

## **Food supply chains - our current understanding**

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### **Summary**

The organisers of this conference have done a remarkable job in bringing together a wide range of experts on the key technologies and areas of innovation that we need to embrace to deliver food security and more sustainable food supply chains in the future. Finding ways to integrate such a wide range of approaches is a vital endeavour; we need to deliver safe, ethical and enjoyable food to many more people in the future, in an urbanised world, and in the face of increasing environmental uncertainties and resource limitations. The agenda and outcomes of this conference with the resulting review papers will reflect this complexity.

The contributors together make a powerful case for developing and using technological and social innovation to ensure that important information flows from farmer to consumer – partly to provide food safety or “sustainability” assurance and partly to ensure that the risks and impacts of each stage in the supply chain can be identified and addressed. The information flows associated with supply chains also need to run in the other direction so that farmers and other producers can better understand the needs of the market and have access to knowledge, technologies and finance that can enable them to improve production and profitability while reducing environmental impacts.

**Key words:** Food supply chain, biotechnologies, behavioural change, environmental impact

### **An Initial Overview of the Challenges: Our Starting Point for this Conference**

The world is changing very quickly. Those of us who work in foods businesses are increasingly aware that we must take action to make our food supply chains more sustainable in a world where many Governments, Agencies and Businesses recognise through detailed research and published reporting (such as the UK Government’s Food 2030 report), now or soon

- Food production must increase by 50% by ~2050
- Rainfall and the length of the growing season will be more unpredictable in the future
- Most people live in urban slums.

The big messages emerging from the papers presented in the first part of the conference are focussed on the ways in which we apply and disseminate knowledge within food supply chains,

- how knowledge can flow within supply chains (from farmer to consumer- and vice versa) in order to create value by aligning more sustainable production and consumption, and

- specific examples showing the power of group formation at the farmer/landscape management scale and the value this can create.

There are notable examples of technology transfer, knowledge exchange and agricultural extension. Most importantly these actions are often embedded in management systems such as reported by Drummond for the LEAF Marque and the LEAF Audit, and, Marriott and colleagues for Landcare approaches. The lead author of this overview has previously reported Unilever approaches to engaging stakeholders in sustainable actions across supply chains in the 2008 *Greening the Food Chain, Aspects of Applied Biology* (Volume 87). A common theme across these systems is stakeholder engagement, this can be carried out at the level of field working groups through to the use of generalised media such as internet portals.

Training and assessment holds a specific value in food supply chains because of the requirements to ensure human safety using systems such as HACCP. This is clearly identified by Barlow's paper on the potential for fraud and adulteration of food products when regulatory procedures are not adhered to. Vorst and colleagues robustly show the value of training in improving food supply by increasing safety and reducing waste.

While the footprinting and LCA methodologies described by Kay, Keating, Sellahewa and others at this conference, cover many environmental issues important within supply chains, measuring more socially-determined or locally-relevant aspects of sustainable supply, such as "social responsibility" or "biodiversity" requires a different approach which may be less quantitative. At the moment, businesses currently rely mainly on audits for the former, and collecting "good stories" from suppliers and projects for the latter. We would suggest these responses needs to be more robust and quantifiable in future when reporting to stakeholders.

### **Improving Knowledge and Information Flow**

Materials and money flow along all supply networks; the key challenge is to ensure that knowledge and information also flow within these networks.

Regulators and businesses need to use a wide range of tools to understand where the biggest social and environmental impacts of our food systems lie and then use this knowledge and that of the structure and key points where interventions may be most successful to focus efforts in the most important areas. Understanding land and water use is becoming a higher priority as the finite nature and scarcity of each is appreciated, with techniques such as water footprinting such as that reported by Symonds and LCA by Sellahewa and Martindale. Social impact studies are becoming more sophisticated and valuable to decision-making.

Businesses working within food supply chains increasingly need to gather data from their own suppliers, and the farmers who supply them, to satisfy internal demands for strategic decision-making, risk assessments and for monitoring progress towards internal targets, as well as to satisfy external opinion-formers who often have a "single issue" focus (e.g. forest footprinting; dependency on ecosystem services; greenhouse gases) but apply their methodology across different businesses. Improved information flow through supply networks all the way from farmer to consumer is vital to enable the necessary understanding. What is clear is organisations such as Landcare and LEAF, and commercial companies such as Unilever have been collecting information on sustainability within supply chains for many years, and there is now a realisation that these data must be collected and organised in more formal ways to communicate complex issues such as 'what is sustainable' quantitatively to wider audiences.

