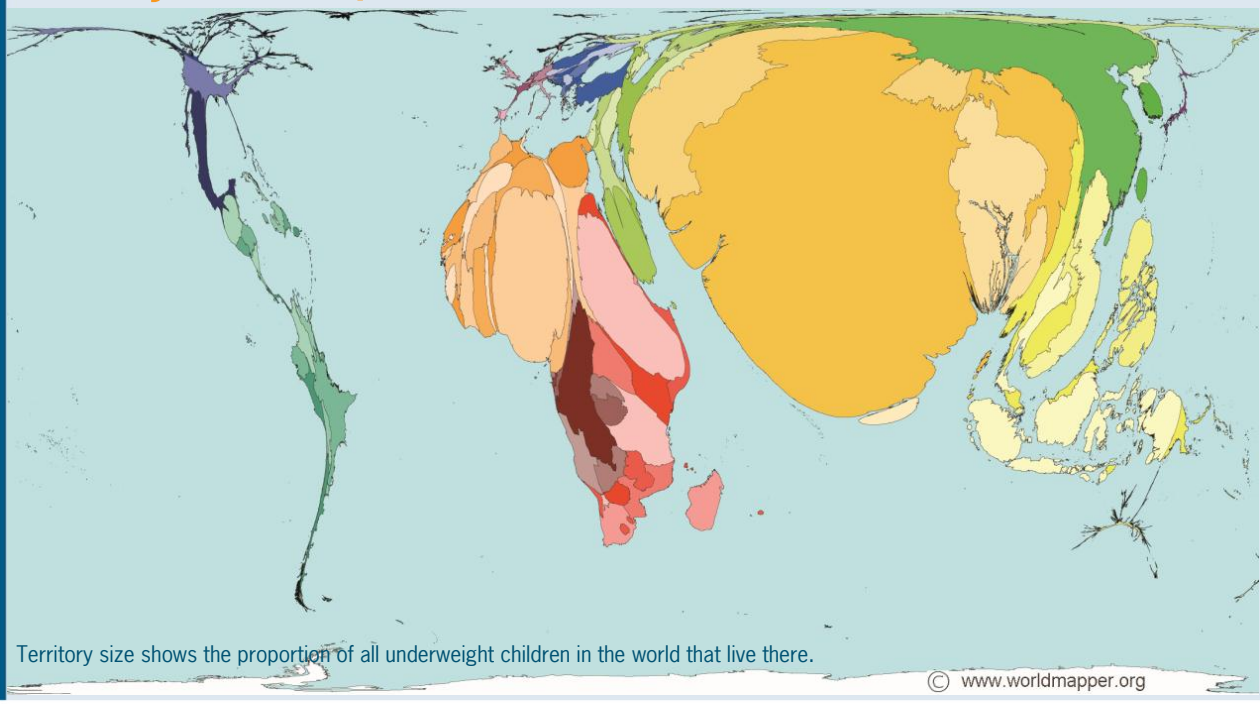
Centre for Development Innovation

Going for gold in innovation partnerships responsive to food insecurity in Africa – the role of knowledge institutes

Volume 1: Context study

Seerp Wigboldus
Jan van der Lee

Project Report



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Centre for Development Innovation, Wageningen University & Research centre

Summary

The Dutch 'gouden driehoek' refers to successful partnership in agricultural development between government, sector and knowledge institutes. This has been key in securing food & nutrition in the Netherlands. Could this model be applied to African conditions and be the basis for similar success in relation to food & nutrition security? This report is part of the documentation of an exploration in relation to this question. It explores the global context of agriculture and food systems as well as current and anticipated challenges that these systems will be facing in the future. This sketches the backdrop for understanding the range of roles to play by various actors in innovation systems responsive to food & nutrition security. Public-private partnerships will need to feature prominently in this. But we need to explicitly consider the role of civil society and farmers & communities in (relation to) such partnerships as well. Harnessing the potential of what knowledge institutes have to offer, will need to involve looking beyond traditional roles, to include more flexible roles such as being innovation broker. A companion report documents five examples of such flexible roles in the context of agriculture and fisheries innovation in Africa. Strengthening capacities of African knowledge institutes for playing such flexible roles more effectively in innovation partnerships, will be an important contribution to improving conditions that shape the state of food & nutrition security in Africa.

Companion document to

Borland, Gareth, Jan van der Lee, Ted Schrader, Monika Sopov, Petra Spliethoff, Marja Thijssen and Seerp Wigboldus (2011). Going for gold in innovation partnerships responsive to food insecurity – the role of knowledge institutes. *Vol. 2: Five case studies.* Wageningen UR Centre for Development Innovation. 34 pp.

and

Wigboldus, Seerp, Jan van der Lee, Gareth Borman, Karen Buchanan and Wouter Leen Hijweege (2011). Going for gold in innovation partnerships responsive to food insecurity – the role of knowledge institutes. *Policy paper.* Wageningen UR Centre for Development Innovation. 6 pp.

Photos

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Preface

Food & nutrition security is a subject that has featured high on international agendas over the past few years and will remain doing so for the years to come. This year, there were high-level seminars, conferences and policy meetings almost monthly on this topic, and more has already been scheduled for 2012. The increased attention was partly ignited by the 2007-2008 food crisis, but also relates to a growing awareness that food security for all is going to be increasingly challenging, if only because of the effects of climate change. During an FAO conference in June 2011, Kofi Annan therefore stated that delivering global food and nutrition is the challenge of our time.

Though the increase in food availability has kept pace with soaring population numbers, in absolute numbers of people, food *in*security has increased over the past decades, while at the same time threats to food security are gaining momentum. Climate change is one of the most notable threats. Compounding challenges to food security raise the question whether in the future it will be enough to further '*tweak'* agriculture & food systems as we know them now, or whether more drastic change is needed where we may need to think more along the lines of system *transformation*. Answers to this question have implications for what should be on (agricultural) innovation agendas.

There is a growing international awareness of the need for alignment of roles of government, private sector, civil society, knowledge institutes and other key players in development innovation to be able to respond to food insecurity. In terms of (agricultural) innovation, the Dutch agriculture and food system has greatly benefitted from successful partnerships between private sector, government and knowledge institutes. This is often referred to as the 'golden triangle'. Though not all may be gold that glitters in this triangular partnership it is still an inspiring example while looking for clues regarding improved innovation partnerships and related innovation capacities. Conditions for African agriculture and food systems are rather different from Dutch conditions, but, while taking this into account, there are opportunities for using Dutch experiences and expertise as part of the bases for strengthening effective (public-private) innovation partnerships for food security in Africa. We may need to think more along the lines of a pyramid to include other key players such as civil society in the perspective. Effective *collaborative* innovation among those players requires appropriate innovation governance as well as more informal facilitation of interaction and collaboration. And that challenge is what this report connects to.

This report does not stand alone, but is part of a set of three documents. The companion report documents five cases of agriculture and fisheries innovation in Africa. It points to the need for knowledge institutes to play flexible roles in innovation processes. This includes roles that may not traditionally be seen as their role to play, such as facilitating more effective collaboration between other players in the innovation process. By doing so, they can be instrumental in making innovation happen in situations that would otherwise remain constrained by institutional limitations.

The report you are reading now sketches the bigger picture of agriculture and food systems, which is the domain in which change is needed to secure food & nutrition for all. It is meant to connect the on-the-ground realities of (agricultural) innovation as described in the case studies to the bigger picture of global conditions that shape food & nutrition (in)security. The ability to link innovation across dimensions, levels, sectors and countries will make a big difference in making innovation systems be truly responsive to food & nutrition insecurity.

A separate 6-page policy paper summarises key findings from this report and the companion report on cases of agriculture and fisheries innovation in Africa. Copies are available through the Centre for Development Innovation.

Dr. A.J. Woodhill
Director Wageningen UR Centre for Development Innovation

Acknowledgements

This paper has benefitted greatly from the wealth of briefs, reports and books that have been made available by a range of organisations from around the globe, particularly in the past five years. There is so much that it is difficult to select what to use and not. We have tried to reflect studies and ideas from a range of perspectives rather than to choose one particular approach. Still, we realise the limitations of this exploratory study and annex 5 provides an overview of suggested further reading for those who want to develop a richer perspective on the subject matter.

We would like to thank those who have made it possible to embark on this study, allowing us to further develop our own perspectives along the way. First of all thanks to Patricia Wagenmakers of the Ministry of Economic Affairs, Agriculture and Innovation (EL&I), who provided her critical thoughts and made it possible to check tentative conclusions in a meeting with representatives from the Ministry of EL&I and the Ministry of Foreign Affairs (MinBuza). This helped us a great deal in sharpening our focus and made us decide to summarise the study in a 6-page policy brief in order to make findings more useful for policy support. We would also like to thank Floor Geerling-Eiff who supported the process of doing this study from the beginning and has created opportunities for developing the three resulting products.

We also want to thank Gareth Borman, Ted Schrader, Monika Sopov, Petra Spliethoff, and Marja Thijssen who have documented case studies on agriculture and fisheries innovation in Africa, as available in the companion document. These case studies have provided empirical perspectives and a reality check on general conclusions.

Wageningen, 22 December 2011
Seerp Wigboldus
Jan van der Lee

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Executive summary

This paper is a limited exploration of effective roles of knowledge institutes in innovation systems responsive to food & nutrition security. Knowledge institutes play an interactive and interdependent role in relation to a number of other key actors, most notably private sector, government, civil society and farmers & communities. The Dutch experience with the golden triple helix[1] can be inspiring for agriculture & food system development in countries in the South. However, conditions for, drivers of and challenges to food systems in the South are quite different than in the Netherlands. This calls for tailor-made approaches in making innovation system responsive to food & nutrition security for all. To bring in on-the-ground realities in this exploration, five public-private partnership cases of agriculture and fisheries innovation were studied in Ethiopia, Rwanda and South Africa.

Linking the following three conceptual frameworks helps to create a relevant action perspective for influencing and assessing performance of innovation systems responsive to food & nutrition security:

- Food & Nutrition Security
- Food Systems
- Food-related Innovation Systems

Such integrated framework combines perspectives from different arenas and provides an overview of key issues to consider and the many associated roles to be played in enhancing food & nutrition security (for all).

Zooming in on on-the-ground realities of innovation processes helps to see a clearer picture of what breeds success. We need to deepen our understanding about success factors in effective public-private partnerships. The cases in the companion document (briefly highlighted in 4.2) show (amongst others) that individuals and their associated attitudes and behaviour play a key role in successful partnerships. Innovation is a human activity and it should not come as a surprise that how individuals operate determines much of the potential outcome of an innovation process. This also makes the whole point of distinguishing between sectors in describing e.g. the triple helix or innovation systems, less relevant. It is not merely about which sector is represented in a public-private partnerships, but very much also about who is representing that particular sector. This highlights the importance of broad-based (involving all key actors) strengthening of innovation competences, which is not just about having bright ideas, but in the first place about an ability to communicate and work effectively cross-culturally (culturally understood in the broadest sense of the word).

Improving food systems' performance so as to lead to sustainable (also in 2050) outcomes in terms of food & nutrition security for all, involves a range of actors and factors to consider. A natural tendency is to focus on just a few and policy making may become lopsided in the process. This calls for appropriate innovation governance to ensure that we are fighting at the right fronts and do not get stuck in back stage battles. To tackle all the challenges, there is an increasing need for concerted efforts of all agents of change. Getting this right will become increasingly crucial as challenges to the (social, economic and environmental) sustainability of the food system are mounting. Are we going to be innovative enough and who has a role to play in 'lubricating' innovation processes? We see a key role there for knowledge institutes.

[1] The "Gouden Driehoek".

We cannot afford leading innovation blindly into the future without strategic foresight. What direction will trends in relation to agriculture & food take, what scenario will unfold, which prospects will become reality? Knowledge institutes have a key role to play in providing strategic insights in relation to these questions. We also need to distinguish appropriately between different unfolding futures for different people and countries. Conditions for Dutch agriculture & food systems are (and are expected to be even more) different from those in Africa. The role of certain actors (e.g. smallholder farmers) needs to be unleashed, while the role of other actors needs to improve (e.g. regulation by government actors). Global dimensions complicate the picture. There is an emerging international agreement on the key drivers of change in (global) food systems that need to be addressed. It is time to improve the 'orchestration' of roles to play. Who could do this? Knowledge institutes can play non-directive roles in this.

List of abbreviations and acronyms

CDI	Wageningen UR Centre for Development Innovation
Wageningen UR	Wageningen University & Research centre
FAO	Food and Agriculture Organization
EL&I	Dutch Ministry of Economic Affairs, Agriculture and Innovation

1 Introduction

1.1 Background and purpose

BACKGROUND

The Ministry of EL&I would like to understand the role and use of knowledge institutes in relation to public-private partnerships for sustainable agriculture innovation, particularly in the context of food security. The overall objective of this study is therefore to provide policy advice to EL&I on how to shape its international policy in relation to a more effective role of knowledge institutes in public-private partnerships responsive to food and nutrition security. The starting point of this study was inspired by the document "De gouden driehoek in actie – praktische voorbeelden van verbinding bedrijf, kennis en overheid"[2]. The 'Gouden Driehoek' relates to the successful cooperation of agricultural research/education, private sector and government in the Netherlands. This type of cooperation already started in the nineteenth century and is regarded as the basis for success of Dutch agriculture in the twentieth century. Knowledge institutes played a key role in this. This history is being dusted off and used as an inspiration for new forms of public-private partnerships.

Knowledge institutes
When we use the term 'knowledge institute', we refer to formal, not-for-profit groups that provide products and services in the field of knowledge generation, dissemination and exchange. They include universities, research groups and training institutions. We use this term in order not to limit the scope to universities only. Using this broader term connects to the potential of playing varied and flexible roles that we want to highlight in the following.

The 'gouden driehoek' refers specifically to the Dutch situation. The term is better known as the 'triple helix' in other circles. The situation in other countries will likely be different. What kind of partnerships like the Dutch 'gouden driehoek' can be considered as "gold" in international development? What makes such partnerships (in agriculture) become *golden* partnerships (success factors)? And what specifically can and should be the role of knowledge institutes in such partnerships? These are the key questions this study seeks to address.

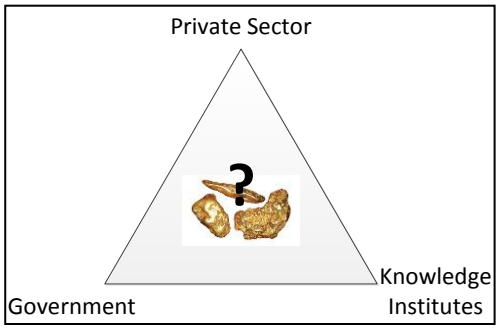


Figure 1: The 'gouden driehoek': what exactly does the 'gold' refer to?

As the report on the 'gouden driehoek' focused particularly on cases in the Netherlands, it is interesting to explore how public-private partnership leads to success in an international setting of agricultural innovation with a particular focus on the role of knowledge (institutes) and links with food security imperatives. This also introduces critical questions as to how 'golden' this collaboration has actually been. Economically, it has definitely brought a lot to the Netherlands. But at what cost to the environment (just thinking of e.g. the use of pesticides in the Dutch flower bulb industry), and to the resources in faraway places (from where we source much of the feed for animal production)? From a global perspective, questions related to

[2] Document in Dutch only. Roughly translated: The triple helix in action – practical examples of connecting business, knowledge and government. Ministry of Economic Affairs Agriculture and Innovation, 2011.

social and environmental sustainability may have to become more prominent, before we export the Dutch model (also see writings on transition management such as Rotmans, 2006)..

Apart from the idea of the 'gouden driehoek', there are many different approaches to this essential idea of the benefit of partnership for development. To name but a few: Public-private partnership, co-innovation, triple helix, innovation systems, innovation ecosystems. It is all about finding the "winning team" that will bring forth "gold". It may take the shape of a triangle (three main partners), a pyramid (four main partners), or even more. The innovation-systems approach tries to view these partners within an even wider framework of system dynamics, including formal and informal institutions. Fostering innovation through partnership.

Global foresight studies indicate that food security is going to increasing concern over the next few decades. Even to the point that some (club of Rome) expect the world population to go back to around 4 billion people by the end of the century because of the anticipated inability to produce sufficient food for all due to crises such as climate change, conflict and financial crunch. This makes food-related innovation processes to not merely sustain, but even improve food security even more of a pressing demand. Against this backdrop, the role of the Netherlands will also be important as a global key player in agro-food systems. This connects directly to two of the selected top sectors (of Dutch top sector policy), which are agriculture and horticulture, and indirectly to two more: energy (biofuels) and water (water security and agriculture). Dutch responsibility to play a key role in sustaining and improving global food security, which, conveniently, is also something that will benefit Dutch business and industry. We focus on the difference that knowledge institutes can make in addressing the challenges referred to in the above, including knowledge institutes in both the Netherlands and the South.

ORIENTATION

We have orientated this exploratory study in relation to the following considerations:

1. We found that many documents on the triple helix do describe success in terms of *outcomes* of the partnership, but they are usually much less clear on what were success factors in terms of the partnership *process*. What made this partnership successful as it unfolded? And, more particularly, what makes for an effective role of knowledge (institutes) in such partnerships? In this paper, we chose to zoom in on what makes for a successful role of knowledge institutes.
2. It soon became clear that as we moved into the international arena, we also need to consider different ways of conceptualising public-private partnerships and the triple helix approach. There appears to be a whole field of overlapping concepts and approaches. Different schools of thought will phrase the same factors and processes differently and on top of that, different organisations have connected to different stages of the development of conceptual thinking. For some, thinking in terms of public-private partnerships and triple helix is the great move forward, while others consider those to be just part of a wider *innovation system*. In this paper, we chose to work with the concept of innovation systems and related approaches as they are rather prominent in the field of agricultural development these days.
3. Though taking the innovation system perspective as leading in our analysis, we not so much seek to broaden the concept of *public-private* partnership to innovation systems, but see public-private partnerships as part of an innovation system. Of particular interest in this study, is to see the role of knowledge institutes in connection with the role of the private sector. Though informed by other perspectives, the case studies presented in this document are necessarily limited in that they provide insights regarding the role of knowledge institutes mainly from knowledge institute perspective. Further study will be needed to get a clearer picture on the role of knowledge institutes in food-related innovations from the perspective of the private sector.

4. A lot is written in terms of 'the role of knowledge' in (agricultural) innovation, where knowledge is easily equated with science, knowledge institutes and/or research. This seems to sometimes obscure the real issues regarding innovation partnerships where knowledge is often first of all a tool and means in the hands of innovation agents. The innovation agents, their interaction and the choices they make in putting knowledge into action, appears to be a more rewarding entry point for studying the role of knowledge institutes. So in this paper, we will zoom in on knowledge institutes and those who represent these institutes, in terms of how they played their role in a wider innovation process[3]. We may call this an actor-oriented approach to the role of knowledge in food-related innovation systems.
5. We wanted to connect food security and the role of knowledge institutes in (agricultural) innovation systems. Though food security is a much respected field of study and practice and much has been studies in the field of (agricultural) innovation systems, the two dynamics are rarely (conceptually) connected. The object (goal) of innovation systems often remains vague and unarticulated, which creates an analysis context where the (agricultural) innovation system appears to be a purpose in and of itself. Not all agriculture is for food, but much is. In this paper we chose to connect food security and innovation systems to the conceptual framework of food systems.
6. Food security is not just about today's food security and agricultural innovation is not just about today's innovation. In order to be ready for the increased need for (safe and nutritious) food on a planet that will be facing a number of crises over the next few decades, we need to also consider how food-related innovation systems will need to be functioning in order to be ready for the challenge. Zooming in on knowledge, we also want to know what role knowledge institutes will need to be playing in being ready for the challenge. Not just in terms of providing new technologies and other tangible innovation products. But also in terms of other services. This paper therefore attempts to include a future-oriented perspective on the role that knowledge institutes will need to be playing in the future, given the challenge on food security. We will illustrate the types of roles that knowledge institutes can play in (agricultural) innovation processes in the five cases discussed elsewhere in this paper.
7. Not all is about food security and it is not just agriculture and fisheries that determines the future of food security. Food, economic and environmental security are very much interconnected. It is hard to put boundaries on an innovation system. Strictly focusing on just food security and directly food-related innovation systems will not provide a clear backdrop against which to sketch the role of knowledge institutes. Though not an emphasis, we will therefore make some brief explorations beyond the borders of food-related innovation systems.

THREE PRODUCTS

The above seven considerations led to a broadening of the perspective of this study. First of all we take on the perspective of food security in relation to the need to feed nine billion (or more) people somewhere around the middle of this century in view of challenges such as climate change, impending water and energy security crises, and financial crises. This is the starting point. This means something needs to change in food-related systems. Choices will need to be made and trade-offs considered. These change processes need to be supported by effective innovation processes. Successful innovation processes will depend on successful innovation partnerships.

This study is an exploratory effort only. There is just too much to be covered when looking at the role knowledge institutes and taking on an integrated analysis of food, economic and environmental security and the related innovation systems, to try to do this in this short study. Also, the limited scope of the case

[3] This appears to be in line with the conclusion "from knowledge for action to knowledge in action" of the book by Paassen, A. et al. (2011) on *Knowledge in action – the search for collaborative research for sustainable landscape development*. Mansholt publication series – volume 11, Wageningen Academic Publishers.

studies and the limited scope of actively involving private-sector perspective and perspectives from the South, means that this study can only be a setup for a more comprehensive analysis. We hope that this paper will provide a good basis for further exploration, an exploration which would be timely given global dynamics in the field of securing food, economy and environment in an integrated way for future generations. This paper intends to therefore sketch in broad strokes the pressing issues regarding (global) food security that require such further exploration as well as tentatively indicating how knowledge institutes can play an effective role in the South in making food more secure for more people.

Having broadened the scope of this study, we realise that the resulting reporting needed to be readable to policy makers. A 100-page report would not fit that bill. For this reason we have developed three products.

1. An 7-page policy paper[4] summarising key findings from the following two reports
2. A report discussing five case studies of agriculture and fisheries innovation in Ethiopia, Rwanda and South Africa
3. A context study report[5] which sketches perspectives on (global) food & nutrition security and related agriculture and which discusses roles of key actors in related innovation systems.

The policy brief is the main product and the other two documents are meant for those who want to read the source of summarised findings and/or for those interested in reading more into the subject matter.

1.2 Methodology

This context study is based on a literature review and informed by the five case studies documented in the companion report.

We have organised this study along the lines of three main components:

1. The Concepts: Sketching the way in which we try to approach this subject of public-private partnership, innovation and food & nutrition security in an integrated way (chapter two).
2. The Context: Sketching an overview of what to consider when taking up a role in making a difference in innovation of agriculture and food systems with the objective to enhance food & nutrition security (chapter three).
3. The Clues: Discussing the role of knowledge institutes in an interactive arrangements of roles to play to secure food and nutrition for all, focusing on emerging trends and developments. Conclusions and recommendations in this section highlight some of the key arguments shared in this paper (chapter four and five).

The sequence of sections indicates the line of argument of this paper.

We have decided to not merely focus on knowledge systems and the role of knowledge institutes, because it would limit the exploration of the scope of potential contributions that knowledge institutes can have. We therefore adopt a kind of team perspective on sustainable food systems (section 2.4). This perspective acknowledges that different actors will have to play different interactive roles in making a system operate effectively and appropriately. To understand how one actor needs to play a role, one also needs to understand the (potential) roles that the other actors can/want to/need to play. Furthermore, the

[4] Wigboldus, Seerp, Jan van der Lee, Gareth Borman, Karen Buchanan and Wouter Leen Hijweege (2011). Going for gold in innovation partnerships responsive to food insecurity – the role of knowledge institutes. *Policy paper*. Wageningen UR Centre for Development Innovation. 6 pp.

[5] Borland, Gareth, Jan van der Lee, Ted Schrader, Monika Sopov, Petra Spliethoff, Marja Thijssen and Seerp Wigboldus (2011). Going for gold in innovation partnerships responsive to food insecurity – the role of knowledge institutes. *Vol. 2: Five case studies.* Wageningen UR Centre for Development Innovation. 34 pp.

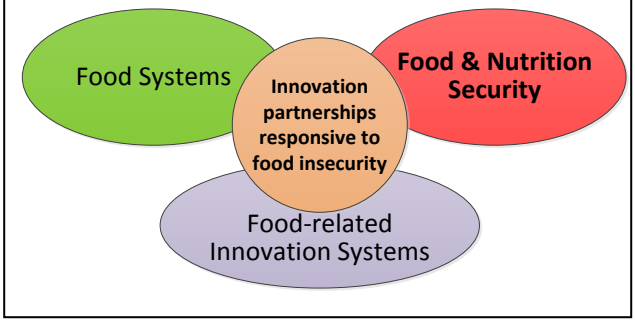
different context conditions under which these 'innovation teams' operate will also influence the roles that actors need to play, including the way they will need to operate interactively.

This is why we have made a rather extensive overview of the context in which knowledge institutes need to operate and make a difference. There is no one role to be played and knowledge will need to become effective in a specific context. The case studies in the companion report are illustrations of a practice of activating knowledge in context by adopting flexible roles by knowledge institutes.

