants to know and see how his meat is produced."
"All doors are open, we have nothing to hide."

The concept of short supply chains provides opportunities to shed a positive light on agriculture. The direct contact between the producer and the consumer opens a window for the producer to educate and interact with the consumer. Besides of selling own products, the contact with consumers is considered as an opportunity to communicate about agriculture in general. The ultimate aim is to bridge part of the current gap between the primary food producer and the end consumer.
"When people visit the farm we receive a lot of positive reactions and valuable feedback."
"Some customers bring their little children to see the animals."
"I take the opportunity to introduce agriculture back into people’s lives."
Conclusions

This paper reports insights from exploratory research focusing on consumer and producer expectations about “superior” quality meat. From these results it can be concluded that although consumers and producers associate “superior” quality meat with different attributes, consequences or values, those who are interested in “superior” quality seem to find each other through the different initiatives. The main limitations of this research are linked to the research methods that are used and more specifically their qualitative nature. As a result, findings are preliminary and can not be generalised to the population. Instead, these insights form the basis for developing hypotheses for further quantitative survey research with large samples of consumers. Another limitation pertains to the fact that this research focused heavily on consumers and producers already engaged in "superior" quality meat. This narrow scope is plausible in exploratory research because these so-called “prime witnesses” have most awareness and knowledge of the topic of debate, and are therefore most valuable as participants in group discussions. Further research, using quantitative methods, will be implemented to further investigate the findings on the existing market of "superior" quality meat. The main hypotheses are that consumers associate “superior” mainly with hedonic and security values, i.e. better perceived taste and more guarantee of safety. Furthermore, older consumers are apparently more interested than younger in “superior” quality meat. Similarly, producers who adhere to livestock production systems aimed at producing “superior” quality meat, refer to taste as a major element of differentiation from classical, other more intensive, production systems. The opportunity to interact directly with consumers is not primarily seen by producers as a means to ensure product safety, though also as a social event that may help improving agriculture’s image with the broader public.

References


Food quality: the African perspective

ISAAC FOKUO DONKOR

Student, Faculty of Agriculture
Kwame Nkrumah University of Science and Technology
Kumasi, Ghana.

Member of Ghana Association of Agriculture Students
(GAAS OF THE IAAS)

Current President of NEWPAD-GHANA FOUNDATION:
a local IT-based NGO in Ghana

Emails: gelaconi@yahoo.com, gelacony@yahoo.com
Abstract

The quality of food is determined primarily by how much consumers expect of it. There is a wide variety of food; and therefore we often are not satisfied with a few kinds of food and seek for a greater variety of flavour, taste and texture. For example in as much as we expect high nutrient values from vegetables, their taste, flavour and palatability in terms of appearance as unique to these vegetables play a central role in their acceptance for consumption by consumers. There is therefore no absolute measure of food quality. Thus, in order to assess it, you have to be selective and subjective and this only comes about when there is sufficiency of food in terms of quantity.

1. Are we sufficient?

1.1 Food Production in Ghana

Agricultural production in Ghana is one of subsistence whereby family entities produce what they can eat and only sell out surpluses. It is highly dependent on the prevailing climatic conditions, available labour, capital and land. About 60 per cent of the Ghanaian working population is involved in agriculture and yet is unable to produce enough to meet the needs of the consuming public. It are women and small farmers working with biodiversity who are the primary food providers in the Third World, and contrary to the dominant assumption, their biodiversity-based small farms are much more productive than industrial monoculture.

The rich diversity and sustainable systems of food production are being destroyed in the name of increasing food production. However, with the destruction of diversity, rich sources of nutrition disappear. When measured in terms of nutrition per acre, and from the biodiversity perspective, the so-called ’high yields’ of industrial agriculture, of industrial foods and fisheries do not imply more production of food and nutrition.
Research done by FAO has shown that small biodiverse farms can produce thousands of times more food than large, industrial monocultures.

The indiscriminate use of artificial fertilisers in production has become the norm in Ghana, gradually but steadily shifting from the hitherto pro-organic method of production, which had impacted positively on the quality of foodstuffs on the market. In sharp contrast our western neighbours who promoted the use of these fertilisers and other agro-chemicals are now going back to the organic methods of farming, free of chemicals.

1.2 Globalisation, food sufficiency and quality

Economic globalisation is leading to a concentration of the seed industry, increased use of pesticides, and finally, increased debt. Capital intensive, corporate controlled agriculture is being spread into regions where peasants are poor but until now have been self-sufficient in food. The industrialisation and genetic engineering of food and globalisation of trade in agriculture are recipes for creating hunger, not for feeding the poor.

Increased economic growth through global commerce is based on pseudo-surpluses. More food is being traded while the poor are consuming less. The globalisation of the food system is destroying the diversity of local food cultures and local food economies. A global monoculture is being forced on people by defining everything that is fresh, local and handmade as a health hazard.

Human hands are being defined as the worst contaminants, and work by human hands is being outlawed, to be replaced by machines and chemicals bought from global corporations. These are not recipes for feeding the world, but stealing livelihoods from the poor to create markets for the powerful.

In the name of globalisation, food quality has become very expensive. Neem, pepper, and turmeric, every aspect of the innovation embodied in our indigenous food and medicinal systems are now being pirated and patented. The knowledge of the poor is being converted into the property of global corporations; creating a situation where the poor will
have to pay for the seeds and medicines they have evolved and have used to meet their own needs for nutrition and health care. In August 1998, small scale local processing of edible oil was banned in India through a ‘packaging order’ which made sale of open oil illegal and required all oil to be packaged in plastic or aluminium. This shut down tiny ‘ghanis’ or cold pressed mills. It destroyed the market for our diverse oilseeds: mustard, linseed, sesame, and groundnut.

1.3 The perception of consumers on food quality

In general, food quality is consciously or unconsciously judged depending on the psychological measure acquired by experience. The psychological measure combined with the proper evaluation of the physical as well as the chemical characteristics of the food; deliver the standards of assessment. However, these psychological measures are subjective and seldom uniform except on occasions where the persons involved share common eating habits.

At the stages of production and distribution of food, its quality is evaluated and its price is determined. When consumers buy food, they will consider whether its price is commensurate with quality. There are basic questions like: is a well-packaged food product necessarily of high quality? Does the pricing co-correlate with the quality? If they conclude the price is reasonable to its quality, the food will gain their support in terms of quality and price. If not, the product will have no consumer support.

Since this is reflected in the sales of foods, distributors attach great importance to consumer attitude. As a result, the opinions of individual consumers on food quality are reflected on its entire assessment. The quality assessment standard is also affected by supply-demand balance, preservation, time and other distribution characteristics, but the quality assessment of consumers is always the most important one.

The food quality assessment standard, which is effective in places where the same diet is shared, may not be practical in areas where there is a different eating habit. Thus, the same kind of food should have different evaluation standards according to districts. Even in the same region, the standard may have to be modified when the food habit changes for some
reasons or other. Food assessment therefore is diverse, unique and subject to change.

2. Food Quality

2.1 What is a quality food?

Food taken by man shares three basic characteristics which border on safety, nutrition and taste. If any of these is absent, it may not be termed as a satisfactory food in evaluating its fundamental elements.

2.2 Safety

Safety is an indispensable element of food. In fact the term food is synonymous with safety. Food cannot and should not be eaten until its safety is fully assured. There is therefore the need for food safety laws to prevent:

1. Food poisoning
2. Food toxicity due to growth of micro-organisms like fungi
3. Future ill effects on health.

The apparent lack of such laws or its enforcement can have devastating consequences. For example in the year 2001, there was a media report of cyanide spillage into the drinking water of inhabitants of a fishing community in the Western Region of Ghana. Due to apparent lack of clear-cut policy on such issues, the government was slow in reacting to solve the problem. Eventually lives were lost from the consumption of fish products from the said river.

In the late nineties, the ‘Ghanaian Chronicle’, a weekly newspaper in Ghana, carried out a report to the effect that “kenkey”, a very popular staple food prepared from maize, contains some amount of aflatoxin as a result of the mode of drying of the maize before processing which promotes mould formation.

This assertion was quickly rebuffed by the Foods and Drugs Boards of the Ghana Standard Board as baseless. The consuming mass whose rights were apparently being fought was ironically even more hostile to the reportage, labelling the editor, Kofi Koomson as a sensationalist.
It was not until late 1999 that Scientists at the Centre for Scientific and Industrial Research and the Grains Board actually confirmed the said report that some sort of official reaction agreed with the said report. Lately the Rotary International has embarked on a massive educational campaign to educate the public on the dangers of consuming contaminated corn.

2.3 Nutrition

This characteristic of food provides us with energy and a balanced diet for activities and keeping a good physical condition. The main biological purpose of eating food is to take up nutrition. Interest in health-improving and functional constituents in connection with the adjustment of physical conditions is emphasised only at time of food sufficiency both in quality and quantity. This is as a result of the development of dietics and fundamental medicine, which classified the physiological functions of food not known in the past. For example the non-digestible constituents of food were considered useless ones that would obstruct the digestion and absorption of nutrients. But it has become clear that a shortage of these substances has a close relationship with occurrence of adult diseases which pose a serious issue in an aging society such as cancers of large intestine and high fat blood.

These fibres are now attracting attention as dietary fibres, which contribute to a healthy food life. Fortunately nature has blessed us with so much nutritional values but blind eye has deliberately been turned to those aspects in pursuance of more advanced search for these values.

Take the case of the much flouted “golden rice” or genetically engineered vitamin A rice as a cure for blindness. It is assumed that without genetic engineering we cannot remove vitamin A deficiency. However, nature gives us abundant and diverse sources of vitamin A. If rice were not polished, rice itself would provide vitamin A. If herbicides were not sprayed on our rice fields, we would have amaranth leaves as delicious and nutritious greens that provide vitamin A.

There again in an attempt to cure blindness with this so-called golden rice using vitamin A, you stand a chance of suffering from hip fracture. In a recent Swedish study, researchers analysed blood samples from 2,047 men for 30 years. Those with the highest levels of vitamin A
(seemingly clear sighted) in their blood were 1.6 times more likely to break a bone than men with moderate levels of the vitamin and hip fractures were 2.5 times more common. The current recommended daily allowance for vitamin A is 700 mg for men and 600 mg for women. Most people will get this from foods that contain the vitamin naturally.

2.5. Promotion of indigenous foods

Such highly nutritious local foods often grow in profusion, ignored by farmers. The leafy plant, Amaranth (Amaranthus hybridus) and Spider herb (Gynandropsis gynandra) have three times the protein and ten times the iron found in the same weight of cabbage. Both also contain beta-carotene, which is converted to vitamin A in the body. Amaranth seeds, leaves and stalks also have high quality protein with essential amino acids. Blacknight shade (Solanum nigrum) has five times the riboflavin of cabbage. Lack of riboflavin, a factor of the Vitamin B complex, can result in stunted growth.

2.6 Taste

Taste is based on our instinctive demand for delicious food, and it is the most important element we expect of food when we take meals everyday. Good taste constitutes the basis of one’s comfortable and healthy dietary life. Food may be safe and nutritious but yet may not be accepted as a good food if it is not appetising. Deliciousness is a psychological element but it is also affected by texture and other physical and chemical factors such as flavour and taste.

2.7 Towards an improved food quality: South-South cooperation

For a long time, staples were regarded as inferior by western nutrition expects: they were foods required simply to provide the bulkier carbohydrate part of a diet, while vitamins and proteins had to be obtained through green vegetables, dairy products, fish and meat.
They contend that a hard working adult – a farmer for example – needs approximately 3,500 kilocalories and 50 grams of protein per day; a one-year-old child needs about 1000 kilocalories and 15 grams of protein per day. Yet these quantities of essential nutrients are missing in the diets of many rural Africans, which are based on staples of grains such as maize, or tubers such as cassava.

Without nutritional supplements, Africa’s staples do not provide adequate protein or micronutrients such as vitamins and iron. Starchy tubers like cassava contain 320 calories per 100g, with only 1.5g of protein, and have little nutritional value when eaten on their own. Yet women often lack the means to buy the vegetables, milk, fruits or eggs that would balance their family’s diet.

An ‘improved diet’ was therefore perceived by planners to be the one in which staples played a lesser part, and higher value foods became more significant. This frequently led to investment in expensive and land intensive schemes to provide these commodities. Their higher prices often meant that only more prosperous urban people could afford them while at the same time they deprived poorer rural people of the best land on which to grow their staples.

The net effect of many of these diet improvement programs has been obesity for an urban elite and a reduced level of nutrition for many of the poor.

It has now been widely recognised however that an increase in the staple diet can in itself address many of the problems of malnutrition facing the world. A balance of traditional staples can provide a nutritious diet with only infrequent additions of green vegetables and high-protein items.

The present reality of inadequacies in the levels of nutrition among the world’s poor has forced those involved in development to focus on staples. A South-South corporation in this regard is therefore of necessity.

3. Integrated Chain Management as a solution for safety problems

Often, the origins of food safety problems can be traced back to contamination or other factors in the early part of the food chain, an area
which until fairly recently has received scant attention from those responsible for food safety. It is important that consumer’s confidence in food supply and quality is restored and maintained, not by public relations exercises but by actually increasing food safety. Consumers should be assured that all food offered for sale is safe for its intended use right from the initial producer through the processor, distributor to the final consumer. By the selection and implementation of appropriate measures, risks associated with food to the public should be well managed. FAO and WHO jointly organised a series of expert consultations on the different components of risk analysis: assessment, management and communication. The risk management recommendations during consultation held in Rome in 1997 have been used as the starting point for the introduction of the risk analysis principles into the codex systems of the FAO and they have also been used by many government agencies in developing food safety risk management at the national level.

4. Food processing and storage

Virtually none of the staples is edible without some form of processing; indeed some are potentially poisonous without proper processing. For example certain types of cassava contain cyanide complexes, which are only broken down through specific ways of processing, and unprocessed sorghum contains significant amounts of tannin. Many beans have a number of undesirable characteristics: some are simply anti-social while others can for example block the absorption of protein through the gut. The processing of staples tends to be very labour intensive, especially primary processing for which women are responsible in most parts of the world including Ghana. Any increase in production therefore can as a matter of fact place great strains on traditional processing activities, which is in very short supply. The solution to this is an introduction of labour-saving changes and satisfactory storage facilities. When introducing these changes, it is important to be very clear that the development of worker’s perception of the need is the same as those of the users.
5. Conclusion

No man can live without food and for that matter safe, nutritious and palatable one as such. Malnutrition, food poisoning and deaths have resulted in the absence of some of these food qualities and it is therefore essential that government, producers, processors, distributor as well as consumers all work assiduously to ensure that the food we eat is of the highest quality. At the end of the day, we are all consumers.

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Some elements of Food Quality: the meaning of ‘Genuine food’ among the Birifor of Ghana.

Joost Dessein

Email: Joost.Dessein@agr.kuleuven.ac.be.

The author is a Bio-Engineer and an Advanced Master and Doctor of Philosophy in Social and Cultural Anthropology. His research is focusing on social and cultural dynamics within farmer communities in Flanders (Belgium) and Northern Ghana. He is affiliated with the Policy Research Centre for Sustainable Agriculture (Katholieke Universiteit Leuven and Universiteit Gent), with the Cultures and Development Program (CADES) of the Katholieke Universiteit Leuven and with the Centre for Intercultural Management and International Communication (CIMIC).
Abstract

Food quality is often interpreted in terms of human health and/or environmental safety. This safety approach is a restriction of the multiple semantic components of ‘good food’ as it is experienced by both producers and consumers. ‘Good food’ is pre-eminently a culturally embedded, multilayered vehicle of meaning that (re)connects the several constituents of the cosmological environment in which consumers and producers act. Proper food quality evaluation should include such aspects of ‘social and cultural well being’.

A case study drawn from a Brifor community in Northern Ghana illustrates the theoretical stands.

1. Introduction

Food quality\(^1\) has become a hot topic in debates about sustainable agriculture world-wide. Inspired by the lasting problem areas of malnourishment (especially in the South) and environmental and health issues (especially in the North), several aspects are usually linked up with the twin concepts of food quality and safety: safety for human health, nutritious value, environmental damage and post harvest possibilities (such as conservation or transportability). When social aspects are included in the concept, they relate to working conditions (healthy environment), terms of employment (prohibition of child labour, social security, relationships between employer and employee, salaries) and fair trade aspects.

The essay at hand argues that this ‘safety and health’ purport withdraws food and food production from the socio-cultural context where it belongs to. Considering food as a mere commodity neglects the cultural meaning of food. If nutritious food (the sum of proteins, carbohydrates, carbohydrates, vitamins, and minerals which are needed for healthy development’ (Oxfam, 2003).

\(^1\) Two common definitions of food quality are given by FAO and Oxfam. ‘Food quality’ is understood as food that is ‘free from food-borne hazards – everything from pesticides and industrial chemicals, through to unwanted bacteria and contaminants’ (FAO, 2003). And ‘food of good quality provides the energy we need to ensure that our bodies work efficiently, and provides the essential protein, carbohydrates, vitamins, and minerals which are needed for healthy development’ (Oxfam, 2003).
vitamins and minerals) feeds the human body, the process of farming, cooking and eating feeds the society. This essay elaborates on the notion of ‘genuine food’ among the Birifor of Northern Ghana. A first paragraph deals with the socio-cultural setting of the Birifor. The second paragraph dilates upon three dimensions that contribute to the specific quality of genuine food. The conclusion at the end touches briefly upon the universal need for a broader definition of food quality.