Information flow, and analysis, can ensure not only that efforts can be focussed on the most effective interventions, but also to minimise the risks of contamination and fraud as highlighted by Barlow at this conference, and as a way of adding-value to products by demonstrating to consumers. Lakner makes the case that credible systems and communications are essential, but that cultural trends must be reflected in them making regulatory application difficult, as a 'one system fits all'

approach is not possible for diet. An emergent demand from consumers has been the expectation that that food safety and quality should be achieved using responsible production methods creating positive environmental benefits as discussed by Drummond.

Drummond looks at the use of farm assurance schemes such as the LEAF Marque and how they provide a framework for farmers to develop and improve their businesses while also providing opportunities for consumers to get involved and benefit. The aim of such systems must always to create balanced supply and demand in order for the market to operate. There are, of course, a wide range of certification and assurance systems competing for attention within the business-to-business environment (e.g. ISO 14001, GlobalGap) or for our attention, as consumers, on the supermarket shelves (LEAF, Rainforest Alliance, RSPO, Little Red Tractor, Carbon Footprinting, in-house assurance schemes and others) each with a different focus, although compliance with the law and international conventions is becoming a mainstream requirement for nearly all of them.

Knowledge flow from consumers (or “the market”), research and government agencies to farmers is equally important. Many of the “markets” for foods, and not only in the “developed” world is now demanding higher levels of assurance (food safety and more sustainable production) and this is more likely to become mandatory in some markets as manufacturers, retailers and government-sponsored food outlets (such as hospitals and schools) choice-edit and refuse contracts to suppliers who do not comply with internal or external standards.

Farmers often need not only information, but also need support to enable them to make the changes that will make their produce more attractive in the marketplace. The paper by Agwanda and colleagues illustrates the huge potential for smallholder farmers to increase their production and income if supported properly with physical and financial access to locally-appropriate planting material (crop varieties, uninfected “clean” seeds or seedlings), fertilisers material) and knowledge and skills to improve not only production, but also processing and marketing their produce. With the right inputs and information, as Drummond points out, research often shows that small farms are generally more efficient than larger farms.

Those of us who work directly with farmers know how interested they are in where their produce ends up and the ways in which it travels through the supply chain before the consumer buys it. Once farmers appreciate that the buyers of their produce increasingly value “sustainable production”, and ways are found to fund training and capital expenditure (such as smallholders purchasing and using personal protective equipment when handling pesticides), they are generally keen to ensure that they can continue to sell into relatively high value markets by undertaking the necessary training and improving practices on their farms.

### **The Power of Land-Management and Farmer Groups**

Knowledge flow is, in itself, insufficient to ensure that farmers and others can improve yield, quality and resource-use-efficiency. Cultural, organisational, and sometimes regulatory, change is also necessary for positive actions to be made and maintained. Both Magwanda and Marriott make it clear that grouping together of farmers or rural communities around areas of common interest is key to enabling producers to gain access to the knowledge they need, for training to be accessible and affordable (e.g. specialists are more prepared to talk to groups than individual farmers, and training grants and aid money is often more available to groups). Group dynamics create a supportive atmosphere for farmer-led experimentation and change and for wholesale adoption of new ways of working once the group is satisfied as to its value.

Whole farming communities often need to be motivated and involved in the process; Marriott’s paper on the Landcare system shows how this can be done, emphasising the need for the group itself to determine priorities, and the need for skilled facilitators (rather than conventional trainers) to make the process work. The Farmer Field School movement, where farmers undertake hands-on experiments with different techniques on their own farms, and then come together in a facilitated

“lesson” to discuss their findings and agree a way forward together, adopts a similar philosophy. And food businesses such as Unilever are often only able to link through to the farmers that grow their raw materials through groupings created around the primary processors that are themselves Unilever suppliers.

However, group learning is no panacea- it requires considerable investment in culturally-appropriate learning for groups to be created and positive changes made and maintained. It is not only in rural Kenya that farmers tend to be older and less well educated than their children; in many parts of the world, the children on farms have moved to the cities because the land available to them cannot support them or in search of a better life. Middle-aged farmers do not readily become entrepreneurs and marketeers without support, or spontaneously group together to take advantages of training, education and investment opportunities.