2 An integrative reference framework

Food security is shaped by many complex and interactive dynamics. It is easy to lose sight of the bigger picture of food security determinants and dynamics. The result is then a tendency piecemeal engineering and efforts that often appear to not be taking into account all relevant aspects of a change process and its impact. E.g. agricultural technologies may be developed that later turn out to have adverse environmental effects. Or, new crops with great potential are introduced, but market linkages are failing. We think it is important to somehow stay connected to that bigger picture of what is involved in food (in) security. For this reason we are looking for a way of conceptualising such bigger picture. Though this could be done in other ways as well, we have found it helpful to connect three areas of conceptual thinking: Food & Nutrition Security, Food Systems, and Innovation Systems. In the following we try to briefly explain why we think this is a helpful perspective and then move on to discuss some of the essential ideas related to the concepts.

Figure 2: Interrelated concepts used in this paper



In this paper we focus on innovation partnerships for food security and the role that knowledge institutes (can) play in these partnerships. So we need to first of all understand what is involved in food security. We will broaden this to food & nutrition security. Next we need to understand in what context innovation partnerships function, particularly in connection to food & nutrition security. The concept of innovation systems is useful for exploring such partnerships. Many studies have been done in relation to agricultural innovation systems, which are not necessarily connected to the imperative of food & nutrition security. We try to broaden this perspective to innovation systems responsive to food & nutrition security. Agricultural innovation systems feature prominently in this, but do not present the complete picture. Finally, we looked for the domain of change, which 1) produces a certain measure of food & nutrition security as an outcome, and 2) is the workshop for innovation systems. Without being clear on that domain of change, it is difficult to assess how innovation systems could best function to enhance food & nutrition security. The closest we could come defining that domain of change was the notion of a food system, which is a commonly used perspective. Agriculture is part of a food system, though food is not the only output of agriculture. The very fact that it is also part of other systems, such as energy systems, contributes to challenges to food system performance. Food systems form the **domain of change** where change needs happen to lead to positive outcomes for food & nutrition security.

This chapter explores the above mentioned three concepts that we consider to be helpful while sketching the context in which the role of knowledge institutes need to be positioned. It is structured according to the three main concepts as shown in figure 2.

2.1 Food & nutrition security

The concept of food (& nutrition) security is not new. It was coined around the beginning of the 1970ies. However, under different labels, the issue of food security has been on international and national agendas since more than 3500 years as evident in e.g. the story of Joseph in the Bible who secured food both nationally and internationally through the grain reserves he had created in Egypt.

At the World Food Summit in 1996, **food security** was defined as: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."

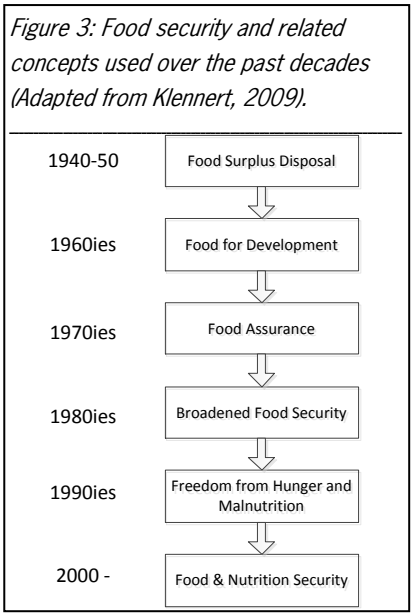


Figure 3: Food security and related concepts used over the past decades (Adapted from Klennert, 2009).

This definition has been further specified to encompass 'stable' food availability, food access and food utilization. This refers to the following interrelated components:

Food availability is the physical presence of food in the area of concern through all forms of domestic production, commercial imports and food aid. Food availability might be aggregated at the regional, national, district or community level. Food availability is determined by:

- *production*: food produced in the area;
- *trade*: food brought into the area through market mechanisms;
- *stocks*: food held by traders and in government reserves;
- *transfers*: food supplied by the government and/or aid agencies.

Food access concerns the ability (depending on the level of analysis, of a household, a community, a country or region) **to acquire** adequate amounts of food, through one or a combination of own production and stocks, purchases, barter, gifts, borrowing and food aid. Food may be *available* but not *accessible* to certain households if they cannot acquire a sufficient quantity or diversity of food through these mechanisms.

Food utilization refers to the use of food (by individual or group) and the ability to absorb and metabolize the nutrients – the conversion efficiency of the body. Food utilization includes:

- the ways in which food is stored, processed and prepared, including the water and cooking fuel used, and hygiene conditions;
- feeding practices, particularly for individuals with special nutrition needs, such as babies, young children, the elderly, sick people, and pregnant or lactating women;
- the sharing of food within the household, and the extent to which this corresponds to individuals' nutrition needs - growth, pregnancy, lactation, etc.;
- the health status of each member of the household.

Food may be *available* and *accessible* but certain household members may not benefit fully if they do not receive an adequate share of the food in terms of quantity and diversity, or if their bodies are unable to absorb food because of poor food preparation or sickness such as HIV/AIDS (Appleton, 2008).

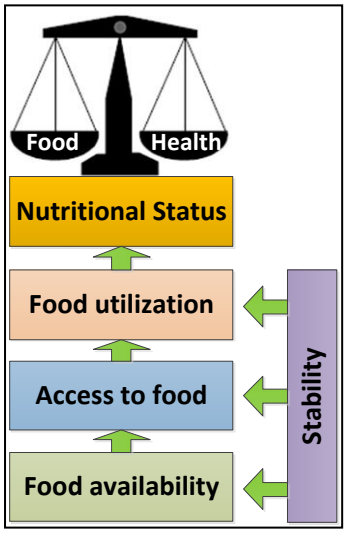


Figure 4: Building blocks of the concept of food & nutrition security (Adapted from: Klennert, 2009)

The term 'security' relates to the degree to which we can count on availability, access and utilization. This introduces the concept of 'stability', which is often used to qualify the required status of availability, access and utilization.

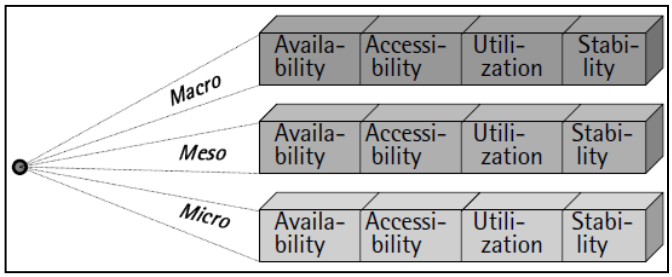


Figure 5: Levels at which food & nutrition security needs to be targeted (Source: Klennert, 2009)

As we already referred to, the four elements of food security play out differently at different levels. A region known to be food insecure may include countries that are better off than others. Within communities known to be food insecure, certain households may be thriving. Furthermore, areas producing a surplus of food, may still have inhabitants who are food insecure because of not having access to sufficient food. Hence analysing food insecurity will need to look at diversity at different levels and at diversity in relation to the four elements of food security (figure 5). An assessment system such as the Food Insecurity and Vulnerability Information and Mapping System (FIVIMS)[6] uses this integrated approach to the four elements.

Nutrition security

There are many reasons why organisations have started talking about not merely food, but food & nutrition security. In fact, "feeding 9 billion" and similar expressions do not express that it is not merely about ***that*** people eat, but also very much about ***what*** they eat. In the poorer parts of this world, food deficiencies are a severe health hazard, but in richer parts of the world eating patterns similarly cause health problems (including obesity). **Nutrition security** is achieved when secure access to appropriately nutritious food is coupled with a sanitary environment, adequate health services and care, to ensure a healthy and active life for all household members. **Hunger** is often used to refer in general terms to MDG1 and food insecurity. Acute hunger is when lack of food is short term, and is often caused when shocks such as drought or war affect vulnerable populations. Chronic hunger is a

Box 1: Sobering facts about the effect of food deficiencies

178 million children become physically stunted, partly because of not having enough foods or vitamins.
146 million children under five are underweight
More than 500.000 child deaths every year are linked to lack of vitamin A.
More than 20 percent of children under five in developing countries suffer from iron deficiency-related anaemia
40-60 per cent of children in developing countries have impaired mental development due to iron deficiency
2 billion people worldwide are iodine deficient
176,000 people die from diarrhea linked to zinc deficiency each year
406,000 people die from pneumonia linked to zinc deficiency each year
Up to 20 per cent of children under five are overweight in some developing countries.
More than 60 percent of chronically undernourished people are women.

Source: http://www.scidev.net/en/features/the-challenge-of-improving-nutrition-facts-and-figures-1.html

[6] http://www.fivims.org/ (FAO). Other relevant assessment initiatives by FAO include:

- SOFI (The State of Food Insecurity in the World) Purpose, presenting the latest statistics on global undernourishment, monitoring progress towards hunger reduction targets MDG 1.
- GIEWS (Global Information and Early Warning System) monitoring global food supply and demand & to provide early warning on imminent serious food shortages.
- IPC (Integrated Food Security Phase Classification), which classifies the situation in a country/region according to various stages of food insecurity
- CountrySTAT (Country statistical information system for food and agriculture), which derives food and nutrition security statistics from existing national sources.
- National Food Security Assessments using Household Surveys with Food Consumption Data.

constant or recurrent lack of food and results in underweight and stunted children, and high infant mortality. 'Hidden hunger' is a lack of essential micronutrients in diets. Nutrition-security and food self-sufficiency are not the same. Many countries have achieved "food self-sufficiency", which simply means they are not net food importers, but have not achieved nutrition security. While food insecurity is acknowledged as a cause of undernutrition, the exact relationship between the two is not well understood. Even if a person consumes enough calories, this does not guarantee adequate intake of essential micronutrients – vitamins, minerals and trace elements (DFID/UKAID, 2009).

Agriculture and nutrition are highly interconnected. Larger yields may increase food supply, but mono-crop production or greater quantities of low-nutrient content crops do not necessarily translate into adequate quality with respect to nutrition. Improving nutrition therefore also involves addressing issues in agriculture.

Another important factor in (child) nutrition is women's education. It is estimated that improvements in women's education were responsible for 43% of the reduction in child malnutrition that occurred between 1970 and 1995; improving the availability of food has accounted for only 25%30. Data from 25 developing countries suggest that 1-3 years of maternal schooling reduces child mortality by 15% (DFID/UKAID, 2009, Hawkes & Ruel, 2006).

To improve nutrition security, various pathways have been suggested, including working on making value chains nutrition-sensitive, the role of horticulture and livestock, women empowerment (education), biofortification of food[7] (e.g. golden rice[8], but similar treatments are done to sorghum and cassava), and dealing with the seasonality of food shortages (AED/FAO, 2011).

The United Nations Standing Committee on Nutrition, (which has a mandate "to promote cooperation among UN agencies and partner organizations in support of community, national, regional, and international efforts to end malnutrition in all of its forms in this generation"[9]) developed in 2010 what is called a road map for scaling-up nutrition (SUN). It provides the principles and direction for increased support for countries as they scale up efforts to tackle under-nutrition across a range of sectors. Annex … shows a more comprehensive conceptual framework of child nutrition determinants. It indirectly points at the many issues to address and the many roles to be played.

Appleton (2008) points out the two-way causal linkages between food insecurity and malnutrition. Food insecurity can cause malnutrition by e.g.:

- Poor access to food may lead to inadequate dietary diversity and insufficient consumption of micronutrients;
- The use of dirty water in cooking may cause diarrhoea, and hence poor absorption of nutrients.
- Malnutrition can cause food insecurity by e.g.:
- Malnourishment diminishes a child's learning capacity, which may limit his/her ability to find well-paid work in the future;
- Malnourishment in adults can lead to poor productive capacity and frequent sickness; these have severe economic effects on the household, leading to poor food access.

[7] The Global Alliance for Improved Nutrition is very much in favour of this http://www.gainhealth.org/

[8] http://www.goldenrice.org/

[9] http://www.unscn.org/

Food security through food aid and food reserves

Though we focus on structural support to food security through (agricultural) innovation processes, it is important to consider this in the context of measure taken to cope with emergency situations. With increasing effects of climate change, disasters in terms of food insecurity cannot be prevented around the world. Those places already vulnerable, will be more so in the future. Strategies for enhancing food security for 9 billion people in 2050 will need to include measures for coping with disaster. This is part of strategic thinking from a bigger picture perspective.

Voices that point to the importance of securing food availability through (national) food (grain) reserves are getting stronger. The argument is that we just cannot oversee all the acute challenges we will be confronted with in terms of food availability in the nearby future. Severe droughts and other adverse weather conditions in extended areas may push many more into acute food insecurity than we may be anticipating (ActionAid, 2011; Shahidur and Lemma, 2011). Bruins (2008) in his presentation on the rationale for national grain reserves as part of disaster contingency planning, reminds us about the ancient wisdom of having grain reserves in the story of Joseph in the Bible. Countries like China are actively strategizing for this.

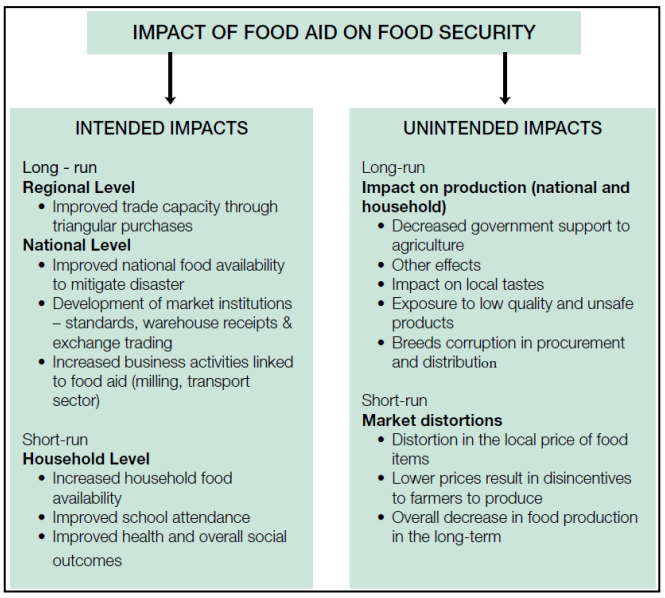


Figure 6: Source: Economic Commission for Africa, 2007.

At the same time, strategies for coping with disaster also affect innovation processes. The Economic Commission for Africa (2007) highlighted a number of unintended impacts of food aid on food security (see figure 8).

Food security and social protection

One way of looking beyond food while trying to improve food & nutrition security, is to explore social protection mechanisms. In the absence of social protection, people are subjected to increased risks of sinking below the poverty line or remaining caught in poverty in which food insecurity features prominently. Besides providing for people's sustenance, social protection can play a central role in improving social cohesion and in strengthening the link between state and citizen. By providing protection to its citizens, a state bolsters its legitimacy. In fragile states this is particularly important. It provides incentives for economic growth, job creation, and infrastructure development (European Communities, 2010). However, people vulnerable to fall through there basis of existence need to have solid enough ground to stand on while working on that. This also relates to the concept of Social Protection Floors. The social protection floor (SPF) approach promotes access to essential social transfers and services in the areas of health, water and sanitation, education, food, housing, and life- and asset-saving information. It is an approach that emphasizes the need to implement comprehensive, coherent and coordinated social protection policies to guarantee services and social transfers throughout the life cycle, paying particular attention to

vulnerable groups. The challenge is how to cover the entire population effectively, especially those who are at risk or who are already in a situation of deprivation, and in a sustainable manner (ILO, 2009; European Communities, 2010;UNDP 2011).

Social protection proponents do not believe that markets alone can solve poverty and food insecurity. Some people lack a solid (food secure) foundation, which means that any small or bigger disaster will immediately send them back into food insecurity and malnutrition. They are very vulnerable. Rather than trying to solve this merely through food aid, many argue for social protection mechanisms from a rights-based perspective. E.g. Devereux (2009) argues

- that social protection policy agendas need to engage more directly with agricultural seasonality if it is to address this fundamental source of risk and vulnerability facing millions of Africans every year.
- for appropriate state-led intervention to correct market failure.
- that seasonable hunger is predictable in many places. Mechanisms for social protection could be institutionalised rather than treating situations again and again as emergencies.
- that a neglect of investments in rural areas and agricultural development needs to be addressed, rather than buying off responsibility through occasional food and/or cash transfers.
- for more insurance instead of hand-outs.
- to move away from 'discretionary welfarism' to guaranteed entitlements and enforceable claims.

Food security and nutrition are particularly critical for vulnerable groups, These vulnerable groups include individuals, households and communities affected by HIV. Adults with HIV have 10-30% higher energy requirements than a healthy adult without HIV, and children with HIV 50-100% higher than normal requirements. Lack of food security and poor nutritional status may hasten progression to AIDS-related illnesses and undermine adherence and response to antiretroviral therapy. HIV infection itself undermines food security and nutrition by reducing work capacity and jeopardizing household livelihoods. (Frega et al., 2010, UNAIDS, 2008 and The World Bank, 2007). Of the 10.8 million deaths estimated to have occurred in Sub-Saharan Africa in the year 2000, HIV caused 20 percent of them. (The World Bank, 2007).

Digging deeper to help those who are coping with food and nutrition insecurity

Food & nutrition security has a different meaning for people in Europe/North America than in Africa or Asia. Increasing food prices push millions of people into extreme poverty and hunger in Africa and Asia. Different levels of food insecurity relate to different coping mechanisms that people adopt, from dietary adaptation to reduction of consumption to no consumption for periods of time (Borrel, 2011). It is important to try to understand what happens when people slide into food insecurity. In extreme situations it leads to irreversible coping strategies such as selling land[10]. Long-term solutions are necessary to help people climb out of this poverty trap. Though there are situations which could hardly be anticipated, many of the food-related emergencies have to do with structural malfunctioning of the food system. To address this, not only technological hurdles will need to be taken. Dysfunctional social, political and related institutions often form the main bottle-neck (FAO/EU, 2003). Together with the

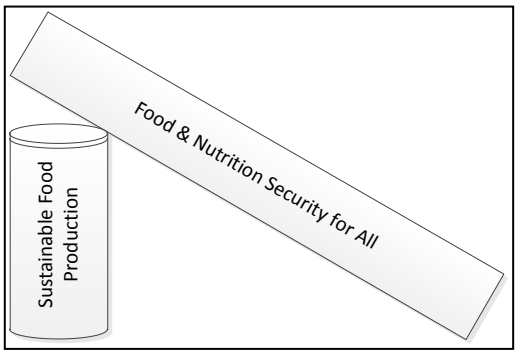


Figure 7 : No silver bullets in achieving food & nutrition security for all.

[10] See http://www.fews.net/ml/en/info/pages/scale.aspx for an table which shows the connection between severity of food insecurity and associated coping mechanisms.

additional challenges such as climate change and increasing food prices sketches a picture of building on sinking sands. As the Dutch have found in construction work in marshy land over the centuries, many pillars will need to hold up a building.

2.2 Food systems

A food system concerns the whole of interconnected actors and factors that relate to the social, economic and environmental functions and/or implications of food production, marketing and consumption. Food systems include not just the production aspects of food (alongside fibre, feed and fuel) but also the preparation of agricultural inputs, processing, distribution, access, use, food recycling and waste. Food chains,- from the point where food and fibres originate to where they are consumed and disposed of-, are important components of the food system. Food systems range from the local to the global. Some of the key differences between the various food systems relate to the ecology of food production, markets, rural life and governance[11].

In line with the extension of food security to food & nutrition security, it is appropriate to talk about food systems. The reasons for emphasizing the nutrition aspect of food has been discussed in the previous section. Similarly, the stability aspect of food & nutrition security can be transferred to the concept of food and nutrition systems, which brings us to the working concept of stable or sustainable food systems. This section zooms out from food & nutrition security to a different level of aggregation in which food & nutrition security is one of the key outcomes of food systems.

A number of visualised conceptual models of food (and nutrition) systems have been developed. We have copied some of them in annex. Figure 12 is a simplified way of showing the connection between food & nutrition security. An analysis at the level of a food system, even if it is not complete (see complex picture in annex which does try to be complete), clearly point to the many issues need to be addressed and many roles played by many actors to make food systems deliver food & nutrition security as its key outcome.

Food system drivers include markets, infrastructure, knowledge, ICT and climate. Food system activities include agricultural production and processing, distribution and retailing. Food system drains include environmental degradation, climate change, post-harvest losses and crop pests. The performance of the food system is largely determined by the interplay between these factors. The status of food & nutrition security is a key indicator of food system performance.

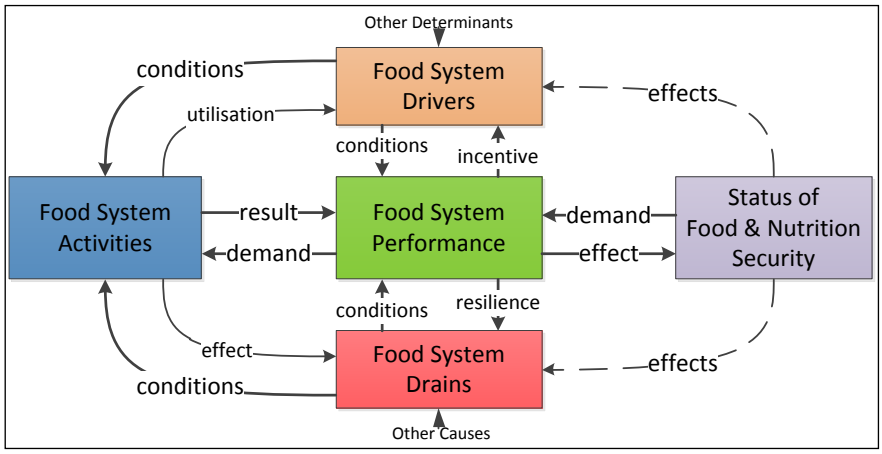


Figure 8: The connection between a food system and food & nutrition security

[11] Adapted from http://www.diversefoodsystems.org/keycon.html (accessed 28 October 2011).

Changing systems

Changes in food systems can come from any direction: from changing production techniques to loss of biodiversity to market failure. The driving forces of income growth, demographic shifts, globalization and technical change have led to a reorganization of food systems and the related food chain (farm to fork). The characteristics of supply chains - particularly the role of supermarkets – have changed dramatically. This has had an enormous effect on smallholder farmers, particularly in developing countries (McCullough et al., 2008; Mcintyre, 2009). Some have called this the "supermarket revolution". The "take-off" of this revolution started somewhere in the early/mid 1990s; the sector grew so strong thereafter that in many countries supermarkets now dominate urban food retail and have gone way beyond the initial middle-class clientele to penetrate the food markets of the poor. This "shock" downstream in the food system has had expanding ripple effects upstream in the food system, on the wholesale, processing, and farm sectors (Reardon and Berdegué, 2006).

Other food system changes include increasingly varied diets (e.g. meat products), consumer pressure (food safety, animal welfare), food processing & technologies (convenience), declining rural economy and agriculture sector, increased government regulations, and changing environmental conditions (climate change).

The way in which these changing systems play out differs between countries and within them. Nevertheless, one story is the same, which is that drivers of change of global food & agriculture are becoming more complex and more unpredictable. Changing consumer preferences and environmental, social & well-being concerns (and associated regulations) are having significant impacts on the dynamics of food system, including associated markets. Because of the interconnectedness of actors and factors in such systems, it is important to take a whole (food & nutrition) systems approach in identifying food system deficiencies and related policy making and strategy formation (Rutten et al., 2011).

The way in which food systems work is very much a subject of debate as to how they ought to be functioning and what contributes (root causes) to their vulnerability or resilience in view of economic and environmental shocks (Holt-Giménez, 2008; Levidow, 2011[12].). Choices are to be made regarding e.g. grain subsidies, foreign aid, investments in agricultural development, and the role of regulation regarding social and environmental effects of agriculture and food industries. In the following chapter this will be further elaborated on in relation to subjects such as food justice, food system governance, right to food and food sovereignty.

Faber and Alkemade (2011) argue that there is a need for policy reorientation from efficiency and optimization towards more comprehensive principles of system organization. This would require a long-term perspective on structural change, rather than on equilibriums or defined states of the environment. It would involve a rethinking of the 'means-end dichotomy', where the focus of policy is then not on a specific aim that has to be efficiently reached, but rather on a providing specific incentives that will change economic patterns of development. This is a different way of looking at system change than is generally adopted. We will not further elaborate on this important field of transition system's thinking.

[12] It requires being clear about e.g. what kind of agriculture we want to have. What to sustain? What should it be resilient against? Who is supposed to benefit in what way? Etc.

Sustainability and resilience of the food system

Sustainability of the food system relates directly to the sustainability of all the contributing aspects of the system. E.g. agricultural production needs to be sustainable, market access needs to be sustainable, etc. Depending on the type of component, a lack of sustainability in one aspect, may put the sustainability of the entire system at risk. In turn, the sustainability of different aspects depends on the resilience of that aspect in the face of adverse conditions. We may see sustainability as the active perspective (the ability to perform without creating adverse effects) and resilience as the passive perspective (the ability to cope with adverse conditions)

The key question is therefore what results food systems can deliver sustainably in terms of people, planet and profit (Poppe, Termeer and Slingerland (eds), 2011). This challenge is high on the agenda in various policy arenas, including the recent international conference on transitions towards sustainable food consumption and production in a resource constrained world[13]. Other notable contributions in this field include UNEP's report on the Green Economy (UNEP, 2011). Some (e.g. Heinberg and Bomford, 2009) argue for a need for a drastic change of current food systems in order to ensure long-term sustainability. More along these lines will be discussed in the next chapter.

