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New Avenues of Value Creation in the Agro-Food Sector

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NEW AVENUES OF VALUE CREATION IN THE AGRO-FOOD SECTOR

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NOTE

This paper was presented as part of the Programme of Work 2007-2008. It suggests some avenues to explore as new sources of value creation and capture in the agro-food sector.

The paper is illustrated by five case studies that were prepared in cooperation with the agro-food sector in several OECD countries. The principal author of the report is Céline Giner. Linda Fulponi assisted in the drafting. Shingo Kimura, Mauro Migotto and Michael Stennis participated in the background research for the paper.

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NEW AVENUES OF VALUE CREATION IN THE AGRO-FOOD SECTOR

Executive summary

1. This paper suggests some avenues to explore as new sources of value creation and capture in the agro-food sector. The range of opportunities for value creation is vast, and this paper does not pretend to be exhaustive. New strategies are being prepared by different stakeholders in the sector, in an uncertain and competitive context of globalisation where the expectations of consumers and society in general are evolving.

2. The first section of the paper highlights the fact that "conventional" products can be a source of value creation for the agro-food sector. Farmers, in particular, can take greater advantage of their role in the sector if they are active stakeholders in reorganising the value chain and if they participate in promoting certain "specific" characteristics of products. To illustrate this point, one of the case studies describes the emergence of alternative fruit and vegetable marketing channels in Japan. This first section shows that changes in the agro-food sector can be facilitated if governments support the introduction of appropriate signalling systems, if they allow flexible and innovative organisation systems to take root, and if they encourage cooperation among participants in the sector.

3. The second section deals with broadening the range of value creation options in the agro-food sector by fostering innovations that will translate into the introduction of new products on the market and the adoption of new production methods. The report looks at how farmers can be associated with this value creation process. The section is illustrated by four case studies on the development of new production methods and new products, in particular functional foods and bioproducts. The second section and its case studies illustrate the following points:

- The agro-food sector can take advantage of innovations developed in other sectors of the economy and/or it can invest in R&D activities.

- Government can boost the sector by facilitating innovation.

- Government can also help structures for private and public sector cooperation to emerge in certain areas.

4. The paper concludes with a discussion of the agro-food sector's capacity to become an innovative industry that will generate wealth for the entire economy.

I. Introduction

5. An analysis of the strategies available to farmers for creating and capturing value in the agro-food sector of OECD member countries is part of the Programme of Work 2007-2008. A distinction is frequently drawn between large-scale farming operations that can reap economies of scale, on one hand, and small, family-run farms on the other. In fact, however, agricultural production structures are heterogeneous. The process of value creation will differ from one producer to the next, and it is difficult to define standard strategies that will allow farmers to maximise their revenues over the short, medium and long terms, or simply to remain economically viable. Even if agricultural commodity prices remain persistently higher than in the past, farmers in OECD countries are likely to face an uncertain and competitive environment. This could result from a combination of factors including, among others, the gradual removal of farm subsidies, the growing power of large retail chains and multinational agro-food companies, the progressive liberalisation of international trade, and the resulting competition from developing countries.

6. In this context, farmers will need to look at all the possibilities for value creation and capture. Given the complex linkages between the different activities in the agro-food chain, it is impossible to appreciate the value creation process for farmers in isolation from other participants in the chain. The role of farmers in the agro-food system will have to evolve, then, and this means that innovative and appropriate organisational structures for linking farmers to processors, retailers and the scientific research community will have to be developed.

7. The approach to governance in the agro-food chain will also have to change to keep up with consumer expectations. Society now insists that the industry guarantee not only food safety but a whole range of complementary objectives relating to health or the preservation of resources and the environment. The agricultural sector must offer products adapted to consumer needs. These products may take the form of "conventional" products, with emphasis on certain attributes such as quality, the method of production, or the marketing system. The form of organisation selected within the chain will then determine the possibilities of creating value for producers. Shifting social expectations in terms of health and environmental concerns should also spark the development of innovative products that are quite different from those traditionally offered by the agro-food sector. Innovation should lead to the development of new production techniques and a to steady market supply of bioproducts made from renewable resources, as well as functional foods and food components that can offer greater health benefits than ordinary foods.

8. Bioproducts embrace far more than food products. The term can be applied to construction materials such as biomaterials, "green" chemical products, or biofuels produced from biomass. The development of bioproducts will require specific investments in research and development (R&D) in order to bring innovations to market. Such innovations should become feasible with the diminishing cost of new technologies and with collaboration among the various stakeholders: farmers, private R&D firms, specific industries, and government.

9. The main purpose of this report is to offer delegations some avenues to explore as new sources of value creation and capture in the agro-food sector, in an uncertain and competitive context of globalisation. It does not pretend to be exhaustive. The range of opportunities for value creation is vast, and farmers will choose their solutions in light of their specific circumstances. However, their choice will result from a combination between positioning the farmer within the agro-food chain and orienting output in response to consumer demand.

10. The first section of the report seeks to understand the ways in which the agro-food sector, and farmers in particular, can respond appropriately to shifting consumer expectations through a focus on

"conventional" products. Highlighting specific characteristics and reorganising the agro-food chain could allow farmers to reinforce their role in the sector.

11. The second section of the report discusses how the agro-food sector can broaden its options through innovations that involve, among other things, the development of new products or the use of new farming techniques. The potential for farmers to take advantage of these innovations is analyzed, with particular attention to the need for appropriate organisational structures that may take the form of networks linking the various participants in the sector.

12. One objective of the report is to consider the extent to which agro-food could in the future become an innovative industry that generates wealth for the entire economy. It will be shown that governments can facilitate the innovation process and the choices made by farmers and the agro-food sector as a whole.

II. "Conventional" products and value creation

13. Consumers may entertain many expectations about their food. One thing is certain, however: consumers want food that is safe from a health viewpoint.[1] Next come such considerations as price, convenience, taste, quality, method of manufacture and marketing, nutritional value, and the origin of products (Blandford 2000).

II.1. Signalling product characteristics

14. One illustration of a differentiation strategy is to signal certain characteristics of a product, such as its geographic origin, quality, method of production, marketing or processing, as attributes for which some consumers are willing to pay a higher price. Product differentiation and value creation are central themes of general theories of marketing (Lindgreen and Wynstra 2005). The purpose of differentiation is to place on the market a product that is similar to an existing one but not readily comparable to its competitors.

15. In the agro-food business, consumers are not usually in a position to assess the truthfulness of information on product characteristics. There is a degree of information asymmetry here. To maintain consumer confidence, characteristics are often indicated on a label, *i.e.* on an attribute that signals characteristics not visible upon purchase. These characteristics, which correspond to specific production characteristics, are subject to controls during the production and marketing cycle by an official independent agency that guarantees the reliability and the veracity of the label. Such signals can generate value, as measured by the willingness of consumers to pay a premium for a labelled product over a standard one (Loureiro and McCluskey, 2000).

16. Quality labels or protected indications of origin have long been among the characteristics that consumers look for in purchasing food products (OECD 2000). Label-based differentiation strategies for food products are discussed in the paper on "Creation and Capture of Value in Sectors of the Agro-food Industry: Strategies and Governance"[TAD/CA/APM/WP(2007)16]. This paper stresses the importance that the forms of organisation associated with the signalling of a product's specific features will have for value creation. Producers will derive greater advantage from the quality signal if they control it, either directly or through the intermediary of a producers' cooperative.

[1] The results of a survey of consumer organisations, reported in document AGR/CA/APM(2004)22, "Changing Food Lifestyles", showed that consumers expect governments to address their concerns over specific problems such as food safety (70%) and food labelling (65%).

17. New consumer expectations with respect to health and environmental preservation are giving rise to new kinds of labels for food products. These labels may provide information on the fairness of the product, its nutritional value, its production methods, its respect for the environment, or its use of genetically modified organisms. From their empirical study of these new food labels, McCluskey and Loureiro (2003) note that concerned consumers will be willing to pay a premium for products bearing these new labels only if they are convinced of their quality. Society's evolving concerns are creating new market niche opportunities in the agro-food business. Price and quality, however, remain the determining elements of consumer choice.

II.2. "Alternative" forms of marketing

18. Consumers often drive new agro-food product development (Linnemann *et al*, 2006), and can even initiate it (Winter, 2003). Consumer concerns over preservation of the environment, together with health worries, may lead some people to consume "differently" (Toyne *et al*, 2004 ; DuPuis, 2006 ; DuPuis and Goodman, 2005).

19. "Consuming differently" can take several forms: buying organic products, foods with little processing, or goods that are fair-traded, or reducing the distance between the place of production and the place of consumption. The value chains resulting from this new consumer movement cannot be regarded as competing with the dominant value chains in the agro-food sector, but they offer some innovative characteristics in terms of production, marketing method and organisation.

20. One of the common features of alternative value chains is that they bring the production and consumption functions closer together. This involves "short-circuiting" the middlemen. Products are sold in a more direct manner, and this allows farmers (often small or medium-scale producers) to improve their incomes.

21. Farmers' markets are an example of "alternative" form of marketing. In the United States, the number of such markets rose from 1 785 in 1994 to 4 500 in 2007, and sales amount now to a billion dollars a year. Farmers' markets give consumers access to fresh products. Organising them demands sound infrastructure. The National Farmer's Market Coalition[2] was established in 2003 with support from the USDA Agricultural Marketing Service and the North American Farm Direct Marketing Association, to encourage the sharing of information and good practices in the development of farmers' markets. Value creation opportunities generated by this type of direct marketing can impose some constraints on participating farmers. According to Lawson *et al*. (2008), who examined the progress of farmers' markets in New Zealand, one requirement for their survival is strong cooperation among vendors.