2. Research context: the Birifor of Northern Ghana

During 25 months between 1996 and 2000, research through participant observation was carried out among the Birifor of the chieftaincy of Wechiao in the Ghanaian Upper West Region. The Birifor live on the either side of the Black Volta within the territories of Ghana and Burkina Faso. They live in compound houses, scattered around to occupy much of the savannah landscape. Each compound house consists of extended families, with an average in the research area of 29 members per compound house. The whole compound is headed by the landlord, who is seen as the house owner. In most cases he is genealogically the most senior elder of the family group. Marriage is virilocal (the wife comes to live in the house of the family of her husband), and the system of descent is bi-lineal (each individual belongs to one of the four major matriclans, and to one of the many patriclans). In counter-distinction with the populations surrounding them who have massively converted to Christianity or to Islam, the Birifor have largely stuck to their traditional religion and belief.

Birifor agricultural practice is principally based on a bush-fallow subsistence farming method. Through the use of the hoe, the Birifor farmer cultivates mainly millet, sorghum and yams. Other crops include beans, groundnuts, rice, maize, tomatoes, onions, and most recently and in small-scale, soybeans, cashew and cotton. The average Birifor farmer holds a good head of cattle, which is mainly used in marriage

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1 For a more differentiated outline, illustrating agriculture in the ‘autochthonous matrix’ versus agriculture in the ‘capitalist matrix’, I refer to earlier publications (Dessein, 2000).
transactions. Besides this, he holds a large number of domestic animals, including sheep, goat, pig and poultry.

Farming is the *raison d’être* of each individual within the Birifor society.\(^3\) Quintessential for the achievement of the status of ‘successful farmer’ (*kworá*) is not the fulfilment of particular requirements in terms of production, neither the reaching of a specific age. Rather such status is the result of accumulated respect, based on the way the individual is able to continuously negotiate his position within his social network (household, relatives, neighbours) and cosmological environment (the ancestors, the Land (*Tè?*) and many other forces) (Dessein, 1999, 2000 and 2002).

### 3. Good food: a multilayered vehicle of meaning

The Birifor idiom *siéma* (literally ‘things to eat’) indicates all kinds of food products, without differentiation for specific categories or qualities. But the products of the *siéma* notion fall apart in two main categories.

On the one hand side, the category *govment siéma* (literally: things to eat, coming from ‘the government’\(^4\)) denominates those food products that are imported into the local society (such as canned tomatoes, bouillon cubes, oranges, bananas, Asian rice, sea-fish, potatoes, salt, beverages, bottled beer and so on) or those crops which have been introduced relatively recently and are now grown by the Birifor farmers themselves (such as tomatoes (since 1966), yam (since 1920), groundnuts (early 20\(^{th}\) century) and others). They are ‘uncultured’ food products: they are only appreciated for the inherent characteristics of the product (such as good or bad taste, high or low nutritious value, easy or

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\(^{3}\) Even somebody who is not a professional farmer (e.g. a teacher) will in a conversation with a stranger identify himself as belonging to the Birifor, ‘who are strong farmers’. Compare to the neighbouring Wala, who will identify themselves as traders, even though the individual might not be a trader himself.

\(^{4}\) ‘The government’ stands for all kinds of foreign instances such as agricultural government services, but also NGOs, and in general all strangers.
difficult storage) and/or the exchange value of the product (cost price at local market). As such they might be considered as mere commodities.

On the other hand we find food products that are above all appreciated for the way they are culturally embedded. The notion *tengkora bomboro* (literally: crops from the old land, i.e. from the ‘land of the ancestors’) can be interpreted as ‘genuine food’. Sorghum, millet, maize, beans, okra and pumpkin are the main examples of genuine crops. In contradistinction to the uncultured food, genuine food is the result of and contributes to the way the Birifor society continuously reshapes and redefines its position within a larger social and cosmological environment. As such genuine food is a multi-layered vehicle of meaning. This regeneration of the social and cosmological environment through the production and consumption of food happens basically in three dimensions:

3.1 A first dimension entails the **weaving of the social texture** through the cultivation of genuine food crops. Three main components bind the Birifor society together. *Kinship* relations are based on marriage or on descent through consanguinity. They create bonds within and between households, matriclans and patriclans. Relations of *vicinity* originate from the belonging to a common cult area of the Land. People living in the same cult area share the responsibility for the continuity of the relationship between themselves and the Land. *Authority* is the third structuring component of Birifor society. Authority is acquired through seniority (ultimately leading to the position of the landlord), through inheritance of specific positions (as is the case for the land-priest, the chief or the blacksmith) or through the obtaining of a particular status because of specific skills (as is the case for midwives, rainmakers or diviners). The correct attitude of an individual vis-à-vis kinship, vicinity and authority is concentrated in the Birifor notion *gurma*, which combines aspects of respect, gratitude, awe and fidelity. While the

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1 The Land points to the physical, territorial extent of the surface of the earth, as well as to the cosmological field of force; two meanings that are inseparable in the cosmology of the Birifor. Fertility is central in the cult of the Land, and the domains in which the Land acts to protect, favour or sanction are all interrelated with the fertility of man, animal or land. The Land is divided in a number of cult areas. In each cult area a land priest mediates the relationship between the community and the Land.
cultivation of uncultured food crops happens on the initiative of an individual farmer who does not have any obligation towards the society as far as the modalities of the cultivation or the relationships with others are concerned, the cultivation of the genuine crops occurs through more or less streamlined processes of co-operation. This co-operation contributes to the fulfilment of the required *gurma* towards those persons who have a relation of kinship, vicinity or authority with the participants of the co-operation.

The co-operation is realised in different ways. *Gurma* towards kinship relations requires the co-operation between household members to cultivate the communal fields of the own household or the fields of the in-laws of the household members. Vicinity leads to the formation of a farmer group (composed of farmers who live within the same cult area of the Land) that goes round to work each member’s fields by turns. In this it is essential that each household of the cult area has at least one representative in the farmer group. Authority leads to the voluntary commitment of (mostly young) farmers to work the farms of the village chief or any other persons endowed with a higher position in terms of authority.

3.2 Genuine food serves as a **link between producers and consumers**, **providing them with an own identity towards each other**. Within the Birifor household, the groups that farm together are agnatic, with a (grand)father and his sons (and grandsons) as the basic unit. Consumption on the other hand is matrilineally structured: centred around a mother, her children and husband (see figure 1). In Birifor society, two ways of connecting producers and consumers are possible.
1. **left**: A simplified Birifor household composed of a husband, his wives and their sons. (Husband A is married to wife B. They have two sons (C and D). The dotted line demarcates the consumption groups. The husband belongs to both consumption groups (not indicated). The full line marks off the production unit, with a husband and his sons as members. Grey symbols indicate living household members; white symbols stand for deceased household members, belonging to the lineage. **Right**: clarification to interpret the left figure.

**Primo**, the transformation of unprocessed food crops into edible food through processes of harvesting, bringing home, drying, storing, sharing, grinding and cooking (and eventually fermenting in the case of brewing) coincides with a handing over of the food from the producer groups (symbolised in the father figure and the patrilineage) to the consumer groups (symbolised in the mother figure and her matrilineage). As distinct from uncultured crops, a series of rituals marks the significance of the transformation of a harvested ‘genuine’ food crop into nutritious food. Through the mediation of cosmological forces (such as the ancestors and the Land) the mutual dependency of producers and consumers, the necessary reciprocity in their relationship, and the appreciation for each other’s role are repeatedly confirmed.
Secundo, at times part of the genuine food crops is sold on local markets, be it for intra-community self-sufficiency or for interregional trade. This transaction is only possible once the above-mentioned series of rituals has been executed, i.e. when the crops have been turned (at least symbolically) into food. The money obtained in the transaction, is strictly predestined to feed the own household through the obligatory purchase of other food (prohibiting the acquisition of for instance clothing, or any other mere commodity). In other words, the unknown consumer (especially in the case of the selling to professional traders) is replaced by the own consumer group, which is (after an intermediary stage of selling and purchasing) linked to the producers of the house.

3.3 The production of genuine food is based upon autochthonous knowledge practices that create continuity with past and future generations. The notion ‘autochthonous’ points at the ‘inseparability from a particular place in the sense of embeddedness in a particular labour process’ (Kloppenburg, 1991: 537, italics in original). The notion ‘knowledge-practices’ is derived from the French expression ‘le savoir-faire’ (Lacroix, 1981: 95). It is knowledge generated in and through labour as a dynamic process. Knowledge, the labour process and those involved in it compose a unity hard to unravel into separate elements (van der Ploeg, 1993: 209). ‘Le savoir-faire’ stands for ‘situated practices’ (Hobart, 1993: 4) or ‘performances’ (Richards, 1989, 1993). The decisions taken in the (production) process lead to new experiences and skills and the possible uses of these new experiences and skills are limited by and intimately linked with the context in which the actions occur. As such there is a mutual dependence between experience, knowledge, context and action. The intimacy between the actor, the actions, the equipments and the used inputs blurs the line between subject and object. Metaphors used to describe all kinds of agricultural aspects create a ‘network of meaning’ in which each knot allows links with other contexts. For instance the use of metaphors as sweetness versus bitterness (kpāār versus tuo) to characterise the harvest of sorghum refers to the quality and the quantity of the grains, but is also a measure for the degree of satisfaction of the ancestors for the way the farmer has dealt with the land and the crop.
The autochthonous knowledge practices are passed on from generation to generation. As such the farmer belongs to a web of intergenerational collectivity. Important aspects of this continuity are the continual use of own harvest as sowing-seeds, and the transfer of the hoe from father to son. At the same time the agency of the farmer will continuously reshape ‘the way the ancestors use to farm’ to new circumstances, influences, experiences and insights. Investing on both aspects leads him to the desired status of excellent farmer (kworá, cf. supra) and strengthens the fame of the house, the lineage and the society as a whole. The ‘genuine food crops’ embody this dynamic continuity.

Cartesian ‘science’ on the contrary has as its main objective the creation of knowledge in the absence of situational circumstances. The laboratory serves as the ultimate concretisation of this objective. This ‘exogenous’ knowledge is then applied to a specific situation that often requires the adaptation of the environment to the de-contextualised knowledge. An example in point is the cultivation of tomatoes in irrigated gardens. An exogenous knowledge owner (the Ghanaian Ministry of Food and Agriculture) could only introduce the crop as well as the required knowledge and skills after the construction of dams (in the 1960s) that opened up the possibility of adapting the environment through irrigation. Cotton serves as another illustration. In order to obtain a harvest of ‘good quality’, the extension agent of the cotton company (the ‘scientific expert’) guides the farmer through the cultivation process, giving him strict guidelines concerning timing (dates of sowing, spraying or harvesting), techniques to be used, or adaptation of the environment to the requirements of the crop (such as use of pesticides or fertilisers). The cultivation of uncultured crops among the Birifor is not based on the collectivity of autochthonous knowledge practices or an intergenerational continuity. The engagement of the farmer in the cultivation of these uncultured crops is but the result of his individual initiative and motivation.

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*Recently Ghana Seed Growers’ Association made high yielding varieties for most of the ‘genuine crops’ (sorghum, millet, beans, maize) available. Despite the formal explanations (high cost, poor distribution channels), the rupture in the continuous cycle of seed-harvest-seed might elucidate the aversion of the Birifor farmers to accept these high yielding varieties.*
4. Conclusion

The weaving of the social texture, the link between production and consumption within a wider cosmology and the continuity with past and future generations through the use of autochthonous knowledge practices, are the three main dimensions that determine the specific quality of ‘genuine food’ among the Birifor. Neglecting these dimensions (for instance through individual cultivation, the use of high yielding varieties, commoditisation, or the cultivation of uncultured crops) does not lead to a degraded food product in terms of nutritious value or environmental damage. But the detachment of the socio-cultural embeddedness makes it impoverished for the Birifor, resulting in a lower ‘food quality’.

Although the description of ‘good food quality’ through the notion of genuine food is culture specific, the underlying rationale is widely applicable for most of the societies all over the globe: the production of food through agriculture is pre-eminently a relational activity that (re)connects the different actors of the society and eventually the constituents of the wider cosmological environment⁷. As such agriculture is not only about production of food, but also about production and regeneration of society and culture. Therefore the anxiety for good food quality should not only be inspired by the urge for healthy bodies, but also by the desire for a healthy society. The evaluation of the quality of food should take these considerations into account.

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⁷ As is the case among the Birifor where genuine agriculture is only possible when reciprocal relations with the Land and the ancestors are established.
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Assessment of food quality in North and South with respect to the health and development of childhood

VINCENT TH. RAMAEKERS, M.D. PH.D.

Division of Paediatric Neurology
University Hospital Aachen, Germany

Email: vramaekers@ukaachen.de
Abstract

Food quality assessment with respect to the child’s health and development can be best derived from long-term observations and epidemiological data on specific health problems encountered in various parts of the world. The nutritional requirements for water, calories, proteins, carbohydrates, fats, minerals, vitamins and trace elements vary according to the child’s age and have been well defined by different health organisations. All over the world breast feeding is still advocated to be the method of choice to safeguard healthy development of babies and young children, but the mother’s health and nutritional status are prerequisites to guarantee optimal quality of human milk.

Although in the South, food and water shortage due to famine, war and environmental hazards poses a major concern, the increasing frequency of overfeeding with junk food of low nutritional value in the North endangers the health of children, resulting in obesity, diabetes and cardiovascular diseases at a young age. This paper includes some general aspects of factors influencing food quality and its relation to the child’s health with special emphasis on the nervous system.

Introduction

The definition of optimal food quality is related to its nutritional value and its lack of contamination by chemical compounds that cause a health risk to the child. The nutritional value of food can be best estimated from the growth charts of babies and children, their health and resistance against infectious diseases as well as their neurological development. However, the long-term effects of various food regimes during childhood with respect to the risk of later occurrence of obesity, cardiovascular diseases and diabetes have only gained interest during the last decades. Here the individual’s genetic constitution may play an important role like hereditary disorders of fat metabolism (hypercholesterolemia) or coagulation (thrombophilic disorders) and genetically determined higher risks running in families to develop obesity, diabetes and neurological diseases. It is the interaction between nature and nurture or in other words the individual’s genetic make-up
(nature) and his environment (nurture), composed of the quality of dietary factors, educational and psycho-social influences, which ultimately determines the well-being and health of each child and person. Although we cannot change the child’s genetic constellation, we can diagnose certain risk factors (like familial hypercholesterolemia) at an early age and take preventive measures (diet, medication) to minimise long term risks of cardiovascular diseases. Here a well controlled diet with optimal quality food has to be adapted to each individual’s special requirements.

This paper will outline the major problems encountered in North and South with respect to food quality. It is not in the scope of this short overview to provide a complete list but only to focus on different trends and aspects of food quality in various parts of the world.

**Definition of nutritional requirements.**

The individual's nutritional requirements vary according to age and have to meet the basic goals of satisfactory growth and the avoidance of deficiency states. The age-dependent quantities of water, calories, proteins, carbohydrates, fats, minerals, vitamins and trace elements can be found in various publications and text books (Behrman RE, 1992). Breast feeding continues to be the most appropriate means of feeding infants because human milk is uniquely adapted to the needs of the baby, is readily available at a proper temperature, is fresh and free of contaminating bacteria and contains a means of passive immunisation through transmission of high concentrations of secretory IgA antibodies against viral and bacterial micro-organisms. The latter IgA antibodies prevent micro-organisms from adhering to the intestinal mucosa. No infant milk formula has been developed which can imitate the quality of human milk. However, the breast feeding mother must be healthy, the mother’s milk supply should be ample and her diet must contain sufficient quantities of protein and vitamins.

The development and production of milk formulas has improved significantly the last decade and is still in full evolution to ameliorate its full range of essential components.
Our own analysis of the content of the trace element selenium in human milk of breast-fed babies and in samples from milk formulas of various European companies has shown absence or serious deficiency of selenium. One breast-fed child suffered from selenium and vitamin \( \text{B} \)\( \text{B} \) deficiencies as a consequence of insufficient supply of selenium due to the fact that his mother was on her own ill-composed vegetarian diet, which does not always contain enough iron, selenium and vitamin \( \text{B} \)\( \text{B} \). Some baby milk formulas lack on their label the indication of selenium content and were indeed found to contain very low values or no selenium at all. Clinical examination of these babies with selenium deficiency demonstrated liver function disturbances, delay of motoric development, muscle weakness and even seizures. This example supports the importance of maintaining sufficient selenium quantities in breast-fed or bottle-fed infants and children.

**Environmental contamination and poisoning of foods**

A good example of the catastrophic effect of exposure to methyl mercury in utero, is the Minimata Bay disaster in Japan, when mothers ingested fish from water contaminated by methyl mercury. Other similar disasters have been reported from Iraq where mothers had eaten bread made from methyl mercury treated seed grains, or from New Mexico where meat had been contaminated as the animals had been reared on methyl mercury contaminated seed grains. The levels of methyl mercury in the foetus and young infants who received additional mercury through breast milk, tended to be higher than maternal levels. The methyl mercury readily crosses the placenta and the blood brain barrier and causes severe neurological disease due to irreversible brain damage with microcephaly, deafness, blindness and muscle hypotonia (Harada Y, 1968).

**Deficiencies of food components**

The effect of foetal iodine deficiency due to severe maternal iodine deficiency (intake less than 20 µg per day) during the first half of gestation was first reported in Europe from the Alpine regions but still exists in certain mountainous areas in the world. The so-called endemic
cretinism is a clinical picture of goitre with signs of hypothyroidism due to a iodine deficiency state with consequent failure to produce thyroid hormone. In addition these children show severe mental deficiency, spastic diplegia, neurogenic deafness and strabism with nystagmus. The cause is iodine deficiency in the diet and administration of iodised oil, salt or bread during pregnancy can totally prevent this disorder (Hetzel 1979).

Deficiencies of proteins, calories, minerals and vitamins are encountered in many countries over the world and there are numerous examples where famine and wars put whole populations at risk. Diseases like marasmus and kwashiorkor are affecting still too many children in our world.