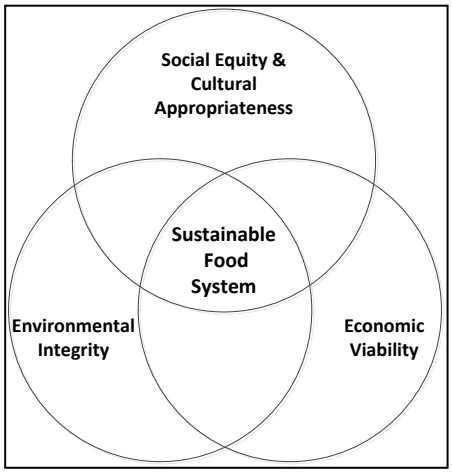


Figure 9: Integrating dimensions of sustainability

In conclusion on the concept of sustainable food systems, figure 9 (based on input from Blay-Palmer, 2010) represents the essence of areas that need to be included in policy development in relation to these systems. In other words, this is about integrating economic, social and environmental sustainability. The tendency towards making one or two of the three pillars taking precedence over the other can be observed regularly. Interdisciplinary and integrated analysis and policy making along the lines of those three pillars will be key in this (Ingram, 2011). Furthermore, as Blay-Palmer (2010) argues, sustainability is a process, rather than an endpoint. Food and nutrition systems will keep being shaped and reshaped with all expectable implications for sustainability. This also requires being in touch with the future to get an idea of how different drivers of food and nutrition systems may play out in the future (see e.g. Muetzelfeldt, 2010 writing on system dynamics modelling). In both fields, interdisciplinary and integrated analysis and policy development, as well as in strategic foresight analysis, knowledge institutes can play a significant role to help ensure keeping policy makers and other key actors in the system informed so that appropriate trade-offs can be made in the process of system innovation.

It is hard to keep the bigger picture of food systems in mind as they relate to so many interacting actors and factors. Academics will tend to limit themselves to specialisms, policy makers to hot political issues, civil society group to one-liners, and private sector to business interests. Knowledge institutes are well-placed for keeping the bigger picture alive and activate this through providing facilitation, advisory and networking services.

[13] Organised by the European Commission in Budapest in May 2011.
http://ec.europa.eu/research/agriculture/conference/index_en.html

2.3 Food-related innovation systems

Though coined as such only relatively recently, innovation systems have always been there as such. It is no more than an intellectual and social construct, a concept that is useful in understanding complex interactions between multiple players in order to create change (Group of Eight, 2011). Hall (2006) describes the innovation system as a system of innovation involving all the actors and their interactions involved in the production, use of knowledge, and the institutional and policy context that shapes the processes of interacting, knowledge sharing and learning. It is difficult to find a good definition of innovation. It relates to creating something new, but it is important to distinguish from a mere change process. One or a combination of the following four components may be involved in calling something an innovation rather than 'business as usual': 1) The reason (cause) for the change process, 2) the purpose for which change happens, 3) the way in which change comes about, and 4) the result of the change. Some further distinguish between e.g. radical innovation, incremental innovation and system innovation, just the same way as change processes are distinguished (Eris and Saatcioglu, 2006). Within innovation systems, we can distinguish radical, incremental as well as system change processes and the associated dynamics are different.

Box 2: Innovation Systems refer to:

"(networks) of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behaviour and performance. The innovation systems concept embraces not only the science suppliers but the totality and interaction of actors involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways." (Rajalahti, Janssen & Pehu, 2008). Innovation systems can be identified at different levels, and in relation to different domains (e.g. environment, agriculture, health). Due to the complexity of issues involved, food & nutrition security requires (actors at) different levels and domains of innovation systems to work in unison. This requires different forms of 'orchestration'.

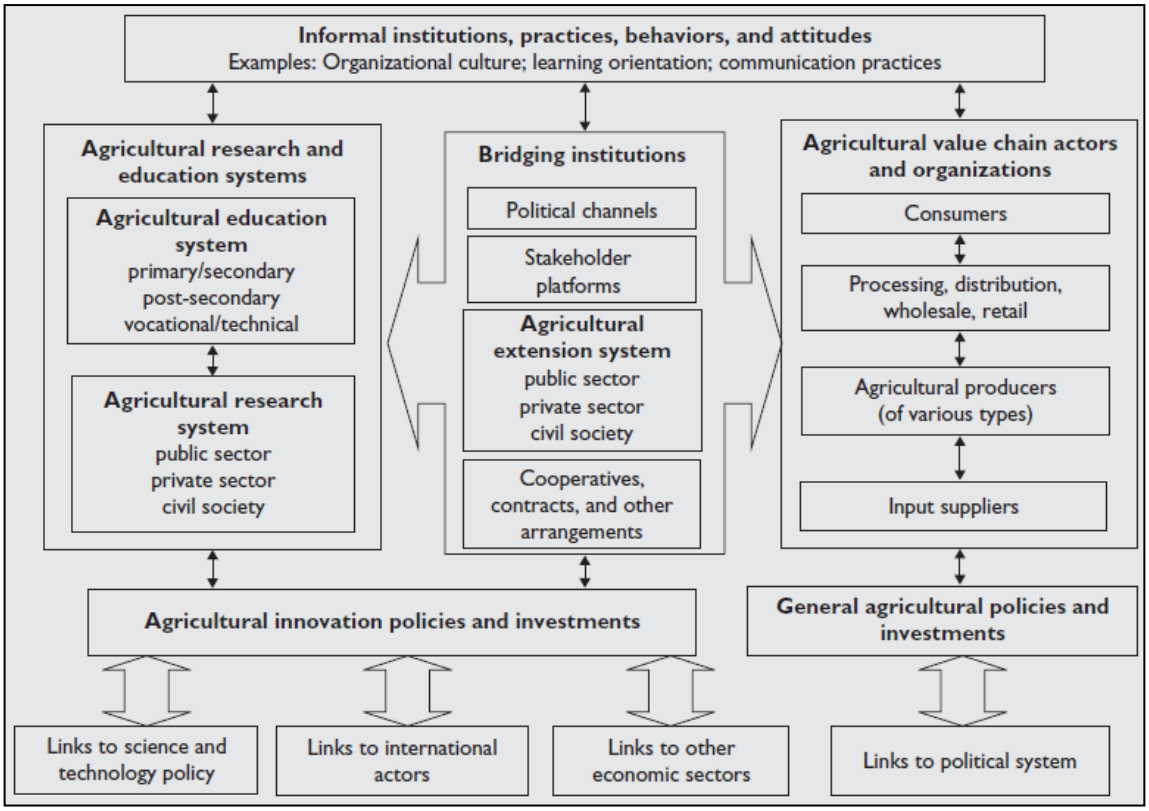
We can describe many kinds of innovation systems at different levels and with different focus, such as national innovation systems, health innovation systems, environmental innovation systems, and also agricultural innovation systems. For some reason, a few decades ago in the age of 'technology transfer', the multiple roles to be played by various actors in a change process were not as much recognised as they are now. Expectations of what technical inventions could do were extreme (McIntyre, 2009). But the innovation systems as such were there. Due to the lack of the broader perspective though, innovation systems at that time were often frustrated through dominance of one or just a few players that need to make the innovation system tick. Learning from experience, decentralisation processes, recognition for 'indigenous knowledge', democratisation processes and other transitions have brought the perspective of innovation systems more to the front. From about the 1990s onwards innovation processes in agriculture have been increasingly driven by market-led development. (McIntyre, 2009).

The construct of the innovation system is a helpful framework from which we can identify and explore what is involved in how innovation takes place. From a systems perspective we can see the need for recognising system boundaries. Most system studies will have certain more (or often less) defined boundaries. Different people may put different boundaries on what is and isn't part of e.g. an agricultural innovation system. Various defined innovation systems will often also have a certain measure of overlap. E.g. on the subject of nutrition, health innovation systems and agricultural innovation systems will partly overlap. Often innovation systems are identified along the lines of sectors. National innovation systems incorporate elements of a number of lower-level innovation systems. So when the OECD does an assessment of a national innovation systems, information from e.g. agriculture, health, technology, industry and other sectors are brought together.

Getting the picture of innovation systems

Figure 10 combines the pictorial approach with words and helps to see the range of actors and complex dynamic which the agricultural innovation systems perspective tries to reflect. This is a rather well-known and often quoted representation of this perspective. We are showing this picture as an example of what the concept of innovation systems encompasses. It is striking that there is often no reference to the purpose or goal of the innovation system. This can be considered a weakness of how agricultural innovation systems are conceptualised. Without a clear purpose for innovation the system appears to be having a purpose in and of itself. This is where the link to the purpose of food & nutrition security is actually very useful in creating a focus of what the innovation is supposed to be contributing to.

Figure 10: National agricultural knowledge system conceptual diagram (Source: Larsen, Kim & Theus (eds), 2009, based on Spielman and Kelemework, 2009).



Linking innovation systems to the purpose of securing food & nutrition

In this paper we are interested in innovation systems in food systems responsive to food and nutrition security. This means we want to look at all the actors and factors involved in ensuring food and nutrition security. What makes this happen and what is undermining it? These boundaries extend beyond the agricultural sector and therefore also beyond agricultural innovation systems. Agricultural innovation systems for the larger part can be seen as part of that larger food-related innovation system[14]. At the same time, seeing agricultural innovation systems in relation to securing food and nutrition (for all) makes

[14] Not all in agriculture relates to securing food and nutrition. Fuel and fibre are the main other outputs of agriculture.

it easier to assess the (required) innovation capacities and performance. Having browsed a wide range of literature on the subject on food security and innovation systems, we were surprised to find hardly any document that explicitly links the two concepts. A notable exception is Brooks and Loevinsohn's (2011) article on shaping agricultural innovation systems responsive to food insecurity and climate change[15].

Innovation systems and (food) supply chains

Supply (or value) chains are subsets of innovation systems. They usually relate to a specific commodity, such as the soybean value chain or rice value chain. The innovation system perspective will usually have a more broad-based focus. Supply chains look at the chain 'from farm to fork', considering how actors along the chain perform and connect to the next link. Supply chains tend to be the focus of economists and innovation systems more of sociologists. Supply chains are often particularly assessed in relation to economic viability. When private sector assesses the sustainability of the (food) supply chain, it will often be along those lines. The value chain perspective is in a way clearer on its purpose than the innovation systems perspective as we discussed before. Both perspectives are very much actor-oriented. Anandajayasekeram and Gebremedhin (2009) have tried to integrate the two perspectives in relation to agricultural research. Perhaps it is more useful to link the two perspectives rather than to integrate so as not to lose out on what each perspective can contribute.

Innovation and innovation systems

Having shown the broad perspective of the innovation system, it is important to stop for a moment and clarify how this relates to different types of innovation processes. Innovation takes place and needs to take place at various levels, from small teams working on a small part of a larger process, to a national process in which different sectors collaborate. Also, the types of innovation processes will be different. From 'simple' technical innovation processes (e.g. a piece of biotechnology) to 'complex' institutional innovation processes and strategic innovation (e.g. shifting a sector's orientation). All these types of innovation processes taking place at all these levels will need to work together and will interactively determine the effectiveness (performance) of the innovation system vis-à-vis (e.g.) securing food and nutrition (for all)

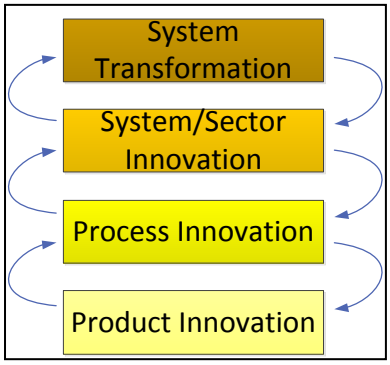


Figure 11: Innovation processes are different according to the specific setting in which they take place (adapted from Loorbach, quoting Rotmans, 2005)

Another qualifier which needs to be put on innovation systems, is the fact that how an innovation system functions will be different from place to place. This is particularly relevant when comparing Dutch successes in the (agricultural) innovation system[16] with innovation systems in the South. Informal institutions, education and research, formal institutions, policies, market opportunities: everything can be different. The innovation system perspective is therefore not a reflection of the status of players and dynamics in the system, but first of all an assessment framework that helps to understand what needs to be considered in making innovation prosper and to help determine actual and needed innovation capacity and performance.

How innovation happens

The question of how innovation happens is at the heart of understanding innovation systems. However, there is no simple answer. Perhaps not even a complex answer. There is no one way in which innovation

[15] Which inspired the choice of title for this paper.

[16] The 'Gouden Driehoek' experience.

happens. There are plenty of theories on the subject though and many schools of thought. Theories on transition systems (see e.g. Poppe, Termeer and Slingerland, 2009; Vellema (ed.), 2011) and strategic innovation (a concept originating more from the corporate sector) are part of this. Though very interesting, we will not further elaborate on this.

Some try to identify who really makes the difference. Some identify the market as the key factor in agricultural innovation (e.g. Woodhill et al., 2011). Others argue for paying more attention to the role of entrepreneurs (e.g. UNDP, 2004 and Sonne, 2010). This probably more reflects a response to a tendency to neglect those roles, than an assertion that those are the only roles to unlock the potential of an innovation system. The use of adjectives such as 'market-led' in various approaches therefore needs to be qualified as attempts to bring that issue into the picture, rather than pushing other issues out.

The following are some key concepts related to 'how innovation happen':

- **Innovation capacity**. This is about the ability to make innovation happen. It involves the whole range from enabling context and assets to individual competences and attitudes, with all the associated cultures and institutions[17].
- **Innovation performance** relates to two aspects. One aspect relates to the outcome of an innovation process in terms of technologies, institutions, etc. The other aspect relates to the process of innovation itself and the way in which innovation system elements function in separation and in interaction. Innovation capacity is a key driver for innovation performance.
- **Innovation leadership** is not the same as innovation management. It is about creating conditions in collaborative efforts for enhanced innovation performance. This may include taking the lead to get an innovation process going. However, innovation leadership, similar to strategic leadership, relates to all levels of operation and is not necessarily associated with management responsibilities. In terms of a metaphor, the innovation leader may be compared to the director of an orchestra.
- **Innovation governance**[18] relates to mechanisms to align goals, allocate resources, and the assignment of decision-making authority for the purpose of achieving ambitions set for the associated innovation processes. Because of the nature of innovation processes, governance in this context needs to be very much an adaptive kind of governance.

Example of a brief characterisation of innovation system performance:

- Many diverse public and non-public actors in system, but private sector having limited scope and constrained by knowledge resources and policy.
- Public sector actors weakly integrated and having weak links with other actors such as NGOs, private services, producer groups, policy makers, etc.
- Dysfunctional public-private collaboration; no culture of inter organizational collaboration
- Private sector seen as competitors, facing bureaucratic hurdles and uneven playing field.

(From Lemma et al, n.d.)

Performance of innovation systems and associated innovation capacities

Having created an overview of what makes innovation systems tick, it is clear that performance will relate to the actors & factors, and their interactions as represented in the framework (see figure …). An important issue regarding diagnosing innovation systems relates to the question whether performance should be mainly assessed on the basis of outputs (and outcomes) of the system, or whether it will include a close look at processes and what breeds success in the process of agricultural

[17] See e.g. Wigboldus et al., 2011.

[18] See more in OECD, 2005.

innovation. In broad terms the key determinants of success of the innovation system therefore include conditions shaped by:

1. The policy, institutional, economic, social, cultural and natural environment in which the system operates and the ability of the actors in the system to influence this environment.
2. The information & communication, transport, storage, processing, market and financial infrastructure available.

3. The capacity of the partners in the innovation system to:
    a. Define a shared vision and set realistic and motivating targets that best reflect the needs of the actors involved and enable them to make optimal use of opportunities (which implies trade-offs and negotiated compromises between the interests of different actor groups and between inclusiveness and exclusiveness).
    b. Identify, access and mobilise relevant external and internal resources (e.g. external and endogenous knowledge, know-how, skilled people and organisations, financial resources, entrepreneurship).
    c. Achieve functional linkages, networks and interaction among various actors
    d. Establish and sustain the required trust for these interactions and exchanges, manage power differences, build and maintain joint "ownership" and keep actors motivated.
    e. Improve its performance by learning from experience, critical reflection, documenting lessons, formulating and applying improved practices.
    f. Adapt its targets, actor-configuration (boundaries) and process in a timely manner and continuously in response to changing needs and opportunities. These system capacities are dependent on leadership, institutions and competencies of the actors. (adapted from Daane et al. (2009).

Spielman and others (2008, 2009) have developed a number of measuring tools for assessing (agricultural)innovation system performance. They also make use of a wide range of indicators available from existing sources such as OECD's Science, Technology, and Industry indicators and Knowledge for Development indicators.

Strengthening innovation capacities and associated performance of innovation systems requires a broad range of actions in the public, private and civil society sectors and across many different fields of activity. They will be needed at different levels, from national level to individual level. Such capacity strengthening efforts will be interdependent for their success (Daane, 2010). They need to be both formally governed (role for innovation leadership) and informally facilitated (innovation intermediation and brokering, discussed in more detail in chapter four).

Role of (agricultural) extension

Agricultural extension describes the services that provide rural people with the access to knowledge and information they need to increase productivity and sustainability of their production systems and improve their quality of life and livelihoods (NRI, 2010). In large parts of Africa this remains an important role to play in agricultural development. However, serious questions have been raised as to how extension can play a more effective role in view of agricultural innovation systems. This involves looking beyond research stations and a 'transfer of technology' mode of operation (Hall et al., 2006). The process of extension reinventing itself (Ponniah et al. 2008) will need to include more farmer involvement and not be primarily driven by research, but by entrepreneurs as well (Larsen, Kim and Theus, 2009; Markwi et al. 2010).

Larsen, Kurt, Ronald Kim and Florian Theus (2009). Agribusiness and innovation systems in Africa. The World Bank.

Innovation system dynamics

For a long time, linear thinking has dominated development thinking. In short, it asserted a linear flow of causal factors. The rise of complexity thinking has also introduced a number of useful ideas to the understanding of innovation. These ideas support the usefulness of the concept of innovation systems. One of the key learnings from complexity thinking relates to the theory of complex adaptive systems. Two of the key properties of complex adaptive systems have been described as:

- **Emergence** which means that rather than being planned or controlled the actors and factors in the system interact in seemingly random ways. From all these interactions patterns emerge which informs the behaviour of the agents within the system and the behaviour of the system itself.
- **Co-evolution** which means that systems exist within their own environment and they are also part of that environment. As their environment changes they need to change to ensure best fit. But because they are part of their environment, when they change, they also change their environment, and as it has changed they need to change again, and so it goes on as a constant process.

This would mean that we cannot simply plan for change and that the innovation system may evolve differently than we anticipate. Plans for intervention in innovation systems will need to take into account these limitations to control and predictability. Kurtz and Snowden (2003) are among the ones having developed suggested ways forward in dealing with these complex dynamics.

2.4 Innovation partnerships responsive to food insecurity

We have already seen earlier in this paper that food systems and related innovation systems, involve many roles to be played to make this all work toward food & nutrition security for all. Most will agree on this, but critical questions then still remain such as how the roles will need to be played effectively to create synergies that will lead beyond the sum of what the different roles can contribute in separation. Some associated questions are:

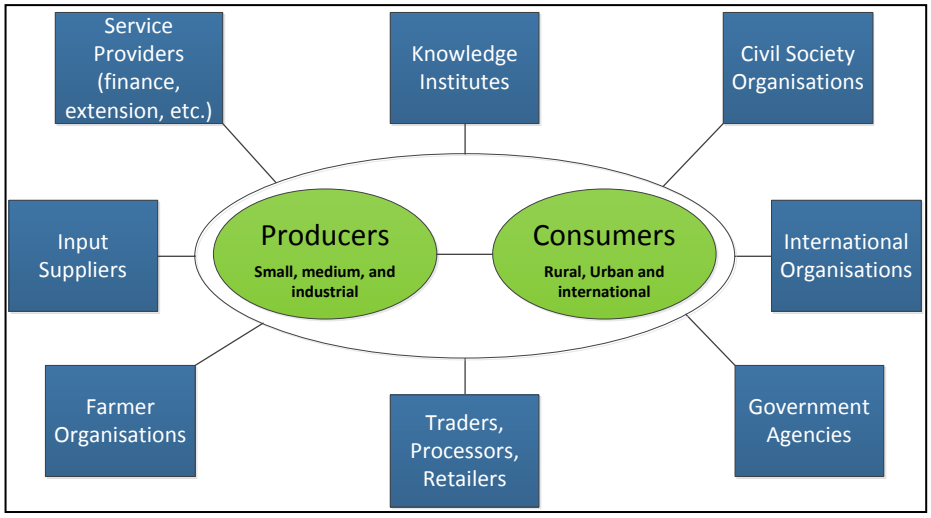


Figure 12: Many interactive and interdependent roles to play in (agricultural) innovation systems. Adapted from: WFP, 2010.

- Who and what will determine who will need to play what role in the system?
- Who and what will determine how the various roles need to be played?
- Who and what will determine how to assess performance of how roles are played?
- How much of the above is 'determinable' at all and how much essentially emerges from a complex dynamic without much process control?
- These questions are not that easy to answer. In the following we will share a number of contemplations inspired by these kind of questions.

Role dynamics

The issue of roles to play closely connects to questions regarding the governance of food systems and related food supply chains. There has been a significant move from a dominant role played by the public sector to private sector taking over part of that role (see e.g. Swinnen and Vandeplas, 2007). This becomes tricky in crises situations, cases of malfunctioning of the system (e.g. perverse incentives) and in relation to benefit distribution. Securing food for all therefore needs to remain a public sector responsibility to ensure proper food system governance. This is just one example of how roles change as well as the way in which they are played. There is a tendency to stay stuck in an 'old' perspective on what roles are there to be played and who is supposed to play what role (in what way). Private sector and government have started playing different roles in food systems as illustrated in the above. Knowledge institutes' roles can and should evolve over time as well. A traditional view of knowledge institutes is to provide 'knowledge products and services' only along the lines of the perceived role of "science & technology". In this paper we argue for and support the argument of others to expect knowledge institutes to be able and even be uniquely positioned to play other new and critical roles as well.

Public-private partnerships

Numerous people have argued for effective public-private collaboration in addressing challenges related to food & nutrition security and particularly about raising the profile of the role of private sector (e.g. World Economic Forum (2009); UN Global Compact Office (2008)[19]. Private-sector actors in the food supply chain include agricultural input companies, farmers, intermediaries, processors and retailers. Business-enabling services such as telecommunications, financial services, energy and logistics play a vital role throughout the chain. In this paper we will be lifting farmers out of this category, not because they do not belong here, but because their specific role (and interest) in innovation systems is quite different from most of the other private sector actors.

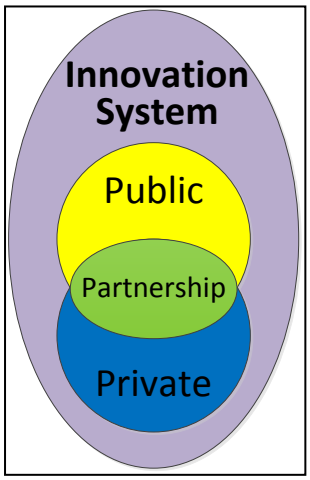


Figure 13: Public-private partnerships and innovation systems

A key question remains how the role of private sector can be strengthened to play a more effective and – in some cases – more appropriate role (Fan, 2010). Section 3.4. discusses the concept of 'inclusive business models' in more detail. An increasingly important role of the private sector that is easily assumed to be played almost exclusively by knowledge institutes, is research & development. Also in relation to innovation for food & nutrition security, private sector R&D has an important role to play (Brown (ed.), 2010).

Public-private collaboration is not always easy. Public actors focus on creating public goods and private sector on private goods. This may lead to conflicting strategies. Hartwich et al. (2008) emphasise the importance of finding common interest as part of the process of partnership building. Also legal implications need to be discussed such as intellectual property. They also found that the focus tends to be on getting the organisation of the partnership right, with little attention paid to roles in the partnership and role expectations. In relation to public-private partnership they conclude that in such partnerships there are

[19]The ASEAN Conference on Food Security: Role of the Private Sector in June 2010 is one example of international conference on this topic (see annex 7 for reference to more international conferences in past and future). Another set of examples can be found at http://www.feedthefuture.gov/psemodels.html, which discusses private sector engagement models and provides links to examples.

two mindsets involved: the public mindset and the private mindset. They have summarised a number of issues that can cause problems in the public-private partnership (box …).

Many public-private partnerships work on technical issues such as creating a pest-resistant or biofortified crop (Hall, 2006). But public-private partnerships also need to work beyond technical issues, tackling the bigger, strategic challenges of improving food systems so as to lead to sustainable outcomes of food & nutrition security. For both public as well as private partners this will ask for a different way of engaging with the innovation process.

The benefits of public-private partnership can also be found in the process of cross-fertilization where each of the three actors keeps distinctive role, but learns from other roles and incorporates this into own functioning (Hall, 2006). And along the way social capital is built.

The World Economic Forum (2010) has provided a summary of key roles to be played in relation to their new vision for agriculture. Though we have broadened the perspective to encompass food systems, the types of roles, how they are different between key actors and how they interact, still holds true.