22. Another "alternative" marketing possibility for agro-food products is through the direct sale of baskets of farm produce. This seldom requires cooperation among several producers. The producer undertakes to supply one or several groups of consumers. The consumers, in turn, undertake to purchase a share of the season's output at a price set in advance, and that share will be delivered in weekly baskets during the harvest period. Consumers in this way shoulder a portion of the climatic risk. The farmer consults his consumers in deciding what to produce. These marketing approaches demand a close relationship between the farmer and the representative of the consumers' group, and it must be based on mutual trust.

23. This concept of marketing fresh produce first appeared in Japan in the 1960s (see case study A-I, dealing with the development of alternative food distribution channels in Japan), it was taken up in Anglo-

[2] http://www.farmersmarketcoalition.org/ .

Saxon countries in the 1980s, and a number of European countries have pursued it since the early years of this decade. It concerns primarily fruits and vegetables, but also dairy and meat products. Processed foods account for a relatively small share. In 2007, according to Alliance PEC, a French coordination network, nearly 900 farmers and 100 000 consumers were involved in these forms of marketing in France,[3] and 1 700 farmers and 500 000 consumers in the United States.

24. As with farmers' markets, "basket sales" are of anecdotal interest in terms of marketing possibilities for farmers: although potentially profitable, they are very labour-intensive, as the farmer bears the burden of marketing his output. This channel also imposes constraints on consumers, who will not be able to make all their food purchases at the same place, but it seems to be in tune with growing civic concerns about consumption, and its future is fairly promising.

25. With the alternative marketing channels described above, farmers can garner the bulk of the economic benefits from marketing their products. The absence of intermediaries and the relationship of trust between producer and consumer suggest that farmers can expect higher margins. Although they are of marginal importance in the global scheme of things, these alternative practices are spreading quickly. In Japan, for example, with the diversification of consumer demand, alternative marketing channels for food products have expanded rapidly in the last few decades. Whereas wholesalers distributed 82% of fresh fruits and vegetables in 1990, their share was reduced to 65% by 2005. These alternative marketing channels in Japan are the subject of case study A-I appended to this report.

26. It is a difficult matter, however, to predict the future of "alternative" forms of marketing. A number of questions hang over that future. How can a relationship of trust between producers and consumers be established on a large scale? Will information asymmetries between consumers and producers lead to distortions? Do these channels need to be controlled by the State or by independent official agencies?

II.3. Suitable governance structures

27. The premium commanded by products that have specific attributes valued by consumers will tend to diminish as production expands. Thus, in order to protect their margins, farmers often attempt to build solid governance structures that will allow them to derive maximum advantage from signalling their products' particular characteristics.

28. Among the most successful differentiation strategies are those based on signalling certain characteristics of products, where producers are organised collectively. Box 4 of document TAD/CA/APM/WP(2007)16 describe the experience with the *Savéol* trademark that was developed by French tomato growers' cooperatives. *Savéol* is an expression of the "collective entrepreneurship" defined by Cook and Plunkett (2006), as an emerging phenomenon in farmer-led organisations. This entrepreneurial spirit seeks to capture rents at different levels through reliance on innovation, the search for new opportunities, and a capacity to appreciate the risks.

29. "Traditional" cooperatives, established primarily to allow economies of scale, are not very competitive against more flexible enterprises on innovative product markets (Hanf and Pieniadz, 2007). To address these problems, "new-generation cooperatives"[4] (NGC) have sprung up over the last 20 years (Waner, 2000). Farmers are stakeholders in the cooperative. They share the risks and the profits and they

[3] The consumers are based primarily in the Provence-Alpes-Côte d'Azur region and in the larger cities.

[4] NGCs differed from "traditional" cooperatives in that they have a limited number of members who own specific delivery rights based on the number of shares they hold. Those shares, which can be transferred, determine members' returns and give them a democratic voice in decision-making.

have an incentive to make the system workable and competitive (Chaddad and Cook, 2004). The new forms of farmers' organisations sometimes run afoul of existing legal provisions, which are not adapted to these "hybrid"[5] entities. In fact, these organisations need to develop not only new forms of financial and intellectual property but also structures that can segregate and limit the risks for the different parties.

30. Appropriate governance structures that can allow an enterprise to retain control over its output and to develop its expertise will open new opportunities for the agro-food sector (Gow *et al*. 2002, 2003). This means that participants in the sector must exploit their core competencies and cooperate with other entities that have the knowledge of various kinds needed to develop the business, for example in the field of marketing or processing. This complex process shows that farmers can drive the value creation process if they know how to play a leading role in the sector. According to Goldsmith and Gow (2005), the governance structure does not create value as such, but it can facilitate value creation. Thus, while the choice of vertical coordination within the supply chain seems to allow a farmers' organisation to capture all the benefits, it still creates some important managerial constraints. These constraints can be overcome, and information can be accessed quickly and directly by moving to quasi-integration through alliances with strategic partners, or the creation of "net chains".[6]

II.4. A role for government?

31. Considerations relating to consumer concerns and value creation opportunities in the agro-food sector involve private players primarily: farmers, processors, and retailers. However, in OECD countries the farm sector is characterised by heavy government intervention. Government can play a role in determining all the possibilities offered by shifting consumer expectations. It can support the development of labels by establishing appropriate public or private frameworks. These labels need to be understandable and reliable. Crespi and Marette (2003) describe the potential cost problems with public labelling in particular. The government can also foster alternative marketing methods by facilitating their implementation and providing the necessary controls. In addition, flexible and forward-looking governance structures can only be established if the legal framework is appropriate.

32. Government can also encourage cooperation among participants in the sector. This is happening in the United Kingdom. Since the hoof-and-mouth crisis, there has been an interest in understanding how farmers can create and capture more value within the agro-food system. The "Sustainable Farming and Food Strategy"[7] was designed on the basis of the Curry Report,[8] which called for reconnecting the agro-food chain with customers. It seeks to bring farmers, processors and retailers together, through the independent English Farming and Food Partnerships[9] (EFFP) organisation, which works directly with farmers' associations and willing agro-food firms.

33. EFFP offers practical advice for value creation through, for example, developing industrial solutions that meet consumer needs: these solutions are based on cooperation between participants in the chain. EFFP focuses in particular on supplying the public sector and promoting the production and

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5 The term "hybrid" is taken from Ménard (2007).

6 Net chains are complex networks that link producers to input suppliers, processors and consumers, horizontally and vertically (Lazzarini *et al*, 2001)

7 http://www.defra.gov.uk/farm/policy/sustain/index.htm.

8 The report of the "Policy Commission on the Future of Farming and Food" (2003), chaired by Sir Don Curry, is commonly called the Curry Report. It is available at http://archive.cabinetoffice.gov.uk/farming/

9 www.effp.com

marketing of local goods. EFFP works with the Dairy Farmers of Britain (DFOB, a dairy cooperative)[10] to strengthen its organisation through training and work-study programs. The intent is to allow DFOB members to enhance the profitability of their output and to advise DFOB in its strategic choices, i.e. investments in processing facilities and in the development of dairy products and their associated brands.

II.5. The outlook for farmers

34. The initial success of the "LocalChoice" fresh milk brand,[11] launched by Tesco in cooperation with DFOB in May 2007, points to the potential for greater collaboration within the chain between the member producers of DFOB and retailers. Small family farms belonging to DFOB that participate in the "LocalChoice" operation are finding that they can sell their milk at a premium through Tesco.[12] The cooperative processes and packages the milk at sites close to the source farms, and then sells it at a higher price than the retailer's "standard" milk in nearby stores under the "LocalChoice" trademark.

35. This initiative is interesting from several viewpoints. First, it highlights the sales growth potential for locally produced goods that are marketed as such. Next, it shows how the entire agro-food chain can benefit. The "LocalChoice" brand gives DFOB member farmers the chance to increase their revenues without changing the characteristics of their output (hence at lower cost), and it allows Tesco to boast of its support to the dairy industry in the United Kingdom and its willingness to offer its customers "local" products. The organisational structures of DFOB and of Tesco ensure that the milk sold under the "LocalChoice" brand is processed and marketed close to source.

36. The "LocalChoice" example shows that producers can also use differentiation strategies to create and capture value, even if they do not enjoy economies of scale. In general, such a strategy requires that farmers organise themselves into a collective in a structured way. Differentiation strategies for "conventional" food products are finding favour with consumers and can be used in one way or another to increase farmers' revenues.

37. What is the future outlook for these strategies? For any given product, growth in demand may be limited by the low price-elasticity of demand for quality and for other aspects such as environmental concerns. But by informing consumers and anticipating their needs, the agro-food sector may be able to attract new customer groups to differentiated versions of "conventional" products that are often implicitly considered elitist.

38. Among the threats to the economic viability of betting on products "adapted" to consumer demand is the need to maintain consumer trust in the systems used for signalling product characteristics. Independent certification agencies that will verify respect for the specifications are therefore particularly important. This underlines once again the need for suitable organisation structures.

39. Then too, products can be readily imitated internationally as average quality levels rise. New market entrants in developing countries are using similar strategies, for example organic production and fair trade. If there are too many differentiated products, the impact of signals to consumers could be compromised.

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10 DFOB has 2,600 member dairy operations in England and Wales and employs 2 750 people. It has 60 distribution depots and 10 processing sites in the United Kingdom

11 Currently, 500 000 litres of "LocalChoice" milk are sold weekly.

12 According to DFOB (http://www.dfobmember.co.uk/DocFrame/DocView.asp?id=361&sec=-1), the premium that farmers earned from selling their milk under a "LocalChoice" contract averaged one pence a litre in November 2007

40. Highlighting the specific characteristics of "conventional" products is not the only way to respond to shifting social expectations. Another promising approach is resort to innovation, with the development of new products and new production methods. Innovations, and all the opportunities they open, are the subject of the second section of this report.