In certain endemic areas specific deficiencies occur like for example selenium deficiency in Siberia causing Kashin-Beck disease, a severe osteoarthropathy with skeletal deformities. In the Yang province in China, a so-called Keshan cardiomyopathy occurs and has been associated with selenium deficiency states. However, in an urban and suburban area like Aachen, many children with selenium deficiency have been diagnosed and treated at our hospital. Among the population of prematurely born babies on our Neonatal Intensive Care Unit, many babies have been found to have selenium deficiency. The origin was possibly selenium depletion among their mothers, but could also have been the result of abdominal surgery for necrotising enterocolitis or volvulus of the jejuno-ileal intestine. The removal of necrotised jejuno-ileal parts of the intestine markedly diminishes the absorptive capacity for selenium and certain vitamins. The clinical picture associated with severe selenium deficiency in the neonatal period and thereafter manifests as a combination of poor growth, microcephaly, liver function disturbances, neurodevelopmental delay with hypotonia and sometimes seizures.

A preliminary study on the effect of selenium deficiency as a possible trigger of seizures in children suffering from epilepsy, confirmed that selenium deficiency was present amongst the group of children suffering from intractable seizures which were unresponsive to anticonvulsant drugs (Ramaekers, 1994). The children with epilepsy who responded to anticonvulsant drugs were found to have normal selenium values. Correction of selenium depletion in the children with
intractable epilepsy made them responsive again to the anticonvulsant
drugs and led to far better control with more than 75% reduction of
attacks. The origin of selenium deficiency among the children with
intractable epilepsy had multiple causes like vegetarian diet,
overconsumption of junk food, concomitant intestinal diseases,
neurological swallowing disturbances with limited intake of purified or
liquid foods, gavage feeding and sometimes unknown causes of possible
genetic origin of selenoprotein P deficiency. Therefore, the search for
possible dietary errors and consumption of poor quality food should be
stimulated among paediatric neurologists. Here the child neurologist
should step down from the hyperexcitable brain to the basic logics of
dietary habits and identification of poor food quality. Even measuring
selenium content in baby milk formulas should be considered to check
for its content among children with intractable epilepsy.

**Junk food**

What is junk food? Junk food is a slang word for foods with limited
nutritional value. This would include foods that are high in salt, sugar,
fat or calories and have a low nutrient content. Salted snack foods,
candy, gum, most sweet desserts, fried fast food and carbonated
beverages are some examples of the major junk foods. Generally, they
offer little in terms of protein, vitamins or minerals and contain lots of
calories from sugar or fat. The term ‘empty calories’ reflects the lack of
nutrients. There is a growing tendency to compensate for the possible
lack of vitamins due to the junk food feeding habits by additional intake
of multi-vitamin preparations. However, unlimited intake of these
vitamins is not without risk, since some lipid-soluble vitamin overdoses
(for example vitamin A and D) are known to cause neurological
disorders like headaches and increased intracranial pressure
(pseudotumor cerebri).

Therefore, limitation of these junk foods for children is necessary in
advising parents during their visits to the paediatrician. The tendency to
overconsume junk foods in Western Europe and the US begins to lead
to a dramatic increase of obesity, non-insulin dependent diabetes and
coronary heart disease (Goran, 2003).
As the junk food problem is now beginning to show its long-term dangers of disease in adults, the next era of introduction of genetically manipulated foods has already started. Full information on the manipulated genes in basic food products is a basic right which should be made available to nutritional experts, doctors and the public in order to judge whether these products are safe and do not pose a new short or long term health threat to the consumers. If the manufacturers claim that their product is of good quality, they have to prove it with data and facts and not try to hide any information.

References


PART IV

FOOD QUALITY AND FOOD POLICY
Government action to achieve food security and food safety

Per Pinstrup-Andersen

H.E. Babcock Professor of Food Nutrition, and Public Policy at Cornell University, New York, USA

Professor of Development Economics
Royal Veterinary. and Agricultural. University, Copenhagen, Denmark
Global food supplies are sufficient to meet calorie requirements of all people, if the food were distributed according to needs. Per capita food supplies are projected to increase further over the next 20 years (Rosegrant et al. 2001a, 2001b). Thus, the world food problem now and in the foreseeable future is not one of global shortage. Instead, the world is currently facing three main food-related challenges: widespread hunger and malnutrition, mismanagement of natural resources in food production, and increasing food safety concerns.

The major food-related challenge facing the world is to assure that everyone has access to sufficient food to live a healthy and productive life. Elimination of food insecurity, hunger and malnutrition in a manner consistent with an ecologically sustainable management of natural resources is of critical importance.

The failure of about 800 million people to meet food needs is a reflection of widespread poverty, which in turn is associated with a very skewed and deteriorating relative income distribution.

Although some progress has been made during the last 20 years, the future is not bright. At the World Food Summit in 1996, high-level policymakers from more than 180 countries agreed to the goal of reducing the number of food insecure people by half to 400 million between 1990 and 2015. At the follow-up World Food Summit last year, high-level policymakers from the same countries reaffirmed the goal. Unfortunately, action does not seem to follow rhetoric. During the 1990s, less than one third of the countries managed to reduce the number of food insecure people while one half of the countries experienced an increase.

While rapidly increasing yields per unit of land in large parts of East and Southeast Asia, United States, and parts of Europe, reduced the expansion of agriculture into new lands and thus had positive effects on biodiversity, wildlife, soils, and forests; it also introduced large quantities of chemical pesticides and caused water and soil degradation. In many other areas, including most of Sub Saharan Africa, stagnating yields combined with rapid population growth forced farmers into new lands poorly suited for agriculture, causing deforestation and land degradation. The challenge confronting us is to continue the expansion of food production to meet future demand without negative effects on the environment.
The third challenge, assuring safe food, is of most relevance for this volume and will be given more attention here than the other two. While population growth, increasing urbanisation and changes in prices and household incomes continue to be the principle driving forces behind changes in food demand in developing countries, other factors are taking on increasing importance among the non-poor in both developing and industrialised countries. The most important of these are increasing concerns about food safety and the related increases in the demand for organically produced food, identity preservation, natural foods, and the increasing desire to consume locally produced food.

Within the context of increasing globalisation, one of the policy questions deserving additional analysis relates to food safety concerns as a function of income level. Poor people are frequently facing a trade-off between food safety and food security in the sense that higher levels of food safety are likely to be translated into higher prices and therefore lower real purchasing power among the poor. When these trade-offs occur at a level above the most basic requirements for food safety, one of the globalisation related policy questions is whether different standards are compatible with globalisation and if not, who sets the standard. A related policy question is whether very high levels of food safety standards in industrialised countries are in fact being used as non-tariff barriers towards developing countries who wish to export but who cannot meet the high standards. Another interesting policy question, which deserves analysis, is whether identity preservation and the desire for locally produced food will conflict with trade liberalisation and thus at least implicitly discriminate against food exporting developing countries.

In addition to food safety concerns, the rapid increase in the demand for organically produced food is driven by a consumer perception that organically produced food is healthier or more nutritious and that organic agriculture is sustainable whereas other agriculture is not. While lower levels of pesticide residues, synthetic hormones, and antibiotics may make organic food healthier, there is no evidence of positive nutrition effects. Identifying organic agriculture as the only production system that uses natural resources sustainably is misleading and can lead to policy decisions with adverse effects on agriculture, the environment, and consumers. More policy research is urgently needed to inform the debate and decision-making on the extent to which non-
organic agriculture is sustainable and whether subsidies to promote organic agriculture can, in fact, be justified on environmental or health grounds.

Another aspect of the change in consumer behaviour relates to the impact of globalisation, particularly trade liberalisation on relative consumer prices and promotion of specific kinds of foods. As developing countries open their markets for imported food, there is a tendency for highly processed food with high sugar and fat content to be more readily available at lower prices. With the support of strong advertisement and other promotional campaigns, these changes are likely to result in a reduction in the consumption of staple foods with high fibre content leading to increasing risks of obesity and chronic diseases. Where these developments are likely to occur, policies are needed to counter negative health effects.

**Driving forces and related government action**

To deal effectively with these three challenges, the design and implementation of food and agricultural policies for the future should pay particular attention to seven driving forces. They are:

1. Increasing globalisation;
2. Technological change;
3. Degradation of natural resources and increasing water scarcity;
4. Emerging and re-emerging health crises;
5. Rapid urbanisation;
6. National and international instability and conflict; and
7. Changing roles and responsibilities of key actors

In the following, each of these driving forces will be briefly discussed along with the associated government action I believe will be needed to achieve sustainable food security for all.

**Increasing Globalisation**

Globalisation has benefited hundreds of millions of people but many others have been made worse off (Stiglitz 2002). Effective food and
agricultural policy and institutions are needed to complement and guide
globalisation to achieve sustainable food security.
It is of critical importance that the industrialised countries phase out
trade-distorting agricultural policies including those providing subsidies
based on quantity produced or acreage used. Industrialised countries
have repeatedly committed themselves to open their markets for exports
from the world’s poorest countries (Oxfam 2002). However, very little
progress has been made.
In addition to high tariffs, OECD countries impose a variety of non-
tariff barriers, including food safety and sanitary levels that few
developing countries can meet. Tariff and non-tariff barriers for
commodities and products from developing countries such as foods and
textiles should be gradually eliminated along with subsidised exports
and non-emergency related food aid. It is particularly critical that tariff
escalation related to the degree of processing of agricultural
commodities be phased out as soon as possible. Tariff escalations are in
stark contrast to efforts by development assistance agencies and national
governments of developing countries to promote employment-
generating value-adding processing of agricultural commodities as a
tool for development and poverty reduction.
In the case of developing countries, investments in public goods and
institutions to promote effective and efficient private markets, rural
infrastructure, credit and savings institutions, primary education,
primary health care, and publicly funded agricultural research to
generate knowledge and technology for the smallholder farming
community are essential to facilitate economic growth and poverty
alleviation and to reap the benefits from trade liberalisation and other
aspects of globalisation. Policies and institutions are needed to facilitate
access by women to land and purchased inputs (IFPRI 2000). The de
facto importance of women in agriculture should be recognised by
eliminating discriminatory policies and practices in land tenure and
access to credit, inputs, technology, extension, and education.
Underinvestment by developing country governments in agricultural
research is another serious bottleneck to productivity increases and
competitiveness. Developing countries invest 0.6 percent of the value of
agricultural output on research compared to 2.6 percent in industrialised
countries if only public funding is considered (Pardey and Beintema,
If private research funding is added, the difference becomes much larger.

**Technological Change**

Rapid scientific and technological developments in molecular biology, information, communication, and energy are placing new demands on government policy to guide the design and utilisation of these new scientific and technological opportunities for the benefit of farmers, consumers, and natural resources, while managing new risks and uncertainties. The impact of the new technology on both poor and non-poor people and their food security will to a very large extent depend on accompanying policies (Pinstrup-Andersen and Schiøler, 2000; Pinstrup-Andersen, 2001). Currently, action by governments, the for-profit private sector and civil society tends to be excessively influenced by ideology and unsubstantiated claims about risks and opportunities. Lack of appropriate facilitating and regulatory policies and related low levels of public investment in public goods creating research is a major reason why potential benefits from the new technology are not reaching low-income people in developing countries.

Much of the technology needed by smallholders is of the public goods nature and unlikely to be produced by the private sector. There is an urgent need for substantial increases in public funding of agriculture research for smallholder farming in developing countries. Research aimed at bio fortification, e.g. improving the nutritional value of staple foods, offers a particularly exciting opportunity for reducing micronutrient deficiencies. Policies and new institutions are urgently needed on intellectual property rights questions, bio safety and food safety regulations, facilitation of markets for improved seed, solar panels, cell phones and other information and communication technologies and a variety of facilitation and regulatory policy issues.

**Degradation of Natural Resources and Increasing Water Scarcity**

Failure to achieve yield increases on land that is well suited for agricultural cultivation has pushed farmers into areas less suited for
agriculture, causing deforestation, land degradation and unsustainable exploitation of surface and ground water. On the other hand, efforts to expand yields have frequently been based on excessive and inappropriate use of fertilisers and pesticides, which in turn damaged the environment. The challenge for policymakers is to put in place institutions and incentives that will guide farmers towards productivity increases that will be compatible with sustainable management of natural resources.

Concerns are growing about the extent and rate of soil degradation in the world and its effects on agricultural productivity and preservation of natural resources, including biodiversity. Overgrazing, soil mining for nutrients, deforestation, and inappropriate agricultural practices account for most of the degradation. These problems often result from inadequate property rights, poverty, population pressure, inappropriate government policies, and lack of access to markets, credit, and technologies appropriate for sustainable agricultural development.

Competition for water is becoming more acute, increasing the potential for conflicts between sectors and water wars between countries. Efficiency of water use in agriculture, industry, and urban areas is generally low. Degradation of land and water resources through water logging, salination, and ground water mining are mounting while excessive use of water in some locations causes lack of access to water elsewhere (Rosegrant, Cai, and Cline, 2002). In many locations, water is still treated as a free good with little or no clearly defined property and user rights.

Policy reforms are needed to provide secure water rights vested in individuals or groups of water users that increase incentives for investment, improve water use efficiency, reduce the degradation of the environment, and encourage flexibility in resource allocation. Irrigation infrastructure and management should be turned over to water user associations where well-defined water rights provide incentives for user groups to economise on water use. Governments should reform distorted price incentives and reduce or remove subsidies on water to prevent overuse or misuse (Meinzen-Dick and Rosegrant, 2001).

Much of the current debate about agriculture and the environment is based on the implicit or explicit premise that productivity increases in
agriculture must necessarily harm the environment. This is a false premise. In fact, when productivity fails to increase, the resulting poverty and struggle for survival are much more likely to result in negative environmental effects. Improved production methods and appropriate use of inputs and technology can boost productivity in ways that benefit the environment whether in developing or industrialised countries. The challenge is to help farmers design and implement such win-win solutions.

**Rapid Changes in Consumer Behaviour**

While population growth, increasing urbanisation and changes in prices and household incomes continue to be the principle driving forces behind changes in food demand in developing countries, other factors are taking on increasing importance among the non-poor in both developing and industrialised countries. The most important of these are increasing concerns about food safety and the related increases in the demand for organically produced food, identity preservation, natural foods, and the increasing desire to consume locally produced food. European and to a lesser extent American consumers are complementing their market power with the exercise of power over the regulatory and other policy processes. Nowhere is this more obvious than in the case of the European consumer reaction to genetically modified food. These changes in consumer behaviour raise a number of policy issues.

Within the context of increasing globalisation, one of the policy questions deserving additional analysis relates to food safety concerns as a function of income level. While food safety problems are more severe among the poor in developing countries, one of the ironies of the recent developments is that high-income people in industrialised countries express much more concern about food safety than the poor in developing countries. Poor people are frequently facing a trade-off between food safety and food security in the sense that higher levels of food safety are likely to be translated into higher prices and therefore lower real purchasing power among the poor who frequently spend 50 to 80 percent of their income on food. When these trade-offs occur at a level above the most basic requirements for food safety, one of the
globalisation-related policy questions is whether different standards are compatible with globalisation and if not, who sets the standard. A related policy question is whether very high levels of food safety standards in industrialised countries are in fact being used as non-tariff barriers towards developing countries who wish to export but who cannot meet the high standards.

**Emerging and Re-emerging Health and Nutrition Crises**

The tragic pandemic of HIV/AIDS, the persisting threats from malaria, the re-emergence of tuberculosis, the widespread prevalence of micronutrient deficiencies and the epidemic expansion of overweight and obesity causing a variety of chronic diseases compromise food and nutrition security in both developed and developing countries (Flores and Gillespie 2001). In addition to the welfare effects on those affected, the global health crisis contributes to rising health care costs, labour shortages, and declining asset bases. Labour scarcity and low productivity among people affected by HIV/AIDS along with the disintegration of both rural and urban households call for very different food and agricultural policies and agricultural research priorities with focus on labour saving rather than labour using technologies and food safety nets for displaced individuals as well as affected households (Piot and Pinstrup-Andersen, 2002; Gillespie and Haddad, 2002).

Innovative policy research and interventions are urgently needed to slow down and reverse the strong trend of increasing overweight and obesity. Such interventions should focus on changing consumer behaviour through the dissemination of information, price incentives, and peer pressures similar to those used to reduce smoking. Research to alter the composition and tastes of food along with regulation of corporate behaviour on advertising and promotion should also be pursued.

**Rapid Urbanisation**

During the next 20 years, the urban population of developing countries will double while the rural population will increase by only 4 percent. In 1975, about a quarter of the population of the developing countries resided in urban areas; by 2015, it will have increased to one half
This rapid urbanisation will present new challenges to providing employment, education, health care and food in urban areas. Poverty and malnutrition are increasing at a faster rate in urban than in rural areas (Ruel, Haddad, and Garrett, 1999). Policies and programs are needed to reduce the cost of food to urban consumers and create income-generating opportunities for them, provide low-cost efficient safety nets and stimulate the generation of social capital, provide acceptable and affordable childcare substitutes, ensure the safety of prepared and processed foods sold in the streets, improve primary health care, water, and sanitation services, and enforce property rights for low-income urban people (Ruel, Haddad, and Garrett, 1999). Government intervention may also be needed to counter dietary changes towards excessive sugar, oils, and fats resulting from more severe time constraints, greater exposure to advertising, and easier access to fast-food and processed foods (Garrett, 2001).

**National and International Instability and Conflict**

Armed conflicts continue to cause severe human misery in a large number of developing countries. About half of the African countries are currently experiencing some form of instability or armed conflict. While humanitarian assistance may be effective in providing food and shelter for the many millions of refugees and displaced persons, policy action is needed to deal with the underlying causes. Recent research shows a clear causal link between poverty, hunger, and natural resource degradation on the one hand and the probability of armed conflict and instability on the other (Messer, Cohen, and Marchione, 2001; Homer-Dixon, 1999; Esty et al., 1999). While these studies have been undertaken at the national level, it is reasonable to hypothesise that continued extreme inequalities and poverty among nations along with further information globalisation will lead to similar relationships at the international level. Widespread hunger, hopelessness, and lack of social justice generates anger and provides a perceived justification for international instability and terrorism instigated and supported by non-poor individuals and groups. Failure to recognise and deal with these underlying causes of international instability will render much of the
current investments in military solutions, intelligence, and other protective measures ineffective.