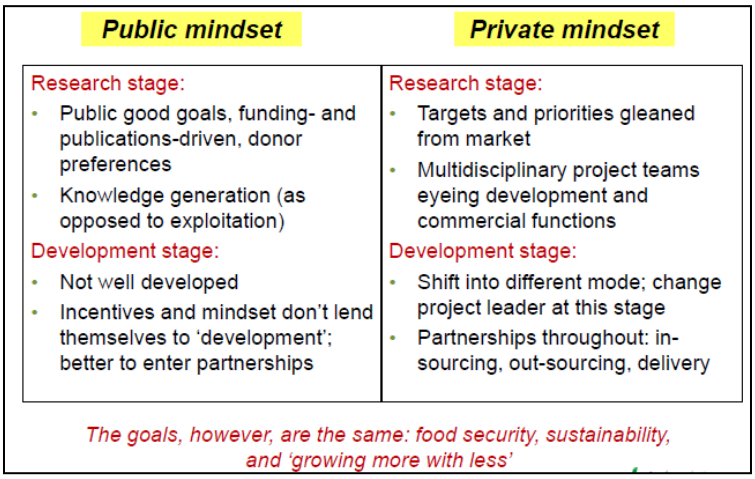


Figure 14: Different mind-sets in public and private sector. From: Ferroni, 2010

"Private Sector: Businesses & Consumers

- Continuously evolve product offerings to target nutritional, environmental and economic needs
- Design simple, affordable "base of the pyramid" products and technologies
- Ensure availability of long-term, affordable credit and financing
- Leverage sophisticated R & D technology to address complex social needs
- Enforce results orientation
- Make expertise available in precompetitive environment
- Share/offset risks of smallholders, vulnerable producers
- Leverage local processing and distribution channels
- Invest in welfare of workforce (e.g. development, benefits)

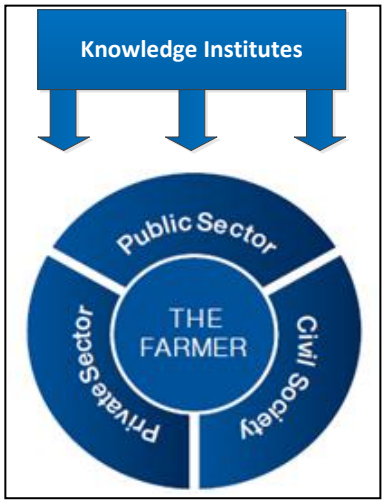


Figure 15: Multiple service role of knowledge institutes. (Adapted from World Economic Forum, 2010)

Public Sector: Governments & Multilaterals

- Ensure basic infrastructure
- Prioritize agriculture in public spending (or in food security efforts of donor aid)
- Deliver consistent, transparent business regulations (e.g. trade, investment, financing)
- Enforce good governance, particularly in social safety net programmes, contracts

- Facilitate land tenure rights, property administration
- Secure a stable investment environment, assuring ethical opportunities for profit
- Impose strict, evidence-based safety standards
- Promote gender parity in contracts, services, resources
- Guard social welfare, facilitating fair and inclusive growth

Civil Society: NGOs & Foundations

- Pilot innovative programmes that can be scaled
- Adapt models to meet cultural/political contexts
- Actively convey voice of farmers, consumers and environment
- Provide external source of credibility and accountability
- Facilitate risk-sharing on behalf of smallholders/ unconventional borrowers
- Make upfront investments to attract and catalyse capital
- Offer a forum/framework for competitors to align on social objectives
- Provide training, skill-building
- Ensure basic needs of the most vulnerable (e.g. landless, disaster victims)"(World Economic Forum, 2010).

McIntyre et al. (eds) (2009) complement this picture by zooming in on agricultural knowledge, science & technology. Leaving knowledge institutes out of the picture in terms of stakeholders in the new vision for agriculture, in fact also introduces us to the innovation role that knowledge institutes play and could play even more. For the very fact that they are not seen as having a stake themselves, they are in a unique position to support public-private innovation processes in support of farmers & communities (figure…). This relates to the subject of innovation intermediaries and the facilitation of innovation processes, which we will discuss in more detail in chapter eight.

A much more comprehensive framework on the role of knowledge, science & technology in relation to food & nutrition security (and other development goals), food systems and drivers of change can be found in annex five. It is the assessment framework used for the study entitled 'Agriculture at a Crossroads' (McIntyre et al. (eds) (2009).

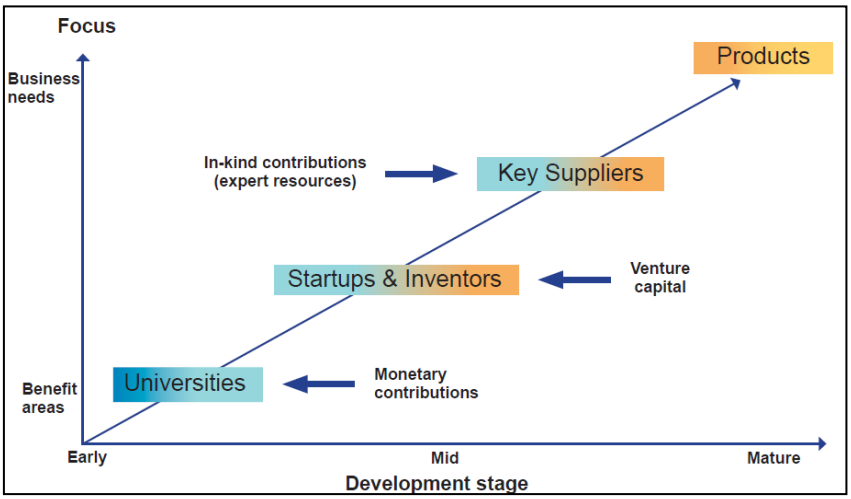


Figure 16: Connecting roles to play in innovation processes

Public-private partnership – seeing the connections

The 'innovation chain' is a useful perspective to understand connections between key actors in innovation systems. These are outlines of how actors are functionally connected from start to end. These models may sometimes give a too limited perspective on roles (and how they can be different), still they give more insight into the interplay between innovation actors (see figure 16 for a simple example).

Figure 17 takes this perspective one step further by showing critical connection points in an innovation process. A 'death zone' for innovation is the point in the process where the initial innovation process actors have delivered an innovation result up to a certain level and start to pull out, expecting later

process innovation actors to take over from there. It is like handing someone a cup and letting it go while the person you were handing the cup to did not yet grab it. It falls to the ground and is lost.

Role of knowledge institutes

The first role that is associated with knowledge institutes relates to science and technology. Many think that (agricultural) technologies are key to reducing food insecurity and coping with the effects of climate change (e.g. Worldwatch Institute, 2011). The Nature special on: "Can Science Feed the World?" (July 2010) reads in the editorial: "producing enough food for the world's population in 2050 will be easy. But doing it at an acceptable cost to the planet will depend on research into everything from high-tech seeds to low-tech farming practices".

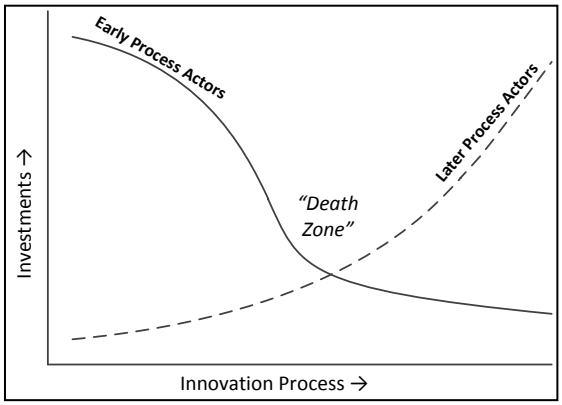


Figure 17: Securing proper connect between roles to play in an innovation process

UNCTAD/TIR (2010) highlights the range of knowledge interactions necessary for enhancing food security in Africa. It is not only knowledge institutes who are involved in these interactions:

- Knowledge interaction between university departments, centres of excellence and public research institutes conducting research of relevance to agriculture;
- Knowledge interaction between traditional knowledge holders (farmers communities) and other more research-based and product development actors;
- Knowledge interaction between local and foreign firms and universities;
- Knowledge interactions between local and foreign firms and domestic research institutes;
- Knowledge interactions between local and foreign firms engaged in product, service or process innovations;
- Knowledge interactions between farmers, consumers, seed banks and other intermediary organisations that help gauge local demand and issues imminent to the agricultural system;
- Knowledge interactions between farmers and providers of extension services, such as marketing
- boards
- Knowledge Interactions between various governmental agencies responsible to promote
- these competencies locally.

We will further zoom in on different roles to play by knowledge institutes in innovation processes in chapter four.

3 The context of food and innovation systems: Challenges, opportunities and debates

To strengthen food & nutrition security, work is needed on many fronts A range of fields of work have emerged as a consequence of these issues related to securing food & nutrition. The overview in annex 1 on the roots and fruits of agriculture & food system shows that there is no silver bullet in addressing the challenge of feeding 9 billion earthlings in 2050.

Many of the subject areas that we are briefly dealing with in the following sections are the entire focus of some organisations. Needless to say we will not do justice to all that is important in that field. The purpose is to show the many areas in which many actors will need to interactively play their roles effectively if we want to see food systems sustaining food & nutrition for all, also in 2050. At the same time, this is also meant to provide a rough outline of the kind of areas in which knowledge institutes need to play a role and how these roles will need to be different according to the type of challenges faced in that field.

3.1 Selected challenges to food system performance

The following sections cover a selection of important challenges to sustainable food systems. Other challenges include the cost of corruption (IFPRI, 2001; Gordon, Harding & Akinyemi, 2010), of which the effects on food security are not as easy to determine, but no less important for that reason.

3.1.1 Climate change

Climate change will act as a multiplier of existing threats to food security: By 2050, the risk of hunger is projected to increasy by 10-20%, and child malnutrition is anticipated to be 20% higher compared to a no-climate change scenario (IASC Task Force on Climate Change, 2009).

Different organisations and groups respond differently to this message. Some point at the role of ecological agriculture to mitigate climate change (e.g. Ching, Edwards & Scialabba, 2011). Others focus on managing climate variability and risks, accelerated adaptation to progressive climate change, mitigating greenhouse gas emissions from agriculture, generating policy relevant knowledge (e.g. Vermeulen et al, 2010). With increasing numbers of people at risk, others call for enhanced efforts in the field of disaster risk management (e.g. Vincent, Tanner & Devereux, 2008). Yet others address the challenge of (international) trade, because climate change effects will be different across the globe (Hoffmann, 2011).

Developing scenarios has become very important as climate change is a not yet fully understood and changing phenomenon and we do not know what exactly to prepare for (Nelson et al., 2010).

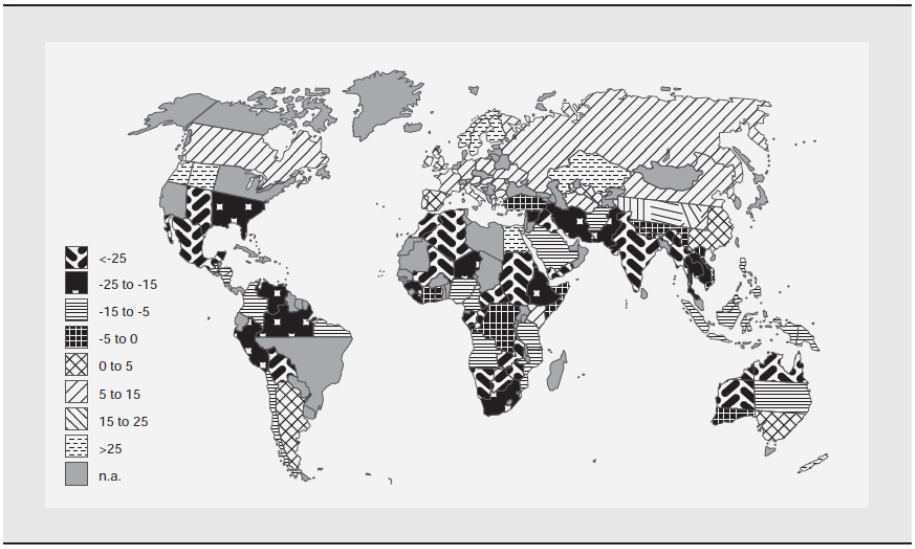


Figure 18: Projected changes in agricultural productivity by 2080 as a result of climate change (Source: Yohe G et al. (2007).

Conway (2009) points out that among some of the knowns, there are many unknowns regarding the effects of climate change on agriculture: "There are some things we know about the impact of climate change on Africa. We know that northern and southern Africa will become much hotter (as much as 4 °C or more) and drier (precipitation falling by 15% or more). Wheat production in the north and maize production in the south would then be adversely affected. In eastern Africa, including the Horn of Africa, average rainfall is likely to increase. Vector-borne diseases such as malaria and dengue may spread and become more severe. We also know that sea levels are very likely to rise, perhaps by half a metre, in the next fifty years with serious consequences in the Nile Delta and certain parts of West Africa. But there is much that we do not know. The Sahel may get wetter or remain dry. The flow of the Nile may be greater or less. We do not know whether overall the fall in agricultural production will be very large or relatively small. Part of our ignorance comes from a still poor understanding of the drivers of the African climate, their interactions and the effects upon them of global warming. Part also is due to a severe lack of local weather data, particularly for central Africa. There are many other known unknowns. Will climate change experience tipping points, for example an accelerating and irreversible ice loss from the Greenland ice cap and the Antarctic shelf, resulting in much greater rises in sea levels? Will El Niño become a more permanent phenomenon with consequences for Africa's rainfall patterns? There are also, probably, many unknown unknowns – potential tipping points that we are unaware of: for example diseases that can be transmitted from animals to humans, which may emerge as a result of climate change."

At discovering the many unknowns, he then argues that this relatively poor state of knowledge has two implications. 1) we urgently need more research, into the dynamics of the global drivers and the detailed consequences at regional and local levels, and 2) we need to design and build on existing adaptation measures to cope with high levels of uncertainty (Conway, 2009). More along these lines can be found in Cline (2007) who provides an overview of impact of global warming on agriculture estimates by country. Metereological models and simulation techniques (though tending to be sensitive due to the necessary selection of parameters) are important in predicting changes in crop yields and other expected effects of climate change (Lobell and Burke (2010).

The number of the implications of climate change for food systems, and food & nutrition security in particular, is reason enough for starting to think about a need for what some call a need for a 'fundamental

transformation of agriculture' (Cline, 2007). We will return to this call for system change in relation to our discussion on food and agriculture.

Various groups and organisations have already developed responses to this situation, including the CGIAR group (Moorhead, 2009). They conclude that "the climate is changing and agricultural systems must also change if we are to avoid catastrophe". Serious language from a serious group. FAO has responded in similar ways some of which is reflected in their 2008-document on Climate Change and Food Security (FAO, 2008). The subject was revisited by FAO in their 2011-document on Climate Change, Water and Food Security (Turral, Burke and Faurès, 2011), broadening the focus to include water security imperatives which very much underpin food security.

It will not come as a surprise that dry areas receive particular attention in relation to climate change, for which reason an international conference was organised by ICARDA on food security and climate change in dry areas in February 2010, Amman, Jordan. About one-third of global population lives in dry areas and competing claims for natural resources feature high on the list of challenges in these areas. Ahmed et al. (2011) go a step further up the value chain and calls attention to the need for changes in consumption patterns as well. This will need to include institutional capacity development, and improving information, education and communication they argue.

This brief discussion of what climate change may do to food & nutrition security shows the importance of What developing interdisciplinary, transdisciplinary and integrated efforts in dealing with the challenges that (global) food systems are and will be facing (Ingram, 2011, also see Clark et al. 2010). Clark et al. (2010) conclude in relation to this that there is still a poor understanding of trade-offs between different, technical opportunities to increase food security, increase carbon sequestration, reduce emissions—e.g., examples of net climate impact of implemented activities to increase food security (inputs, yields/management, post-harvest and distribution). Other questions they put on the table include whether it is possible at all to reduce greenhouse gas emissions while increasing food production. This again relates to the question whether tweaking existing food systems will be enough and whether we may need to consider full system innovation.

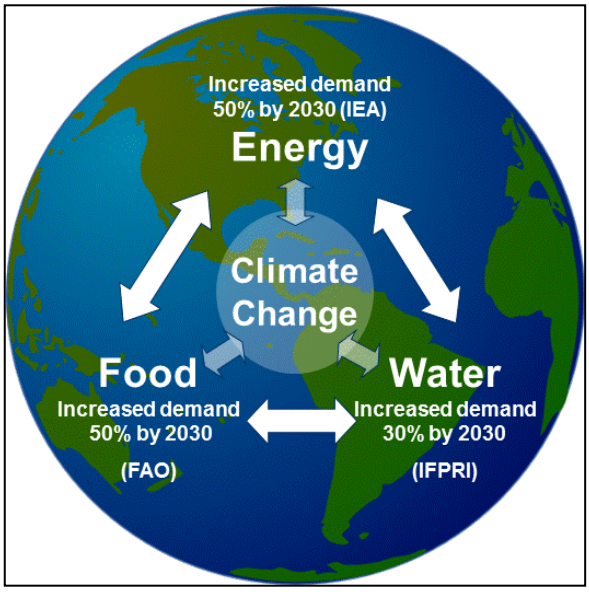


Figure 19: Some of the interconnected threats posed by climate change. Source: Beddington, 2009.

Many of the discussions on climate change mitigation are not as hot as the criticism from various food movements, such as Agribusiness Action Initiatives. Their recent publication puts much of the responsibility for mitigating climate change squarely in the corner of industries (Smith, 2010)[20].

[20] Smith, Gar (2010) A harvest of heat: agribusiness and climate change. How six food industry giants are warming the planet. Agribusiness Action Initiatives. http://www.agribusinessaction.org/

The list of key reading on the relation between climate change and food security (see annex 4) shows the broad interest in this topic. An attractive presentation of key issues in relation to climate change can be found in Vital Climate Change Graphics (UNEP, 2005).

3.1.2 Environmental degradation

About 40 per cent of the world's arable land is degraded to some degree and will be further affected by climate change (IFAD, 2011). At the same time, biodiversity and ecosystems deliver crucial services to humankind – from food security to keeping our waters clean, buffering against extreme weather, providing medicines to recreation and adding to the foundation of human culture. Human society (from a global perspective) is living well beyond the carrying capacity of the planet, compromising sustainability, well being, health and security. Environmental degradation is augmenting the impact of natural disasters such as floods, droughts and flash floods affecting 270 million people annually and killing some 124,000 people worldwide every year, 85% in Asia, and is, in some cases, even a primary cause of disasters. Degrading and polluted ecosystems are also a chief component in over 900 million lacking access to safe water. Poor management of activities on land and sea is further exacerbated by changing climatic conditions. In some scenarios loss of ecosystem services are depicted to result in up to 25% loss in the world's food production by 2050 along with hunger and spread of poverty in many regions (Nellemann and Corcoran (eds). 2010).

Agricultural biodiversity is regarded as essential for sustainable improvement of food and nutrition security by many studies (Frison, Cherfas and Hodgkin, 2011; FAO/PAR, 2011). The effects of loss of biodiversity include increased pests and diseases in crops and livestock. Understanding and enhancing the role of biodiversity and the genetic resources and ecosystem functions it conveys is essential. Biodiversity underpins to food security, sustainable livelihoods, ecosystem resilience, coping strategies for climate change, adequate nutritional requirements, insurance for the future and the management of biological processes needed for sustainable agricultural production.

A basic challenge to improving food security by capitalizing on agricultural biodiversity over the next few decades, is to balance relevance and realism. While there are many possible ways in which agricultural biodiversity could improve food security, they may not all be feasible in all production systems or they may prove uneconomic or too labour intensive for adoption by farmers. New approaches based on increased reliance on biodiversity may fit uneasily with production practices based on continuing simplification of agro-ecosystems. Identifying what works in practice, taking into account regional differences and different scales of farming, as well as supporting change will therefore also be essential elements of using diversity to improve sustainability, and food security in the face of change. Successful approaches are likely to bring together positive aspects of sustainable intensification, to reflect the realities of small-scale farmers and to be supported by appropriate policy and economic frameworks (Schiller, Simone and Nadja Kasperczyk, 2010).

Production practices based on a continuing and increasing dependence on external inputs such as chemical fertilizers, pesticides, herbicides and water for crop production and artificial feeds, supplements and antibiotics for livestock and aquaculture production reduces food system resilience. They are not sustainable, damage the environment, undermine the nutritional and health value of foods, lead to reduced function of essential ecosystem services and result in the loss of biodiversity. At the same time, food production needs to make its contribution to reducing the number of people who are food insecure and malnourished which remains unacceptably high at nearly 1 billion.

Changing agriculture and food production in ways that ensure improved sustainability and a healthier and more nutritious food supply involve the increased use of biodiversity for food and agriculture. If loss of biodiversity (including agricultural biodiversity) has been a feature of agricultural intensification, increased use of biodiversity is necessary to improve sustainability and to cope with climate change (Schiller, Simone and Nadja Kasperczyk, 2010).

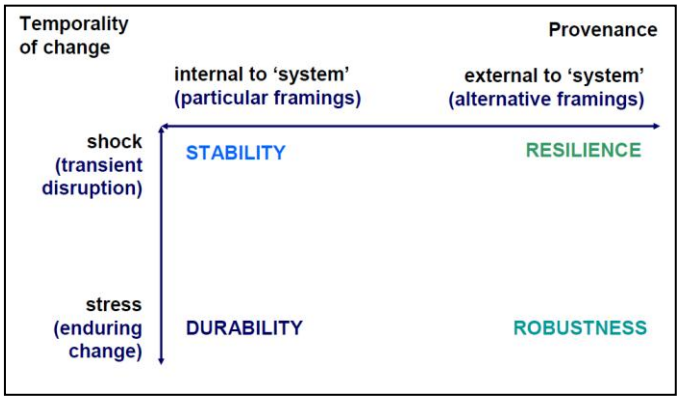


Figure 20: Different dimensions to sustainability (Thompson, 2008)

3.1.3 Competition for water & energy

Food and water security

In its recent "State of the world's land and water resources for food and agriculture" (2011), FAO reports not only reports an increased competition for water, but also a slowing rate of agricultural production. Water courses and bodies are becoming increasingly salinized and poluted. Rivers such as the Yellow River do not reach the sea anymore for part of the year. Large lakes and inland seas have shrunk (not only lake Aral) and half the wetlands of Europe and North America no longer exist. Runoff from eroding soils is filling reservoirs, reducing hydropower and water supply. Groundwater is being pumped intensively and aquifers are becoming increasingly polluted and salinized in some coastal areas. According to this report, land and water institutions have not kept pace with the growing intensity of river basin development and the increasing degree of inter-dependence and competition over land and water resources. Much more adaptable and collaborative institutions would be needed to respond effectively to natural resource scarcity and market opportunities. This may include considering asking payment for environmental services.

> "If we assume 'business as usual' by 2050 about 40% of the projected global population of 9.4 billion is expected to be facing water stress or scarcity. With increasing climate variability being predicted by global climate models, we are likely also to have more people without adequate water more of the time, even in water-rich regions" Garrido and Ingram, 2011.

Agriculture accounts for 71% of water withdrawals today and many countries are extracting groundwater faster than it can be replenished (Mexico by 20%, China by 25%, India by 56%). If current trends continue, two-thirds of world population will live in areas of high water stress in 2030. As demand continues to grow, competition for water will intensify between economic sectors, as well as regions and nations. The competition for resources will generate new geopolitical dynamics. Unable to rely on trade to ensure their food security, fast-growing economies are increasingly striking land-lease deals with poorer nations that have fertile, well-watered land. Japan now has three times more land abroad than at home. Actually, what is often called land grabbing should perhaps be called water grabbing. It is likely that these lease-land deals will continue, and they may accelerate (The World Economic Forum Water Initiative, 2011).

Water footprint assessments[21] are helpful in supporting how we manage water resources because they provide a tool to measure and understand water use throughout our supply chain. People use lots of water for drinking, cooking and washing, but even more for producing things such as food, paper, cotton clothes, etc. The water footprint is an indicator of water use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business.

Water needed to produce:
- 1 kilo of wheat: 1 000 litres
- 1 kilo of meat (beef): 15 000 litres

Food and energy security

Access to electricity and modern energy sources is a basic requirement to achieve and sustain decent and sustainable living standards. It is essential for lighting, heating and cooking, as well as for education, modern health treatment and productive activities, hence food security and rural development. However, three billion people – about half of the world's population – still rely on unsustainable biomass-based energy sources to meet their basic energy needs for cooking and heating, and 1.6 billion people have no access to electricity. While biomass is the primary energy source for the rural poor in developing countries, it has also been of special interest in recent years, for the production of liquid biofuels for transport. This has caused strong controversy, mainly regarding the potential risk that the production of biofuels may pose to food security of the rural poor in developing countries, but also regarding issues related to global climate change[22]. IIASA (2009) calculated that ten percent biofuels share in transport fuel at global will cause about fifteen percent increase in the number of people at risk of hunger.

240 kg of maize are needed to produce 100 liters of ethanol. It can fill the tank of an SUV or feed one person for a year.