III. Innovation and value creation

41. With the globalisation of markets, agro-food enterprises will find themselves obliged to operate in an environment that is increasingly competitive, whether in terms of price or the development of new attributes, new markets, or new procedures. These new elements will result from innovations that generally take place far from the farm. In this context, agro-food enterprises have already begun to adapt, and some have shown success. They do so by expanding their field of activity, for example by forging alliances within the sector or with firms in other sectors. They have also instituted new operating models and new forms of organisation and cooperation.

42. In addition, firms are investing in new technologies relating to equipment, competencies and processes, and they are modifying all the techniques and processes used to enhance productivity and profitability in light of new market configurations. All these changes are being made possible through innovation or R&D activities that are being pursued upstream and downstream from the farm, and often in sectors of the economy that have nothing to do with agriculture. The innovations available to farmers can help them remain competitive even in the face of shifting demand and market trends. The linkages between a competitive farm sector and innovation could therefore be crucial for allowing the sector to create value, or simply to remain competitive.

43. This section of the paper discusses the linkages between innovation and value creation in the agro-food sector, and on the farm in particular. It is illustrated by some case studies presented in the Annex. It first discusses the concept of innovation in the economy, and presents a framework for understanding how innovative activities begin and the possibilities for governments to support these activities. It goes on to present a selective overview of new production methods and new products now being developed in the sector. These new products may be intended primarily to improve health or to replace certain products that rely on non-renewable resources.

III.1. The wellsprings of innovation

44. Innovation is now recognised as one of the key elements of long-term economic growth, as it gives rise to new products, new procedures, and new markets. It is an aspect of private sector activities that are driven primarily by market competition. In contrast to most economic activities, the costs and benefits of a given investment cannot be known in advance. Innovation activities are uncertain in terms of outcomes, and they are complex. They depend on basic scientific research, on accumulated knowledge, and on experience ("learning by doing") (Dosi, 1988; Baptista and Swann, 1998). However, it is important to understand how innovation can be stimulated by policies to promote the innovation efforts of firms.

45. A common theme of neoclassical economics is the "demand pull" approach. Enterprises respond to new consumer demands or expectations for goods and services that do not yet exist. Latent opportunities for future profits will steer firms toward certain choices relating to innovation or R&D investment decisions. This presupposes that there is a mechanism for recognising and understanding consumers' needs, and a set of available technologies and products that can meet their demand. The "supply push" approach, according to which the supply or availability of know-how is the engine of technological progress or innovation is likewise a simplification: R&D spending gives birth to new products and

processes that consumers need and are willing to pay for. These linear approaches to innovation are subject to criticism (Freeman and Louca, 2001; Teece, 1989).

46. The specific determinants of any given innovation can be difficult to identify. Innovations often occur when a firm perceives an anomaly in its normal course of activity. Firms generally follow predefined routines when they launch into R&D activities. It is the problems encountered and the work needed to resolve them that will indicate the areas where resources must be reinforced, and the paths to take or avoid (Teece, 2008). These routine activities are technological paradigms that guide the trajectories selected for research (Dosi, 1982). However, firms also look outside these paradigms, and excellent firms will seek to identify opportunities and to use specialised technologies and assets to create "new combinations" or innovations (Teece).

47. Even if innovations are developed at the level of the firm, they operate in an economic and institutional environment that may be more or less favourable to research activities. This framework can be of national scope, but also regional and even local, as described below. Firms must conduct their R&D in an environment propitious to achieving innovations that are both necessary and financially feasible. These aspects have been examined in the context of national innovation systems and in the study of comparative country performances with respect to R&D productivity (Nelson, 1993; Rosenberg, 1995; Stern *et al.*, 2000).

48. Research has shown that even if R&D activities are dispersed around the planet, their specific location seems to be one of the determinants of firms' capacity to create "new" technological advances. This difference has been attributed to different national innovative capacities (Stern *et al.*, 2000). National innovative capacity is defined as a country's aptitude to produce and commercialise a flow of innovative technology over the long term (Stern *et al.*, 2000). It demands an interconnected set of investments and political commitments and resources that will support new technologies and the innovative character of the economy as a whole. In this context, firms can benefit from favourable economic and institutional infrastructure (Rosenberg, 1972 ; Nelson, 1993 ; Nelson and Rosenberg, 1994 ; Stern *et al.*, 2000).[13]

49. Similar frameworks at the regional and local level have been suggested as necessary to thinking about innovation. In this context, localised institutional factors and local and regional infrastructure can determine innovation capacity in a given place (Rodriguez-Pose and Crescenzi, 2005). This capacity to innovate locally can be revealed by the presence of clusters of firms in a given territory, often centred around a scientific institution, and initiating innovative activities. Krugman (1991), in a manner similar to Becattini (1987), develops a theory of regional specialisation of industrial activities based on pools of skilled labour and on intermediate goods.[14]

50. What characterises a cluster is its capacity to generate positive externalities. This is due to various factors: 1) the creation of a pool of qualified workers with common skills; 2) the availability of all the necessary inputs, at low cost, when demand rises; and 3) spillover effects from the exchange of information and experience between firms in the cluster. These induced effects, which can take either formal or informal shape, are important to innovation because they supply a technological infrastructure base (Baptista and Swann, 1998). This means that clusters in a given industry can make use of these externalities and create a more effective and productive economic environment for their operations and R&D activities.

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13 The three theoretical structures underlying the national innovative capacity are: 1, national innovation systems (Nelson 1993); 2, endogenous growth sparked by knowledge (Romer 1990); and 3, the paradigm of competitive advantage of a nation’s industry (Porter 1990).

14 Marshall initiated the idea that location can be a source of positive externalities in 1920.

51. These innovative clusters clearly benefit from a strong innovation capacity at the national level, which is where they operate. The national innovative capacity is reflected not only in the level of R&D spending but also in the development of human capital through greater investment in education. Other incentives at the local level can create synergies with national macroeconomic policies to enhance the benefits derived from clusters and innovations. The role of government here is to see to the constant renewal of an environment favourable to innovative activities, and to improve the competitiveness of firms in the clusters.

III.2. Implications for the agro-food sector

52. Generally speaking, farmers do not engage directly in research and development. They adopt innovations generated in other sectors of the economy, for example in the chemical industry, transportation, or new information and communication technologies (ICT). They benefit from the enhanced productivity that these innovations produce, as well as from possibilities of accessing new markets or developing new attributes for their products.

53. Just as there is no single value creation process within the agro-food sector, there is no single path to innovation. The innovations that flow from shifting social concerns can take many forms: innovations in production methods, sparked among other things by the declining costs of new technologies; innovations in the products manufactured by the sector, in particular through the development of new products aimed at health or at non-food uses. The next three subsections offer a selective overview of developments underway in the agro-food sector in these fields, and examine the outlook for the sector as a whole, and for farmers in particular.

III.3. New methods of production and value creation

54. With the development of new production techniques, farmers can respond to social concerns over environmental sustainability and at the same time they can participate in the value creation process by lowering their production costs. The boom in information and communication technologies (ICT) and their associated innovations in agriculture in fact presage profound changes in agricultural production systems.

55. Thus, recent years have seen the emergence of precision agriculture, which consists of fine-tuning the management of each plot of land in light of its specific agronomic and climatic features. It uses new technologies such as computer programs and satellite data to optimise crop performance in ways that will preserve the environment and increase producer margins. For example, it can be used to determine the proper dose of fertiliser or to limit irrigation, or to track the productivity of plants.

56. Fountas *et al.* (2005) note that the adoption of precision agriculture is being held back by the learning needs of farmers and the efforts required to master the techniques. Yet as their costs decline, these new technologies now offer a significant range of choices for enhancing operational efficiency and reducing the environmental impact of farming.

57. Case study A-II, appended to this report, gives an example of drip irrigation and fertigation techniques that make use of nuclear technologies to create added value in the growing of potatoes in Turkey and to reduce its environmental impact. The study shows that the judicious use of new technologies apparently far removed from the agricultural sector can serve two objectives, an economic one and an environmental one, but that it demands strong commitment from the stakeholders concerned.

58. The development of new production techniques often requires significant financial investments in R&D. As will be seen in the Turkish case study (A-II), public funding or public-private partnerships may be needed, at least in part, to finance such developments and enable farmers to adopt them.

59. The OECD report (2008b) notes that much remains to be done for a substantial improvement in the efficiency of agricultural production from an environmental viewpoint. Fewer than half of OECD countries are monitoring changes in terms of environmental management practices in farming. In this context, international cooperation in developing new farming methods and promoting their adoption by farmers (for example by creating research funds, credits and training for producers who adopt these new technologies) could speed the sector's moves to accommodate environmental issues and could help farmers lower their production costs.

60. In most cases, farmers will not be the ones who develop the innovations that give rise to new production methods. They will therefore have to adopt these innovations, and this will imply a certain financial and learning cost. Their choice in the end will be determined by the perceived cost-benefit ratio.

III.4. The bioeconomy and value creation

61. Can farmers share directly in the new value creation paradigm? In principle, there would seem to be a place for innovative clusters focusing on agriculture at the regional level. These clusters may be geared to conventional agro-food production, but the value creation opportunities would appear to be greater if products are entirely revamped.