### **Looking Forward to the Sessions on Innovation and Transformation**

We have seen how the insights provided by Life Cycle Assessments and other studies can help focus innovation efforts. Today we see how some of the innovations and innovative thinking perform when studied using these same systems. In Tuomisto’s paper, it is good to see that efficiency of use of land area is presented as a high priority issue. For too long, economic and other analyses have presumed that land is an infinite resource in spite of clear conflicts between agriculture (crops and/or livestock), bio-energy crop production, urban development, infrastructure, biodiversity/ecosystem services and cultural priorities and the compelling visual demonstration by organisations such as the World Wildlife Fund that if everyone in the world lived the profligate lifestyle of most of us in this room, that we would need three planets to live on.

LCA studies provide a systematic way of assessing certain impacts, but we should remember that the techniques are often difficult to apply to agriculture. Too often the scenarios assessed are determined by data availability rather than putting more effort into gathering data for the more “typical” or “average” situation; there is no completely rational way to encompass or “discount” land use change within LCA as alluded to by Finnegan. When evaluating innovative technologies and complex systems (such as farming or supply chains), a suite of complementary assessment methods are required, encompassing water footprinting, food safety, biodiversity, social impacts, legality and other variables- a point well made in Sellahewa and Martindale’s paper.

We believe that innovation in primary food processing technology is extremely important. Food processing technologies (e.g. dehydration, chilling) have the potential to reduce vast amounts of wastage and quality loss that occurs when “fresh” produce is transported and distributed to urban populations around the world. In rural areas, small-scale processing units have the potential to reduce the need for near-monoculture around large processing plants, and to enable rural farming communities to access urban markets with added-value, stable products as described by Agwanda and colleagues. Reducing the waste that is almost inevitable in “fresh” produce supply chains (especially those in parts of the world with poor road systems and few opportunities for chilled storage) is identified as a priority for enabling vegetable producers to gain access to profitable markets by Williamson. Sellahewa and Martindale identify a key challenge, which is to ensure that small-scale processing can match the reduction in environmental impact (especially in terms of energy use, greenhouse gas emissions/carbon footprint, water and waste) that larger scale processing has achieved in the last 20 years. It is also often harder to maintain quality and food safety if processed foods are derived from a diffuse supply base that includes more, smaller-scale producers and processing units. The “social innovations” linked to group training and investment discussed by Bell here in terms of flexible logistic frameworks holds promise for innovative approaches. Information flow along value chains linked to food safety and other assurance schemes as described by Bell and Drummond must be integrated with systems that can assess risk and monitor and detect fraud where appropriate as described by Barlow. Such integrated systems of assurance will

be vital as shown by current understanding of safety and potential contamination of products by pesticides as discussed by both Glass and Williamson. Indeed, Glass highlights specific analytical techniques that are providing both traceability and assurance through supply chains.

This ultimately returns us to the subject of data capture and knowledge flow within supply chains, in the guise of options and technologies for tracing and tracking geared, in part, to the vitally-important function of assuring food safety, as foodstuffs pass through dynamic, ever-changing networks between farmer and consumer. Those of us who would classify ourselves as “optimistic technocrats” in this area should remember that it is the management systems and vigilance of authorities and businesses worldwide that enables us to adopt this position. For those of us involved in food manufacturing, it will be just as important to harness the information flow that is predicated on tracking and tracing, for us to gather and report information, provide assurance and monitor progress towards our goal of obtaining our raw materials from more sustainable farming and resource-efficient, socially-responsible, less polluting processing and transport within our own supply chains.

### **Conclusion**

The UK Government Office for Science has published the Food 2030 report that sets out clear objectives for secure and sustainable food supply. This report is typical of many governmental responses globally. Food security, sustainability and safety are all being sought after.

The food industry is charged with meeting these objectives and aligning with policy measures of reports such as Food 2030. How we will constructively measure and maintain all of these outcomes is still “work in progress”:- this conference and the review papers from the conference are part of the movement to help understand define and measure food supply chains that provide safe, nutritional food and are fairer to all the players involved. Behavioural change by consumers, as influenced by the choices available, economic situation, attitudes to food safety, culture and ethics will continue to influence the priorities that businesses place on different interventions in their supply chains. .

Finally, it is clear that the development of sustainable food supply will not be achieved unless activities on-farm are intrinsically linked to those within the processing and manufacturing operations of the supply chain; and that the value of these actions must be communicated throughout supply chains to reach both farmers and consumers.