Integrated Food Energy Systems (IFES) aim at addressing these issues by simultaneously producing food and energy, as a possible way to achieve the energy component of sustainable crop intensification through the ecosystem approach. A number of options have been developed, which include multiple-cropping systems, or systems mixing annual and perennial crop species, which can be combined with livestock and/or fish production. Other options involve maximizing synergies between food crops, livestock, fish production and sources of renewable energy (Bogdanski et al., 2010).

Agricultural and energy sectors became interlinked due to the rapid growth in the biofuels market. Food prices had been dropping for decades, but agricultural commodity markets have started to experience a sustained increase in prices. The potential impact of a large global expansion of biofuels production capacity on net food producers and consumers in low-income countries presents challenges for food policy planners and raises the question of whether sustainable development targets at a more general level can be reached. There are various scenarios as to how this may further develop, but it is surely another risk to food security (Naylor et al., 2007).

[21] http://www.waterfootprint.org/?page=files/home

[22] http://www.worldwaterweek.org/documents/WWW_PDF/2011/Wednesday/K21/UN-Water-Seminar-World-Water-Day-2012/Water-and-food-security-Feeding-the-world-in-a-sustainable-way.pdf

Food-energy-water nexus

The link between food, energy and water is often called the food-energy-water nexus. It has been the subject of high-level conferences over the past few years and will feature prominently in Rio+ 2012. Climate change will exacerbate water insecurity, where sub-saharan Africa will be among the areas suffering the worst effects. Being prepared for a resource scarce future and meeting today's access challenges (water, energy and food) requires solutions that take into account all three sides of the water, food and energy nexus[23]. This not only requires systemic thinking, but also connecting innovation systems in those three domains.

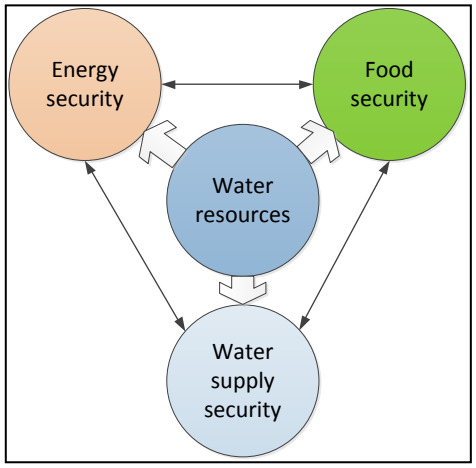


Figure 21: Mitigating different securities involves making trade-offs

The review of the food crisis in 2009 (Christiaensen, 2009) revealed four areas of market and policy failure that deserve immediate attention to safeguard the strengths of the current global food architecture.

- The erosion of public investment in agriculture and global destocking has left the global food system ill prepared to cope with the longer running challenge of global food supply uncertainty.
- The world cannot afford to have its food prices being determined in the infinitely larger fuel market, and the current policy induced link between food and fuel markets must be broken.
- The introduction of export restrictions by food exporters to protect their domestic markets from rising food prices has eroded confidence in the world grain markets.
- To more efficiently assist the poorest in accessing food in times of crises and make a market based national food policy politically sustainable countries need to establish effective social safety net systems.

3.1.4 Land acquisition/grabbing

Depending on who you are talking to some will talk about land acquisitions and some about land grabbing. Land acquisition/grabbing (particularly in Africa) is receiving growing attention as it is a growing phenomenon. It is often connected to biofuels production (Matondi, Havnevik & Beyene, 2011).

The contentious issue of 'land grabbing' has become the subject of numerous media reports since the global food crisis worsened in 2008. For countries such as Saudi Arabia, India, Canada, Belgium, France, South Korea, the Netherlands and even multinational organizations, like the West African Development Bank, African countries such as Ethiopia, Uganda, the Democratic Republic of Congo, Liberia, Mali and Zambia are attractive for their arable land and water resources.

This land acquisition of more often than not a desperate attempt to bolster food security by import-dependent

Recent estimates about land acquisitions include the following:

- "between fifteen and twenty million hectares of farmland in poor countries have been subject to transactions or talks involving foreigners since 2006";
- "upwards of twenty and even thirty million hectares transacted between 2005 and mid-2009";
- "twenty to fifty million hectares in play, out of potential 200-800 million available";
- "over $100 billion for the acquisition of upward of 50 million hectares".

Source: http://www.foodfirst.org/sites/www.foodfirst.org/files/pdf/Land%20Grabbing%20Fact%20Sheet.pdf

[23] http://www.water-energy-food.org/documents/bonn2011_presentation.pdf

countries such as China, Saudi Arabia and South Korea. They have acquired many hectares of farmland from poorer, resource rich nations such as Brazil, Cambodia and Sudan – and especially Africa where the trend is being dubbed the "new colonialism" or a modern day version of the 19th-century scramble for Africa[24]. In this discussion land security and food security are closely linked.
Deininger and Byerlee (2011, The World Bank) have developed a number of principles for responsible agro-investments:

"Gold rush is a thing of the past. The name of the new game is "land grab", where governments of developed nations and multinational companies are leasing or buying large tracks of land across the African continent and other countries around the world in a feverish rush to grow crops for food and bio-fuel. While China in particular is looking to cultivate far-away lands to meet their national demand for food, the burgeoning markets of the European Union are hungry for agrofuels."

One of the ways in which criticism on land acquisitions is voiced.

Source:
http://www.foeeurope.org/agrofuels/FoEE_Africa_up_for_grabs_2010-Map-Tables.pdf

1. Respecting land and resource rights. Existing rights to land and associated natural resources are recognized and respected.
2. Ensuring food security. Investments do not jeopardize food security but strengthen it.
3. Ensuring transparency, good governance, and a proper enabling environment. Processes for acquiring land and other resources and then making associated investments are transparent and monitored, ensuring the accountability of all stakeholders within a proper legal, regulatory, and business environment.
4. Consultation and participation. All those materially affected are consulted, and the agreements from consultations are recorded and enforced.
5. Responsible agro-investing. Investors ensure that projects respect the rule of law, reflect industry best practice, are economically viable, and result in durable shared value.
6. Social sustainability. Investments generate desirable social and distributional impacts and do not increase vulnerability.
7. Environmental sustainability. Environmental impacts of a project are quantified and measures are taken to encourage sustainable resource use while minimizing and mitigating the risk and magnitude of negative impacts.

The contentions that we discuss under the heading "food justice" are often strongly fed by what is happening in the field of land acquisition/grabbing[25]. Notable research on the impact of Europe's policies and practices on African agriculture and food security has been done by the FoodFirst Information and Action Network (FIAN) (Graham et al, 2010). Whatever the policy choice made, it is clear that this is a hot issue that is strongly debated.

Insecure tenure will undermine efforts to optimize utilization of land (Economic Commission for Africa, 2004). Though land acquisitions may have potential local economic benefits, poor local people run the risk of losing access to and control over land on which they depend. This has also been phrased as land tenure insecurity (Cotula and Leonard (eds), 2010; also see Wright (2009) on land access and the impact of agricultural commercialization on smallholder livelihoods). The problem gets even bigger when smallholders whose land is acquired by foreign investors have no formal title to the land, but rely on customary tenure arrangements. This situation is cause for serious concern even though there not yet

[24] http://www.stwr.org/food-security-agriculture/land-grabbing-the-end-of-sustainable-agriculture.html

[25] Groups like Via Campesina (http://viacampesina.org/en/) are highly active in this field. Also see http://farmlandgrab.org/

evidence of direct impact on livelihoods in terms of loss of food security. Conflict and post-conflict areas are even more vulnerable to land tenure insecurity.

The subject of land acquisitions/grabbing also relates to the concept of collaborative or inclusive business models, which are discussed in a later section of this chapter.

3.1.5 Crop and Post-Harvest Losses & Food Waste

A recent study suggests that about one-third of food produced for human consumption is lost or wasted globally. This means that many resources used for food production are used in vain and that the associated emissions of greenhouse gas were in vain as well. The per capita food waste by consumers in Europe and North America is 95-115 kg/year. In Sub-Saharan Africa and South/Southeast Asia this is only 6-11 kg/year… (Gustavsson, Cederberg and Sonson, 2011). The study looked at the entire food chain, focusing on causes for losses along the food chain including financial, managerial and technical limitations as regards harvesting, storage, cooling, infrastructure, packaging and marketing systems. Before harvest, cereal crop losses to weeds, pests and diseases amount up to 40% (Oerke and Dehne, 2004). Estimated loss in Eastern and Southern Africa 13.5% of the total value of the annual grain production (which comes down to US$ 1.6 billion) The International Bank for Reconstruction and Development/ The World Bank (2011).

Significant as the losses are, they have been often a forgotten factor in discussions on sustainable food systems. Recently, this issue is being put back on the agenda, including in the UN Comprehensive Framework for Action in relation to Food Security and Nutrition, the Global Agricultural and Food Security Program (World Bank endorsed) en the Committee on World Food Security (FAO)[26]. Attention is also drawn to this factor in food security is the 2011 State of the World report by the Worldwatch Institute.

Response to this situation requires efforts in agricultural technologies, but also in changing human behaviour (particularly in relation to food waste in Europe and North America). There is a difference between food losses and food waste. Waste appears to be linked to levels of affluence. Those spending close to 10 percent of their income on food are inclined to waste much more than those spending 70 percent of their income on it. It's estimated that the amount of cereal-based food wasted in the UK and US alone could lift 224 million people out of hunger." (Dr. Tom MacMillan of the Food Ethics Council[27])

There is an African Post Harvest Losses Information System: http://www.aphlis.net/ They also developed the post harvest losses calculator.

The issue is big enough to have led to the conceptualisation and practical work around postharvest innovation systems (e.g. see Morris et al., 2005 and Hall et al. (eds) 2003).

Nellemann et al. (2009)[28] argue that food supply is not only a function of production, but also of energy efficiency. Food energy efficiency is our ability to minimize the loss of energy in food from harvest potential through processing to actual consumption and recycling. By optimizing this chain, food supply can increase with much less damage to the environment, similar to improvements in efficiency in the traditional energy sector. However, unlike the traditional energy sector, food energy efficiency has received little attention. Only an estimated 43% of the cereal produced is available for human

[26] The International Bank for Reconstruction and Development/ The World Bank (2011). Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa. The International Bank for Reconstruction and Development/ The World Bank / FAO.

[27] http://www.foodethicscouncil.org/

[28] http://www.grida.no/files/publications/FoodCrisis_lores.pdf

consumption, as a result of harvest and post-harvest distribution losses and use of cereal for animal feed. Furthermore, the 30 million tonnes of fish needed to sustain the growth in aquaculture correspond to the amount of fish discarded at sea today. They conclude that a substantial share of the increasing food demand could be met by introducing food energy efficiency, such as recycling of waste. With new technology, waste along the human food supply chain could be used as a substitute for cereal in animal feed. The available cereal from such alternatives and efficiencies could feed all of the additional 3 billion people expected by 2050. At the same time, this would support a growing green economy and greatly reduce pressures on biodiversity and water resources – a truly 'win-win' solution.
In dealing with in particular crop losses, ethical discussions emerge regarding genetically modified crops. Disease resistance mechanisms in GM crops have been suspected by some to create potential human health risks, while other report pests outsmarting genetic modifications[29].

3.1.6 Food prices

Food security is inevitably connected to food prices, particularly as urbanization increase since those living in cities have no alternative food sources than that which is bought on the market (Cohen and Garrett, 2009). In the wake of the financial crisis in 2008 we have seen soaring food prices that seemed to come down again afterwards, but are on the rise once again. In countries such as the Netherlands, rising food prices may not immediately threaten livelihoods. Figure … illustrates graphically how it cuts right into the livelihoods of those who already spend most of their financial resources on food. Food price hikes are therefore a double blow to the poor (Braun, 2008; Ortiz, Chai and Cummins, 2011).

Figure 22: Food prices are an immediate threat to those who already spend most of the income on food. Source: http://documents.wfp.org/stellent/groups/public/documents/communications/wfp235481.pdf

A range of factors influence food prices. The shocking news that Peter Wahl reported (Wahl, 2009) was that food speculations were the main factor of the price bubble in 2008. Others point to the effect of conversion of land to growing biofuels. The effects on food prices have been estimated to amount from 10% to 75% (Holt-Giménez, 2008).

Food prices to double by 2030, Oxfam predicts
Source: Bailey, 2011

The drivers of food prices have become more complex, extending beyond traditional factors of supply and demand. The average levels of food prices are driven by long-term demand (population expansion, income growth, and changing diets) and supply (resource use and technology). Short-term variations in prices are influenced by weather variability, trade policies, more volatile oil prices (including through biofuels based

[29] E.g. see http://www.agbioforum.org/v2n34/v2n34a03-altieri.htm, where Miguel A. Altieri and Peter Rosset discuss Ten Reasons Why Biotechnology Will Not Ensure Food Security, Protect The Environment, And Reduce Poverty In The Developing World.

on agricultural feedstock), macroeconomic policy, financial investments, and short-run market sentiment influenced by all of the above. These short-term factors, as discussed in the paper, are manifesting themselves more frequently and are likely to continue to produce short-run food price volatility, especially when global food stocks are low. Even though these short-term factors are likely to persist, a key message is that actions to mitigate both short-run food price volatility and sudden rises in average food price levels that produce hardship and unrest need to focus on long-term fundamental drivers of food prices; this is fundamental to addressing the growing underlying problems. International food prices are spiking again for the second time in three years, igniting concerns about a repeat of the 2008 food price crisis and its consequences for the poor (World Bank, 2011). However, comparing the attention to food price hikes in 2008 to the (media) attention for the same (or even extremer) phenomenon in 2011, seems to point to people getting used to it, not causing the same shock into action that it produced a few years ago.

In emergency situations, rising food prices affect the ability to respond appropriately. E.g. together with increased energy costs (transportation) they negatively affect WFP procurement and delivery. Between June 2007 and February 2008 the cost of meeting the needs of WFP's existing client load increased by US$ 775 million. On top of this, new clients will arise because of the effects of the increased food prices. This added US$ 186 million to WFP's bills. WFP has responded by building up stocks, which of course also only goes so far. Futures and food options contracts are considered to be a more stable way to hedge against price volatility (Braun, 2008) .

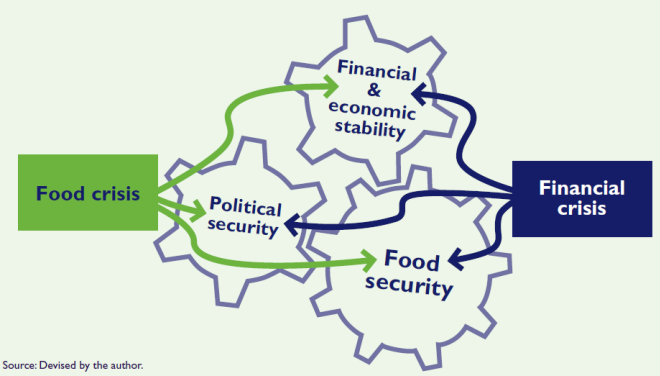


Figure 23: Interconnectedness of food crisis and financial crisis. Source; Braun, 2008)

Coping with price volatility will also need to involve targeted safety nets and emergency food reserves such as referred to in section 2.1.

3.1.7 Cities and urban agriculture

In 2008, for the first time in history, the world's urban population outnumbered its rural population (FAO, 2011). By 2025 more than half of the "developing world" will be urban. But at a pace that does hardly allow for making appropriate adaptations in relation to many issues, including food security. The impact of expanding urban populations will vary from country to country. Depending on national policies settings and economic structure, increased urbanization can affect hunger and poverty in both positive and negative ways. The greatest increase in undernourished of whom we have more than 1 billion, are among the urban poor, women and children (FAO, 2010).

Urban households have been hard hit as they saw their purchasing power declining drastically, while they have a very limited capacity to produce their own food. Food riots in cities therefore belong to the potential prospects if urban food security is not addressed sufficiently.

Specific attention needs to be given to the links that connect urban and rural communities, shape the economic relationships between them and determine how water and other natural resources are shared. At a time where cities are expanding and merging, it is urgent to bridge the increasingly divide between

the urban landscape and the countryside. It is imperative to think in terms of territorial planning that incorporates rural, peri-urban and urban areas and food systems (FAO, 2011)

Havana, Cuba, is a world leader in urban agriculture[30]. After the collapse of the Soviet Bloc, food production was decentralised from large mechanised state farms to urban cultivation systems. Today more than 50 per cent of Havana's fresh produce is grown within the city limits, using organic compost and simple irrigation systems.

3.1.8 Demography

According to the Malthusian school of human ecology, population growth is putting food security in the danger zone, while those supporting Esther Boserup's thesis would argue that population growth is a driver of innovation and development. Both schools, however, would agree that population growth does challenge food security. The difference in resulting policy making would show that Malthusians will focus on trying to limit population growth, whereas the Boserup school would focus on creating conditions for innovation. A combination of the two approaches may be an acceptable compromise.

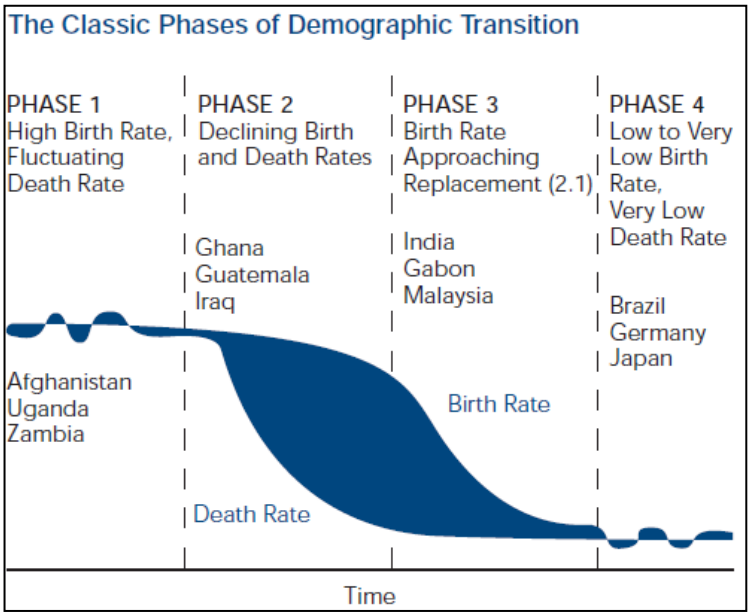


Figure 24: Haub, Carl and James Gribble (2011) The world at 7 billion. Population Reference Bureau.

Studies have shown (Das Guptas, Bongaarts & Cleland, 2011) that reducing fertility facilitates economic growth in low-income countries and that rapid population growth will constrain economic growth in the absence of an enabling context for rapid rise of productivity. Furthermore, lower fertility is often associated with better health (nutrition) and schooling and other positive social and economic effects.

As suggested above, both the Malthusian and Boserup perspective need to inform policy making. Innovation is not a panacea that cannot fail. At the same time, controlling population growth introduces ethical, social and psychological questions that cannot be sacrificed on the altar of economic growth. Even in economic terms, it poses serious challenges for at least one generation: ageing population. Who will produce food for the 30% of world population aged 60 and older in 2100?

The world's demographic centre of gravity will continue to shift from the North to the South. If conditions for (agricultural) innovation are not improving in the South, food security will suffer as an indirect result (Bloom, 2011).

[30] http://sustainablecities.dk/ and http://sustainablecities.dk/en/city-projects/cases/havana-feeding-the-city-on-urban-agriculture

3.2 Selected opportunities for food system performance

3.2.1 Agricultural development

As many have already concluded: agriculture is back on the agenda. Not least because it provides the basis of food security. However, what would be the appropriate road map for agricultural development is a question that brings out many different perspectives. Some still have high hopes that science and technology will bail us out (a second green revolution). Others recognise that intensive farming practices have "ravaged the world's natural resources, causing land degradation, sapping water supplies and contributing massively to climate change" (FAO, 2011). They argue for a focus on smallholder crop production and sustainability of production techniques. FAO's recent report on a "save and grow farming model", was presented in the media centre as "putting nature back into agriculture" (FAO, 2011).

As we are discussing agriculture, many of the concerns voiced could be equally applied to agriculture & food systems as a whole. The World Economic Forum (2010) concluded that 'yesterday's approaches will not be sufficient tomorrow'. They argue for harnessing the power of agriculture to not merely drive food security and economic opportunity, but also drive environmental sustainability. The 'new vision for agriculture' aims to increase production by 20% while decreasing emissions by 20% and reducing the prevalence of rural poverty by 20% every decade.

> 30% of greenhouse gas emissions are agriculture related.
> 70% of worldwide water withdrawals are agriculture related.
> 40% of worldwide employment is agriculture related.
>
> From: The World Economic Forum, 2010)

Agriculture needs to change. It must become increasingly sustainable at the same time as meeting society's goal of providing sufficient, safe and nutritious food. Production practices based on a continuing and increasing dependence on external inputs such as chemical fertilizers, pesticides, herbicides and water for crop production and artificial feeds, supplements and antibiotics for livestock and aquaculture production need to be altered. They are not sustainable, damage the environment, undermine the nutritional and health value of foods, lead to reduced function of essential ecosystem services and result in the loss of biodiversity. At the same time, food production needs to make its contribution to reducing the number of people who are food insecure and malnourished which remains unacceptably high at nearly 1 billion (Poppe, Termeer, and Slingerland (eds) (2009).

> If climate change effects continue to grow, soil degradation continues and agricultural technologies and methods are not upgraded, Africa will be able to feed a mere 25% of its population by 2025.
>
> Freemantle and Stevens (2010).

Key messages from conference on climate-smart agriculture in 2010 (FAO, 2010) included that agriculture in developing countries must undergo significant transformation in order to meet the related challenges of food security and climate change, calling for considerable investment to fill data and knowledge gaps, in research and development of technologies, methodologies as well as the conservation and production of suitable varieties and breeds. The transformation to 'climate-smart agriculture' is defined as a transformation to an agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals.

A study by Oxfam points out that it depends on the type of food security aimed for and the context in which this is meant to take place, that can lead to a choice of either low external input agriculture or high external input agriculture. It is not either small scale or industrial scale. However, in terms of effect on the environment, the impact of this choice will be different (Wegner and Zwart, 2011).

Many studies have argued for more seriously exploring the potential of small and medium-scale ecological agriculture (e.g. Nærstad, Aksel (ed), 2010; Ho, Burcher and Ching et al., 2008; UNEP/UNCTAD, 2008). They point to the advantages in relation to reduced greenhouse gas emissions and energy consumption, biodiversity conservation, reduced need for chemical fertilizers and more. The related methods and techniques are very suited for many poor, marginalized farmers in Africa as they require minimal or no external inputs, use locally and naturally available materials to produce high quality products and encourage a whole system approach to farming, which is more diverse and resistant to stress. It is, however, often not specifically supported by agricultural policies in most African countries, and sometimes even actively hindered. As for the reduced dependence on chemical fertilizers, this is not a small concern since some forecasts expect peak phosphate by 2030 (Cordell, Drangert & White, 2009).

Agriculture needs to change. So much is fairly broadly agreed, but the way in which it needs to change brings different perspectives in view. These include debates on genetically modified organisms (crops) or GMOs. Paarlberg (2009) uses a polemic title in relation to this debate: Starved for science: how biotechnology is being kept out of Africa. Though the USA thinks GMOs are one of the key ways forward to boost agricultural productivity, African governments are mostly wary of transgenic technologies. As it is just one of the potential methods for increasing agricultural productivity in Africa, interventions should align with national priorities of individual countries, many of whom may not opt for embracing GM technologies (Cooke and Downie, 2010).

There are around 500 million smallholder farms in the world.
Smallholders provide up to 80 per cent of food consumed in Asia and sub-Saharan Africa[31]*.*

Low agricultural production leads to low incomes, poor nutrition, vulnerability to risk and threat and lack of empowerment. Land degradation and soil fertility depletion are considered the major threats to food security and natural resource conservation in sub-Saharan Africa. Investments in technology, policy and institutional reforms are needed to increase agricultural productivity, to ensure food security and sustained national economies. Africa must break the cycle between poverty and land degradation by employing strategies that empower farmers economically and by promoting sustainable agricultural intensification using efficient, effective and affordable technologies. In addition, farmers and local entrepreneurs need to be linked to markets to increase their capacities to invest in sustainable land management (Bationo et al., 2007).

According to Kariuki (2011), Brazil and China are two examples of how agriculture can be developed. Brazil is now the biggest producer of ethanol and a world leader in agricultural exports using commercial farming approach. China has managed to move hundreds of millions out of poverty through rural development focused on improving small-scale agriculture. Africa's characteristics will require a model that is a mix of Brazil and China, according to Kariuki.

The number of things to discuss in relation to agricultural development are numerous. We have picked only a few topics from the range of choices. We conclude with a contribution by Jason Clay on "Freeze the footprint of food" by in Nature 2011[32]. He argues for working on eight elements that together could enable farming to feed 10 billion people and keep the Earth habitable:

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[31] IFAD (2011). Factsheet on Climate Change: Building smallholder resilience. IFAD, Rome.
http://www.ifad.org/climate/factsheet/climate_e.pdf

[32] vol 475, 287-289

- Work on Genetics
- Improve farming practices
- Improve efficiency through technology
- Rehabilitate degraded land
- Address issue of property rights
- Reduce waste drastically
- Half overconsumption of 1 billion consumers
- Conserve soil organic matter
- Link to innovation systems

3.2.2 Fisheries and aquaculture development

Fish is the main source of animal protein for about 1 billion people worldwide and an important economic activity supporting livelihoods across the world. 30-45 million people in Africa, directly or indirectly, depend on fish for their livelihoods. Fish products are often one of the cheapest and most accessible sources of protein available. However, competing demands for resources and access can lead to conflicts and overexploitation of fisheries (FAO, 2010).