**Changing Roles and Responsibilities of Key Actors**

The roles of the state, the market, private voluntary organisations, and the for-profit private sector have changed markedly both internationally and in countries exposed to globalisation, structural adjustment, and related policy and market reforms. However, lack of knowledge about the proper role of each of these agents in the new socio-economic and political environments within which many countries find themselves is a major bottleneck to successful transformation. Failure to arrive at proper roles and appropriate institutions is a major reason why reforms have been disappointing in many developing countries.

The role of the public sector appears to be shrinking in many aspects of food security, while civil society and the private sector have taken on increasing importance. While such a shift may be appropriate, recent research and experience clearly show the importance of an effective public sector in many areas related to food security such as agricultural research to develop appropriate technology for small farmers, rural infrastructure, health care, education, development and enforcement of a legal system, and the creation of public goods in general (Paarlberg, 2002). Market liberalisation and globalisation require new institutions, rules and regulations (Kherallah et al., 2000). An effective government is needed to facilitate privatisation and guide the transformation of the agricultural sector in a direction beneficial for the poor.

The impact of governance (including democracy, adherence to human rights principles, the rule of law, and empowerment of civil society) on transaction costs and efficiency of food systems and poor people’s access to food should take high priority and efforts should be made to identify appropriate governance structures. Current efforts in many developing countries to decentralise public sector decision making and resource allocation are hampered by a lack of understanding of how best to implement local government action.

Market liberalisation often assumes that the private sector is capable and willing to take over the roles traditionally managed by the government. Where that assumption has been taken too far, the elimination of
inefficient government agencies and institutions have not been replaced by effective public goods creation and the private sector performance has been disappointing. Where market fundamentalism (see Stiglitz, 2002 for definition) has directed economic reforms, the results have been disappointing. Strong and effective public sectors are essential for successful privatisation.

Private sector agents and non-governmental organisations must be held accountable for their actions both nationally and internationally. Institutional innovation is urgently needed for this purpose.

Concluding Comments

Eliminating hunger, food insecurity and malnutrition is humankind’s foremost challenge. Failure to meet the challenge will result in continued high levels of unnecessary human suffering, foregone economic opportunities for both poor and non-poor, and an increasingly unstable world.

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Transfer of appropriate technology in agriculture: the challenge to quality food production and eradication of food insecurity in the South

CONSTANTINE S.L. LOUM

Nutritionist Ministry of Health, Uganda.

Graduate of Gent University, Dep. Food Science & Nutrition; MSc. Agricultural Development.

Enrolled Research Nutritionist
Queen Margaret University College
Faculty of Health Sciences, Department of Dietetics
Nutrition and Biological Sciences
Edinburgh, Scotland, UK.

Email: cloum@qmuc.ac.uk.
Abstract

Appropriate technology is that technology that is suitable for the small-scale businesses and adopted for local conditions. It meets the needs of the people, protects their environment, uses local skills and material, earns good living and is affordable.

The paper explores the role of technology transfer between North and South in uplifting agricultural food production in the South. It identifies the major modes of technology transfer and the constraints met in the process. However for it to work well, proper Technology Needs Assessment (TNA) has to be carried out with technology beneficiaries fully involved in order to improve their livelihood.

Introduction

The World Food Summit in Rome [4], 1996 noted with concern that it is intolerable that more than 800 million people throughout the world, more so in the South still do not have enough food to meet their basic nutritional needs, not to mention the quality of the food. The problems of hunger and food insecurity have global dimensions and are likely to persist and even increase dramatically in some regions, unless urgent determined and concerted action is taken; this is given the anticipated increase in world’s population and the stress on national resources.

The World Development Report, 2003 of the World Bank [24], is about sustainable development; it is about people and how we deal with each other (North and South). It notes that any serious attempt at reducing poverty requires sustainable economic growth in order to increase productivity and income in developing countries with focus on environment and social issues. The development challenge is about population growth, which most current estimates suggest that 2 thousand million will be added to the world population over the next 30 years.

The core challenge for development is to ensure productive work and better quality of life for all these people. This will require sustainable growth in productivity and incomes in developing countries. Thus the key elements of this development challenge for rural transformation are:
• Eliminate rural poverty and strengthen rural-urban linkages – including preparing out-migrants for a productive urban life.
• Intensify agricultural production and manage land and water to feed growing and increasing urban population.
• Get ahead of the agricultural frontier to control wasteful land conversion.

Technical innovation is vital for growth and poverty reduction in developing countries, [7]. Many of the technologies most important for the needs of poor women and men do exist, but they are not accessible to them. However it also argues that international technology transfer, through foreign direct investment (FDI) or trade does not necessarily have a poverty reduction impact. Indeed in many cases this form of technology transfer has little bearing on the technology needs of rural poor in developing countries and may even undermine their production systems. But [11] argues that, the rationale behind FDI stems in large part from the belief that FDI generates externalities in the form of technology transfer, which is indeed confirmed by [2] in their study of globalisation of technology and implications for least developed countries (LDCs).

For sustainable long term development, the focus of attention of policy makers and development agencies should be on the development of local capabilities to develop, adopt and use technologies, [1].

“The great disparities in levels of human development between the northern and southern countries of our world are mirrored by ‘technology divide’. The lack of access by poor women and men to the most basic technologies and knowledge needed to create sustainable livelihoods has condemned billions of people to an existence of recurrent poverty, disease and hunger. With admirable hope – or perhaps blind ignorance, the international community as a means to address this great divide has presented the concept of ‘technology transfer’”, [7].

This paper will dwell on the current world trend on technology transfer, the methods and criteria of technology transfers, some case studies on the success of technology transfer i.e. their impact on local productivity, constraints and lessons learned, as well as suggested solutions and way forward plus a conclusion as part of the final document.
Situational Analysis of Technology Transfer.

The livelihoods of the great majority of poor women and men in developing countries depend on micro- and small-scale enterprises of one sort or another. They must forge their livelihoods working in their fields, homes and small workshops, and by making vital decisions about the best use of their limited assets in order to survive on the tightest of margins. These women and men do not depend on employment in the formal sector, where Foreign Direct Investment is directed. Indeed, the formal sector accounts for a minority of the economically active population in most developing countries, [12].

Advances in scientific knowledge of biosynthesis in plants especially the identification and use of plant breeding of dwarfing genes in wheat and rice were embodied in the new technologies associated with high yielding varieties; these and others led to the ‘Green Revolution’. These technologies were a composite affair, as high yields were achieved by providing improved varieties with other technical know-how to the populace. [5]

In every age of capitalism since the Renaissance, advances in technology have been accompanied with widening inequalities and deepening poverty, [12, 5]. Also the impacts of technologies on the natural environment are not truly known for a generation after their introduction. Yet new technologies are being developed and commercialised at an increasing rate with no possibility for governments to have independent advice from the United Nations scientific monitoring teams concerning their adoption.

Priority issues according to [12] mean that the effective transfer of technological knowledge that meets the needs of people living in poverty has two critical dimensions:

- the development of people's capabilities to acquire new knowledge and make their own choices about technology change;
- the establishment of a supporting institutional and policy environment which fosters decentralised technological adoption in remote rural areas and in urban low income settlements, particularly information technology, energy services and agriculture and livestock innovations.
The state of technology transfer and commercialisation in Sub-Saharan Africa is here shown:

Table 1. Summary of Agricultural Technology Development, Transfer and Commercialisation

<table>
<thead>
<tr>
<th>Country</th>
<th>Production Technologies</th>
<th>Postharvest technologies</th>
<th>NRM technologies (Natural Resource Management)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>31</td>
<td>3</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>Uganda</td>
<td>34</td>
<td>6</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Côte d’Ivoire</td>
<td>14</td>
<td>1</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>Mali</td>
<td>9</td>
<td>9</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>Ghana</td>
<td>11</td>
<td>9</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Senegal</td>
<td>15</td>
<td>10</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>114</td>
<td>38</td>
<td>13</td>
<td>165</td>
</tr>
</tbody>
</table>


Despite the above initial success, [23, 7, 19] note that LDCs in general and in particular Sub-Saharan Africa (SSA) are way far behind other developing regions in the generation, transfer and commercialisation of agricultural technologies because of:

- The very low utilisation of transgenic plants in SSA except in South Africa;
- The low utilisation of productivity enhancing technologies such as hybrids, fertilisers, modern irrigation and post harvest technologies;
- The small number of multinational corporations involved in technology transfer and commercialisation;
- Still the inadequate legal framework for commercialisation of agricultural technologies; and
- The inadequate government support for enhancing technology transfer and commercialisation. Also, approval procedures for technology transfer and lack of standards to enforce quality in technology make it difficult to obtain better services.
• Suppliers and contractors of equipment are not locally available. Lack of skilled specialists and use of foreign agents increase transaction cost.
• The labour force is fragmented into workers currently under pressure by government redundancy policies and a labour market that lacks skilled experienced personnel.
• The R&D facilities are inadequate to deploy technologies acquired.

All these can be summarised under information, financial and project development, institutional and capacity needs barriers, [19].

3. Methods of Technology Transfer/Evaluation

Technology Needs Assessment (TNA)

Technology transfer is of high importance in the context of country development activities, thus for technology to work properly, technology needs assessment (TNA) forms an important part of an integrated set of activities to improve technology transfer, [22]. Three types of activity are required for effective TNA; i.e. institutional arrangements for stakeholders engagement that facilitate the process, assessment processes and activities and the process for implementation. The TNA process comprises a number of activities that include: identification of priority needs (with the beneficiaries) i.e. determination of criteria for technology assessment, preliminary overview of options and resources, selecting technologies and prioritising sectors and policies, identifying barriers, defining and selecting actions, implementation and finally pulling it all together, [22]. To be truly appropriate, technology must be compatible with available natural, human and financial resources and correspond to the cultural practices of users, [12, 13].

Thus the objective of technology strategy for sustainable livelihoods must be the development and adoption of technology that: improves the productivity of communities’ assets; enhances capabilities and provides for new livelihood opportunities for the poor; be sustainable in an environmental and socio-economic sense (i.e. technology that promotes equity in society) empowers communities especially vulnerable groups.
within this sector and promotes *macro, meso and micro linkages* between relevant stakeholders through appropriate networks, [12, 13]. Key stakeholders in technology transfer include governments, entrepreneurs, ultimate users, and experts (research institutions), [15, 9].

*Criteria and methods of technology transfer*

Technology transfer is widely accepted as essential for improving the economy of a nation especially in developing countries where industrial growth is assigned a very important role, [9, 10, 3, 18, 16, 19]. In this aspect, the technical institutes and universities play essential roles not only as the creators of new technologies, but also as providers of much needed skilled personnel.

The process requires that the institutions collaborate with industry (agriculture and others) in order to make full use of the transferred technology from the adoption stage to commercialisation stage. In turn the universities need the industries’ knowledge of the market to come up with more and more new, applicable and successful technology development, [10]. Indeed most of the success of the project of transferring agricultural technology for crop diversification in northern Thailand, from 1995, [19] was due in part and strongly to the relation between the research institutes and the implementing projects. Close to home Belgium, the Katholieke Universiteit Leuven has a research policy, which determines the position of industrial research projects. The part strategy is the non-profit organisation, Leuven R&D, an autonomous entity that constitutes the interface between the university and the industries, [3].

The mechanisms of technology transfer, [10, 16, 17, 14, 3, 18, 19, 21] especially between university research centres and industries may take one of the following nine forms: collegial interchange, conference and publication; consultancy and technical services provision (comprise an advisory committee, informal grouping of companies, university research centre or industrial liaison units and the management foundation); exchange program; joint venture of R&D; co-operative R&D agreement; licensing; contract research; science park, research park, technology park or incubators, spin-offs and training.
Evaluation of the success of technology transfer is always done best while following the initial findings and recommendations of the TNA. If the set goals of the community are met then the process achieved the required objectives of changing the livelihood of the people for the better.
4. Case Studies of Technology Transfer

There are several examples of successful cases of technology transfer in the developing countries, while there are also cases of nearly failed transfer of technology due to poor TNA. A few examples of success are seen in [19], the transfer of agricultural technology for crop diversification to northern Thailand, this led to high development of highland agriculture, with beneficial externalities to the rural people.

An ITDG project in Chivi, Zimbabwe uses simple acceptable technologies to improve production during drought periods; the outcome was very remarkable, [6].

In the Vilacanota Valley in Peru, the improved construction and maintenance of irrigation schemes coupled with attention to crop variety access led to increased production of traditional and introduced food crops, and there has been 70% reduction in water conflicts, [6].

Finally in northern Darfur in Sudan, the 1985 famine provoked some local people to set up a response and link up with ITDG on technology development to mitigate against the effect of drought; the impacts for the households had been substantial: increased area under cultivation, increased yield, and greater participation by women, [6].

Other success cases are shown in [13].

5. Lessons Learned and Recommendations

Transfer of technology has a substantial role in developing countries, however we have to be on the look for their limitations as well, if they are implemented without prior technology need assessment with the project beneficiaries.

With proper TNA, transferred technology will have key aspects, which should all improve their sustainability and impact on livelihood [13, 20, 7, 8], i.e.:

- Technology should be based on the needs of the specific social, environmental and climatological conditions of local communities; it should also empower the communities especially so for the vulnerable groups within the communities;
• It should blend local with international technologies, which will help to make the best use of the available know-how and capital base of the communities one aims to develop;
• Technology will be refined through a participatory process, since local solutions, assets and ideas are central to transfer process and technology development;
• Technology will be integrated and networked so that it creates a connection between regional, national and international science and technology stakeholders and the poor, and should be flexible to changes in the socio-economic and environmental conditions;
• Technology transfer should have aspects of information dissemination activities for successful adoption and diffusion of new technology, since they generate interest about the programme;
• Demonstration projects and capacity building exercise are major steps to successful technology transfer;
• Through proper TNA, financing programmes of bilateral and multilateral organisations should focus on areas that are of need and will be of substantial benefits to the communities;
• Technology transfer thrives best when government legal frameworks and policy are suitable and the institutional environment is supportive and in running status.

6. Conclusions

Increase in world population, is mainly found in the developing world, and the core challenge for development in LDCs is to ensure productive work and a better quality of life for all these people. The key to quality food production in developing countries is to intensify agricultural production, through local innovation and transfer of technology. Noteworthy is that technology is liable to fail if no prior needs assessment and sensitisation is done. Enabling access to new technologies therefore is partly about making more productive technologies available (technology transfer), providing a suitable environment (institutional, financial, social, political etc) and providing information and micro-credit skills that support access
opportunity by marginalised people. Building poor people’s capacity to make these choices not just means bringing new technologies to their doorsteps, but addressing their organisational, management and marketing skills as well as opening new channels of information and knowledge. Technology innovation and transfer is vital for growth and poverty reduction in LDCs. However, for beneficial outcome, proper technology needs assessment (TNA) with the beneficiaries is a must component for proper and long lasting diffusion and adoption of new technologies in agriculture to improve on quality food production and better livelihood of the people.

Finally, enabling policies and legislative framework in LDCs are very important aspects of technology transfer as well as the link between research institutes/universities and industries (agriculture). They help to formulate the methods and criteria of technology transfer and promote capacity building all of which are key aspects for the sustainability of transferred technology.

Thus technology transfer is useful, but should be tailored to the needs of the people and should evolve through a participatory process among the key stakeholders.

Selected References

Improving food quality of rural families through education: the cases of the Philippines and Colombia

ROBERTO GARCÍA-MARRIRODRIGA

Agricultural Engineer, PhD.
Associate Researcher at the Innovation Unit for Sustainable Rural Development
ETSI, Polytechnic University of Madrid, Spain

Emails: robertogarciam@wanadoo.es & rgarciam@ppr.etsia.upm.es

Acknowledgements: to my friends E. Emukpoerno and A. Afonso
Abstract

The connection between poverty and food security is clear. For the majority of the poor, agriculture is the main source of livelihood. This implies that when poverty is alleviated, levels of food insecurity may be reduced. Adequate education has been repeatedly identified as perhaps the most crucial variable in the rural transformation processes. But a unique educational system focusing on rural youth necessities and interests is required.

One alternative system to traditional education is “alternating cycle”. This paper, after a brief description of this educational system, defines an impact evaluation methodology validated in two different contexts (the Philippines and Colombia). The results allow us to successfully verify the impact on the quality of life – including improvement of family food quality – in rural areas, sustainability of agriculture and territorial equilibrium.

1. Introduction

At the World Food Summit in November 1996, the heads of states or governments around the world pledged their commitment “to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate view of reducing the number of undernourished people to half of their present level not later than 2015.” The connection between poverty and food security is clear and for the majority of the poor, agriculture is the main source of livelihood. This implies that when poverty is alleviated, levels of food insecurity may be reduced. But the majority of the problems of food insecurity and poverty, moreover, are made worse by inequality in income distribution – not by incapacity of production – and are increased with high levels of urban migration because of the outflow of human resources. One of the effects of urban migration from the rural areas includes the decrease of available manpower to pursue agricultural activities. Farmers are forced to sell their land and if they do, there is no guarantee that it will be reused for agriculture. Hence, there is also a decrease in usable or available agricultural land. If this happens, there will be insufficient
food supply, again slowing down the economy due to decreased production and trading. Sustainable development processes are favoured, in the first place, with the permanence of people in the rural areas. And, in the second place, when those who perform changes have the appropriate training. There are a lot of changes required for achieving the objective of improving food security and food quality in the rural environment of developing countries. These changes, like education, have still not been made in several areas. For example, a study by the International Food Policy Research Institute concluded that 44% of the reduction in child malnutrition between 1970 and 1995 is attributable to increases in women's education. All throughout this article, the central ideas are that education at all levels and vocational/professional training, are precisely the fundamental keys for a truly sustainable development focused on the human being, and that working to improve the quality and relevance of rural education is one of the best investments we can make in efforts to overcome poverty and food insecurity. “But to educate the people with a sustainable vision of development, does not consists of adding the protection of the environment to the contents of the curriculum, but of giving to the students the tools to achieve an equilibrium between economic objectives, social necessities and ecological responsibility” (Annan, 2001).