III.4.1. Innovation and bioproducts

62. The growing demand for products derived from renewable resources, in particular for nonfood purposes, it is a powerful driver of innovation and technical progress in the agro-food sector. Many bioproducts have been developed in recent years. Society sees them as potential ways of encouraging environmental and industrial sustainability. The notion of the "bioeconomy" has emerged as a way of describing the development of bioproducts, and it is indeed the subject of a major project under the OECD International Futures Program (IFP): "The Bioeconomy to 2030".

63. The OECD report (2006) defines the bioeconomy as the aggregate set of economic activities that use the latent value in biological products and processes to capture new growth and welfare benefits for citizens and nations. These benefits derive from productivity gains, the health effects of certain bioproducts, substitution effects vis-à-vis existing technologies, and the sustainable and respectful use of resources.

64. The bioeconomy is being made possible by the swift advance of scientific and technical knowledge. Its dynamism is facilitated by declining R&D costs, by the variety of bioeconomy applications, and by the heavy involvement of all stakeholders, from individual citizens to government and including large industrial groups and farmers. In this context, new technologies are enhancing prospects for the agriculture sector.

65. The growing output of first-generation biofuels over the last five years illustrates the boom in bioproducts. Policy initiatives in the OECD countries have contributed to this development, and to the surge in raw material prices, which are likely to remain high in coming years (OECD 2008a; OECD 2008c). The development of first-generation biofuels is placing non-food uses of agricultural products in competition with food uses. This could change in the future, with the development of new non-food products in the bioeconomy.

III.4.2. New opportunities for value creation

66. With improved bio-refining processes, i.e. processes for processing biomass in its entirety, plant products could be used for both food and non-food purposes. Basic agricultural ingredients could be

processed into a series of products including food, gasoline, construction materials or "green" chemical industry inputs.

Box 1. Prospects for second-generation biofuels

The OECD report (2008a) gives a detailed description of prospects for the development of second-generation biofuels.

What technology should be used?

The technology for producing second-generation biofuels is still a work in progress. It relies on refining the biomass. Pilot facilities and demonstration projects are being mounted or tested in Canada, France, Germany and in the United States. In the end, the technology that will be adopted on a large scale in the future will depend on the results of these tests. Two technologies are currently in competition: cellulosic ethanol and Biomass to Liquid (BtL). The opportunities for value creation in the agriculture sector are not yet known, but they are likely to be considerable.

Given social concerns over climate change and the environment, the definition, development and implementation of second-generation biofuels technology must look beyond questions of economic profitability and value creation and address ecological performance as well.

Where should second-generation biofuels be produced?

If the biomass is of agricultural or forestry origin, then production facilities will have to be located close to regions with a strong agricultural or forestry potential. The feedstocks for these factories will come directly from farms or forests, or from plants that process agricultural raw materials. Farmers will therefore have an edge as suppliers, and they should benefit from this status. Of course, once the technology is developed, the profitability of biorefineries will depend on where they are located and on economies of scale.

What is the outlook for farmers?

If the new second-generation biofuels technologies can make use of agricultural wastes that would otherwise find little or no use, a new market could emerge. Farmers could resell materials that were previously of no value and which they may even have had to pay to get rid of. For farmers, it will be a question of alternate uses for these wastes. In fact, farm wastes can be used to some extent as organic fertiliser.

Moreover, if lower-yield farmlands are used to produce tree varieties that mature quickly or non-traditional agricultural crops such as switchgrass or miscanthus, there could be significant value creation opportunities for farmers. These lands would then be used solely for nonfood purposes, and this could have unknown effects on the prices of food commodities. One of the potential problems with these new crops is the cost of installation: in the initial years, they will earn little or nothing. Moreover, a proper crop rotation system would be needed to contain the impact on biodiversity, for example.

67. The second generation of biofuels should be based on technologies for transforming biomass. The biomass used could take the form of farm or forestry wastes, specific species of trees or plants that could be planted on less productive farmland[15], or even organic wastes or algae. Box 1 reviews briefly some prospects associated with second-generation biofuels development. Of course, non-food uses of farm products are not confined to first- and second-generation biofuels. Bioproducts such as natural construction materials, solvents of plant origin, and green chemicals of all kinds are expanding rapidly. This development will require the agro-food sector to innovate profoundly with the development of new technologies.

[15] Less productive farmland may require less intensive farming techniques to avoid degradation of the soil and the disturbance of potentially fragile ecosystems.

68. The development of innovative processes is illustrated in case study A-III, which describes the French agroindustrial cluster known as the "*Pôle de compétitivité Industries et Agro-Ressources"*. The ARD company, which is part of this cluster, is developing patents related to plant chemistry, often in partnership with public research and industry. Its subsidiary Soliance handles the production and marketing of the associated products.

III.4.3. Networking to take advantage of innovation

69. Farmers can profit from the development of these high value-added products by participating in the technological innovation process. This will only be possible through appropriate forms of organisation. In the case of ARD, farmers have a shareholding interest, through their cooperatives, in the R&D enterprise.

70. If non-food uses of agricultural products involve converting the entire product, it would seem necessary that all the processing of the same initial product should take place in factories located nearby, in order to reduce or eliminate transport and storage costs between the different stages of processing. This need is also illustrated in the A-III case study with the Pomacle site in the Champagne-Ardennes region of France, where all the activities involved in processing sugar beets and wheat for food and non-food uses are concentrated in the same zone.

71. The "*Industries et Agro-Ressources*" (IAR) cluster links product innovation with organisational innovation. It is in effect a network of interconnected stakeholders including public research institutes, R&D firms, industry and farmers' cooperatives. It illustrates the fact that new product development is often supported by innovative organisational structures. Research into competition strategies has shown that successful firms tend to cluster geographically near research centres. Over time, these effects can be cumulative because of the positive spill-over and synergies generated. It is very difficult to predict the future of bioeconomy clusters, as their networks are still in the process of formation.

72. One thing is certain: these clusters are likely to take root in agricultural regions, where they should bring benefits to farmers and the local economy in terms of income and employment through product development or through induced demand from processing industries. It is in this context that the potential role of government in supporting the establishment of clusters and innovative activities can best be understood. In the case of the IAR cluster, the government is a major player and it finances a portion of the innovation projects. Thanks to the new information and communication technologies, the location of innovation-related activities could become less important as a factor. Long-distance networks could develop. For example, the IAR cluster is collaborating with research centres and firms in other regions of France and even abroad.

III.5. Innovation and functional foods

73. Shifting expectations of the society are driving the agro-food sector to develop new products that can improve the health of the people who consume them. The term "functional foods"[16] is applied to foods or dietary components that may provide a health benefit beyond basic nutrition. The food industry has long recognised the opportunity to offer consumers food products with certain specific nutritional features, in particular with respect to health.

[16] The International Food Information Council (IFIC) foundation provide specific information on functional foods at http://www.ific.org/nutrition/functional/index.cfm.

III.5.1. The rise of the functional foods market

74. Starting with Unilever's launch of an anti-cholesterol margarine 20 years ago, the functional foods industry now amounts to USD 75.5 billion around the world (Weststrate *et al.*, 2002). It has expanded its scope well beyond margarines and now has a presence in all agro-food segments. Omega-3-enriched products[17] are among the best-known functional foods. Case study A-IV describes the purposes and the development of these products. At the present time, great efforts are underway to market an entire range of plant-based functional foods, nutraceuticals, and even new synthetic medications.

75. As noted in the report of Agriculture and Agri-Food Canada (2002) on the potential benefits of functional foods, the functional foods market is likely to grow a pace with rising health concerns in OECD countries. The demand for nutraceuticals and functional foods poses both a challenge and an opportunity for the food industry. If innovations can be adapted to meet and anticipate new demands, they will produce benefits for farmers, processors and consumers alike.

76. In this context, the Nordic Information Center,[18] sponsored by the Nordic Council of Ministers for promoting innovation and economic intelligence in industry in the Nordic countries, launched a functional foods initiative in 2006. According to the Center, foods prized for their health impact offer a range of opportunities for local farmers. Thus, a series of projects was launched in 2006 to help the Nordic agro-food industry position itself as a competitive participant in the functional foods market.

77. The Grainity project[19] involves a public-private partnership to exploit the health potential of whole cereals (whole wheat, rye and oats) and to promote them among local consumers or on export markets (United States, United Kingdom). It has capitalised on the success of the "6 fruits and vegetables a day" campaign in Denmark to launch a comparable campaign on the benefits of whole cereals, which are consumed more heavily in the countries of northern Europe than in other parts of the world. The campaign relies on cooperation between the commercial partners (cereal producers, processors and supermarkets) and the health partners (governments and researchers). The health partners provide the legitimacy and the scientific backing,[20] while the commercial partners have organised themselves to make a business of it.

78. Before it is marketed as a functional food, each product must be accorded recognition under official regulations. To the extent that regulations are still at the conceptual stage, public health standards can in effect pose an obstacle to the development of innovative functional foods. Official approvals and certifications can influence public opinion but, as with any new product, most functional foods brought to market fail to make inroads there. This is the case, for example, with the VITO products that were developed by the Canadian company Les Petites Fermes du Centaure and approved by the government, as described in case study A-IV.

III.5.2. Consumer acceptance

79. The market success of functional foods depends largely on consumers' acceptance of the message linking these foods with their health objective. The process of gaining acceptance differs from country to country (Labrecque *et al*, 2006), and will depend on the scientific evidence (and its credibility) that the producers can marshal (Roberfroid, 2002; Frewer *et al*, 2003; Sibbel, 2006), as well as on prevailing legal requirements.

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17 Omega-3 DHA are a type of polyunsaturated fatty acid.

18 http://www.nordicinnovation.net .

19 http://www.vtt.fi/proj/grainity/.