World Fish Center (2005) estimated that fish provides 22% of the protein intake in sub-Saharan Africa. This share may exceed 50% in the poorest countries (especially where other sources of animal protein are scarce or expensive), 47% for Senegal, 62% in Gambia, 63% in Sierra Leone and Ghana. It is also very important as source of micro-nutrients such as iron, iodine, zinc, calcium, vit A and B, for which reason it is important on the nutrition development agenda.

They also found that Africa is the only continent in the world where fish supply per person is declining, mainly because capture fish production is levelling off while population is growing. There is therefore a need for attention for local fisheries for local, regional and national markets. They argue that currently, there is too much attention for export-oriented industrial or semi-industrial fisheries.

There are also conflicting research findings presented. What sustainable possibilities for increasing production from fishers are there really? How to reconcile food security with conservation of (marine) biodiversity? Projections (models) of fish stocks development are not always sufficiently correct and may even be politicised (Rice & Garcia, 2011).

As with crops, post-harvest losses are considerable (more than 30% of the catch lost) (World Fish Center, 2005). The ASEAN-SEAFDEC Conference on sustainable fisheries for food security towards 2020. Fish for the people 2020: adaptation to a changing environment. 13-17 June 2011, Bangkok. ASEAN/SEAFDEC.

3.2.3 The role of women

Women make essential contributions to agriculture in developing countries, but their roles differ significantly by region and are changing rapidly in some areas. Women comprise, on average, 43 percent of the agricultural labour force in developing countries, ranging from 20 percent in Latin America to 50 percent in Eastern Asia and sub-Saharan Africa (FAO, 2011). This was the reason for IFPRI to use the title of "Women: the key to food security" (IFPRI, 2000).

> Giving women the same access as men to agricultural resources and inputs could increase production on women's farms by 20-30 per cent, reducing the number of hungry people in the world by 100-150 million.
>
> Source: IFAD (2011)

If women had the same access to productive resources as men, they could increase yields on their farms by 20–30 percent. This could raise total agricultural output in developing countries by 2.5–4 percent, which could in turn reduce the number of hungry people in the world by 12–17 percent.

One of the key policy interventions to release this potential would be to eliminate discrimination against women in access to agricultural resources (including land ownership), education, extension and financial services, and labour markets (Mehra and Rojas, 2008). Rural women's associations are among the drivers of change in this area.

The story about women as the key to food security is especially true in sub-Saharan Africa where women play a pivotal role in agriculture, being responsible for nearly all food production, 60 percent of marketing, and at least half the tasks involved in storing food and raising animals (Mehra and Rojas, 2008).

IFPRI (2000) summed up the benefits of focusing on women as the key to boosting agricultural productivity and food security in the following way.

1. Agricultural productivity increases dramatically when women get the same amount of inputs men get.
2. Gender differences in property rights hinder natural resource management.
3. Increasing women's human capital is one of the most effective ways to reduce poverty.
4. Increasing women's assets raises investments in education and girls' health.
5. Women's education and status within the household contribute more than 50 percent to the reduction of child malnutrition.
6. Females in South Asia consistently fare worse than males on a number of health fronts, while girls in Sub-Saharan Africa do better than boys. This difference is linked to the relative value placed on boys and girls in these two regions.
7. Good care practices can mitigate the effects of poverty and low maternal schooling on children's nutrition
8. Women are at a disadvantage when food and nutrients are distributed within a household.

However, in the recent State of Food and Agriculture (2010-2011), FAO reports that despite evidence that gender-informed approaches are needed to bolster women's roles and productivity, they are not yet a mainstay of development and agricultural programs. According to the report, this gap persists largely because decision makers continue to regard women as home producers or "assistants" in farm households, and not as farmers and economic agents in their own right.

Though we include the discussion on the role of women in the section on food production, basic principles equally apply to the subject of markets, value chains and entrepreneurship.

3.2.4 Inclusive business models

Many consider the potential of the private sector as .partner in development to be underutilized (e.g. Berdegué, Biénabe and Peppelenbos, 2008). To achieve and sustain inclusion of small-scale farmers in markets access, different actors need to participate and cooperate. This is still a big challenge. Over the past decade there has been a strong turn to market-driven initiatives. Business can generate massive change in a short period of time, driven by a straightforward profit incentive. Mobile phones in Africa are a good example of this (Nijhoff, 2010).

Inclusive business means creating profitable business models and strategies that help drive economic opportunity for those who would otherwise be left behind – small-scale farmers, local agribusinesses, the rural unemployed. In practice, inclusiveness requires, the right incentives, building trust within supply

chains, joint decision-making and the transfer of skills. In the big picture, scaling inclusive agri-business is about creating the investments, assets and incentives so that smaller-scale producers and rural enterprises can be effective partners in the business of sustainably feeding 9 billion people (http://www.seasofchangeinitiative.net/).

Large-scale acquisitions of farmland in lower- and middle-income countries have resulted from a renewed interest in agricultural investments. Partly as a result of sustained media attention, these acquisitions have triggered debates about land grabbing (see). Less attention has been paid, however, to alternative ways of structuring agricultural investments that do not involve large-scale land acquisitions. These include a wide range of more collaborative arrangements between large-scale investors and local small-scale farmers and communities, such as diverse types of contract farming schemes, joint ventures, management contracts and new supply chain relationships.

More inclusive business models encompass a wide range of arrangements. Some models involve large-scale farming but with closer involvement of local landholders. Others bring smallholder farmers into the value chain. Many are thoroughly tried and tested, while others are confined to narrow sectors and could be applied more widely, or else are still isolated, interesting pilots. None of these models is perfect – the intention here is not an overview of "best practice", but a survey of a range of possible business models, considering their pros and cons, opportunities and constraints, and options for scaling up (Vermeulen and Cotula, 2010).

We need a different kind of business thinking where the purpose is beyond just profits (Fisk, 2010). This means creating sustainable businesses while living within environmental limits and ensuring a fair society.

Yumkella et al., 2011 discuss what they see as seven pillars of agribusiness development in Africa:
Enhancing agricultural productivity, upgrading value chains, exploiting local, regional and international demand, strengthening technological effort and innovation capabilities, promoting effective and innovative financing, stimulating private participation, improving infrastructure and energy access. Vermeulen and Cotula, 2010 provide in-depth understanding about different (inclusive) business models that can be considered where they consider no single model emerges as the best possible option for smallholders (while still being attractive to investors) in all circumstances. It seems to be very much context-specific. Therefore, it is important to get more understanding about what models work well under what circumstances. Once this is clearer, (national) policies need to support this.

UNDP's study on "Creating value for all. Strategies for doing business with the poor" (2008), provides some ideas on the different roles to play in increasing the adoption of appropriate inclusive business models:

What business can do—reaching the poor as consumers, producers, employees and entrepreneurs
- Create capacity and space for innovation inside the organization.
- Develop appropriate investment tools
- Deepen community engagement
- Build capacity for effective collaboration, even with non-traditional partners and for novel purposes.
- Engage in policy dialogue to improve the playing field.

What governments can do— building capacity and conditions for functioning markets
- Remove constraints in the market environment.
- Establish information hubs that gather and share market information and act as brokers between local and regional businesses, nongovernmental organizations and other relevant organizations and initiatives.

- Strengthen entrepreneurship capacity through training, organizing, capacity building and technical advising.
- Strengthen human capital to engage in productive economic activity through effective education and health care.
- Improve consumer awareness and education to strengthen demand for pro-poor products.
- Support and finance inclusive business models through carefully calibrated incentives.
- Strengthen government's institutional capacity to collaborate with the private sector.
- Establish platforms to engage business as a partner in economic development.

What communities can do—business development from the ground up

- Identify opportunities that business can seize.
- Identify products that the community can produce competitively.
- Develop networks of small enterprises (such as retailers) to aggregate and strengthen distribution networks, diversify inventory and link to larger corporate suppliers.
- Build transparent community organizations

What nongovernmental organizations and other development organizations can do—facilitating links and best practice exchange

- Partner with businesses to facilitate community engagement that is fair and equitable, that is sensitive to local values and that contributes to human development.
- Act as a platform for business collaboration and best-practice dialogue.
- Cultivate an openness to collaborations with the private sector.
- Facilitate effective, legitimate and transparent public-private dialogue by providing guidance, tools and processes— and act as a watchdog within this dialogue.

What donors and international organizations can do—catalysing and expanding new approaches

- Raise awareness among business and development practitioners about the opportunity of including the poor in business.
- Provide 'patient capital' and other appropriate forms of financing to develop inclusive business models.
- Create innovative, impact-oriented grant-giving models, such as challenge funds or prizes for innovations that will break critical barriers to human development.
- Facilitate cross-sectoral dialogue. Provide common platforms for learning, exchange and decision-making. Offer capacity building and brokering services. Work to establish a common language.

What others can do—target learning, awareness and consumption to expand inclusive business practices

- Academia and other research institutions can work to improve our understanding of the size and structure of the markets where the poor live, how inclusive business models work, what effective investments mechanisms look like and how dialogue processes between business and government can be made accountable, legitimate and effective. They can also identify new technologies to catalyse inclusive business models.
- Business and public policy schools, together with other teaching institutions, can impart knowledge about inclusive business models and the opportunities they can create, motivating students to enter the field. They can offer opportunities for cross-sectoral learning and enable and encourage students to pursue study projects with inclusive business models.
- Business associations and partnership brokers can pool information about inclusive models from different sectors that are open for collaboration, help find the right partner for specific projects and provide guidance on how to design and manage collaborations.
- Business associations can coordinate collective private-sector action to remove constraints. For example, industry associations can build joint training programmes or conduct joint market research.

- The media can raise awareness about the opportunities for business in development. By featuring successful initiatives they can help raise awareness, foster mutual understanding and remove barriers between stakeholders.
- Individuals can support pro-poor business models by purchasing from companies who source from the poor, or by contributing money and skills to nongovernmental organizations that facilitate inclusive business models.

Cotula and Leonard report from a workshop on inclusive business models and argue that entrepreneurship is a crucial ingredients for more inclusive business models to succeed. The willingness of experienced business players to work with smallholders and local operators as part of the very core of their business model underpinned experiences shared at that workshop. At the same time, the workshop highlighted the important role that public policy and non-profit organisations can play in promoting and shaping more inclusive business models (Cotula and Leonard, 2010)

3.2.5 Entrepreneurship and market access

Markets are extremely important in livelihood strategies of most rural households. Markets is where they buy their inputs and sell their products; and, as consumers, they buy their food requirements and other consumption goods. Because of this, the serious difficulties in accessing markets which rural poor people in many parts of the world face form an important part of the reason why they cannot improve their living standards. These difficulties relate to physical difficulties such as remote location and high transport costs, but also their lack of understanding of the markets, their limited business and negotiating skills, and their lack of an organization that could give them the bargaining power they require to interact on equal terms with other, larger and stronger market intermediaries. Accessing rich countries' markets is often impeded for rural producers from Africa.

In their report "Africa 2060: Good news from Africa", Barakatt et al. (2010) list a number of what they consider to be drivers of Africa's future. One of the drivers is "entrepreneurship". They highlight that Africa is the youngest continent with the fasters growing population. They also object to a picture of Africa of poverty and deprivation. Taking Africa as a whole, the average per capita income is higher than India. There is already a substantial middle class in Africa, and local and international companies are expanding into this market. Barakatt (et al.) and others (e.g. UNDP, 2004) consider the entrepreneurship of particularly the young in Africa to hold the potential for activating Africa's latent capacity.

There are many constraints preventing smallholders from moving from (sub) subsistence farming towards a more entrepreneurial mode of farming. Eenhoorn (2007) describes, four categories of constraints for smallholders from an entrepreneurial perspective: **Production and processing** constraints due to limitations in access to land, labour and capital. Examples include lack of capital, limited access to (micro) credit, poor soil quality or no possibility of increasing soil fertility, poor seed quality, a lack of water, uncertainty about land entitlement, a shortage of adequate labour, a lack of traction and a lack of knowledge and technology. **Risks and uncertainties** related to erratic climates, a lack of

Entrepreneurs are essential drivers of innovation and progress. In the business world, they act as engines of growth, harnessing opportunity and innovation to fuel economic advancement. Social entrepreneurs similarly tap inspiration and creativity, courage and fortitude, to seize opportunities that challenge and forever change inequitable systems. The social entrepreneur aims for value in the form of transformational change that will benefit disadvantaged communities and, ultimately, society at large. Social entrepreneurs pioneer innovative and systemic approaches for meeting the needs of the marginalized, the disadvantaged and the disenfranchised – populations that lack the financial means or political clout to achieve lasting benefit on their own.
Source: http://www.skollfoundation.org/aboutsocialentrepreneurship/whatis.asp10.

information, uncontrollable market forces, corruption, crime (a lack of 'law and order') and hostile institutions. This creates a sense of vulnerability which undermines efforts to organise themselves in order to offset these risks and uncertainties. Partly because of this sense of vulnerability, there is a **lack of incentives to invest**. This prevents farmers from taking entrepreneurial risks. Most activities that sustain rural livelihoods are essentially unprofitable under current conditions (unfavorable input/output ratios). Cultural backgrounds may also support a **mindset** that limits their entrepreneurial activity.

The private sector's effectiveness in fostering development depends on the strength of the state and on the quality of political, social and economic institutions. A strong state with enough human, financial and institutional resources can ensure that a market economy gives private agents the incentives to expand their productive capacity and to use it well. The State must also be able to ensure fair competition as well as redistribution of income—market outcomes are not always politically or socially acceptable (UNDP, 2004). Technology is often not a main cause for limitations in (agricultural) development. The institutional context usually is and given the right institutional environment, entrepreneurship can work as a technology multiplier. This would then include home-grown (African) technologies, which would boost further entrepreneurship (Swart, 2011).

Nijhoff (2010) identified a number of recommendations for catalysing rural entrepreneurship in Africa:

– Make sure there is a business driver

Initiatives must start with the private sector and involve them.

– Invest in hardware for transparency and reliability

Focus on that which enhances transparency in trading situations and supports the building of trust-based collaboration.

– Understand the context

It is therefore very important to invest sufficient time and effort in understanding critical factors in the context, including:

- what are market opportunities with short and long-term possible viability?
- what are critical hampering factors for market initiatives?
- what are the asset bases of the local 'poor' and how will initiatives contribute to building key assets?
- what services and capacities are present locally?
- how effectively and rapidly can a local ABC respond to opportunities?

– Learn fast and adapt

Build effective learning processes that are able to work within private sector dynamics.
Making business approaches in one situation widely available through modern communication media can generate ideas and give elements for new approaches in different contexts. This process of adapting what has been tried elsewhere can be institutionalised.

– Invest in capacities and trust

Invest in capacity building at all levels, from producers to all kinds of local enterprises. Training needs are determined by the local context.

3.3 Selected debates on food system performance

3.3.1 Food system ethics

Pinstrup-Anderson and Watson II (2011) devote a significant part of their recent book on "food policy for developing countries" to ethical aspects of food systems. They define ethics in this context as "the rules or principles that dictate whether certain actions or ends are considered virtuous, right, good, moral,

responsible, or proper." They argue that the most important questions regarding food systems are ethical questions. And as these questions cannot be resolved by a mere appeal to objective, scientific methods, they often remain outside the scope of studies related to food systems. As a consequence they are therefore often also considered by many as leftist hobbies, rather than referring to fundamental issues that need to be addressed on the way to trying to secure food for all 9 billion people in 2050.

> Some of the significant ethical questions:
> "How can the extreme hunger and deprivation of hundreds of millions of poor people be ethically reconciled with the abundant opulence displayed in the world's richest countries?"
> "By what methods could food be better distributed-not only globally, but within communities and households-to ensure food security and better nutrition."
> What are the effect of (international) standards and legal standards on smallholder production systems and are these right and responsible? (Pinstrup-Anderson & Watson II, 2011: 305).

Though these questions are out in some arenas, there are a number of significant contributions from an academic background. These include Kaiser and Lien (2006) who discuss "ethics and the politics of food" from a range of academic disciplines' (mostly social science) perspectives, and Casabona et al. (2010) who discuss ethical and legal questions in relation to global food security. Others link ethics to discussions related to bioscience, such as Miller, West & Nerlich (2009).

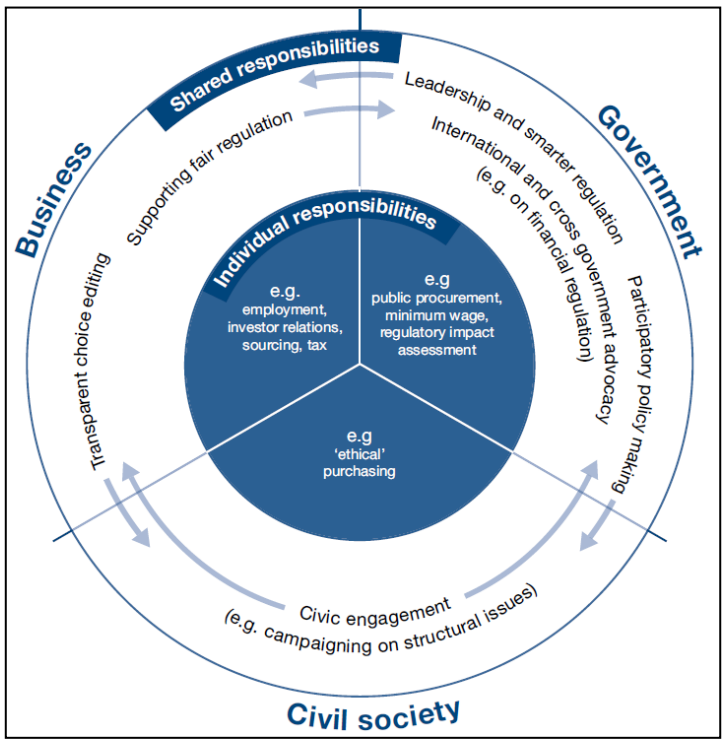

Figure 25: Roles to play in establishing social justice in food systems (Source: Food Ethics Council, 2010)

The Food Ethics Council[33] in the UK is an illuminating example of a platform where key questions and policy tools are put on the table in front of main players in food systems. The Food Ethic Council is a charity that provides independent advice on the ethics of food and farming with the aim to create a food system that is fair and healthy for people and the environment. One of their key publications is the "Food Justice: the Report of the Food and Fairness Inquiry" (2010). It is the result of a year-long investigation into social justice in food and farming, undertaken by a committee from across the food sector. They include representatives from Fairtrade Foundation, the British Retail Consortium, and the Food and Drink Federation.

[33] http://www.foodethicscouncil.org/

As expected, NGOs have also provided a number of analyses of the subject, such as Oxfam's recent study "Growing for a better future- food justice in a resource-constrained world" (Bailey, 2011)[34]. They come to sobering conclusions: The global food system works only for the few – for most of us it is broken. It leaves the billions of us who consume food lacking sufficient power and knowledge about what we buy and eat and the majority of small food producers disempowered and unable to fulfill their productive potential. They relate this alleged failure of the system flows from failures of government – failures to regulate, to correct, to protect, to resist, to invest. They have strong words to say about what this would in effect mean: Companies, interest groups, and elites are able to plunder resources and redirect flows of finance, knowledge, and food.

Along these lines, there are a number of well-organised groups that advocate for a radical change to the way that much of our food systems currently operate. These are by no means insignificant groups and they are related to other groups that voice criticism to the way politics and governance systems currently play out. The recent street protest on Wall Street are also part of that. A recent news article indicates the measure of influence these groups have (box on Walmart).

In all of these discussions, the concept of "**food sovereignty**" usually features high. It is often argued that food sovereignty is the means to achieving a (food) system that will provide for the food needs of all people while respecting the principles of environmental sustainability, local empowerment and what is called "agrarian citizenship" (freely translated as farmer participation). This concept and related practice is well expounded in Desmarais, Wiebe & Wittman, eds (2010) in "Food Sovereignty – reconnecting food, nature and community" and Pimpert (2009).

Walmart and the Good Food Movement
Posted October 6th, 2011 by admin

Walmart recently created a firestorm of controversy within the 'Good Food Movement' when it donated $1.2 million to Milwaukee-based Growing Power, a national leader in the struggle to get good healthy food to low-income communities. Some food activists have criticized Growing Power for taking the money, saying the donation is a thinly veiled attempt to buy goodwill. Others assert Growing Power deserves the money – and indeed should have received even more from Walmart.

Source: http://www.foodfirst.org/

Many of these issues and related ethical questions deal with the core question of 'who controls the food system' and is closely related to the concept of food governance. Hospes and Hadiparyitno, eds (2010) argue that "localised food systems provide the foundations of people's nutrition, incomes, economies, ecologies and culture throughout the world. (…) These local food systems provide a livelihood for more than 2.5 billion small-scale farmers, pastoralists, forest dwellers and artisanal fisherfolk worldwide. However, despite their current role in and future potential for meeting human needs and sustaining diverse ecologies, local food systems—and the organisations that govern them— are threatened by two main processes. The first is the global restructuring of agri-food systems, with a few transnational corporations gaining monopoly control over different links in the food chain. This process is undermining local people's capacity for autonomy and self-determination. The second threat is the modernist development agenda pursued by organisations such as the World Bank and the Gates Foundation. This agenda envisages achieving the Millennium Development Goals by reducing the number of people engaged in food production and instead encouraging them to get jobs in the largely urban-based manufacturing and service sectors—regardless of the social and ecological costs." This brings out a

[34] http://www.oxfam.org/en/grow/reports/growing-better-future

concern about what values are driving scenario and foresight studies and the extent to which ethical concerns play a role in assessing how food systems work and ought to be working[35].

3.3.2 Food system governance

Food system governance covers the field of how institutions and policies govern (global) food systems. The term 'food governance' is used to refer to the institutionalised social, economic and political processes – the formal and informal rules and procedures – that organise and coordinate food production, processing, distribution and consumption among a diverse array of actors. It involves the actions, processes and institutions by which power and authority is exercised and decisions are taken and implemented across the food system (Renn, 2008).

Research in the field of food system governance may focus on any one or a number of the following issues: Governance mechanisms and what exactly (issues) is governed, governance failures, effectiveness of governance mechanisms and issues in relation to especially food security and safety, trends in food system governance and possible future trends (Millstone and Thompson, 2011).
The organisational arrangements of law and governance regimes of a public or private nature may contribute to the prevailing food security situation in positive or negative ways (Hospes & Hadiparyitno, 2010). That is why it is important to address food governance related questions and issues. It also introduces the question of who benefits from the way food governance effectively operates, as Anderson (2009) discusses in a study meaningfully entitled "A question of governance. To protect agribusiness profits or the right to food?" and aptly illustrated by the picture in figure ….
Food governance issues are closely related to that which is addressed through the concept of food sovereignty. Pimbert (2009) discusses that the notion of food sovereignty[36] is perhaps best understood as a transformative process that seeks to recreate the democratic realm and regenerate a diversity of autonomous food systems based on equity, social justice and ecological sustainability.

Another concept that is closely related is "right to food" for which a Special Rapporteur has been appointed by the UN. It is defined as a human right to protect the right of all human beings to live in dignity, free from hunger, food insecurity and malnutrition[37].
Tansey and Rajotte (2008) provide an overview of political choices through negotiations and instruments in the World Trade Organization, Convention on Biological Diversity, UN Food and Agriculture Organization, World Intellectual Property Organization, the International Union for the Protection of New Varieties of Plants and various other international bodies. The final part discusses the responses of civil society groups to the changing global rules, how these changes affect the direction of research and development, the nature of global negotiation processes and various alternative futures.

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[35] More along these lines at http://www.foodethicscouncil.org/node/647

[36] *See* www.nyeleni.org *for six principles in implementing the food sovereignty policy framework*

[37] http://www.righttofood.org/

Paskal and Furrie (2011) further specify dimensions of governance by relating food security at the confluence of three major, and shifting, global vectors:

- **geophysical** (with large scale environmental change– including urbanisation and climate change – affecting food production)
- **geoeconomics** (with the shift in the economic centre of gravity towards Asia and the emergence of nationalistic capitalism in the form of, for example, sovereign wealth funds investing in agricultural land)
- **geopolitics** (with an uneasy new dynamics amongst the west and 'the rest' exacerbated by agro-politics) These three geos influence, and are influenced by, food security, something vividly illustrated in different contexts around the world.