2. The “alternating cycle” educational system

The problem of education in rural environment, as well in the developed world as in the developing countries, is the inadequacy of educational systems of the traditional schools to the specific necessities of the young (FAO, 1997; UNESCO, 1999; BID, 2000) and its predominant “urban” focus (FAO, 1997). Therefore an educational system focusing on rural youth necessities and interests is required. This lack of relevance – unleashing factor for the putting in motion of the first alternating cycle school in France in 1935 - was translated into some direct effects on the sustainability of the rural development as a consequence of the demotivation of many of the young people that opted for the exodus towards urban environments that are more favourable in theory (García-Marirrodriga, 2002).
We can say that the technical and professional schools everywhere face a double challenge. On the one hand, the difficulty of training programs suitable for the jobs that exist in the market. Precisely, one of the major difficulties on the rural educational institutions is that the curricula are rigid in their structure, contents and mode of execution (Taylor, 1998). On the other hand, an imbalance exists between the offered curriculum and the possibilities of employment. Because professional training requires tangible results, it is of interest only when it leads to employment (BID, 2000). In this sense, the “alternating cycle” educational system represents one alternative to traditional education because it creates stable and efficient bonds between education and the world of labour (OCDE, 1994).

A unique educational system based on this alternating cycle (training periods in the socio-professional environment and in the school involving the families, the community and the environment), is being applied in more than 1,100 rural associations in 47 countries of the five continents. These associations - in which families have the majority - set up a school that demonstrates to the rural youth and community in general that farming and other rural alternative activities, more or less related to farming, can still be viable. The promoted schools give the students the proper value formation (intellectual, professional, technical, social, human and moral) that would prepare them for a much better life, including the improvement of food quality for themselves and their families. The challenge is to train the people on how to manage agricultural activities and to consider it as a business rather than just as their “day-to-day” subsistence.

These schools can be described as “Associations of families, professionals and institutions that assume the responsibility of development and the promotion of the rural environment through integral educative actions and professional trainings especially with the young, as an answer to a common problem. For this, their pedagogy is based on alternating cycle, which implies learning and acting starting from the experience of the work environment and the lecture halls and, therefore, a continuation in the acquisition of knowledge built on the discontinuity of spaces and times shared between the socio-professional medium and the school” (García-Marirrodriga, 2002). They teach a basic high school programme in rural farm communities. The official curriculum is supplemented by professional agricultural training in
fields such as technology and mechanics, farm management, marketing, crop and animal production, and commercialisation. Besides, the students are encouraged to undertake different livelihood projects on their farms. Many times, the introduction of vegetable, fruits and cattle products, for example, contributes to the enrichment of the family staple diet.

This “integrative alternation” between the socio-professional medium and the school is directed to achieve that the people – beginning from the young in order to reach the family and the community where it is unfolded – become responsible and produce processes of change in the environment as an answer to the problems of local development they encounter. That is to say, produce an effect of response to the problem of local development on the part of beneficiaries that demand the putting in motion of the processes of change. This can therefore be considered as a type of schools capable of actively promoting changes in the rural environment (FAO, 1997).

The idea of using the working environment as a place of learning and of the established artisan as an instructor continues today to be as valuable as in the past. The workers learn by doing because the place of work is also the same place of learning (BID, 2000). Alternating cycle connects the past with the future, experience with science, the concrete with the abstract, facilitates the relations between generations and, for so much, the adoptions of innovations, without excluding anyone of the protagonists of the training. We are speaking, therefore, of a system that assumes the interaction of school and work, in such a way that the two environments are enriched mutually. There is a creative reflection, while in other systems wrongly called alternating, only the practical enrichment is achieved. Definitely, it is trying to obtain a leader from a graduate that has the profile of a local actor of development (Herreros, 1998) because he has followed a training that facilitates personal and collective development.

This system makes the evolution of the environment possible starting from education and training of the young because it is inscribed in two co-ordinates: personal development and the insertion into the environment. These co-ordinates are facilitated through the practice of a professional activity that is converted into a source of training and through participation of the parents and of all the local actors in this training for which they are also rewarded. This articulation between
training and development is obtained thanks to alternating cycle that, starting from personal development, mobilises the local environment.

3. A methodology for the impact evaluation of alternating cycle

As a part of a planning model for the alternating cycle schools (García-Marirrodriga, 2002) a methodology was designed for the evaluation of the results of training. Thus, we find ourselves before an evaluation of the results of training by alternating cycle on local development, as well for the direct beneficiaries, as for the indirect. The concept of impact, much wider than that of efficiency (BID, 1997), allows us to detect more easily the repercussions of a type of action – local development through training – in which the results are not seen in the short term.

The objectives of the evaluation are:

a) to demonstrate the pertinence of the alternating cycle as a catalyst of local development actions compared to systems of traditional trainings, as well as its relevance for responding to the necessities of their environment;

b) to prove the validity of the alternating cycle in terms of impact: the success of the effects on the beneficiaries (personal, family and communitarian development and insertion) and the environment (local development);

c) to verify the sustainability of these schools for agriculture and development, understood as the permanence of the beneficiaries in their environment (contribution to the territorial strength and balance), not only from the temporal point of view, but also spatial.

The following figure (Figure 1) shows the criteria of evaluation. Then, these criteria are defined.
Figure 1. Criteria of evaluation and its links to variables.

Source: own results

- **Relevance** in the sense of adequation of the pedagogy as a response to the training necessities of the environment. This will give us the idea of the efficiency understood as the achievement of successes in a determined time (job insertion of the graduates in their environment and channelling of the process of local development).

- **Impact** on the individual – as the agent of change capable not only of achieving the socio-professional insertion, but also of putting in motion significant transformations – on the family union and on the local environment.

- **Sustainability** for agriculture and rural development (territorial strengthening and balance are successfully established as a consequence of the permanence of the graduates in the environment). Thus the social viability of the schools is verified.

The evaluation is based on a survey through closed interviews (even though with some open or semi-open questions) designed specifically for graduates of these schools, at least five years before. This design was used for allowing an evaluation of the indicators that are defined subsequently in function of the criteria of evaluation. Control groups,
formed by persons randomly chosen that have not been participants or beneficiaries of the intervention that is being evaluated, are established (BID, 1997).

In reference to the indicators applied on the defined variables, they can be characterised according to criteria. Thus, for the criteria of relevance, five indicators on the variables “employment” and “local development” were defined. For the criteria of impact, eleven indicators on the variables “employment”, “family situation” and “local development”, and for the criteria of sustainability, six indicators on the variable “permanence in the environment” were defined.

In our case, the validation of this methodology of analysis (well described in García-Marírodriga, 2002), is applied on the first 102 graduates of the first two alternating cycle schools in the Philippines (called “Family Farm Schools”, FFS) and on the first 40 graduates of the first alternating School in Colombia (called “Centro de Formación Familiar por Alternancia”, CEFA). All of them finished their five years of secondary technical studies in 1996 and were evaluated in 2002 (more than five years after). As “control group”, the data of the graduates were taken from two colleges of Fusagasuga – for the case of Colombia – and from two colleges of Lipa – for the case of the Philippines – that use traditional pedagogy.

On applying the indicators defined, we have the following results:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Indicator</th>
<th>Columbia</th>
<th>Philippines</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>Response rate</td>
<td>100</td>
<td>98</td>
</tr>
<tr>
<td>%</td>
<td>(very high/high level) adequate training received</td>
<td>100</td>
<td>96</td>
</tr>
<tr>
<td>%</td>
<td>Job insertion in the environment (indicates the rate of permanence due to job insertion)</td>
<td>100</td>
<td>86</td>
</tr>
<tr>
<td>%</td>
<td>(very high/high level) job satisfaction</td>
<td>82.5</td>
<td>87</td>
</tr>
<tr>
<td>N°</td>
<td>Projects developed by the school association</td>
<td>6</td>
<td>56</td>
</tr>
<tr>
<td>%</td>
<td>Graduates’ participation in the institutions or activities for encouraging the environment</td>
<td>72.5</td>
<td>88</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td>------</td>
<td>----</td>
</tr>
<tr>
<td>%</td>
<td>Total job insertion</td>
<td>100</td>
<td>98</td>
</tr>
<tr>
<td>%</td>
<td>Improvement in the quality of family nourishment</td>
<td>82.5</td>
<td>91</td>
</tr>
<tr>
<td>%</td>
<td>Improvement in the quality of family housing</td>
<td>87.5</td>
<td>78</td>
</tr>
<tr>
<td>N°</td>
<td>Innovations on the job</td>
<td>20</td>
<td>93</td>
</tr>
<tr>
<td>N°</td>
<td>Improvement projects of their own family business</td>
<td>35</td>
<td>84</td>
</tr>
<tr>
<td>%</td>
<td>Participation in the activities of the school association</td>
<td>75</td>
<td>66</td>
</tr>
<tr>
<td>%</td>
<td>Uses that incorporate new technologies</td>
<td>60</td>
<td>46</td>
</tr>
<tr>
<td>%</td>
<td>Graduates that formulate projects</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>N°</td>
<td>Services’ projects rendered to the local community</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>%</td>
<td>Graduates that think that the processes of development are favourised with received training</td>
<td>90</td>
<td>86</td>
</tr>
<tr>
<td>N°</td>
<td>Uses that achieve sustainable practices</td>
<td>19</td>
<td>73</td>
</tr>
<tr>
<td>%</td>
<td>(very high/high level) quality and stability of employment</td>
<td>87.5</td>
<td>71</td>
</tr>
<tr>
<td>N°</td>
<td>Total projects in motion</td>
<td>52</td>
<td>113</td>
</tr>
<tr>
<td>%</td>
<td>Uses of diversifying activities towards non agricultural</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>N°</td>
<td>Non beneficiary uses that imitate sustainable practices developed by beneficiaries</td>
<td>12</td>
<td>89</td>
</tr>
<tr>
<td>%</td>
<td>Level of assistance of graduates’ projects by schools’ trainers</td>
<td>90</td>
<td>67</td>
</tr>
<tr>
<td>%</td>
<td>Graduates who are members of the council of schools association</td>
<td>10</td>
<td>29</td>
</tr>
</tbody>
</table>

*Source: own results*
4. Conclusions

The alternating cycle educational system constitutes a relevant alternative for satisfying the demands of the rural youth of developing countries because it strengthens individuals, families and communities. If, in general, the goal of education is empowerment, it is clearer in alternating cycle. Indeed, the proposed methodology for the evaluation of the results on the direct beneficiaries of alternating cycle is shown to be valid for proving this hypothesis.

In reference to the control groups, the graduates of CEFA (Colombia) showed a 233% higher job insertion than the colleges with the traditional system. In the case of the Philippines, the rate is 104% favourable to the FFS. The commitment with the environment is almost 46 times greater in the graduates of the Colombian CEFA, comparing to the graduates of the colleges with traditional systems of training. In the case of the FFS, this graduates’ commitment is 41 times greater than the graduates from traditional systems. Thus, it can be affirmed that the training through alternating has a high relevance in order to favour employment, the improvement of the quality of life and the putting in motion of local development processes with an impact on sustainability of the rural environment. All these contribute to food security and to improved food quality.

Asked concretely about improvements in the quality of family nourishment due to alternating cycle education, 82.5% of graduates of the CEFA (Colombia) and 91% of graduates of the FFS (Philippines), answered affirmatively. Many times, the livelihood projects in their own family farms had contributed to the crop diversification and therefore, the enrichment and balance of the staple diet. These changes permit the slow but firm improvement of quality of rural life.

Selected references


The need of communicating food safety in Indonesia

PURWIYATNO HARIYADI AND RATIH DEWANTI-HARIYADI

Department of Food Technology and Human Nutrition
Faculty of Agricultural Technology
Agricultural University
Bogor, Indonesia

Email: Hariyadi@uwalumni.com
Abstract

Food safety is a critical issue in many countries. Food Safety is closely related to health and productivity of the population and directly associated with competitiveness of food and agricultural products in the international trade arena. Many reported food safety problems in Indonesia are caused by basic errors in preparing foods due to lack of knowledge of basic food safety. Therefore, many food safety problems could have been avoided if those who prepare meals were trained in elementary food safety. Besides developing food safety regulations, government should develop intensive trainings or education for food producers as well as consumers. Communication of food safety to all stakeholders involved – from farm to bale – is essential to ensure that only safe food reaches consumers’ tables.

1. Introduction

The International Conference on Nutrition held in Rome in 1992 adopted the World Declaration and the Plan of Action for Nutrition, calling governments and other concerned parties to “adopt” and strengthen comprehensive measures to cover the control of food quality and safety with a view of protecting the health of consumers. However, since obtaining food for a large segment of the population is often still a challenge, the food safety issue is often overlooked. This condition is also shared by Indonesia. In Indonesia, however, there is a growing recognition of the importance of food safety. This is especially true due to improved education and/or income, increased inflow of information, as well as the development of international trade. It is realised that assurance of today’s consumer demands that his food supply is protected from (i) contamination by pathogenic microorganisms, chemical residues, and physical hazards; (ii) decomposition; (iii) adulteration; and (iv) deception or fraud in the form of misleading claims and descriptions on labelling or in advertising. Consequently, the national food industry system needs to respond to the consumer demands for food safety. Food industries do not only need to comply with mandatory legislation set by food safety authorities, but also with trade specifications set by trade or industry organisations. To win the
competition in the global market, Indonesian food industries must comply with both; one is their legal responsibility and a prerequisite for market entry, the other is simply commercial reality, survival and development in ever increasingly competitive markets. Most recently, the challenge is responded by the government of the Republic of Indonesia through the establishment of an independent institution, i.e. The National Drug and Food Agency that reports directly to the president (Formerly a Directorate General of Drug and Food Control existed under the Department of Health). The change is expected to provide better management of food safety, which in turn improves human health. In addition, several other institutions are collaboratively responsible for the supply of safe food, namely the Ministry of Agriculture, the Ministry of Fisheries, the Ministry of Trade and Industry, the Ministry of Interior and the Ministry of State of Research and Technology. Another institution, the Ministry of State of Environment – that issues regulations on environment such as water supplies, treatment of wastewater etc – is also important to support the production of safe agricultural products.

2. Problems of food safety in Indonesia

Many reported food safety problems in Indonesia are caused by basic errors in preparing foods, due to lack of knowledge of basic food safety (Hariyadi and Rimbatmaja, 2003). Although not well documented, available data on food safety problems confirmed this statement. In general, the food safety concerns were associated with lack of knowledge and poor practice, including poor sanitation and hygiene. Especially for processed foods, the problem is magnified by the use of non-food grade additives. The use of illegal colorants such as methanyl yellow and rhomdamine B has been reported in syrup and street food sold in school areas. Chemicals such as boric acid and formaldehyde have been found to be used as food preservative. Furthermore, several food grade additives, such as artificial sweeteners, saccharine and cyclamate, are sometimes used in concentrations exceeding the recommended ones.

Based on epidemiological surveillance data, microbial pathogens are still the leading cause of food borne outbreaks (Kandun, 2000).
Salmonella was most frequently found as causative agent, although serotyping has never been conducted to confirm the outbreak investigation. While data of reported (or recorded) food borne outbreaks showed a low number of cases, (Table 1) it is estimated that the real number is a lot higher because of unreported cases. Among the low number of the outbreaks, it was reported that 33.8% resulted from food catering, 29.2% from home made food, 18.5% was caused by street food, 4.6 % came from processed (fabricated) food while 13.9% was not known (Suklan, 2000).

Table 1. Reported food borne outbreaks in Indonesia 1995-2000

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of outbreak</th>
<th>No. of cases</th>
<th>No. of death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>58</td>
<td>1,919</td>
<td>24</td>
</tr>
<tr>
<td>1996</td>
<td>42</td>
<td>3,123</td>
<td>35</td>
</tr>
<tr>
<td>1997</td>
<td>31</td>
<td>3,671</td>
<td>6</td>
</tr>
<tr>
<td>1998</td>
<td>13</td>
<td>1,078</td>
<td>8</td>
</tr>
<tr>
<td>1999</td>
<td>19</td>
<td>1,267</td>
<td>1</td>
</tr>
<tr>
<td>2000</td>
<td>2</td>
<td>1,051</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Suklan, 2000

When the epidemiological data were compared to studies conducted on several agricultural products, primarily horticulture and marine products, it was shown that there was a correlation. Salmonella was frequently isolated from both fresh and processed food. Isolation of Salmonella or S. paratyphi has been reported from local vegetables such as bean sprout and cabbage (Isyanti, 2000), ocean and pond shrimp obtained from Java (Dewanti-Hariyadi et al., 2000), ocean and freshwater fish (Wiryohadi, 1988), and even processed food (Apriyanthy, 2000; Dewanti-Hariyadi and Hapsari, 2000).

A limited number of studies on emerging pathogens in food has also been conducted. Isolation of enterohemorrhagic E. coli O157:H7 from local ground beef has been reported (Dewanti-Hariyadi, 2000). However, none of this serotype was found in street (processed) food, and ten clinical isolates of E. coli of patients with diarrhea or bloody diarrhea were confirmed as non O157 (Dewanti Hariyadi and Nurairilyasti, 1999). Another emerging pathogen, Listeria monocytogenes, was absent in ocean and pond shrimps collected in four
catching places in East and Middle Java. Up to present, isolation of *L. monocytogenes* from food has not been reported.