20 For more information on the health effects of whole grains see http://www.oatsandhealth.org/ .

80. Acceptance could be a problem, for example, with the genetically modified organisms (GMO) that are likely to be brought to market in the near future, as illustrated in case study A-V, because of fears about their effects on health or on environmental sustainability. This case study deals with the work of an Australian research institute, CSIRO, on Omega-3 enriched oilseeds, the oil from which would be used as feed to enhance the nutritional characteristics of farmed fish and ensure the sustainability of the fish farming industry. A good deal of research and investment is going into these oilseeds, although marketing them will not be easy.

81. Since introduction of the first generation of GMOs, of which farmers were expected to be the principal beneficiaries (with higher yields and lower costs), these plants have become the focus of a health and environmental debate. To the extent that the new GMOs developed in the near future may have different objectives (perhaps more attune to consumer expectations) it is legitimate to consider the prospects for better acceptance of GMOs by consumers, and by governments through their legal systems (Giannakas and Yiannaka, 2008).

82. Investments in research hold out significant prospects for future growth in the functional foods market. For example, researchers have now succeeded in producing milk and dairy products with high conjugated lineolic acid levels (Coakley *et al.*, 2007).

III.5.3. What do functional foods hold for the agro-food sector, and farmers in particular?

83. Functional food markets are likely to grow rapidly, and participants in that market will have to adapt continuously to new inputs and to new production and processing methods if they are to maintain their position. The development of innovations relating to the health attributes of foods is of interest to farmers in particular.

84. This is the case when producers change their production methods, as illustrated in case study A-IV with the examples of the *Association Bleu-Blanc-Cœur* and the VITO brand. In both cases, animal feed is modified so that the meat is marketed with a higher omega-3 content. Success in marketing these products at a premium over standard products depends both on the extent to which consumers value their characteristics and on the way the chain is organised. Producers hoping to "go it alone" in marketing their new products are likely to face difficulties, as the VITO case demonstrates. Producers who organise themselves with other participants in the chain, as in the case of the *Association Bleu-Blanc-Cœur*, may be better placed to reap the opportunities created by these new products.

85. Innovation can also change the characteristics of foods when they are processed. In case study A-IV, the Humana baby milk formula combines milk and vegetable oils, for example. In this context, producers' ability to draw advantage from the marketing of functional foods will depend on their involvement in the value chain. If they remain mere suppliers of standard products, they will have little chance of creating supplementary value.

86. Moreover, innovation can lead to the development of new inputs (for example, new seeds) that will yield crops with particular characteristics. This is the case with the Omega-3-enriched oilseeds developed by CSIRO, as discussed in case study A-V. The farmer’s prospects of capturing benefits from this type of innovation will depend on the financial and legal structures governing commercial relations among producers, input suppliers, and the rest of the chain. With the addition of specific features to the product, its value should increase and farmers' incomes should rise accordingly.

87. Yet the costs associated with inputs, production and processing technologies can be significant. For example, if inputs are protected by patent, as is often the case with seeds that have specific

characteristics, their cost will be higher. From the farmer's viewpoint, the value of the final product will have to be higher by at least enough to cover the increased input costs.

88. To some extent, the handling of certain kinds of functional foods could be come to resemble that of products derived from first-generation GMOs, involving higher input costs, and segregation during harvest and storage, and in the transport and processing phases.

89. To summarise, the Agriculture and Agri-Food Canada report (2002) found that raw ingredient producers can expect to receive a lower proportion of the value created in the functional foods industry than in conventional foods production (5% to 25% versus 10% to 70%). This reflects the fact that value is often created in other stages, in particular the R&D stage.

90. It is the ways the value chain is organised and the capacity of farmers to innovate and adapt to change that will determine whether they can take full advantage of developments in this sector. The emergence of functional foods as an entirely new product line could then, to some extent, be synonymous with creating value in the agro-food sector.

IV. Towards a dynamic sector that shares in growth

91. With the decline in farm support and the disappearance of trade restraints, the agro-food sector will have to adapt to a new economic environment. It will need to redefine its activities over the long term. New expectations on the part of consumers and of society in general are bringing about changes in farming practices, involving the development of new products to meet demand as well as changes to marketing structures and production methods, for example.

92. To remain competitive in this new environment and to keep abreast of consumer expectations, the agro-food sector, and farmers in particular, will need to update their products and their techniques continuously. They will also have to be able to seize the opportunities offered by a world where technology is rapidly evolving. To do so, the industry must innovate. Innovation in the agro-food sector is not a linear process. The industry can take advantage of innovations developed in other sectors of the economy. It can also invest in research and development. The opportunities for value creation are significant, and they can extend beyond the agro-food sector by creating employment, for example, in major agricultural areas.

93. The strategies now being developed with respect to organisation and collaboration among different participants in the agro-food sector have great potential to foster innovation and to create value. In this context, the role of governments may be to set the parameters in terms of the legal and institutional structure. They may also be expected to provide regional or local services, educational institutions, research facilities in partnership between the public and private sectors, training and related services. Infrastructure of this kind can be the starting point for developing the critical mass of services, firms and research or training facilities that are the essence of clusters. The example of the *Industries et Agro-Ressources* cluster shows that the establishment of clusters associating farmers, industry and public or private research can help create value in the sector and allow farmers themselves to benefit from the process.

94. Innovation and growth involve a process of creative destruction, where new technologies, new markets and new forms of organisation replace old modes of functioning in economic sectors. In this context, attention should be paid to the potential role of government in making the adaptation process less painful, while ensuring that innovation and growth contribute to the general welfare. The legal system itself can encourage innovation and can help make the agriculture sector more dynamic from an economic viewpoint. Thus, there is a role for the State in helping to design or implement new regulatory frameworks. Some participants in the agro-food sector, and farmers in particular, are likely to suffer if they are unable to

adapt to the new economic environment. Policy initiatives, then, should be designed from the viewpoint of helping the sector as a whole to create an environment that will support a flexible and dynamic industry.

95. There are many opportunities to create value in the agro-food sector, in response to the new expectations of society and the new economic environment. This report has looked at a selected range of such possibilities, with a particular focus on the development of new products such as bioproducts and functional foods. Yet there is a great risk that most of the value created from these new opportunities will elude the farmers themselves unless they can organise collectively and work in partnership with the rest of the chain. Farmers who do not enjoy economies of scale and who are not integrated into value chains exploiting new opportunities can also profit from the new economic environment. To do so, they can differentiate their production, develop new modes of organisation within the chain, or establish new marketing networks.

96. In conclusion, the agro-food sector is in the midst of a profound upheaval. The transformations now under way provide an occasion for all participants to redefine their working methods and goals. The possibilities are great, and they should allow the sector to play a dynamic role in the economy. For farmers in particular, there are many ways to benefit from this upheaval. To create and capture value, producers must reposition themselves within the chain. This will require sound organisational structures and clear choices in adapting output to consumer demand.

ANNEX: THE CASE STUDIES

97. This Annex presents five case studies that illustrate the discussion in the report with examples of initiatives that are helping the agro-food sector to create value. Wherever possible, the case studies highlight the way farmers are participating in the value creation and capture process, and the extent of any government participation. All the examples are drawn from OECD countries. They are provided as indicative illustrations, and are in no case intended to be taken as models to be followed or not. The authors are grateful to the people directly involved in these projects, whose collaboration was indispensable in the preparation of this Annex.

A-I. The development of alternative food marketing (Japan)

98. The assistance of Mr. Kobayashi, Senior Principal Researcher at the Policy Research Institute of the Japanese Ministry of Agriculture, Forestry and Fisheries and of Mr Kimura, analyst within the Trade and Agriculture Directorate is gratefully acknowledged in preparing this case study.

The Teikei movement started in the 1970s

99. The early stage of alternative food movement emerged mainly from consumers who demanded local food and direct connections with producers. In 1971, a group of farmers, consumers and researchers established the *Teikei* (partnership) movement to promote sustainable farming by means of partnerships between producers and consumers. Consumers were not just the buyers of products, but sometimes participated in farm work. The *Teikei* movement was limited to specific groups of people who share similar concerns over health and environmental conservation. As such, it did not provide opportunities of alternative food marketing for most of the producers.

Sanchoku started to develop in the 1980s

100. In the 1980's, consumers did not only ask for affordable and standardized products but also went into specialty products such as organic products. As a result, consumers' cooperatives, local agricultural cooperatives and supermarkets expanded *Sanchoku* (direct marketing) movements. While, conventional wholesale market deals with standardized products, *Sanchoku* usually markets specialty products in terms of quality and variety. In this movement, producers and retailers, restaurants or food processors (or sometimes a group of consumers) are directly connected. They sometimes set up contracts where variety, quantity and price are predetermined between the two parties.

101. The producers of differentiated products can capture more value from *Sanchoku* than marketing through conventional channel. Retailers obviously depend on wholesale markets to purchase specific quantity of products all year long, but they also make use of *Sanchoku* to differentiate their products and attract specific groups of consumers. The ALIC survey conducted in 2003 on 170 agricultural corporations producing vegetables indicates that 40% of farms in the sample sold more than 80% of their production through contract farming.

1990s: Development of farmers' markets

102. Since the 1990's, farmers' markets (direct marketing outlets) have become an important channel of food marketing. The government agricultural census in 2005 found 13,538 farmers' markets all over Japan. Another government survey shows farmers' markets are selling JPY 100 million annually on average and some of them are selling even more than JPY 2 billion annually.