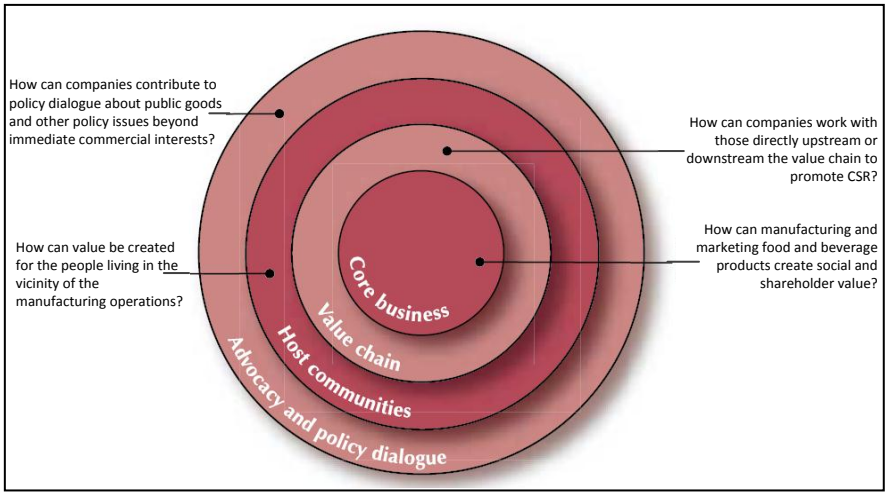
Governance of food systems is highly complex, further complicated by differing understanding of scales and levels and a range of governance approaches (Ingram, 2011). This is not least because of the growing environmental concerns that need to be addressed while changing food systems' architecture. Questions concerning food governance will need to addressed at different levels: global, regional, national, subnational and local. While addressing food & nutrition security, the challenge is to find the right level of governance for each challenge (Pinstrup-Andersen and Watson II, 2011: 271).
One of the key changes of the last few decades is that supermarket chains and food industries have come to play a much stronger role in food system governance. This is part of the reason for the food movements fixing their eyes on the role of those actors and the growing importance of the CSR of those corporations.

3.3.3 Corporate social responsibility in food systems

> *A business that makes nothing but money is a poor kind of business*
>
> Henry Ford

A subset of the role of private sector in innovation systems responsive to food & nutrition insecurity. The British Food Journal will devote special issue to Corporate Social Responsibility in Food and Agriculture (2012). Usually core business of private sector operates on different terms than their corporate social responsibility departments. Corporate social responsibility labels and rhetoric is often used as a flag to wave to customers. It may be limited to shoving some money to NGOs and other organisations that try to improve people's living conditions. If corporate social responsibility helps to boost the business' image it can be seen as marketing expenses.

Figure 26: Key questions regarding CSR engagement in food systems. Source: Prescott, Singh and Davy, 2002.



The picture does not look that bleak in all corporations though. Some enlightening examples try to feed their day-to-day core business operations with corporate social responsibility recommendations and ideas as well. Confusing use of terminology may sometimes obscure real issues. E.g.

sustainability may be interpreted as caring for the environment and poor, but may merely mean sustained levels of returns throughout the supply chain as well. Rana, Plats and Gregory (2009) and Hartmann (2011) have conceptualised these issues to create greater clarity.

Corporate social responsibility questions play at different levels and platforms. Figure … is a helpful illustration of explaining the tensions between questions asked at different levels.

Not every company is ready to engage with CSR questions at all these levels. In relation to this Vanja Markovic distinguishes five stages of CSR maturity[38]:

1. Defensive – It is not our responsibility
2. Compliance – We'll do what we have to do
3. Managerial – Process orientation
4. Strategic – Looking at the competitive advantage
5. Civil – Multi-stakeholder partnership for promoting sustainable development

Sustainable businesses manoeuvre their way in view of not just their core business concerns, but in view of climate change, water shortages, toxic poisoning, rising population, etc. Those engaging with CSR questions at different levels, find themselves facing a number of challenges across the value chain as illustrated in figure 27.

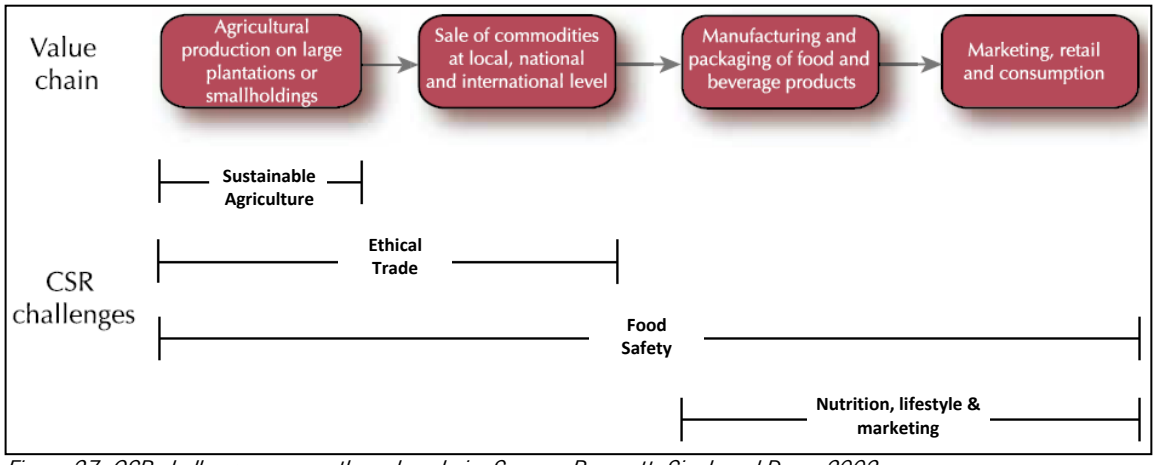


Figure 27: CSR challenges across the value chain. Source: Prescott, Singh and Davy, 2002.

Broadening the scope of challenges, CSR in food supply chain will need to interact with a number of dimensions as illustrated in figure 28. CSR is a tricky field. Some corporations take this very seriously, while others use it as a cover-up act. The 2008 report of the UN International Assessment of Agricultural Knowledge, Science and Technology (IAASTD) concluded that the key to global food security is not the costly industrial model favoured by powerful multinational corporations but a global

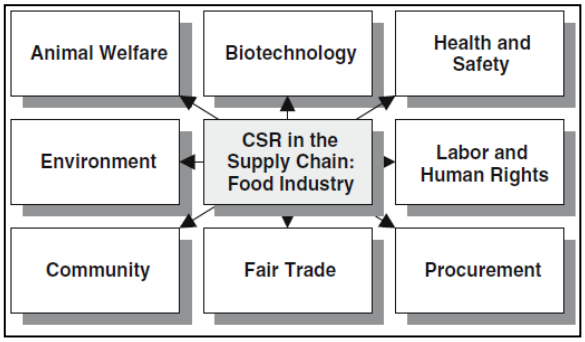


Figure 28: Dimensions of CSR in the in a supply chain perspective. Source: Maloni and Brown, 2006)

[38] Excellent presentation for 3E company on Strategies for Corporate Social Responsibility http://msds.3ecompany.com/files/StrategiesCSR.pdf.

matrix of small-scale farms applying simple, low-cost, agro-ecological practices. This may not be good news to some corporations.

Knowledge institutes can play an important role in helping in a process of distinguishing between corporate CSR rhetoric and honest CSR efforts that inform a corporation's DNA in terms of its mode of doing its core business. With the increasing criticism of food movements on how (global) food systems are geared towards food industry profits, CSR is going to be of increasing importance for the development of sustainable food systems in general, but also for the food industry ('s business performance) itself.

4 Looking for clues – Strategic innovation capacity for food & nutrition security

4.1 The future of food, farming and fishing – what to prepare for and how?

Forward thinking is a strategic tool for exploring and anticipating rather than simply adapting to a situation. It also relates to an ability to develop early-warning mechanisms. In the latter part of this chapter, we want to zoom in on the role that knowledge institutes will need to be playing in innovation systems in view of anticipated challenges to sustainable food systems. Before that, we will try to create a brief overview of the different pictures of the future of food and farming that have been sketched by various organisations and the people representing those. It will not cover all studies that have been done, but has enough of a variety to give an idea of the different trends and developments analysed, the challenges put in front of us and the variety of suggested policy measures to be taken.

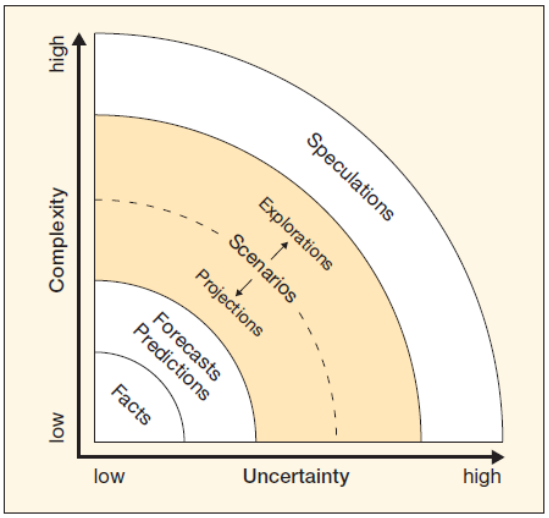


Figure 29: Distinguishing between different types of foward/futures thinking. Source: Zurek and Henrichs, 2007.

Creating future scenarios/projections is a bit of science, a bit of artwork and probably also involves quite a bit of common sense and gut feeling. Zurek and Henrichs (2007) have done a useful job in conceptualising different approaches to forward/futures thinking. The outcome of scenario analysis very much depends on which factors have been taken into account and the level of accuracy regarding anticipated events and developments. The danger of politicised use of scenario analysis is therefore significant. Leaving out inconvenient factors can be tempting for those who want to tweak models to their political taste. Because of the fact that constructing scenarios is by no means an objective task, it is therefore always important to understand how they were constructed.

For some reason, it has become common practice to develop four scenarios in relation to two scales of options. Figur30 gives an example of how this was applied in relation to climate change models at the beginning of this millennium.

More technical implications of how scenarios are constructed can be found in Henrichs and Zurek (2008), discussing the way in which scenarios can be linked across geographical scales. Reilly and Willenbockel (2010), in reviewing food system scenario analysis and modelling arrive at a number of important observations, including:

- Scenarios are not predictions and probably most powerful as a learning tool.
- Growth is too much the point of departure in basic narratives, at the expense of more multi-dimensional narratives of adaptation.
- More work is required on the validation of model components used in integrated assessments.
- There is a risk of constructing models too much on the bases of past processes that might not necessarily be the processes driving future developments.

Over the past few years and as we are writing, future-oriented studies have been and are being conducted in large numbers. This probably has to do with the fact that there are so many factors and dynamics

involved in food & nutrition security, many of which we have no clear idea of how they will play out and especially how they will interplay. **Annex four contains an overview** of international future-oriented analyses and policy recommendations. They show a certain measure of common ground, but are also different in a number of areas, which highlights the importance of being informed from different perspectives to get a more complete picture. We would have liked to analyse this more in relation to international policy trends and developments, but for this moment we will need to leave it at providing the short overview. For Dutch policy development purposes, however, it would be useful to pick this task up at a later stage.

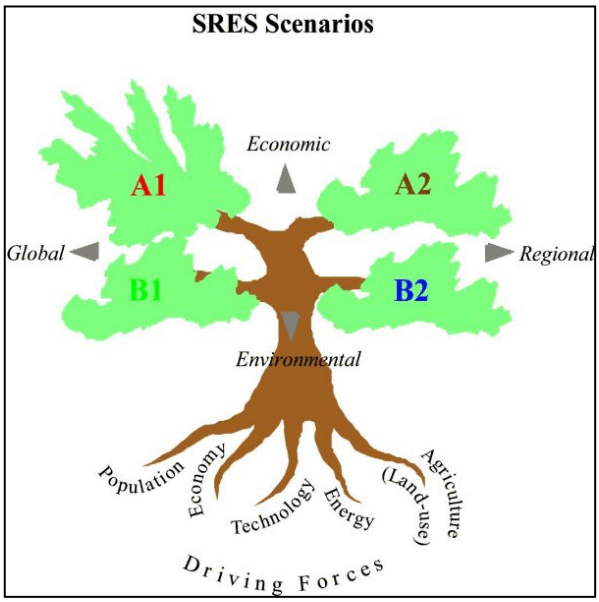


Figure 30: Building up scenarios on the basis of driving forces and dimensions of change. Source: Nakicenovic and Swart, 2000.

There are many relevant studies done in the field of the future of agriculture & food foresight (such as the ones summarised in annex 4). Hubert et al.(2010)[39] have tried to make sense of a range of such studies, looking for where convergence and divergence can be found. They found convergence in scenarios and prospects along the lines of:

- Global food availability in 2050 is not so much a production problem as a local food access problem
- Understanding the situation of poor rural people, in particular farmers, and their perspectives for the future remains a huge challenge for conceptualization, data gathering and assessments, etc.
- Ecosystem degradation and climate change impacts will put more pressure on poor farmers.
- Divergences was found in:
- Different worldviews: public vs. private goods or investment, for example.
- The implicit model of farming in the future (if any?): family farming, multi-activity, agro-business, or new entrepreneurship farms? Does "small-scale farming" actually refer to the concept of "scale" or to other elements, such as types of technological means, skills, outputs, etc.? Will future agricultural systems be diverse? Are there normative models?
- Food sovereignty, food security and self-sufficiency do not mean the same depending on the context, the cultural background and the political goals. It is necessary to clarify the use of these terms and their implications in public policies and trade negotiations.

They recommend setting up a permanent forum to help forward thinking, where diversity – of stakeholders and approaches – will be critical. Such forum can present and debate alternative methods and visions for the future. It can mobilize various approaches and organizations. And thereby increasing the chances that today's decisions actually address the needs and widen the options of future generations.

The Chatham House study on Food Futures in the context of UK strategies for a secure food future provides an interesting perspective on four required key characteristics of a future food (supply) system: Resilience, sustainability, competitiveness, and managing consumer expectations. We see a particular value in how they analyse needed shifts in paradigms in relation to food systems to meet future food

[39] www.cirad.fr/content/download/4595/42828/.../Perspective06.pdf

system demands (see figure31). Meeting the future prepared will include an ability to change your mind and thinking on how change and how innovation happens.

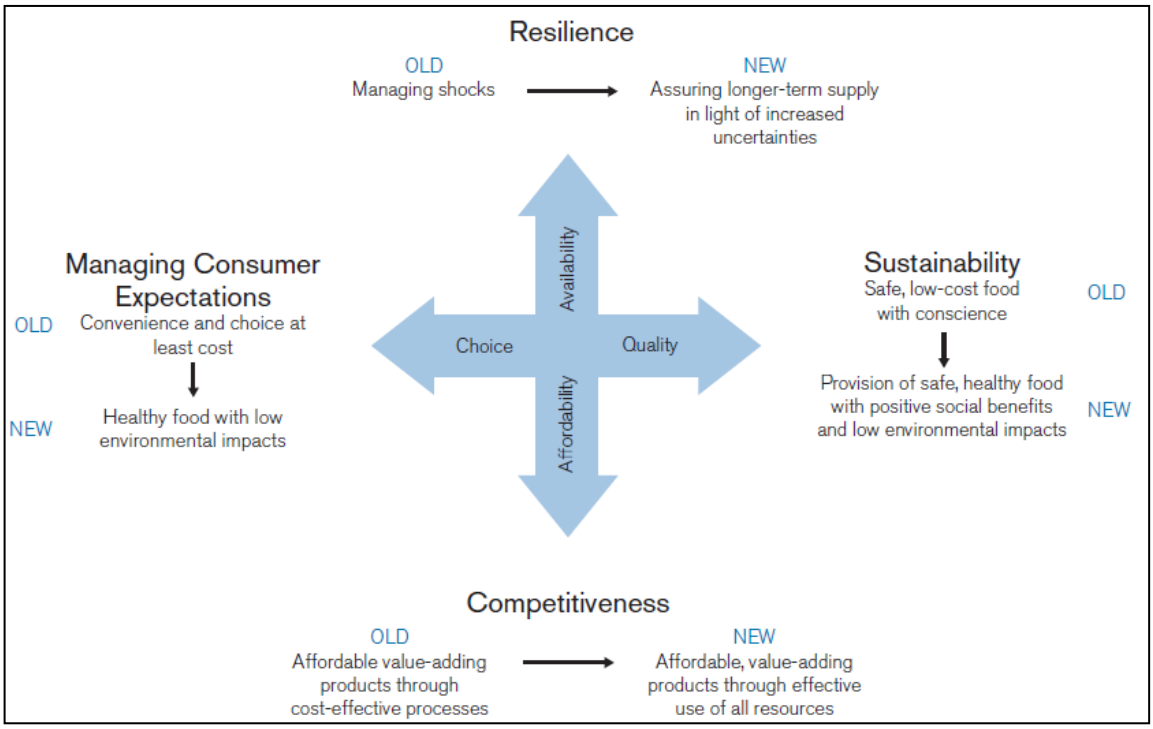


Figure 31: Required transitions to meet future food system demands. Source: Ambler-Edwards, et al. (2009)

Meeting the future informed and prepared

In conclusion on foresight studies, it is not too much to say that different studies provide different and often complementary ideas on key drivers of change, related anticipated key challenges as well as different ideas on how to deal with defined challenges. Also, we have seen that those involved in doing foresight studies realise the limitations of their efforts due to the many known and unknown factors and dynamics involved. This calls for three attitudes: caution in adopting any analysis to guide decision and policy making, ensure being informed by a variety of scenario analyses, and broaden strategic foresight to being informed from a multi-sector perspective, e.g. not just looking at the future of agriculture, but also looking at interactive dynamics with trends and developments in other sectors. Useful platforms for this include the World Foresight Forum[40].

4.2 Connecting local realities and the bigger picture

We have explored a bit into the bigger picture of food and innovation systems. Now we want to zoom in on some on-the-ground experiences with (agricultural) innovation and how knowledge institutes could make a difference. The following are some highlights from five case studies on agriculture and fisheries innovation in Ethiopia, Rwanda and South Africa. The case studies are described in more detail in Borman et al., 2011.

[40] http://www.worldforesightforum.org/index.html

Case 1: Farmer-led research as catalyst in cassava sector innovation in Rwanda

Cassava is cultivated by 42% of the agricultural households in Rwanda, e.g. 700.000 households. Although mainly grown for home consumption, cassava is increasingly becoming a commercial crop. As a result of the the replacement of traditional varieties with resistant ones, successfully effectuated since the outbreak of the cassava mosaic disease, national production has doubled, reaching 2 million metric tons in 2009 and 2010. In this context, INGABO, a farmer's union operating in the Southern province where cassava is an important crop, was most interested in options for involving farmers in cassava processing and marketing. A network of more than 20 professionals (INGABO staff, WUR-CDI, ISAE, RAB and young professionals), conducted action research to identify levers for making cassava value chain development more competitive, sustainable and inclusive. The studies provided various new insights, among others: a typology of value chains of bitter and sweet cassava varieties, price transmissions, the monetary value of the sector, the conversion rate of tubers into flours, market segmentation, product development, the functioning and entrepreneurial outlook of cassava farmers and their cooperatives, the agronomic and economic feasibility of agricultural intensification and experiences with the promotion of local cassava agribusiness clusters. Key ideas for pro-actively addressing technical, commercial, organisational and institutional challenges innovation were suggested and options for value chain and market system development were shared during a national cassava event 'ManiOK-CaCAVA'. This may induce Government, e.g. the Rwanda Agriculture Board, although already playing a very active role in the transformation of the Rwandan agricultural sector, to give more attention to the cassava sector. The research process and outcomes have led to the installment of a task force that formulates action plans for 4 priority issues: the fight against Cassava Brown Streak Virus, crop intensifcation programme for cassava, market-oriented development of processing capacity (with specific attention for farmers' supply of cassava tubers to two factories under construction) and the relations between cassava cooperatives and financial institutions.

Case 2: Platforms facilitating innovation partnerships and up-scaling of lessons learnt into institutional and political frameworks for seed sector development in Ethiopia

The partnerships and innovation component of the ISSD Ethiopia programme aims at solving bottlenecks in the seed sector by collaborating with institutions that are unable to address these challenges unilaterally. In each region, a partnerships' platform and core group have been established. Platforms involve as many stakeholder institutions as are interested in discussing issues and suggesting innovations for addressing these. A select core group (from the public, private, research and civil society sectors) forms the decision making body responsible for the planning and follow-up on the execution of regional partnerships' projects. Key to the innovation process is the involvement of a sufficient number of stakeholders who together want to work on demand-driven solutions to the problems.

Important up-scaling interfaces occur at two levels: (1) between the local and regional level, to provide an evidence base for problem interventions, and (2) between the regional and federal level, for communicating with decision makers who can exert influence on the enabling environment. Partnerships' facilitators broker these connections. From experience, the choice of individual facilitator is crucial: a positive attitude motivates others; good interpersonal skills and competencies for communication are important; good diplomacy is necessary for dealing with many actors; and an extensive personal network is a key characteristic in the selection of the individual tasked with facilitating partnership formation.

Case 3: Knowledge brokering building upon existing capacities in dairy sector innovation in Ethiopia

Ethiopia has good potential for dairy production. Currently, the sector is shifting towards greater market-orientation. A number of development interventions have targeted the dairy sector, however, with limited success and poor rates of adoption. Despite these interventions, productivity has remained low and subsistence oriented with poor access for surpluses into the market.

A significant challenge for the dairy sector is the absence of institutional linkages among key actors in the value-chain and the weak capacities among service agents for implementing market-oriented innovations. In the most successful examples of innovation in the Ethiopian dairy sector, the predominant driving forces were market incentives and the coordination by individuals or organizations acting in the 'brokering' role. The Netherlands Development Agency (SNV) has been one key actor in this process, strengthening capacities predominantly through the creation and strengthening of branch and business associations in the dairy value-chain. This includes improving the advisory services provided by local organizations. The core of SNV's approach is bringing all the value-chain actors and stakeholder groups together in so called Coordination Groups (CGs). CG meetings involve stakeholder members from the value-chain, different relevant institutions and other invited clients with experiences to share based upon: specific capacity needs assessment; networking; building upon existing relationships and forming new ones; sharing lessons learnt; and creating awareness on innovations in the value-chain.

Case 4: Helping create shared perspectives for innovation in the small scale fisheries sector in South Africa

In 1994 the apartheids regime of South Africa was transformed into a regime in which access rights were recognized for all inhabitants. This transformation had a serious impact on the fisheries sector and a new policy was needed to keep fish stocks at a sustainable production level while at the same time keeping the fishing industry alive. The need for improved marine ecological-economic management systems for the small-scale fisheries sector became apparent, but due to the complex nature of the small scale fisheries sector such policy is as yet not in place. A study was initiated to explore options and trade-offs between fisheries economics, market demand and marine environment. By doing so, the knowledge institutes involved helped create transparent decision-making options and trade-offs for key stakeholders by establishing a shared knowledge base for understanding the dynamics of the marine ecosystem, the economics of fishing and concerning the management of the resources. The resulting shared perspectives help stakeholders in taking steps towards a better managed small-scale fishing sector that takes into account environmental as well as economic factors.

Case 5: Linking producers to processors in soybean sector innovation in Ethiopia

The soy bean was introduced to Ethiopia in the 1950s for the purpose of import substitution, but to this moment, production is still insufficient for this. While producers seem unable to find markets for their products, processors of animal feed and edible oil are operating at 60-70% capacity due to insufficient amount of available soy. Fragmented markets appeared to be a major cause for this situation. A project was initiated to investigate opportunities for soy bean value chain innovation. Both local and international (Wageningen UR) knowledge institutes were involved. The key roles they played reduced transaction costs for producers and processors by networking, identifying potential partnerships and linking key players to each other, providing a platform for all actors in the soy chain to discuss burning issues, such as pricing and thereby contributing to trust building among producers and processors. This put further development of the soy sector on the agenda at national level, linking research institutes to private sector for

knowledge brokering, e.g. in relation to available soy varieties and characteristics. The resulting collaboration helped create new perspective on roles and linkages in the soy bean value chain, leading to enhanced efficiency of markets and indirectly to improved food security.

Discussion

The five cases can be seen as indicators of what is possible when knowledge institutes tune their innovation support to the characteristics of local settings. Countries are different, sectors are different, (potential) innovation actors (incl. individuals) are different, and so does innovation support need to vary according to context specifics. The cases show how different approaches, methods and styles were adopted. They are therefore examples of making knowledge work in context, a practice that we would like to see adopted more widely in Africa. The resulting opportunities for contributing (indirectly) to food & nutrition security proved to be also dependent on the active support by government actors (including Dutch ministries and embassies) for playing such flexible roles. At the same time, though local settings vary, the bigger picture of (global) A&F systems and challenges to food & nutrition security in Africa is shared in common. Helping connect local realities of (agricultural) innovation to the bigger picture of (global) A&F systems, and the other way around, is an important service to integrate efforts toward enhanced (global) food & nutrition security.