Another microbial contaminant of concern is mould, particularly its mycotoxin production. A review by Dharmaputra (2000) suggested that aflatoxin was frequently found in large amounts (> 30 ppb). Most maize samples collected from different places in Indonesia contained aflatoxin, with aflatoxin concentrations ranging from ten to several thousands ppb (Table 2). Aflatoxin was also frequently found in peanuts, especially during the rainy season. Eighty percent of the peanuts collected in West Java contained more than 30 ppb aflatoxin. Storage and slow drying processes of the grain were thought to be the main cause of the problem. However, Dharmaputra also reported that generally the aflatoxin content of soybean was low and fell within the acceptable range.

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of samples</th>
<th>Aflatoxin content (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B1</td>
</tr>
<tr>
<td>Lampung</td>
<td>15</td>
<td>22-3308</td>
</tr>
<tr>
<td>Central Java</td>
<td>8</td>
<td>52-4074</td>
</tr>
<tr>
<td>East Java</td>
<td>11</td>
<td>101-3710</td>
</tr>
</tbody>
</table>

Chemical contaminants are also of concern in agricultural product safety. In the 1970s when intensive farming was introduced, the use of pesticides also increased. Studies in the early 1980s on several street foods suggested that there was an alarming amount of pesticide residues in several street food products. Despite the fact that recent data were not available, in general, it can be concluded that pesticide problems are associated with lack of, or low, food safety awareness among farmers and food handlers.
3. Food safety problems of exported foods

To assure fair international trade in the global market, the Codex Alimentarius Commission is working to establish an international consensus on food standards, including food safety standards. The rationale behind the Codex is that the consumers will benefit from international standards because food meeting these standards is safe, wholesome and properly labelled—whether produced domestically or imported. The importance of food safety in international trade is particularly shown by the fact that food safety is appearing frequently on the agendas of international leaders, and it has become central to negotiations with respect to trade over the last decade. Government, farmers, food handlers and other stakeholders in the Indonesian food industry system need to realise the growing importance of food safety, especially in the international trade arena. Food safety problems have a negative impact on the Indonesian economy, due to the fact that many Indonesian exported foods are detained and/or refused entry by importing countries. Data from FDA’s Import Refusal Report (IRR) indicate that during the year 2002 alone, more than 200 cases of imported food from Indonesia were refused to enter into the USA due to food safety reasons (Table 3).

Table 3 indicates that more than 80% of the reasons for refusals for exported food are due to being filthy. “Filthy” has been defined as the condition in which the article appears to consist as a whole or in part of any filthy, putrid, or decomposed substance. As compared to other exporting countries, 80% of the reasons for refusals for exported food due to being filthy is relatively high. During the year 1999 (Table 4) world-wide detention due to the reasons of being filthy was only 24%. This data indicated that (1) the food safety awareness and practices of food handlers in Indonesia are relatively poor as compared to that of other countries, and (2) the food safety problem in Indonesia is mainly attributed to the poor understanding of basic principles of food handling and lack of good practices, especially with respect to sanitation and personal hygiene.
Table 3. Refusal of Indonesian exported foods to entry to United State by US-FDA, 2002 (http://www.fda.gov/ora/oasis)

<table>
<thead>
<tr>
<th>Month of 2002</th>
<th>Total Cases of trade Refusals</th>
<th>Total Cases of Food Trade Refusals*</th>
<th>Total Cases of trade Refusals due to filth</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>50</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>February</td>
<td>23</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>March</td>
<td>27</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>April</td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>May</td>
<td>24</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>June</td>
<td>12</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>July</td>
<td>48</td>
<td>47</td>
<td>43</td>
</tr>
<tr>
<td>August</td>
<td>8</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>September</td>
<td>21</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>October</td>
<td>17</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>TOTAL</td>
<td>238</td>
<td>216</td>
<td>181</td>
</tr>
</tbody>
</table>

*) Beside food products, other products rejected are health related products, drugs, antibiotics, etc.

Table 4. USFDA World-wide Detentions (Jan. - Jun. 1999)

<table>
<thead>
<tr>
<th>No</th>
<th>Reasons of Rejection</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Filth</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Microbial contamination</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Food additives</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Pesticide residue</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>Labelling</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>Low acid canned food</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>Others</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>Heavy metal</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Mould</td>
<td>1</td>
</tr>
</tbody>
</table>

4. The Need of Communicating Food Safety

Many of the reported food safety problems in Indonesia are due to mishandling of food, during the course food continuum "from farm to table". Especially food handlers have a very significant role in managing food safety. As poor sanitation and hygienic practices contribute to unsafe food, it is important to raise producers’ (industries, farmers, etc)
awareness on food safety. This can be done by regular education or training. For small to medium scale food processing industries, the training should also include knowledge of illegal additives.

It is also necessary to enforce all available regulation, by communicating food safety, including (i) disseminating information on the legislation to producer and consumer, and (ii) by penalising those who did not comply with the regulation. Communicating food safety matters to consumer is also important to improve consumers' knowledge, so that consumers will be more informed about hazards associated with food.

The need of communicating food safety is apparent, especially focusing on training programs that include, but are not limited to the following:

- The importance of good hygiene
- The impact of poor personal cleanliness and unsanitary personal practices on food safety.
- The importance of hand washing – after each absence from the workstation, after using the bathroom, before and after eating, and before commencing work – on food safety.
- The technique of proper hand washing techniques, that include: hand washing with warm water (if available); proper use of soap; and thorough scrubbing (including cleaning under finger nails and between fingers), rinsing, and drying of the hands.
- The importance of using sanitation facilities. All employees should be encouraged to use on-site latrines and to avoid eliminating wastes outside of these facilities. The use of well maintained sanitation facilities for waste elimination helps to reduce the potential for cross-contaminating fields, produce, other workers, and water supplies, and increases the likelihood that employees will wash their hands after using such facilities.
- The important role of people (employees) in achieving sanitation and hygienic standards. This should be emphasised, since employees are not machines but more important than machines. Respect their individuality and build on their strengths. In a competitive business environment, well informed employees are the most important assets. If you take care of them, they will take care of your business interests.
5. Conclusions

Effective communication of food safety needs to be strategically designed to increase the awareness of all stakeholders involved in managing food safety. Adopting the “from farm to table” food safety approach and involvement of all parties; starting from farmers, growers, handlers, and consumers, are critical to food safety. The role of food industry and the government sector is also critical.

The importance of food safety in health and economic development of the nation needs to be realised fully not only by industry and consumers, but also by the government. Considering the ”from farm to table” approach, many government agencies need to be actively involved in food safety programs, especially in providing a framework for maintenance of food safety across the food continuum "from farm to table". This includes development and/or enforcement of food safety laws, regulations, directives, standards, policies and procedures form a foundation for food control systems. Due to the limited resources of the government, technical and financial assistance from international agencies (such as FAO, WHO and WTO) are needed to develop such systems.

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Wiryohadi. (1985). Microbiological and chemical quality of various fish in Bogor area. Research Report (Skripsi). Department of Food Technology and Human Nutrition, Faculty of Agricultural Technology, Institut Pertanian Bogor (in Bahasa Indonesia)
Trade Barriers to Products of Biotechnology: An American Perspective

RON GASKILL

Director of regulatory relations
American Farm Bureau Federation, Washington D.C., USA
Abstract

Biotechnology, the process of copying the DNA of a preferred trait and inserting it into the DNA of a host plant so the preferred trait is replicated in subsequent generations of the host plant, holds great promise to improve the production of food, industrial products and pharmaceuticals. Innovative biotechnology will not only allow us to produce more and better food for a hungry world, it will also allow us to produce consumer and industrial products from renewable ingredients with greater care to the environment.

Background

Like people everywhere, Americans are concerned that the food they eat is not harmful to them and that it is produced in environmentally friendly ways. Through vast experience, Americans generally have developed a confidence in local, state and national regulatory authorities to provide reasonable assurance that the products used and consumed in the United States, particularly those products made here, are free of unhealthy substances and if not, that appropriate messages are provided to inform them of possible concerns. Confidence in the regulatory and oversight system allows Americans to embrace new ideas and new technologies quite easily, for they are comfortable that unhealthy impacts of products will likely be discovered before products are given permission to be commercialised.

And once products are commercialised, the level of review by manufacturers, government agencies and other public and private institutions (such as research colleges and universities) is significant. America’s product liability laws alone are so generous to persons who are harmed by faulty products that it is many times less costly for manufacturers to undertake thorough and honest pre- and post-commercialisation testing to discover problems and invoke remedies before they are discovered by others.

America’s confidence in the process of scientific review is the basis for its view on trade and trade barriers to products of genetic modification.
Americans accept that there are extremely few absolute certainties, and that life itself is subject to inherent risks. We believe that all we can do is to minimise risks to reasonable levels, but that elimination of any or all risk is inherently impossible.

Confidence in scientific discovery is embodied in World Trade Organisation agreements. This is because agreements, to the extent possible, should be fair and unbiased to all who have agreed. As members of the WTO, the European Union, the United States and all other members have agreed on a system for allowing the results of scientific discovery to determine the appropriate levels of protections that each is allowed to establish without unreasonably impacting the trade of other members, and the manner in which such protections are to be installed. For the most part, these agreements have served WTO members well since the end of World War II.

**Biotechnology and the EU trade barrier**

The United States strongly believes that competent scientific review and discovery in many different countries have concluded repeatedly that products of biotechnology are not substantially different from their traditionally produced counterparts. U.S. government agencies have reviewed products of biotechnology and concluded that there is no health-related reason to withhold such products from the commercial marketplace or to require that product manufacturers include messages on their products that caution product users about potentially unhealthy effects. The U.S. Environmental Protection Agency likewise reviewed test data and, to date, has not seen evidence to require the withdrawal of biotech products from the commercial market due to negative environmental impacts. The body of scientific evidence overwhelmingly favours biotechnology.

Prior to 1998, the United States and the EU enjoyed strong trade relations for many products, including U.S. corn. The United States sold more than U.S.$300 million annually of corn to the EU, some of it biotech. Suddenly, however, in 1998 the EU halted the import of all biotech corn from the United States. The effect was to halt shipments of
all corn, because biotech and traditional corn cannot be separated in the large-volume grain storage and handling systems that are prevalent in the United States and other major corn exporting countries.

Imposition of the moratorium was the EU’s sudden response to unsubstantiated hysteria that was created by EU consumers and environmental groups, and which gained traction with the general public. Without using the results of available scientific risk assessment on products of biotechnology, which the WTO Agreement on Sanitary and Phytosanitary Measures requires as the basis for the establishment of protective measures, the EU in essence took a knee-jerk, political reaction to the matter and summarily cut off trade.

Since 1998, the United States and the EU have consulted on ways in which the moratorium could be lifted. But after five years of repeated, unkept promises by the EU to lift the moratorium, with U.S. agriculture remembering another recent trade dispute with the EU in which the EU was found to be non-compliant by the WTO but from which the EU did not change its import policy on U.S. beef products, and with several EU member countries talking vigorously about new rules on environmental liability before the moratorium would be lifted, the United States finally lost patience and elected to use the WTO dispute settlement process as the means with which to adjudicate the controversy.

During the five years of the moratorium, competent new scientific discovery in the EU and elsewhere has continued to support the safety of biotechnology. With no scientific justification, the moratorium is increasingly inconsistent with the WTO. Further, the United States is closely monitoring the EU’s enactment of labelling and traceability rules for consistency with the WTO agreement. The United States will not accept labelling and traceability rules as a solution to the moratorium when such rules, as currently proposed, are themselves even more inconsistent with the WTO agreement than the moratorium.

The United States truly wants trade peace with the EU. But as long as the EU uses political motivation rather than scientific discovery as the basis for creating new rules that have the effect of impeding trade, the United States and many others in the international community will push
back. The example for all countries from this biotech case, is how *not* to establish rules for protection when the threat of danger or harm is not real. Several other countries established their rules for products of biotechnology, and the United States didn’t file a single WTO complaint against any of them because they followed the international rules of trade and health protection, even if the United States did not agree with their rules.

With careful consideration, all countries will embrace biotechnology as a tool for advancing the human experience. We hope that time is not too far in the distance.
The Potential of Genetically Modified Crops to Fight World Famine

ANNELEEN VANDEPLAS

Student Master in Agricultural and Applied Biological Sciences
Katholieke Universiteit Leuven, Belgium

Email: Anneleen_Vandeplas@hotmail.com
Abstract

This paper discusses the scopes of genetically engineering of staple crops for relieving famine and food security in today’s world. Although at this moment, enough food is produced to provide the global population of a basic diet, in the future we could face a problem of an insufficient food production. Genetically modified crops could provide a useful – although perhaps not sufficient – means to address this problem, if certain conditions are met. Particularly novel crops with risk-reducing traits like resistance to adverse climatic conditions, pests, diseases, drought and nutrient deficiencies might be appropriate here.

Introduction

Recently, President George W. Bush accused Europe of impeding efforts to feed starving Africans by blocking the use of genetically modified crops, which he said would ‘dramatically’ boost productivity and provide food across the continent. "They have blocked all new bio-crops because of unfounded, unscientific fears," Bush said. "This has caused many African nations to avoid investing in biotechnology for fear that their products will be shut out of European markets. European governments should join – not hinder – the great cause of ending hunger in Africa," he said. The European Commission blasted back this accusation as ‘unacceptable’.

World-wide, biotechnology has been a hot issue, including its potential and even necessity to fight world hunger. Biotechnology offers a range of applications to agriculture including plant tissue culture, marker-aided selection, DNA technologies for genetically modified organisms (GMOs), diagnostic kits for identification of plant and animal pathogens, and many more. This paper will mainly focus on the potential of genetically modified organisms. At first, the current and upcoming challenges for global food production will be identified, and whether they can be met by means of biotechnology. Next, current use of genetic engineering is discussed and finally scopes and conditions for the use of genetically modified crops in smallholders’ production in developing countries are stated.
Challenges for global food production

It might be worthwhile to clearly distinguish between two problems that are all too often intermingled. At this moment, global food production is sufficient\(^8\) to provide food for the world’s population, if only inequalities in access to food were eliminated.

GMOs are all too often perceived as ‘technological fix’ where we fail to address the underlying causes of hunger and poverty that really require economic, political and social change. The Food and Agriculture Organisation of the United Nations has indicated war and other forms of armed conflict as the exclusive cause of food emergencies in 10 to 15 developing countries during the last three years (Nuffield Council on Bioethics, 2003). Political instability, inappropriate national agricultural policies and lack of infrastructure all affect agricultural productivity. The reason why 800 million humans are underfed is mainly due to a lack of access to food, for example because they don’t dispose of an appropriate income to buy it.

Nevertheless, if the world lives up to the predictions on population growth, we will be facing a second problem in the near future. The world’s population is expected to increase from the current 6.3 thousand million to 8.1 thousand million by 2030. The United Nations hope that a stable population of maximum 11 to 12 thousand million people can be attained by 2050. This will bring along a parallel increase in the demand for food. The populations of those regions and groups initially most subject to poverty and malnutrition are expected to increase most rapidly. The increase in supply cannot come from area expansion since that has already become a minimal source of output growth at a world scale, and has become negative in Asia and Latin America (de Janvry et al., 1999). Hence we will need to increase our yields drastically, or we will need to find a way to radically reduce the global population growth

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\(^8\) We should indicate however that to obtain daily 3600 kilocalories (or even the recommended 2000-2500 kilocalories) for everyone from the existing production of staple crops, the consumption of meat, dairy products, eggs and poultry would have to be abandoned. Indeed, approximately 3 to 7 times as much cereals are needed to provide the same amount of calories for people who consume animals as food.
rate, without violating people’s individual rights (in this case procreative freedom).

An even faster rise is predicted in workforce. It is predicted that the number of people of the working age will grow faster than the number of people of non-working age (as a larger number of child survivors reach the working age) (United Nations, 2003). Unless this is at least matched by rising demand for people to take on workplaces, employment or wage rates will fall and the hungry will even have more difficulty in affording more food.

**Increasing global yields**

In developing countries, many crops are produced with simple technologies that result in a large gap between potential and actual yields. As many smallholders are cropping for their own subsistence, they don’t dispose of liquid capital to invest in yield increasing technologies as fertilisers, pesticides, irrigation systems or improved varieties. Nor do they have access to training on how to improve their cropping efficiency. They get stuck in a vicious circle of low yields, lacking yield surpluses to market and consequently lacking capital to invest in their next cropping cycle. Moreover, once there is a bad rainy season or an epidemic of a dreaded insect or fungus, they loose their harvest and don’t even have sowing seed left for the next season. They are continuously subject to food insecurity. Where possible, smallholders resort to off-farm incomes. In Nicaragua, households on the 45% smallest farms derive 61% of their income off-farm. In Chile, the 60% poorest farm households derive 67% of their income from off-farm activities, including agricultural wage labour on other farms (de Janvry et al., 1999). Not in every region off-farm incomes are easy to obtain though, particularly not where unemployment is high.

Although not everyone agrees, there might be a certain potential for biotechnology to increase agricultural production of smallholders in developing countries. Even if potential yield cannot be met, yield stability would certainly be of great interest for them. By means of
genetic engineering, specific traits might be achievable in crops, like resistance to pests and diseases, resistance to drought, heat, frost, acid or saline soils. One must however make sure that genetically modified crops are not used to fully exploit cultivated soils, but rather to provide an ecologically sustainable means of production.

Real financial profits sprouting from increased yields of genetically modified crops should only be expected for the first adopters. After a while, when more farmers adopt the new technology, the general crop price indeed decreases so that in the end all farmers will increase their yields in order to maintain their original level of returns. The greatest profits end up on the account of the seed company, at the expense of for example the company selling a pesticide that is no longer required for insect resistant crops. Smallholders that lack resources to do a first investment in the new technology, don’t just drop out, but are actually worse off due to the decrease in product price if we only consider the direct effects of biotechnology.

However, there are some non-financial profits that can be protruding from the use of genetically modified crops, and that not only apply to the first adopters. Benefits may be a higher nutritious value of the produced crops for home consumption, lower exposure to yield risks or lower exposure to unhealthy chemicals and improved natural resource management.