103. The estimation by Kobayashi *et al.* (2008) at PRIMAFF indicates that consumers purchased approximately 10% of all fresh vegetables at farmers' markets recently. Farmers' markets also provide opportunities for producers to capture more value within the agro-food chain. Indeed, producers participating to farmers' markets are able to determine the prices of their products, while the price of vegetables and fruits marketed through wholesale markets is usually determined as a result of auction. Moreover, those farmers do not need to meet specific standards or volume requirements when compared to the traditional marketing system. Depending on the characteristics of their production, producers can combine different marketing channels. Another important advantage of farmers' markets for producers is the direct connection between consumers and producers. That means that farmers can adapt to meet or anticipate consumer's demand.

The Chisan-chisho movement: promotion of local food since the end of the 1990s

104. The Japanese government started to actively promote the local food movement called *Chisan-chisho* since late 1990's. The Agricultural Basic Plan of 2005, which is the concrete policy plan under the Basic Law for Food, Agricultural and Rural areas, stipulates that the government promotes *Chisan-chisho* movement as a measure to promote agricultural production and improve self-sufficiency rate. In 2008, Local government and agricultural cooperatives prepared 997 local action plans to promote "Chisan-chisho", including the use of local food for school lunch programs. The government promotes local food movement by subsidizing the construction of farmer's markets, providing technical training and exchanging information between regions.

Export of differentiated products

105. Over the past few years, the export of agricultural products became an increasingly important source of revenue for farmers in Japan. Due to the rapid economic development in East Asian countries, exports of Japanese agricultural, forestry and fishery products increased by 36% between 2000 and 2006. This increase is particularly significant for specialty products including fishery products, fresh fruits and green tea. For example, farmers in Obihiro city in Hokkaido have succeeded in marketing Nagaimo (Yam potatoes) to Chinese Taipei since 1999. They found that the consumers in Chinese Taipei prefer large size products (unlike domestic Japanese consumers) and are ready to pay a premium price for them. In recent years, the majority of Nagaimo produced in Obihiro city is exported to overseas, including US and Singapore.

106. The government started to actively promote the export of agricultural products. In March 2005, the government announced an export promotion plan, which aims to double the value of exports to JPY 600 billion by 2009. The yearly policy plan in 2007 under the Basic Plan for Food, Agriculture and Rural areas sets even more ambitious goals to increase the value of exports to JPY 1 000 billion by 2013 through accelerating quarantine negotiation with importing countries and overseas marketing.

What do alternative food marketing movements bring to producers? The example of a farmers' market.

107. Agricultural products sold at farmers' markets are usually cheaper than those sold in conventional stores, but producers can actually increase their net earnings mainly because of lower distribution (marketing) costs and lower rates of products loss due to less restrictive standards.

108. Kobayashi *et al.* (2008) estimated the economic effect of farmers' markets, taking the example of Store A in Wakayama Prefecture which recorded the sales of JPY 2.49 billion in 2006. The store is located in the flat farming area of Wakayama Prefecture and has about 1,400 participating producers. The per farm sale is JPY 1.17 million per year. In total, about 800 000 customers visited the store coming from an area within a 30 km radius that includes Osaka, the second largest city in Japan. They estimated on average that participating producers are earning 38% more in comparison to what they would earn through conventional wholesale markets and that consumers are saving 16% compared to what they would pay in retailers outlets. In addition, the store has hired 5 full-time employees and 48 part-timers.

109. Although conventional food marketing through wholesale markets has been a dominant channel, Japan has developed alternative channels of food marketing in the last few decades as consumers' concerns over food have diversified ranging from food safety to environmental conservation. The main strengths of alternative food marketing channels are not only to cut the marketing margin, but also that they can allow producers to meet more quickly diversified consumers' demand because of the close relationship between producers and consumers. Moreover, producers can have more control on prices and capture more value in food chain. Contract farming usually enables farmers to share the risk of farming with purchasers. However, it is unlikely that these alternative food networks will replace the conventional food marketing. Conventional food marketing through wholesale markets has its advantages: it can provide cheap and constant quality food throughout the year and has an important credibility. For example, organic farm products used to be marketed through alternative channels such as *Teikei*, but these products are now widely acknowledged and marketed through conventional wholesale markets as well. Producers are expected to capture the highest value in food networks by combining different marketing channels depending on the characteristic of their products.

A-II. Drip Irrigation-Fertigation and Nuclear Technologies (Turkey)

110. The assistance of the International Atomic Energy Agency in preparing this box is gratefully acknowledged.

The issue

111. In 2006 Turkey held 3% of the world fresh potato export market, making it the fifth largest world exporter. Over one-third of total potato production (approximately 1.2 million tons) is produced in the Niğde-Nevshir Region. Since this area is characterised by a strong continental climate (avg. summer temperatures of 24C and avg. winter temperatures of -2C), the 2,000 farmers in this region whose farmlands occupy nearly 30,000 hectares are dependent upon residual groundwater provided by spring rains. Thus water shortages are a constant problem. As a subdivision of the Turkish Atomic Energy Authority (TEAK), the Saraykoy Nuclear Research and Training Center (SNRTC), whose objective is to research and provide training for agronomists as well as farmers who risk declining land productivity and water pollution, requested assistance from the International Atomic Energy Agency in addressing this concern.

112. Light-textured, loamy sands characterise this region's soil which when coupled with excessive or inappropriate nitrogen (N) fertilizer application and irrigation make it highly susceptible to soil deterioration, wastage of natural (water) resources and water quality degradation through nitrate seepage and runoff into surface and groundwater.

New approaches

113. Over the past decade, the agronomic services of the Ministry of Agriculture have been looking for solutions which are more technologically tailored to a given problem. Thus Turkish Atomic Energy

Authority (TEAK) joined forces with the researchers at Nigde Potato Research Institute and Soil and Fertilizer Research Institute to improve soil productivity and resolve environmental problems in agriculture. For this particular problem, the request by the TEAK was made to the IAEA. Subsequently, selected farmers in conjunction with governmental, academic, and other research institutions combined efforts to implement an innovative irrigation, fertilizer, and nuclear technology system.

Projects' description

114. The TEAK-IAEA set-up three separate projects - one with sprinkler irrigation during 1992 – 1994 (Halitligil et al., 2002) and subsequently the two with drip irrigation –fertigation one from 1997 to 2000 (Halitligil et al., 2003) and the other from 2005 to 2008 for responding to the needs of the local farmers in Niğde-Nevshir Region. The project, which ran from 1997 to 2000, was directed towards testing the effective use of drip-irrigation and fertigation on potato crops in this specific region. The project's aim was to increase potato yields with these new techniques, which work at improving nitrogen and water efficiencies as well as environmental outcomes by reducing nitrogen pollutants. The third project, from 2005 to 2008, building on the success of the first, had the objectives of improving soil conditions and of increasing further the efficiency of water and nitrogen uptake of potatoes tubers with the introduction of vetch as green manure in the second year of the current potato-wheat rotation or alfalfa as green manure/forage crop in a 3-year alfalfa-alfalfa-potato system.

Technical innovation and large scale implementation

115. Drip irrigation and fertigation have been around for some time, but it is the supplementary use of nuclear technology to quantify the improved efficiency of irrigation technologies on potato cropland that makes this an innovative system. Drip irrigation provides water to plants through a network of valves and pipes that drip water either at the root of a plant or at the soil surface so as to target the flow of water to plants and to minimize the amount of water applied. Fertigation is the application of water soluble fertilizers through a drip irrigation system. The first project began with three local farmers, selected on account of their capability to implement the new technology and trained by the IAEA experts, transitioned a portion of fields from a conventional sprinkler irrigation system to a drip irrigation-fertigation system. Eight field drip irrigation-fertigation systems were installed in the first year and in the second year the fertigation experiment was scaled up by the acceptance of one farmer to 10 000m^2 (1 ha).

116. The second project made use of nuclear technologies to improve further the efficiencies of drip-irrigation fertigation in terms of soil, water, and nutrients management during the growing season. These nuclear technologies consist of neutron probes and N-15 stable isotopes. A neutron probe is used for measuring the quantity of water in soil. The neutron probe operates such that after the probe is lowered into the ground and a nuclear reaction is triggered, fast emitting neutrons are produced and released. Their collision with hydrogen nuclei (a component of water) slow down the emitted neutrons, which are then quantified and used to estimate the amount of water present in a given cross-section of the soil (IAEA, 2008). This process provides valuable information to farmers as to how much water is required for plant growth. Nitrogen (N) stable isotope (i.e., N-15) added into nitrogen (N) fertilizers as N-15 labelled fertilisers, can be used as a traceable marker of N processing in a soil-plant system. After the application of N-15 labelled fertilizers, crops can be measured for N recovery to assess how efficiently N fertilizer is taken up by plants and moved down the soil profile beyond the reach of plant roots. This information allows for more precise management practices of N fertilizers in terms of timing, method, and source of application.

117. The farmers and researchers concluded that the nuclear technologies provided by the IAEA and TEAK drastically assisted in their understanding of improved overall field management. The third project with its preliminary data indicates that vetch is not as effective as alfalfa in improving soil organic matter,

the key ingredient for improving soil quality and hence fertiliser and water use efficiency in the sandy soil of the Niğde-Nevshir Region. Again the use of soil moisture neutron probes and N-15 has been highly valuable in assessing the importance of vetch and alfalfa in the conservation and management of farming inputs such as fertilizers and irrigation water. Since the field site has not been through a whole cropping rotation, detailed results are not expected before 2009. The follow-up steps from this third project are expected to be particularly valuable for farmers in the Niğde-Nevshir Region in the future.