There are arguments of proponents, claiming that indirect beneficial effects of biotechnology might compensate the pernicious effects on non-adopters (de Janvry et al., 1999). Indirect effects may consist of a lower food price for poor people, like landless farm workers, net food buying small holders, non-agricultural rural poor and the urban poor for whom food represents a large share of total expenditures. There are also some employment and wage effects, in agricultural as well as in non-agricultural sectors. As a consequence of the lower food prices, lower nominal wages for employers can be maintained, leading to an increased demand for labour, which is important for landless farm workers, net labour selling small holders, and the rural non-agricultural and urban poor. Cheaper labour and lower costs of agricultural raw materials also
set free the capital for more investments, leading to overall economic growth.

The question remains of course, whether it is a good idea to first lead the farmers to bankruptcy due to a producer price lower than the production price, and afterwards compensate it with lower food prices and a job at the farm factory of a prosperous farmer. The answer may lay in the humanity of the latter farm manager. Without alternative income opportunities left, his employees may be very dependent of the labour conditions the manager decides for, taking into account that in some cases there might be a trade-off between financial profits and social welfare of his employees.

Development economists have recently been debating about the relative importance of the indirect and direct effects of technological change in reducing poverty. The problem emerges if the technologies used to achieve these two effects are not the same, implying trade-offs in the allocation of public research budgets or biases in the impact of privately released technologies.

These trade-offs between direct and indirect effects arise from the unequal distribution of land, market failures (for example on risk and credit markets\(^9\)), institutional gaps and conditions of access to public goods that vary with farm size. These may result in a different optimal farming system across farms. Generally spoken, smallholders will prefer low-risk bearing, simple, divisible\(^{10}\) technologies, which are compatible with their former farm practices and of which the adoption is reversible. Well-off farmers may decide in favour of capital-intensive technologies that combine high risks with outstanding yield potentials.

If there are trade-offs, using technology to fight smallholder poverty at the cost of a lesser aggregate gain in productivity may lower total

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\(^9\) If credits are only available for large farmers who can give substantial land as collateral, small farmers don’t have access to credit for investment in capital-intensive technologies. Hence they’ll prefer to adopt low-risk technologies.

\(^{10}\) Divisible technologies here indicate technologies that can be adopted for a part of the crop area, so that the farmer can check the profitability before deciding for full adoption or so that he doesn’t need to abandon all of his traditional methods.
poverty reduction. According to Alston et al. (1995, cited by de Janvry et al., 1999), innovative agricultural technologies find their main benefit in providing greater food availability and a lower food price. According to them, research should consequently focus on generating the greatest aggregate output gain, while concerns for poverty reduction among smallholders should be achieved through other instruments. Here, we find an argument to justify biotechnology as a solution for the future problem of insufficient food production formerly mentioned, even if this worsens the socio-economic problem.

**Current use of Genetically Modified Crops**

In fact, until today, biotechnology has had other goals than render agriculture more sustainable or fighting the world’s hunger problem. Indeed, most work has been done on industrial crops like soybean, maize, colza and cotton, produced by large-scale companies as Monsanto, Syngenta, Bayer CropScience and Dupont, neglecting those crops which provide employment, income and food for poor people in developing countries. No advances have been made with respect to the important crops of the poor like millet, sorghum, yam and cocoyam. To bring a genetically modified crop on the market, huge budgets are required. Consequently, private companies that dispose of the necessary financial means will only bring those into action when and where profits can be made. Knowles (2001) confirms this, indicating that marketing attempts by corporations like Monsanto, implying that the reason they are developing GM crops is primarily to benefit the hungry in the developing world, make these corporations appear more disingenuous rather than foster their public support.

Nevertheless, various countermoves can be observed. The International Network for the Improvement of Banana and Plantain (INIBAP), a programme of the International Plant Genetic Resources Institute (IPGRI) is to sequence the genome of the inedible wild bananas from South East Asia, as these are resistant to the Black Sigatoka disease. Researchers at the Katholieke Universiteit Leuven Laboratory of Tropical Crop Improvement (Belgium) are currently developing banana cultivars with resistance to various pests and diseases. In 2000, Van
Montagu and Gheysen started the Institute of Plant Biotechnology for Developing Countries at the University of Ghent.

**Adoption of New Technologies by Smallholders**

We can assume that the direct advantages of biotechnology for smallholders could be greater – or the pernicious effects were reduced – if the opportunity for adoption by the smallholder can be increased. What factors influence the successfulness of the adoption of new technologies by smallholders in developing countries?

In contrast to commercial farming, these smallholders are highly heterogeneous, combining in various forms following assets: lack of reliable water for irrigation, incomplete property rights, low stocks of tools, equipment and animals, large family labour endowments, low human capital endowments, low educational levels, formal credit and insurance restraints, low access to extension and information, high transaction costs in accessing markets, location in regions with poorly developed infrastructure and public services, location in marginal lands where soil fertility is low and exposure to risks high, and location in small agro-ecological niches with limited supply of technological options (de Janvry *et al.*, 1999).

The demand of subsistence farmers for capital-intensive technologies that boost crop yields may be very low. Low income and low capital endowment lead to high risk aversion. Hence they prefer low budget investments that provide more yield stability and that don’t render them dependent of any seed or pesticide company. As sources of income are multiple and the farming system diversified, technological change in any one crop will have small overall effects on household income.

From this point of view, the adoption rate of new plant configuration recommendations is expected to be higher amongst smallholders than the adoption rate of fertiliser recommendations. Adoption of row planting technology requires only minimally more resources (like a planting rope or sighting poles) and a little additional labour than the traditional system of random planting. The use of chemical fertiliser, on
the contrary, is a rather complex technology. Chemical fertiliser comes in many different formulations, can be applied in different rates, using different methods, and at different points in the cropping cycle, all depending on the cropping conditions. In a recent impact study of the CGIAR that examines the adoption by Ghanaian maize farmers of improved production technologies, these findings are confirmed (Morris et al., 1999).

Likewise, we could consider the use of improved crop varieties. Improved materials can offer many advantages to smallholders, on the premise that they are cheap to obtain, easy to cultivate, that they don’t make the farmers dependent of other expensive inputs, and that the farmers can have readily access to the materials. Poor farmers would for example be better off with improved open-pollinated varieties of maize than with higher yielding but capital intensive maize hybrids, as from open-pollinated varieties sowing seed saved from the harvest can be used for the next cropping cycle, while hybrid seed has to be bought every year to maintain the hybrid vigour and outstanding yield levels. Low risk, compatibility with the farmer’s other technologies or practices and divisibility are important characteristics for a technology to be successfully adopted. Boosting production should not be the priority of the improvement process, rather should be given priority to the provision of a stable yield by making the plant more resistant to adverse climatic conditions, pests, diseases, drought, and nutrient deficiencies.

Not only the characteristics of the improved material or technology affect the adoption, other factors should be considered as well. In the Impact Assessment mentioned before (Morris et al., 1999), some important complementary factors were identified. As such are the agro-climatic conditions of the farming environment, the nature of prevailing cropping systems and the degree of commercialisation of the cropping enterprise.

A basic hypothesis regarding technology transfer is that the adoption of an innovation will tend to take place earlier on larger farms than on smaller farms. This applies especially but not exclusively to non-divisible technologies. Farm size may as well be a surrogate for other factors, such as wealth, risk preferences and access to credit, scarce inputs or information. Often the farmer’s personal circumstances,
including ethnicity and culture, wealth, education, gender and security of access to land are involved as well. More years of education and/or experience is often hypothesised to increase the probability of adoption whereas increasing age reduces the probability.

Moreover, Morris et al. (1999) indicate that the adoption of improved technologies requires at least an effective extension service, an efficient inputs distribution system and appropriate economic incentives. That a heavy emphasis on extension is required to obtain a successful adoption of improved varieties is confirmed by other authors. In a recent survey taken among Mexican farmers with support of FAO, 63 % of the farmers declared that they needed technical assistance or additional training to make efficiently use of the technical innovations they had access to through the programme Alianza para el Campo, an initiative of the Mexican government to ease transfer of technical innovations to the agricultural production system (Samanez, 2000). Fifty percent was ready to pay for this service. The surveyed farmers all had a level of formal education higher than average for the rural population. It may thus be assumed that before small farmers can make use of technical innovations that improve production efficiency, they will first need considerable training.

On-farm trials can provide researchers with vital feedback about the performance of experimental technologies, while giving farmers an opportunity to observe the technologies and to learn about them. This way, the optimal technologies can be identified and approved. The next step may then be to develop recommendations that are easy for the farmers to assimilate and implement. Finally, extension officers need to be trained to deliver the knowledge and recommendations to the farmers. In the case of improved seeds, extension officers should also teach the farmers to identify pests and diseases, to estimate the severity of infection and to choose the right varieties in order to anticipate that particular problem. A strong link has to be maintained between research and extension, in order to provide the extension agents of knowledge about the latest recommendations.

If the innovative technologies require certain inputs, the agricultural input supply system needs to be developed. Improved varieties need to
be available and accessible to smallholders at a fair price. The additional costs associated with the use of new technologies need to be paid back by the additional revenue these technologies generate. The success or failure of any technology often depends to a large extent on its profitability. Fertilisers and pesticides are often inaccessible due to the badly organised distribution sector, although it is not clear that the cost reductions achieved by improving the efficiency of distribution would be big enough to overcome the profitability problem.

Improved crop varieties and technologies did have an enormous impact in the developing world, but the benefits have not been distributed evenly. Bellon and Morris (2002) state that productivity gains associated with adoption of improved varieties originating from plant breeding research in the CGIAR have been concentrated in favourable production environments characterised by fertile soils, adequate and reliable water supplies, ready access to input and output markets, effective extension services, and economic policies that encouraged investment in improved crop production technology. Contrary to the criticism ventilated by many opponents of the Green Revolution, there has been substantial impact of improved wheat and rice varieties in marginal areas as well. But the development and distribution of these varieties then mainly depended on the presence of strong local breeding programmes to adapt exotic germplasm to local needs and environmental conditions and an effective extension service to reach the small farmers.

I would like to conclude that genetically improved crops – aimed at providing yield stability to small farmers and hereby reducing poverty – have potential, but by themselves are not sufficient. By providing poor people access to education, information and training to capitalise their knowledge, their bargaining power can be increased and they will be more able to stand up for themselves and improve their standard of life.

High heterogeneity among poor smallholders in developing countries implies small domains of application for any technology and a high development cost of different technologies adapted to every local context. Finding the necessary financial resources is still a major challenge for non-profit research programmes, certainly because in a lot
of left-winged milieus, genetic engineering is still a common object of moral concern.

**Selected References**

Food safety and international trade: a challenge for developing countries

ANTOINE KABWIT NGUZ

Department of Food Technology and Nutrition
Ghent University, Belgium
1. Introduction

The globalisation of food trade and increasing world-wide problems with emerging and re-emerging food borne pathogens and other chemical hazards have increased the risk of cross-border transmission of infectious agents. Because of the global nature of food production manufacturing and marketing, infection agents can be disseminated to remote areas or regions. This situation created the need of a well-organised international framework in order to cope with the emergence of (micro) biological and chemical hazards.

One main obstacle to food trade is the non-uniform food safety system and different levels of implementation of regulations pertaining to production, process and product standards.

Many benefits are linked to improving food safety including:

- Contributes to a wider variety of choice of nutritious food,
- Increases foreign currency assets of the exporting countries,
- Enhances in the long run the food safety system of exporting countries,
- Prevents food losses and contributes to food security,
- Contributes to the harmonisation of food regulations and standards based on international standards as per WTO /SPS (sanitary and phytosanitary measures) Agreement,
- Satisfies consumer demand for quality and safe food
- Contributes to consumer’s health protection.
- Promotes a country’s reputation

Achieving this requires an enhanced level of international co-operation in setting standards and regulations.

2. Strategy

2.1. Regulatory approach
The most used regulatory approach to improve food trade in the international arena (EU, NAFTA, APEC) is ideally harmonisation. Harmonisation deals with codes of practice, product and process standards, inspection methodology, control system equivalence, training and common position on SPS matters. However the standards developed are voluntary and cover only a limited number of SPS measures.

The most comprehensive approach to harmonisation is to establish, through multilateral bodies, internationally accepted reference standards for products and processes. The WTO/SPS Agreement directs countries to base their food safety measures on existing international standards, guidelines, or recommendations. Since several years, the Codex Alimentarius is working on the harmonisation of SPS measures related to food safety. It recommends increased reliance on international standards.

As per WTO SPS Agreement, countries are encouraged to base their food regulations on Codex standards as benchmark for international food trade.

Nevertheless, the purpose of harmonised standards is not so much to achieve identical regulations or standards but to converge international methods for developing and administering Codex standards.

In areas where no international standards exist, individual member country measures are allowed in the condition that they are based on a risk assessment and are non-discriminative.

Harmonisation is stated in Article 3 of the SPS Agreement through the adoption by countries of Codex International Standards. Article 4 discusses equivalency and Codex has recently set adequate rules. The development of regional standards is the result of mutual recognition and equivalency.

The regulatory process should **comprise**:

- a) Mutual recognition
- b) Equivalency
- c) Developing of reference standards
Mutual recognition or acceptance of regulations diversity in order to increase food trade volume in the world is the proposed model due to the different level of laws, regulations, codes of practices and enforcement among countries.

As developing countries have different capabilities of setting and enforcing different types of sanitary measures, the focus needs to be directed towards the outcome of the regulatory process rather than the form.

**Mutual** recognition is a longer-run dynamic of sequential strengthening of the rapprochement efforts among different countries. It will enable low standard countries to improve their food system thus offering more opportunities for trade.

This process will be efficient if coordinated by a single technical regional food safety body as shown with the EU experience. This approach allows for economising on the costs of SPS regulations without jeopardising human health, food security and trade.

When dealing with food safety as related to trade, two kinds of technical standards come into play. The first one concerns the voluntary standards promoted by private companies and international bodies including ISO and the second is mandated by respective governments, is meant to protect consumer’s health and is based on Codex or risk assessment.

Voluntary standards are nationally or internationally accepted procedures and guidelines adopted in order to maintain consistent quality. ISO 9000 is probably the most recognised voluntary standard in the world. It is important to emphasise that a voluntary standard, like ISO 9000, is not a substitute for either product safety or other regulatory requirements. Instead, a voluntary standard like ISO 9000 specifies the elements necessary for quality systems to consistently meet specifications.
2.2 Sanitary measures and equivalence

A sanitary measure is any requirement, procedure, criteria or system, either alone or in combination, that is applied to protect human life or health within a territory of a country from hazards in food, including additives, contaminants, toxins or disease-causing organisms in food or feedstuffs, or from risks otherwise arising from diseases carried by food which are animals, plants or products thereof\(^\text{11}\). Under the WTO SPS Agreement, sanitary measures include laws, decrees, regulations, procedures related to end-product criteria, production process and product standards, and testing and inspection.

Sanitary measures should be based on Codex standards and related texts. Product, production and process standards are enacted in the food law, decrees, regulations, and codes of practice, standards, guidelines and methods of analysis. Product standards e.g. refer to quality provisions, levels of chemical and microbiological criteria, nutritional requirements, labelling and methods of analysis. They also include a number of measures designed to protect the consumer against fraud.

Production and process standards deal with conformity assessment procedures, including technical procedures like testing, verification, laboratory accreditation, inspection and certification and sanitation practices like GAP, GHP, GMP and HACCP.

The individual sanitary measures that comprise food inspection and certification systems often vary from country to country. The reasons for such differences include differences in prevalence of particular food safety hazards, national choice about management of food safety risks and differences in the historical development of food control systems.

The application of a particular range of sanitary measures provides the level of protection actually afforded by a consumer population and can be described in quantitative or qualitative terms\(^\text{12}\).

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\(^{11}\) JOINT FAO/WHO FOOD STANDARDS PROGRAMME? CX/FICS 02/04

Thus the appropriate level of protection reflects a particular country’s public health goals in terms of management. In order to successfully conduct trade in food, regulatory authorities need to determine the effectiveness of sanitary measures associated with the food safety undertaken by the exporting country in achieving the legitimate appropriate level of sanitary protection (ALOP) of the importing country.

3. Mechanism for equivalence determination

Article 4 of WTO/SPS Agreement discusses equivalency and Codex has recently set adequate rules\(^\text{13}\). Applying the process of equivalence to food control sanitary measures provides the following benefits:

1. Helping to enhance food safety standards globally.
2. Encouraging scientific and risk-based approaches to food safety, to the mutual benefit of both exporting and importing countries.
3. Facilitating food control systems that apply innovative and cost-effective sanitary measures.
4. Decreasing reliance on routine end product testing (e.g. at port of entry), which may be of limited effectiveness in protecting public health.
5. Promoting harmonisation of international standards.
6. Enabling better allocation of limited resources based on assessment of actual risk associated with specific products or regions.
7. Eliminating duplication of regulatory controls and inspections by importing and exporting country and minimising resource-intensive port of entry inspections.
8. On-site product-by-product inspection tasks can be reduced and/or replaced by risk-based monitoring and verification.
9. Unnecessary paper documentation can be reduced, eliminating resource intensive registration, certification

\(^{13}\) JOINT FAO/WHO FOOD STANDARDS PROGRAMME? CX/FICS 02/04
and other documentation requirements that are not science-based and provide no identified food safety benefits.

10. This produces economic benefits for all partners, for industry and regulatory agencies resulting in lower process for consumers.

Equivalence assumes that sanitary measures from an exporting country, though different, achieve the same **appropriate level of sanitary protection of the importing country**. Then the importing country should allow goods to enter its market. An equivalence determination can be made on a measure or measures related to a specific product or category of product, or a system-wide basis.\(^\text{14}\)

Equivalence affords the same degree of protection to each country, but allows regulations or standards to be quantitatively different. It has the advantage of recognising the different circumstances under which countries protect their consumers and environments, while at the same time recognising the different conditions and factors that influence standard setting.