118. The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture has identified advantages and limitations associated with the use of these nuclear technologies in this and other projects. Further detailed information can be found in the link below.[21]

Outcomes

119. Input costs to farmers, who switched to these new irrigation techniques, equalled approximately USD 200 per hectare in terms of installation costs for a drip irrigation-fertigation system. In addition, they were charged approximately USD 30 per hectare per 5-year period for maintenance.

120. The switch from traditional sprinkler irrigation system to drip irrigation-fertigation generated tremendously positive results in terms of reduction in water consumption and fertilizer use. In a sprinkler irrigation system nearly 65% of the water applied was wastage because it did not reach potato roots. Likewise for fertilizer applications whose benefit was lost because of inaccessible water for the roots of the crop. A drip irrigation-fertigation system, which targets both water and fertiliser at the rooting zone, instead of sprinkler irrigation and broadcast application (surface application) of N fertiliser over the entire soil surface has also been found to reduce the amount of irrigation water applied by 50%. In terms of fertilizer N, the farmers reduced their use from 1000 kg N/ha to 600 kg N/ha while achieving the same level of yield output. In addition, the reduction in fertilizer N use minimized the risk of nitrogen leaching (Halitligil *et al*., 2002). Thus, drip irrigation-fertigation reduced input use costs, minimized the risks of soil deterioration and yet maintained yields. Farmers experienced additional benefits in terms of time, energy, and labour inputs resulting in an estimated USD 2 000 per hectare cost savings. If the drip irrigation-fertigation system were applied to the entire region, total annual savings could reach nearly USD 60 million, which means a substantial increase in profitability.

121. The TAEK-IAEA held workshops and trainings annually to improve performance and build a network among the participating farmers and researchers.

122. The government recognized the economic and environmental value of drip irrigation-fertigation in November 2004, by offering local farmers in the region low-interest loans for all those who made the transition over to drip irrigation-fertigation. Since then, the Niğde-Nevshir Region has witnessed an increase from 500 to 4000 hectares dedicated to drip-irrigation fertigation in simply three years. At the end of 2007 the Ministry of Agriculture began to subsidize 50 % of the drip irrigation expenses to farmers all over Turkey if they get a technical report for their expenses from the specially assigned experts. This means that in coming years more farmers - especially in the Cappadocia region - will be using drip irrigation-fertigation system.

123. For more information on drip irrigation-fertigation and the nuclear technologies mentioned in this case study, please refer to M.B. Halitligil (2007), 'Drip Irrigation and Fertigation: Turkey', Soils Newsletter Vol. 30, No.1 : 9-10.

[21] http://www-naweb.iaea.org/nafa/swmn/use-nuclear-tech.pdf

A-III. The Pôle de compétitivité Industries et Agro-Ressources (France)

124. The authors are grateful to Mr. Duchâteau (Pôle de compétitivité Industries et Agro-Ressources), Mr Dutartre (President of A.R.D.), Mr Le Hénaff (Directeur General of A.R.D.) and Mr Prévoteau (President of Soliance) for their help in preparing this case study.

Cooperation within the agricultural sector in North-East France

125. Farmers in north-east France have a tradition of cooperation extending back more than a hundred years. Historically, farmers sought to protect themselves from the hazards of an uncertain economic environment. The north-east of France was a relatively poor and isolated region, far removed from seaports. In the first half of the 20th century, there was a movement to establish cooperatives with the weight to wield some market clout.

126. Taking advantage of the economic stability induced by the Common Agricultural Policy (CAP), large-scale farmers have steadily reinforced their cooperation. Through alliances and mergers they have extended their cooperation to cover the entire range of processing activities (in the malting, milling, sugar and starch industries, for example). The regions of Picardy and Champagne-Ardenne are today the leading French producers of cereals, oilseeds, sugar beats, and potatoes.

127. Known worldwide for its production of champagne, North-East France is also home to "champions" of the large-scale agricultural industry: examples are Cristal Union in the sugar industry, and Champagne Céréales, the largest cereals group in Europe. This latter cooperative embraces nearly 8 800 farmers, produces 2.5 million tons of cereals a year, and has an annual turnover of EUR 1.3 billion.

128. Champagne Céréales is much more than a cooperative where members can reduce their production costs by sharing materials and purchasing bulk inputs, or where they can achieve critical scale for accessing certain markets. It is in fact a true industrial concern of international dimension, with a complex financial structure. Through its affiliates, this group is involved in activities both upstream and downstream from farming: fertiliser distribution, product processing, marketing, and even research and development.

Taking advantage of non-food opportunities to create value

129. For the principal stakeholders in the agricultural sector in North-East France, value creation involves the exploitation of crops for both food and non-food purposes. They have pursued these two complementary approaches by developing refining processes that can make use of all the raw ingredients of plants to produce food, energy and a whole range of bioproducts.

130. Private research in plant chemistry in Champagne-Ardenne is spearheaded by ARD (Agro Industrie Recherches et Développements). This company was created in 1989, when Champagne Céréales and Sucre Union, the commercial affiliate of the Cristal Union and Sucrerie de Bourdon sugar cooperatives, decided to merge their ethanol and sugar R&D programs (ERC and SRD, respectively). ARD's activities received a boost with the reform of the CAP. In 1994, ARD created Soliance, as an affiliate for the production and marketing of cosmetics derived from chemurgy products, in particular SAA (surface-active agents). Currently, ARD and Soliance, with development and production activities based at the agroindustrial site of Pomacle in the Marne, have 125 employees, most of whom are skilled or highly skilled.

131. The commercial farming cooperatives were driven to invest in R&D in order to develop new chemurgy-based products and processes for optimising production and processing procedures. ARD's projects involve plant material refining, green chemistry, and white biotechnology. The company's

objective is to develop economically feasible technical responses to plant chemistry problems. Its projects involve successive stages: basic research, applied research, the pilot project, and finally the industrial project. Basic research is often conducted in partnership with public research facilities, and patents are filed and owned jointly. ARD is currently filing two or three patents every year.

132. ARD shareholders represent only 30% of its operating costs. It is owned by the cereal cooperatives (with more than 50% of shares), the sugar cooperatives (nearly 18%), the alfalfa cooperatives (nearly 5%), Crédit Agricole du Nord Est (nearly 16%) and the Chamtor starch company (nearly 8%), itself a subsidiary of Champagne Céréales. By way of example, Champagne Céréales producers remit €0.15 per ton of cereals for financing research. External sources cover 70% of its operating costs: revenues from patents, the fiscal integration mechanism with Soliance, and public funds (the research tax credit, and national, regional or European subsidy programs).

The "competitiveness cluster" helps bring innovative projects to fruition

133. The number of innovative projects with which ARD is associated has risen sharply with establishment of the world-scale "competitiveness cluster" (*pôle de compétitivité*) of the *Association Industries and Agro-Ressources* (IAR) on 12 July 2005. IAR is one of 71 clusters recognised by the French government.[22] These clusters cover all fields of the economy and are defined as a combination, within a given geographic space, of enterprises, training centres and research units engaged in a partnership to produce synergies around common projects of an innovative nature, and having the critical mass necessary for international visibility.

134. The ambition of the IAR cluster is to become the European leader in innovation in the nonfood processing of agricultural resources and biomass. It relies on a long-established, well-organised and efficient local agricultural sector, a network of active participants recognised in the field of public and private research, and large industrial groups engaged in the processing of agricultural products (Sucre Union and Champagne Céréales for example). The cluster provides jobs for some 26,200 people, of whom nearly 1,000 are engaged in research. It is organised as an association that serves as intermediary between sources of financing for innovative projects (such as the Oséo innovation agency, Agence Nationale de la Recherche, and European and regional bodies) and members of the cluster who collaborate on these projects. This association also has the role of tracking economic developments and promoting the cluster's profile and reputation.

135. One of the biggest projects sponsored by the IAR is the "*Futurol*" project,[23] launched on 11 September 2008. The project involves a total of EUR 74 million over the period 2008-2016, of which 30 million will be financed by Oséo. It is supported by 11 scientific, industrial and financing partners within the consortium. The aim of the project is the development and marketing of a complete production process for second-generation bioethanol from whole plants or from lignocellulosic biomass. The potential benefits for the various stakeholders are significant. The project includes a pilot phase, followed by a prototype phase. The pilot facility will be constructed at the Pomacle agroindustrial site in the Marne, where ARD and the various firms participating in the plant refinery have already set up facilities.

136. The IAR cluster is building upon the knowledge and skills developed by stakeholders in the sector over many years in North-East France. It allows them to expand and reinforce innovative projects

22 After calling for applications for a research-industry collaboration project, the French government selected clusters on the basis of their capacity to make France more competitive, to boost economic development, and to create jobs.

23 http://www.inra.fr/content/download/14001/172255/version/1/file/DP-Futurol-final.pdf

and it promises significant economic returns for the region, with for example the creation of jobs in the refineries and the second-generation biofuels factories.

137. The cluster also facilitates international recognition and the establishment of partnerships with innovative firms beyond France. Naturally, it relies on the presence of leading firms in the region and on a long tradition of cooperation. This cluster is not directly transposable to other regions in the OECD, but it suggests that the bioeconomy holds the potential to benefit participants in the agro-food sector, and farmers in particular.

A-IV. Examples of functional foods enriched in omega-3 (France, Canada and Germany)

138. In about 30 years, polyunsaturated fatty acids (PUFA) have come to dominate the functional food market. Numerous studies have demonstrated that DHA Omega-3 (a type of poly unsaturated fatty acid) is important to maintaining health as well as offering disease prevention/management potential. Omega-3 fatty acids have evidenced the capacity to provide health benefits, such as a reduction in cholesterol, an increase in blood levels of docosahexaenoic (DHA), reported to improve blood flow to the heart and other cardiovascular benefits[24]. It can thus contribute to lowering the risks of cardiovascular diseases, reduce inflammatory diseases such as arthritis among others (Filmer, 2006 ; Kris-Etherton *et al.*, 2002; Weststrate *et al.*, 2002).

139. Since the body cannot synthesize Omega 3 it must be gotten through diet. The traditional major source of DHA Omega 3 is fish oil, particularly from fatty fish such as salmon, sardines and mackerel. More and more to ensure a sufficient intake people have recourse to foods enriched in omega-3. Worldwide firms are developing innovations to bring functional foods to the market.

140. This case study presents three examples of functional foods. Producers and other actors in the chain are directly involved in their developments. The three examples have in common to be food products enriched in omega-3. In addition to innovative scientific technologies, each company presented in the preceding case studies shares its market risks by being part of a strong organisation whether it is a cooperative of 6,000 dairy farmers like Humana or an association bringing actors from the different stages of the chain like Bleu-Blanc-coeur. The precise production management made possible by these forms of organisation appears necessary in ensuring a certain level of enhanced nutrients.

Omega-3 Polyunsaturated Fatty Acids in Oilseeds: Bleu-Blanc-Coeur

141. Founded in August of 2000 as an association to promote healthy human nutrition with eco-friendly farming techniques, Bleu-Blanc-Coeur produces various nutritionally enhanced products through the use of oilseeds (in particular flaxseed) in feed and food recipes. The association is composed of specialised operators in the chain from seed breeders to farmers to feed manufacturers, animal producers and downstream food processors. These along with researchers and even consumers form a network of 300 agents. Products range from breads and flour to all kinds of animal products like poultry, pork, beef and dairy products; all of which have high omega-3 content. They can be found around the world under a few different brands, which are often sub-brands of national brands or of retailers' brands. In order to maintain quality and authenticity standards Bleu-Blanc-Coeur coordinates the production chain. The Omega-3 story started in 1993 when Valorex – a feed producer from Brittany in France – incorporated cooked flaxseeds in feed rations for their zootechnical benefits. Research carried out by Valorex and public research institutes found in a later stage that the introduction of linseed in livestock diet had an effect on the blood fatty acid composition of consumers of animal products (Weill *et al*, 2002). In particular, oilseeds rich Omega-3 fatty

[24] More information can be found on the International Food Information Council website: http://www.ific.org/publications/factsheets/omega3fs.cfm .

acids could substitute for health enhancing spring grasses and be used year round. Through a special extractive procedure developed by Valorex, the nutrient value of the oilseeds can be assimilated by animals. These oilseeds are hence incorporated in feed rations consumed by animals in the Bleu-Blanc-Coeur food production chain. At present, the Bleu-Blanc-Coeur oilseeds (mostly flaxseeds) are produced only in France, though products are commercialised beyond French borders and thus has been an economic stimulus to the regions where most of the oilseed production occurs.[25]

Omega-3 Polyunsaturated Fatty Acids in Meat: Les Petites Fermes du Centaure Inc.

142. Through a strict diet of vegetal feed high in Omega-3 fatty acids, Les Petites Fermes du Centaure Inc. specialises in value-added meat products. In 2004 the Canadian company of small family farms was the first in Canada to receive an authorisation to sell high value pork. The addition of Alpha-linolenic acid (ALA) sources, such as flaxseed, to the animal feed was proven to increase Omega-3 fatty acids levels in pigs and in pork products. Under the brand VITO, Les Petites Fermes du Centaure Inc. produces a number of food products from pepperoni to sausages, each containing a good "source of Omega-3 polyunsaturated fatty acids". [26] The use of vegetal feed provides additional benefits through a complete change of fatty acid composition in pork by means of less saturated fat and lower omega-6 to omega-3 ratio. According to Health Canada Omega-3 enhanced pork has twice the ALA levels than regular pork. Les Petites Fermes du Centaure inc. is not only concerned with the wellbeing of their consumers, but also of the environment. Each small farm member of Les Petites Fermes du Centaure has to abide by several guidelines where one of which is conformity to "Plan Agro-Environnemental de Fertilisation" outlined by the local government. This plan ensures healthy agricultural practices that promote environmental sustainability. After several years of marketing, Les Petites Fermes du Centaure stopped production. Although given the rising market and governmental approval, several other factors such as lack of marketing capacity as well as other unstated issues, pushed the company towards their decision. At present, the company is searching for additional collaborations to resume production.

Omega-3 Polyunsaturated Fatty Acids in Dairy: Humana GmbH

143. Humana Milchunion eG, a traditional dairy cooperative of over 6 000 dairy farms, has found a new demand for functional foods in the baby food market. Located in Herford, Germany, Humana GmbH, a subsidiary of Humana Milchunion eG, produces a wide variety of dairy products sold in over 30 various countries. For over 50 years, Humana GmbH has been improving its standard and quality of baby food and has recognized a nutritional value of Omega-3 long-chain polyunsaturated fatty acids (LC PUFA) in child development. Certain studies found a possible link by the increase of Omega-3 LC PUFA to an improvement in development in the brain and eye for children. In their 5 step formula series, Humana GmbH increased certain formulas to have a higher content of Omega-3 LC PUFA and Pre-biotic dietary Fibre for a healthy digestive system. The standard infant formula (step 1) is made from milk constituents and premium vegetable oils, which supply the high source of LC PUFA, while Humana GmbH Baby Fit-2 and Humana Follow-on Formula 3 (steps 2 and 3) provide the Pre-biotic dietary Fibres. Humana GmbH ensures high quality for each of their products because of their connections with the dairy cooperative Humana Milchunion. The cooperative allows for product traceability and quality assurance. The success of Humana has spread through Germany, making it the market leader for numerous baby products with their therapeutic baby food, hypoallergenic instant cereals for babies, and their dairy-free baby food. [27]

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25 More information can be found on the Bleu-Blanc-Coeur website: www.bleu-blanc-coeur.com .

26 More information on VITO and Les Petites Fermes du Centaure can be found on their website: http://www.nutrition-omega3.com .

27 More information can be found on the Humana website: http://www.humana.de/en/ .

A-V. Omega-3 Enhanced Oilseeds for Sustainability and Health (Australia)

144. The assistance of Mr Lee, Director of the Food Futures Flagship Programme at CSIRO (Commonwealth Scientific and Industrial Research Organisation) is gratefully acknowledged in preparing this case study.

145. Delivering health enhancing and environmentally sustainable innovations in food and feed production is one of the key research areas of CSIRO's Food Futures flagship research programme. One of their most promising research projects is the development of oilseeds containing DHA Omega-3.

Sustainability of the fish industry

146. The increasing demand for fish and fish oil has put greater pressure on fish resources. There has been a growing demand for fatty fish, such as salmon, sardines and mackerel, all rich in Omega 3.[28] Though the farmed fish varieties have relieved pressure on capture fisheries, their feed rations still used fish oils (FO) and fishmeal. This is leading to a decline in the long term sustainability of the industry. Recently, farm rations have tried to substitute vegetable oils (VO) for FO. This raises the question of whether or not VO fed fish yields the same quantity of DHA Omega-3 as FO fed fish. Certain scientific studies have found that fish raised on a totally VO ration do not have the same quantity of DHA Omega-3 content (Bell et al., 2001, 2003, 2004 ; Mourente and Bell, 2006). In a health promoting vision fish with lower levels of Omega 3 could be less attractive to consumers.

Development of oilseeds enriched in omega-3

147. The problem could be resolved if a way could be found to incorporate the DHA Omega-3 in vegetable oils used in fish rations. Microalgae are the main factories of DHA Omega-3 and fish get their omega 3 directly from consuming the microalgae or indirectly from eating other fish. Given health benefits which DHA Omega-3 can bring, increasing its availability and ensuring sustainability of supply would have substantial value to the industry, environment and consumers.

148. The objective of the cross disciplinary CSIRO research team was to develop oilseed plants that carry the gene of the microalgae so as to yield DHA Omega-3 enhanced grains. Using genetic engineering technologies the researchers were able to transfer the DHA Omega-3 gene into oilseed plants. They have succeeded in developing DHA Omega-3 enhanced linseed and rapeseed and the enhanced oilseeds have been tested in the fish feed rations. Fish fed with the omega 3 enhanced oils had greater quantities of DHA Omega-3 compared to 100% VO fed fish. In fact these levels were equivalent to those in FO fed fish.

New genetically modified organisms and consumer acceptance

149. Genetic engineering is used in developing these enhanced oilseeds and this often raises a number of issues related to human health and the environment. CSIRO recognizes this and is operating within the framework of the ANZFSA authority.[29] Even if approved, consumer acceptance remains an issue. If

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[28] See the 4th case study for the health effects of DHA Omega-3 and the development of omega 3 enhanced food.

[29] Australian and New Zealand law make it forbidden to sale genetically modified food without proper labelling that expresses its GMO content.

however consumers perceive health benefits that also help maintain the sustainability of the world's fish resources, they may more willingly accept the use of the technology.

What are the perspectives for the fish industry?

150. Such an innovation has multiple economic implications: for the agricultural sector, the value-added oilseeds offer Australian farmers a new niche to supply feeds for aquaculture and agriculture as well as inputs to the downstream food processing industries. Producers of processed food who use a value-added input can enhance their products with added nutritional value and create market niches. The aquaculture sector will benefit from the use of omega-3 enhanced oilseeds as feed, through greater availabilities and recognition of their role in helping to avoid depletion of world fish stocks. This innovation should add value to Australia's agricultural markets in the future. CSIRO foundation expects full commercialisation of the Omega-3 enhanced oilseeds by 2013 at the earliest.

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