When conducting an equivalence process, **Food Safety Objectives (FSOs)**\(^\text{15}\) are used as they constitute the operational measures of the ALOP in food safety management (Figure 1). FSOs provide the necessary bridge between the ALOP and individual sanitary measures and thus set target for the control of hazards in food through the application of codes of practice or standards.

Food industry and control authorities can use FSO in estimating the “risk” as a definable goal for establishing a food safety management system that incorporates GMP, GHP and HACCP. FSOs provide a rationale on how and why a particular sanitary measure achieves, or contributes to the achievement of, a country’s ALOP. An FSO is a statement based on a risk analysis process that includes an expression of

\(^{14}\) JOINT FAO/WHO FOOD STANDARDS PROGRAMME? CX/FICS 02/04

\(^{15}\) The Principle of Equivalence, Food Control (1999), 261-265.
the level of (a) hazard(s) in food that is tolerable in relation to an appropriate level of consumer protection.

FSOs are important risk management activities derived from the result of risk assessments and they will enable flexibility for authorities and industry on how to manage and control food hazards. FSOs are useful tools in the process of equivalence determination and find their foundation in the sanitary measures of each country. FSOs have three components: the type of food, the hazard of concern and the ALOP.

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Food products</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chemical</td>
<td></td>
<td>Probability of adverse health effect consequential to a hazard(s) in food.</td>
</tr>
<tr>
<td>2. Microbiological</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Physical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Sanitary measures**
  - Food product(s)

- **FSOs**

- **Appropriate level of protection**
  - Number of tolerable incidences of food borne diseases per Mio inhabitant associated with a particular hazard or a particular food.

Figure 1. Food safety objectives components

FSOs provide the industry with a scientific basis for implementing measures deemed to control hazards of concern in food products and operations. Control authorities will use those measures to develop control, implement and monitor inspection procedures to assess the conformity and adequacy of control measures adopted by the food industry, determine the equivalence of inspection procedures in different
countries and facilitate the communication of risk management decisions to all stakeholders in food safety.

In the case of chemical hazards in food, an ALOP is usually predetermined by regulatory food safety policies, for instance “notional zero risk” in the case of residues for veterinary drugs or pesticides.

FSOs can be quantified by using the following relationship:

\[ H_0 + \sum R + \sum I \leq FSO \]

Where:

- \( H_0 \): is the initial level of the hazard,
- \( \sum R \): is the cumulative reduction of the hazard through processing.
- \( \sum I \): is the cumulative increase of the hazard through, handling, storage, transport and distribution.

4. Process of equivalence determination

The process for the determination of equivalence of sanitary measures related to inspection and certification systems include testing, inspection, certification and approval procedures, sampling procedures and methods of risk assessment, and packaging and labelling requirements directly related to food safety. This process, which applies when a country is willing to export, is given in Figure 2. It comprises a number of alternate steps between the exporting and the importing country through the usage of an agreed process for exchange of the information necessary to facilitate the determination of equivalence.
<table>
<thead>
<tr>
<th>EXPORTING COUNTRY</th>
<th>IMPORTING COUNTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify sanitary measures of the importing country related to food product.</td>
<td>3. Provides food safety objectives</td>
</tr>
<tr>
<td>2. Request for food safety objective (s)</td>
<td>I. Scientific basis of the sanitary measures under consideration, including risk assessment were appropriate.</td>
</tr>
<tr>
<td></td>
<td>II. Explain the goal and the reason behind the sanitary measure.</td>
</tr>
<tr>
<td></td>
<td>III. Clearly identify the risks the measures in question seeks to address.</td>
</tr>
<tr>
<td></td>
<td>IV. State the ALOP the sanitary measure(s) seeks to achieve.</td>
</tr>
<tr>
<td></td>
<td>V. The relationship of the sanitary measure was based, or the technical justification based on the regulation, guideline or relevant interventional recommendation.</td>
</tr>
<tr>
<td></td>
<td>VI. Attach a copy of the risk analysis upon which the sanitary measure was based, or a technical justification based on the regulation, guideline or relevant international recommendation.</td>
</tr>
<tr>
<td></td>
<td>VII. Provide any additional information, which may assist the exporting country in presenting an objective demonstration of the equivalence of its own sanitary measure(s).</td>
</tr>
<tr>
<td>4. Seek clarification if any/explanation of the importing country ALOP expressed as food safety objective (s)</td>
<td>5. Clarify food safety objective (s)</td>
</tr>
<tr>
<td>6. Develop a case for alternative sanitary</td>
<td>7. Evaluation based on risk assessment</td>
</tr>
</tbody>
</table>
5. Enforcement of food safety measures

Individual governmental regulatory systems can provide a framework for maintenance of food safety. Regulatory requirements establish limits and responsibilities but are of little value without effective enforcement. The trade of food and feed cannot be guaranteed without an efficient enforcement system of food control within the region.

As shown in the demonstration of equivalence, the enforcement will contribute to the alignment of standards and controls observance that contribute to assure confidence and transparency in the safety of food and feed and to safeguard consumer’s health.

The main objective of the enforcement is to improve capabilities at the member states level to enforce food safety norms according to Codex standards including:

Figure 2. Flowchart – Guidelines for the determination of equivalence.
1. Food additives
2. Food contaminants and heavy metals
3. Methods of analysis
4. Sampling methods
5. Import and export inspection and certification systems
6. Residues of veterinary drugs
7. Pesticide residues
8. Microbiological hazards
9. Labelling
10. Codes of practices
11. Allergens
12. Novel foods and GMOs
13. Product composition

Food control is the mandatory regulatory activity of enforcement by national or local authorities to provide consumer protection and ensure that food is safe with particular attention to export/import control.

An effective food enforcement system comprises four elements:

- An administration – developing countries should strive to introduce a well integrated, in line with the farm-to-table concept, and coordinated food control system. Integration and coordination of developing countries’ food safety system facilitates equivalence determination and improves SPS activities.
- An inspectorate – able to efficiently perform the following tasks:
  - Inspecting food premises
  - Instigating necessary action for non-compliance with regulations
  - Investigating food disease outbreaks
  - Giving advice to the food producing and processing sectors
The inspection should focus on a modern food assurance system based on methods of controlling and monitoring risks and encourage the food sector to adopt the HACCP technique.
- An analytical capacity is the basic requirement to monitor the quality and safety of food. Regional organisations should cooperate and designate regional reference accredited
laboratories that are vital for the region. Laboratories, private or governmental, should be accredited according to the ISO/IEC 25 Guide. Modalities need to be defined for the participation of private laboratories.

- At the regional level, the accredited reference laboratories have to be integrated in a network of laboratories of excellence with the aim of ensuring continuous monitoring of food safety and playing an important role in the prevention of potential health risks for citizens.

6. Conformity assessment

Conformity assessment systems are fundamentally important to consumer safety confidence in traded goods and are widely used as food control mechanism. The conformity assessment assures that processing and/or production controls are done adequately. The confidence of consumers in the safety, fitness for purpose and truth in labelling of their food supply depends in part on their perceptions of the effectiveness of food control measures.

A substantial proportion of world-wide trade in food and food products depends upon the use of inspection and certification systems. However, inspection and certification requirements can also significantly impede international trade in food and food products. Consequently, it is desirable that the design and application of the systems should reflect appropriate principles.

The WTO/SPS Agreement sets out principles, which include control, inspection and approval procedures. The Codex has developed guidelines, which set out the principles for food inspection systems as basis for aligning food inspections and minimising their adverse impacts on international trade, while at the same time ensuring that they afford an appropriate level of protection to consumers in the importing country.
7. Import/ export procedures

As the trade of food products is expected to increase in the world, it is necessary to lay down procedures for conformity assessment of food and food products meant for import and export. This should comprise the following:

7.1 Confidence building and system integrity

Procedures for assessing other parties’ conformity assessment procedures need to be put in place. This exercise provides information on whether the procedures used give confidence on the level of assurance that meets the requirements of the importing country. The conformity assessment addresses product, process, system or food processing:

- Conduction of on-site visits and evaluations of foreign food processors and producers;
- Obtaining of information concerning manufacturing practices (GAP, GMP, GHP);
- Requesting documentation from processors/producers concerning controls that affect product safety (HACCP) and compliance (microbiological, chemical, physical);
- When the assessment of risk has identified critical points in the production and processing systems, an exporting country should implement such production or processing controls;
- Provision for procedures to take corrective action if HACCP identifies breakdown in safety/quality system;
- Implementation of the quality management systems ISO9000 and ISO14000;
- Maintenance of up-to-date records.

7.2 Research and Exchange of information

Developing countries should establish and participate in a system of systematic exchange of information and build confidence in food safety related issues: food problem outbreaks, food products incriminated, food
borne illnesses and other relevant information. This should be done in accordance with the procedures set out in CAC/GL 19-1995, developed by the Codex Alimentarius Committee on Food Imports and Exports and Certification Systems. This exchange of information could be fruitful if each country supports the research and the collection of information on food borne diseases through epidemiological surveys. This will sustain the activities of this alert system.

The following topics should be addressed when conducting and reporting survey results:

- Microbiological safety of food
- Toxicity of chemicals in foods
- Novel foods and processes
- Pesticides
- Veterinary residues

The information collected should be communicated to WHO, FAO and OIE.

7.3 Product specifications

Exporting countries should have the necessary legislation, powers, resources and expertise to develop, implement and monitor a sanitary control program capable of ensuring that food for export is safe for human consumption and truthfully labelled. This will comprise:

- A complete list of all ingredients including components to establish the safety of the product and compliance with Codex, particular attention should be given to the presence of ingredients and components that may cause severe allergic reactions, new products of biotechnology or novel foods;
- Ensure that microbiological, chemical, physical and nutritional standards meet international regulations for the concerned products or category of products;
• Ensure that written sampling procedures, analytical methodology and limits for acceptance are in compliance with Codex standards;
• Maintain complete and up-to-date records for all products;
• Ensure the compliance of labelling with international regulations.

7.4 Certificate of analysis

The certificate of analysis should be issued by the competent authority or authorised body. The document should:
• Indicate the sampling procedure(s) and analytical methods used to ensure they are acceptable to the importing country;
• Employ an appropriate mechanism to ensure the integrity and adequacy of testing procedures and reports;
• Include the date, type of analysis, individuals/organisations conducting the analysis, product identification (include brand and lot number), competent authority or authorised person;
• Indicate that the lot was sampled recently and stored under good conditions that prevent any deterioration;
• Be randomly verifiable to assess the conformity compliance with importing country regulations;
• Be easily available upon request.

7.5 Exporting country laboratories

• The exporting country should assure that representative samples of food products have been analysed at a required point;
• Laboratories participating in the food and food products for export should be accredited;
• The laboratory should be accredited according to ISO/IEC Guide 58;
• The laboratories involved in official import and export control of foods should comply with ISO/IEC Guide 25:
- The use of internationally recognised analytical methods of protocols set out by Codex or other international standards organisations like AOAC, IDF, AACC, ISO, ICMSF;
- Validated by inter-laboratory method performance studies and shown to have a performance which is equivalent to that of the international standard method;
- Laboratories participating in food analysis for export or import should also be required to participate in relevant proficiency testing performance schemes;

7.6 Random sampling and analysis

Sampling procedures used in order to check and/or confirm the results of the certificates of analysis from the exporting country should be based on appropriate and agreed statistical based sampling plans:

- Chemical, microbiological, physical testing procedures
- Administered by the competent authority or authorised person
- Analyses should be done by internationally accredited laboratories
- Otherwise ensure that laboratories participating in export testing and related activities are adequately equipped, staffed by competent personnel and have demonstrated capacity to provide accurate testing results
- In any case verify the authenticity and accuracy of test reports and take appropriate action on false declarations and test reports.

7.7 Traceability and recall procedures

A well-detailed procedure should be established in order to:
- Set out mechanisms that provide for unique identification of homogenous lots or groups of products to facilitate sampling, testing and inspection;
- Mechanisms to ensure that lots found not to be in compliance are segregated;
7.8 Transportation and storage

Transportation and storage are important processes in the food chain so it is important that critical safety issues pertaining to these operations are addressed. The quality control and sanitary practices at the manufacturing level may be compromised by transportation or storage under non-hygienic conditions. Proper storage ensures that safe and wholesome food products reach the consumer.

Adequate measures to guarantee the quality of the food products should include:

- Inspection of carriers and warehouses: cleanliness
  - Foreign materials, glass, oil and chemicals;
  - Rodents, insects and other pests;
  - Wall, ceiling and floors integrity;
- Precooking the product or the utility environment for refrigerated/frozen products
- Maintenance of appropriate transportation and storage temperature for refrigerated and frozen products
- Sanitation programmes based on appropriate Codex codes of practices concerning, GMP, GHP and GMDP
- Monitoring and recording temperature programme

8. Safety Assurance and Quality Management Systems

The safety programme and activities should be applied to the complete food chain, from food production on the farm to the consumer. The production or manufacturing of safe food should be conform to the Codex ALINORM 97/13). This includes:
a) Control measures at source of production
b) Good product design and process control of critical parameters
c) Application of good manufacturing practice during receiving, production, processing, handling and distribution, storage, sale, preparation and use.
d) Implementation of preventive safety management systems because the effectiveness of microbial and chemical end product testing is limited.

The food industry has the responsibility for the production of safe food. The manufacturing of safe food is tackled by quality control and quality assurance. This is achieved by the hygienic design of equipment and factory, managerial commitment to safety and quality. This should be met through establishing policies and procedures that ensure the safety of its products. This is accomplished with the implementation of GAP, GMP, GHP, HACCP, MRA, QM; ISO 9000 series (9000-9004) and 14000 and TQM. The application of HACCP is compatible with the implementation of quality management systems, such as the ISO 9000 series and the system of choice in the management of food safety within these systems.

GMP covers the fundamental principles, procedures and means needed to design an environment suitable for the production of acceptable quality. GHP describes the basic hygienic measures that establishments should meet and which are the prerequisites to other approaches, in particular HACCP. GMP/GHP requirements have been developed by governments, Codex and the food industry in collaboration with other groups, food inspection and control authorities.

☐ **General GHP/requirements usually cover:**

- The hygienic design and construction of food processing/production premises
- The hygienic design, construction and proper use of machinery
- Sanitation, cleaning and disinfection procedures (including pest control)
- General hygienic and safety practices in food processing/production units
  - The microbial quality of raw foods
  - The hygienic operation of each process step
  - The hygiene of personnel and their training in the hygiene and safety of food
    - Communicable diseases
    - Injuries
    - Washing hands
    - Personal cleanliness and conduct
    - Controlled access

GMPs are the prerequisite for HACCP implementation.

- **Hazard Analysis Critical Control Point - HACCP**

HACCP is an internationally recognised safety assurance system for the food industry. It is an effective approach to establish good production, sanitation, and manufacturing practices that produce safe foods. HACCP is the reference linking together all safety related control measures into a single management system.

New approaches require that HACCP food safety measures be based on an assessment of risks to human health. In order to make risk based HACCP plans effective, the expected food safety outcome must be identified, using FSOs as essential tools in this process. FSOs provide the "target" for the HACCP plan, and a food safety outcome for the product as a result of the implementation of that plan.

- **ISO 9000-9004 Series of standards**

They refer to a cultural approach of an organisation that is focused on quality. They are based on the total commitment and participation of all members of the organisation aimed at continuous improvement in order to reach customer satisfaction. They provide a sound basis for the implementation of quality management.
ISO standards are equivalent to British Standards BS 5750:1987 and European Standards EN2000 series.

- **ISO 14000**

This standard takes into account the new consideration related to environmental protection and preservation.

- **Risk Assessment**

The changing patterns of food processing, supply and consumption and the emergence of new food borne pathogens and chemical toxicants have brought new challenges that require new approaches for managing food safety risks, despite the legislation and measures established by different countries.

RA (Figure 3) is a process that evaluates the likelihood that adverse human health effects will occur following exposure to biological, chemical or physical hazards. RA generates models, which will enable the changes in food processing, distribution and consumption to be assessed with regard to their influence on food poisoning potential.

RA is a management tool for government bodies and is used to define an appropriate level of protection and establish guidelines to ensure the supply of safe foods.

International and national institutions are more and more addressing food safety risk associated with biological, chemical and physical hazards. RA is used as a tool to minimise or decrease the risk. RA information is useful in determining hazards whose prevention, elimination or reduction to acceptable levels is necessary.

Risk assessment itself has two components, variability and uncertainty. Variability is due to biological difference observed in the same species, for instance not all people have the same size, weight, colour etc… and uncertainty deals with lack of knowledge.

It is agreed under the WTO/SPS Agreement that in case of uncertainty the principle of precaution should prevail.
9. Conclusion

The implementation of these tools can ease communication with food production and processing units and regulatory authorities especially at port of entry. It will also facilitate the collection of data needed for the determination of FSOs as required in international food trade. The practical determination of equivalence provisions of the WTO/SPS Agreement for food in international trade requires developing countries to develop the necessary skills.

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List of acronyms and abbreviations

AACC – American Association of Cereal Chemists
ALOP – Acceptable Level of Sanitary Protection
AOAC – American Organization of Analytical Chemists
FSO – Food Safety Objectives
FDA – Food and Drug Administration
GAP – Good Agricultural Practice
GHP – Good Hygiene Practice
GMP – Good Manufacturing Practice
HACCP – Hazard Analysis Critical Control Point
ICMSF – International Commission of Microbiology Specification for Foods
IDF – International Dairy federation
IAPC – Inter African Plant Convention
IPPC – International Plant Protection Convention
OIE – International Office of Epizootics
PCB – Polychlorinated
RA – Risk Assessment
SPS – Sanitary and Phytosanitary
QM – Quality Management
TQM – Total Quality Management
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