4.3 Opportunities for knowledge institutes to make a difference in innovation for food security

The effectiveness of key actors in innovation for food & nutrition security to play their role up to their potential is going to be an increasingly serious issue. We need to anticipate compounding challenges in relation to drains on the food system (see 2.2 for examples of drains on the system) due to interrelated factors connected directly or indirectly to food security (State of the Future, 2011). On top of that, some of our innovations may not live up to the expectations, such as GMO crops backfiring because of pests that outsmart the engineered crop's disease resistance. Food prices are expected to remain volatile in the nearby future (Tuttle, 2011). As agriculture has become highly market-driven, making necessary system changes from production to consumption, will prove to be as difficult as it is to make the Greeks accept the conditions for financial bail-out plans. The stakes are high and the number of gloomy pictures sketched by respected thought leaders concerning the future of (amongst others) food & nutrition security increase (e.g. Brown (2008 and 2010)[41] who writes in terms of preventing environmental and economic collapse, and Cribb (2010) who is of the opinion that there is a coming famine that we need to try to avoid). In relation to these kind of concerns Thompson et al. (2007) write that "despite the power of its underlying production-growth narratives, conventional agricultural science is not able to explain let alone address concerns of providing sustainable outcomes for poor people in developing countries." They are concerned about the "tendency to fail to realise the complex ecological, economic and social processes involved as well as the vulnerability of those processes to shocks and stresses." They are not talking about 'traditional' agriculture alone in this, but think that even agro-ecology and participatory research and development will not be fully able to respond to the dynamic character of complex and rapidly changing food systems. This underscores the importance of a focus on dynamic system interactions, including more interdisciplinary research (we will return to this issue in the next section on various roles of knowledge institutes). Getting to terms with those food systems in light of food & nutrition

> "The key challenge in most successful cases of innovation has not been the creation of new interventions but the adaptation and use of existing ones" (Rajalahti, Janssen & Pehu, 2008)

[41] http://www.earth-policy.org/

security outcomes will need to also look at variations in consequences of (making) changes in those systems, rather than working with (national or even global) aggregates and averages (Thompson et al., 2007).

All this goes to show that we need to be prepared for major challenges in terms of food & nutrition security for all. The "all" part of this has to stay sharp in the minds of policy makers in places that may themselves have fewer immediate concerns regarding food & nutrition security in their own country, lest we sacrifice food & nutrition security in faraway places just so that we do not need to reconsider the foundations on which our own food systems are built.

The global report of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), entitled "Agriculture at a Crossroads"[42] (McIntyre et al, 2009) is an important source of inspiration for understanding the potential role of knowledge institutes vis-à-vis the state of the art and options for the future of agriculture from an integrative perspective. The following is a selected (and edited) summary of the report:

Agricultural knowledge, science and technology (AKST) played a significant role in substantial increases in agricultural production over time, contributing to food security. However, people have benefitted unevenly from these yield increases. Even more, increasing yields and productivity have in some cases had negative consequences on environmental sustainability. They therefore argue for a more multifunctional approach to the positioning of agricultural knowledge, science and technology. Such multifunctional approach would enhance their impact on hunger and poverty, improving human nutrition and livelihoods in an equitable, environmentally, socially and economically sustainable manner. This would also need to involve an increase and strengthening of agricultural knowledge, science and technology towards agroecological sciences to better address environmental issues while maintaining and increasing productivity. Besides this, they call for greater and more effective involvement of women and use of their knowledge, skills and experience will advance progress towards sustainability and development goals.

According to their analysis, targeting small-scale agricultural systems by forging public and private partnerships, increased public research and extension investment would help realize existing opportunities. In order to achieve sustainability and development goals would involve creating space for diverse voices and perspectives as well as scientifically well-founded options. They think social scientists have a role to play here, but we would like to broaden this to a role for innovation process facilitators as we will discuss in the next section. Part and parcel of the suggested fields of innovation would the innovation of institutional arrangements. While they see an important role for public private partnerships, they also call for the establishment and enforcement of codes of conduct by universities and research institutes can help avoid conflicts of interest

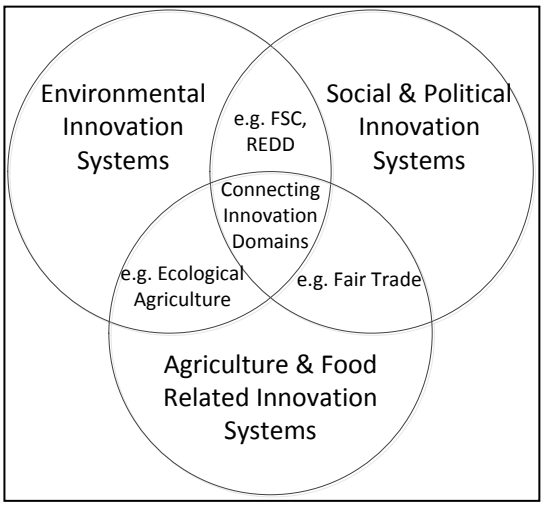


Figure 32: Enhancing strategic innovation capacity by connecting domains of innovation

[42] http://www.agassessment.org/

and maintain focus on sustainability and development in 'agricultural knowledge, science and technology' when private funding complements public sector funds.

The comprehensiveness of their conceptual framework (see annex 5) connects well to our suggested connecting of the three frameworks as discussed in chapter two. As we explore roles to play in support to innovation for food & nutrition security to keep zooming in and out on this policy reference framework to stay connected with the variety of on-the-ground realities as well as with the bigger picture system complexity realities.

4.3.1 Exploring ways forward

Strengthening integrative perspectives

We have seen that food & nutrition security involves a complex dynamic of a range of actors and factors. Though a difference needs to be made in the context of on-the-ground realities, it is important to stay in touch with the bigger picture of (global) food system performance. A sustainable food system delivering food & nutrition security for all, will need to meet at the intersection of 'people, planet, profit'. This asks for connecting innovation across dimensions, levels and sectors. This also relates to the need for linking supply chains in order to be connected and move as on system in achieving food security (Rabobank Group, 2010). This perspective also high-lights the importance of food system governance, concerning the appropriate performance of actors and factors. This not only relates to regulation, but also to the creation of an enabling context for the optimal performance of the food system. The good-governance responsibility for this enabling context also concerns the facilitation of collaborative innovation processes in connection with food systems, to which we will return later in this chapter.

This document has been an attempt at providing a bigger picture perspective. Appropriate policy-making platforms need to be in place for checking strategies and plans in the light of an integrative perspective on food system performance. Food system challenges, opportunities as well debates need to meet at the table. In this process, there needs to be a place for calling attention to (impending) failures of food system, and related innovation and innovation system if relevant (Brooks and Loevinsohn, 2011; Norfors, 2004). Media (journalism) in many cases has an important role to play in this as well.

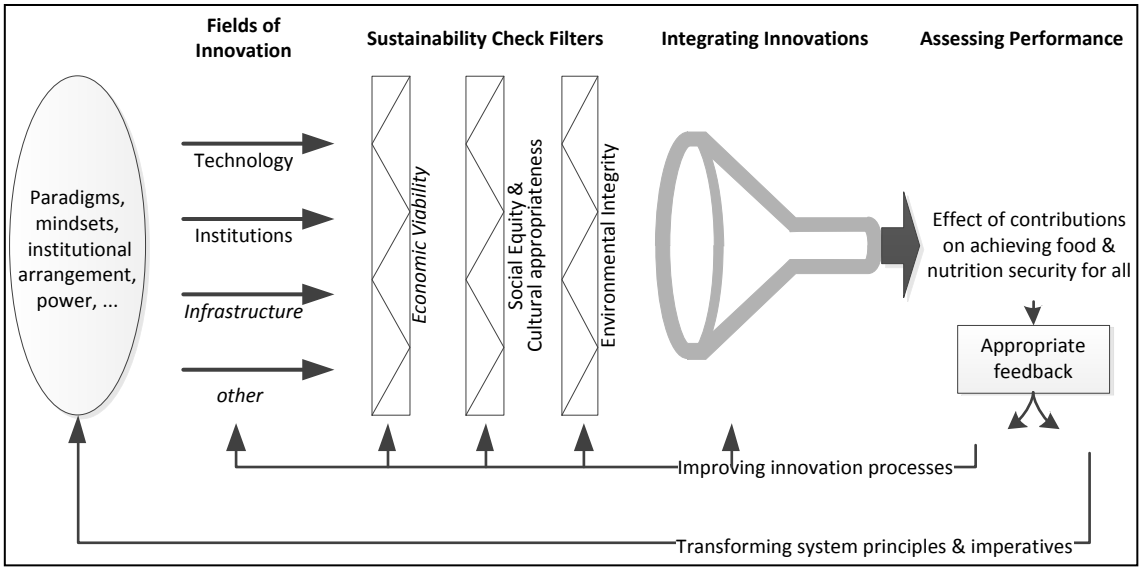


Figure 33: Public-private partnerships: Getting their act together to get systems right, get innovations right, get sustainability right, and get integration right

Strengthening (strategic) innovation capacity

A programme for strengthening competences and capacities for fulfilling the roles of innovation process facilitation needs to be in place. Knowledge institutes are in a comparatively good position to support this. Not because they are in a perfect position. But compared to private sector actors (having their own (legitimate) business interests), government (regulatory bias), and civil society (societal concerns need to be kept alive to retain legitimacy), they are less burdened by subjectivity. However, this relative objectivity needs to be maintain through appropriate funding arrangement for fulfilling this role to ensure both good performance and non-biased perspective.

Need to strengthen capacity in the field of:

- Understanding **core innovation processes** in relation to that which 'makes innovation happen'.
- **Innovation governance** in the sense of the role to play in creating a conducive environment for appropriate innovation, including, but not exclusively, regulatory roles.
- **Innovation leadership** in the sense of strategic competencies where leadership is understood not as a position, but as a role to play (at all levels).
- **Innovation partnership** – engaging in cross-sector, cross-level and cross-cultural innovation processes, and how different the way in which different roles in an innovation are played enable and/or obstruct the roles to be played by others.
- Cross-cultural translation of **good innovation practice** (such as the Dutch 'gouden driehoek') towards general principles for success and then appropriate translate those back to specific contexts.
- Strengthening **capacity for capacity strengthening**, which particularly relates to strengthening the roles of knowledge institutes in the South (most notably in Africa) to play an effective role in innovation systems.

The orchestration of roles to play is something that relates to governance roles as well as to the informal roles as we have discussed in this and previous chapters.

Box 3: On the actual and potential role of African universities in agricultural innovation

The Africa Commission consultations concluded that "African universities are not sufficiently geared to meet the needs of industry. Graduates often cannot find employment, while many small businesses lack staff with the education and skills needed to drive innovation. Essentially, the relationship between the demands of the private sector and what universities teach is too weak. However, studies show that when university graduates do business, they create more jobs than those without a university education. Nowhere are these deficiencies more critical than in agriculture, Africa's dominant industry. The potential of African universities to promote positive change in society needs to be enhanced. Universities have a particular responsibility for generating and diffusing knowledge into the economy and creating opportunities for innovation. They do that most effectively when they have strong links with research and business. However, achieving such links will require adjustments in the way that African universities function. They need to be engaged with private enterprise at all levels, including smallholders and firms in local and distant markets. By linking across agricultural value chains – locally, nationally and regionally – universities would be better able to educate entrepreneurs who can tap the enormous under-exploited potential of African agriculture for growth, job creation and poverty reduction. In doing so, they would also encourage youth and women to take up careers in agriculture and related industries." (Africa Commission, 2009)

Lemma et al (n.d.) defined four interlinked areas in which to enhance innovation capacities:

Actors
- Enhance competencies for managing partnerships
- Empower producer groups to demand services and command accountability

Interactions
- Mechanisms to co-ordinate efforts of multiple and heterogenous actors
- Creating wider awareness about importance of knowledge networks and partnerships

Habits and practices
- Reinforce habits and practices compatible with innovation, especially learning and trust

Enabling environment
- Capacity development to translate policy agenda into operational strategies
- Institutionalize adaptive and participatory policy making, informed by process and impact monitoring
- Appropriate incentive systems
- Make procedures and targets 'innovation-friendly'

"It is relatively easy, with special funding and expertise, to create niches which 'prove the principle', but hard to replicate those lessons in normal government or company policies, procedures and rules of the game" Röling, 2011. This is an important observation. It is relevant to how we go about strengthening capacities. This does not fit with an approach that strengthens capacity to 'get the job done', but relates to strategic and communicative competences of individuals who can adaptively navigate through the situation-specific forests of policies, procedures and rules of the game.

Strengthening (public-private) partnership performance

Larsen, Kim and Theus (2009) argue in the World Bank study on agribusiness and innovation systems in Africa, that public-private partnerships (PPPs) must be strengthened and extended beyond the traditional field of research and development (R&D), the traditional view of public-private partnerships focusing mainly on R&D should be replaced by a broader notion of PPPs that extends to advisory, extension, and other support services.

Partnerships, however, do not form by merely connecting potential partners around a common field of work or interest. Tennyson, Hurrell and Sykes (2008) have studied global business-NGO partnerships. One of their key findings is that we tend to have rather unrealistic views about how partnerships are shaped and how they work best. Though focusing on business-NGO partnerships, many of their findings would equally apply to public-private partnerships. In box … we can find a list of enlightening 'myths' and 'truths' about partnerships.

Box 4: Myth and reality in partnership development (adapted from Tennyson, Hurrell and Sykes (2008)

Issue	**Endearing 'myth'**	**Enduring 'truth'**
Aims	Partnerships are shaped around a common vision	The partners see the partnerships activities as delivering their individual organisational aims
Drivers	Partner organisations are drawn together by a common goal	Partner organisations are drawn together by the complementarity of what they bring to the table
Context	Partners know each other well and partnerships benefit from a stable context	Partnerships are often most effective in fractured contexts where by their very operation they are building bridges and filling gaps

Issue	Endearing 'myth'	Enduring 'truth'
Champions	Individual champions are key to partnership's success	Champions have a very limited function in partnerships – systems and structures are ultimately far more valuable
External inputs	Partnerships work best when locally owned and driven	Even local partnerships can benefit hugely from external inputs and interventions – in terms of sharing knowledge and experience as well as leveraging further resources
Boundaries	Ring-fenced partnerships are likely to be most successful	Innovation in partnerships depends on a more fluid structure if new ideas are to evolve and new opportunities are able to be seized
Costs	Partnering costs are so high they are likely to be unattractive to many	Managed well, and with early investment in partnership-building, costs can be shared and reduced by coordinating not duplicating efforts
Wider benefits	Occur when the partnership itself reaches scale or is replicated	Occur when all those involved take lessons and outputs from the partnership and apply them in their own spheres of operation and influence

Similar studies have been done in relation to partnerships in agricultural research and development (Ferroni, 2010). He also found there to be many myths regarding what builds good partnerships. A key lesson to learn is that partnerships do not form nor flourish automatically. Gaps and divides between groups, sectors and cultures will need to be bridged, demand and supply on the 'knowledge market' will need to be matched and platforms and networks need to be helped to perform and be appropriately adaptive over time. This asks for systematic intermediation and brokering to sustain innovation (Klerkx, 2010).

Nelson (2005) looked for what breeds success in multi-stakeholder partnerships and listed seven key success factor in effective partnerships:

1. Openness, transparency and clear communication to build trust and mutual understanding;
2. Clarity of roles, responsibilities, goals and "ground rules";
3. Commitment of core organizational competencies;
4. Application of the same professional rigour and discipline focused on achieving targets and deliverables that would be applied to governing, managing and evaluating other types of business alliances;
5. Respect for differences in approach, competence, timeframes and objectives of different partners;
6. Focus on achieving mutual benefit in a manner that enables the partners to meet their own objectives as well as common goals;
7. Understanding the needs of local partners and beneficiaries, with a focus on building their own capacity and capability rather than creating dependence. (Nelson, 2005)

We may add 'ownership at all levels' to this list (Oxfam, 2009).

Acting strategically in support of innovation for food & nutrition security

Innovation systems responsive to food systems and security go beyond 'getting the job done' or 'fixing problems'. The whole thing about innovation in complex adaptive systems is that much of it relates to creating synergy and potential and then trusting emergence of appropriate responses to identified concerns. Also, complex interactions within the system will often be unknown. Genetically modified organisms are good example of this. If a narrow focus on increasing crop production is applied then GMOs seem to be a way forward. However, making this change in the system may have unanticipated effects on an entire ecological system or the food system. In complex adaptive systems 'solutions' should not be developed as isolated subsystem innovations but in view of a whole systems innovation approach. Economic and technical innovations need to be informed by and infused with social and environmental innovation perspectives if long-term resilience and sustainability of the food system is a goal. This relates to being innovative about innovation processes. It is about innovation by process rather than by design. It is about putting in place innovation attractors and creating conditions for change (See more along these lines in relation to transition policies in Alkemade & Faber, 2010). Hall and Clark (2010) argue that innovation performance is found most of all in a process which is fit for the purpose of mobilising different pieces of information for dealing with changing challenges and opportunities. Innovation capacity in relation to this is found in multiple actors and interlinkages, which are often not formally organised. They also argue that much of significant innovations emerges in informal settings 'under the radar' of public policy and formal research organisations.

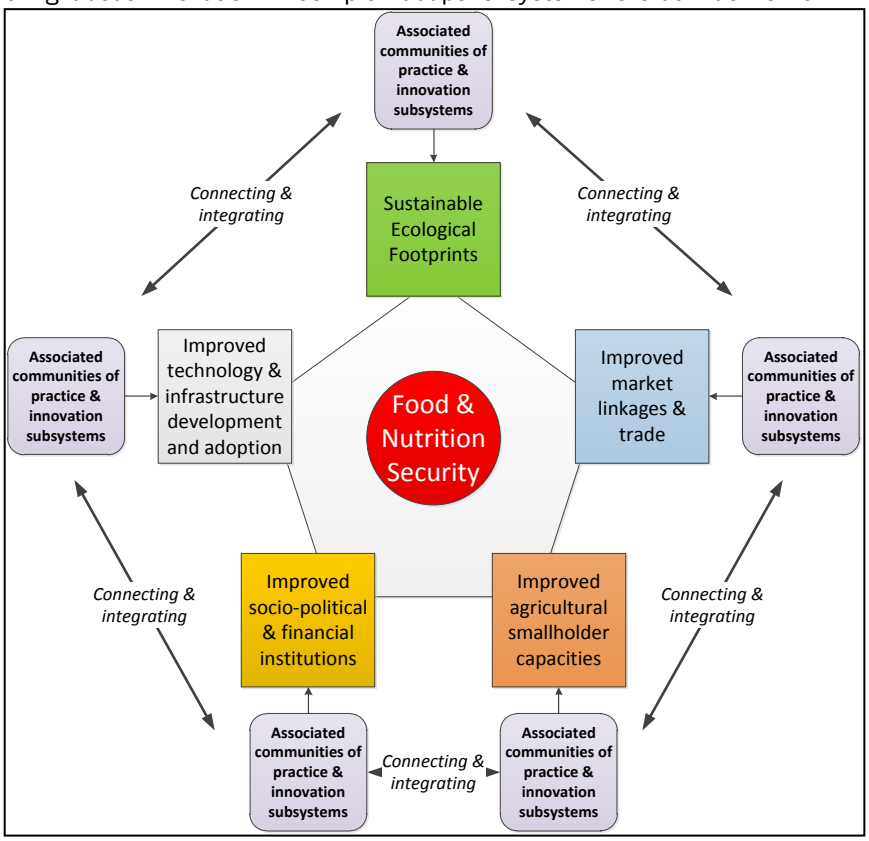


Figure 35: From integrative perspectives on improving food & nutrition security to connecting and integrating associated (sometimes isolated) communities of practice and innovation subsystems

To support this kind of approach to innovation, we need to focus more on innovation process facilitation. This relates to more strategically position various roles of innovation facilitators, intermediaries, brokers, catalysers, etc. to enhance innovation performance vis-à-vis an integrative goal of economic viability, environmental integrity and social equity & appropriateness.

4.3.2 Positioning the role of knowledge institutes in the wider innovation 'role play'

In exploring the future role that knowledge institutes need to play in innovation systems responsive to food security, there are a number of perspectives to consider. First of all we want to reiterate that different actors will have their own specific role to play as innovation systems contribute towards meeting challenges posed to food systems. Knowledge institutes are for a large part not autonomous in playing their role, but are for an equally large part dependent on how other actors play their role. We may call this a team approach to innovation systems. The success of the "gouden driehoek"[43] in Dutch agri-food systems has everything to do with interactive roles and not with a mere juxtaposition of roles. As challenges to national, regional and global food systems are expected to increase, one of the clues for being able to meet those challenges will be in finding ways to foster such interactive roles.

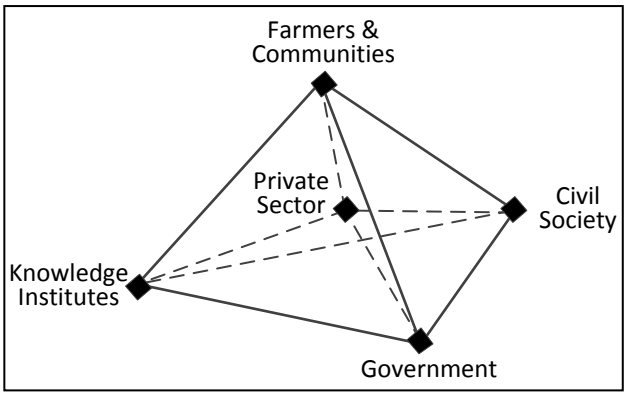


Figure 36: 'Dream team' or 'golden pyramid' of innovation partnership for food & nutrition in Africa

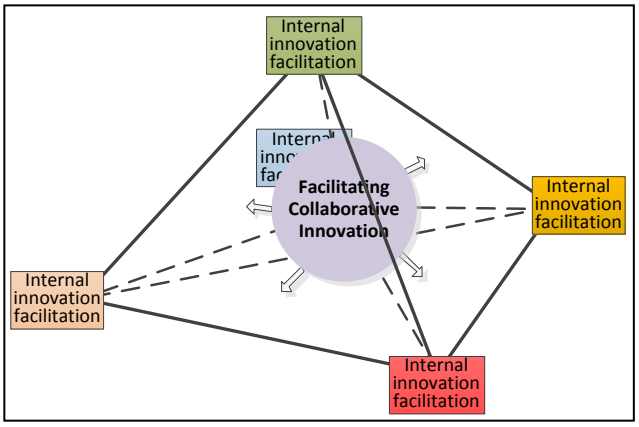


Figure 37: Facilitating innovation processes at actor level and as collaborative process

This takes us to the question of who is supposed to make concerted efforts happen in both agriculture & food systems and the associated innovation systems so that enhanced food & nutrition security for all will be an outcome? Who will facilitate (= make easier) that each actor performs its role up to its potential in the required interactive processes?

Just as the different actors in these system have a specific role to play, each of those actors will be able to play a specific role in the facilitation of collaborative innovation processes. This relates to creating an enabling context for innovation. Facilitation will need to come in many different shapes and forms. It includes roles of leadership, governance, financing, brokering, networking, informing, and more. Those different facilitation roles will fit differently to different actors. A governance role may (not exclusively) fit a government actor. A financing role will not fit very well with knowledge institutes (☺). Depending on the innovation process and the stage it is at, the required facilitation role for collaborative innovation will be different. Hence, the appropriate actor to play this facilitation role will be different. In many cases, it will be a shared (and interactive) role though.

In the following we will zoom in on the potential role of knowledge institutes from two angles:

- Their contribution in relation to the innovation content, which is about knowledge institutes providing input for innovation through science & technology.
- Their contribution in relation to the innovation process, which is about knowledge institutes providing facilitation support to collaborative innovation processes.

[43] Specific Dutch version of the triple helix model.

The first angle is a widely recognised role of knowledge institutes. Most if not all of the future-oriented studies on food systems and food security include this as one of the anticipated success factors. The second angle is what we want to draw particular attention to as we consider this to be a less recognised and underestimated role. We argue that there is a good potential there to enhance innovation for food & nutrition security for all. Even more, we think it can also unlock more of the potential of that first angle on the role of knowledge institutes. Improved facilitation of internal innovation processes (within knowledge institutes as well as better connected knowledge institutes to other actors in the innovation system responsive to food & nutrition security, will unleash more of their potential.

Having said this, we want to emphasise that knowledge institutes are definitely not the only ones who can play a crucial role in facilitating collaborative innovation. As we zoom in on the role of knowledge institutes in the following, it needs to be understood against this backdrop.

The case studies we discussed earlier are taken as small-scale examples of applying principles for knowledge institutes in playing more of an effective role in innovation for food security. We realise the limitations of the cases. The extrapolation we are making is therefore first of all an exploration that will hopefully acquire more substantial evidence in the nearby future. At this point, we are taking the cases as indicators of what could be applied at bigger scales and higher levels as well.

The innovation content support role: science & technology

In the field of 'science and technology', knowledge institutes are not expected to play a very different role than they are already playing. The demand will merely be for more knowledge, new innovations and smarter technologies. What knowledge, innovations and technologies need to respond to, may be different from the past. How this will be financed may also be different. But the essential mode of operation will be the same: generating appropriate knowledge and technologies. The 'appropriate' part very much relates to the institutional context. Röling (2011) argues that "Institutions cannot be imported and adopted as if they were technologies. They are always embedded in historical context and change as a result of endemic processes that can at best be facilitated". Whatever potential agriculture holds for securing food & nutrition for all institutional change will be needed to realise this potential. Such changes relate to changing the 'rules of the game', which involves system innovation. For this to take place, patterns of interaction between actors need to change, which will need to involve multi-stakeholder engagement. The points to the importance of innovation facilitation which we will discuss more in the next section as such engagement needs to be facilitated/brokered (Klerkx et al, 2009).

In order to engage science & technology more effectively in innovation for food & nutrition security more truly interdisciplinary and even transdisciplinary research and innovation will be needed (Röling, 2011; European Commission, 2011; Ingram, 2011). If these calls would be taken seriously, this would require a reorientation in the organisation of research and education.

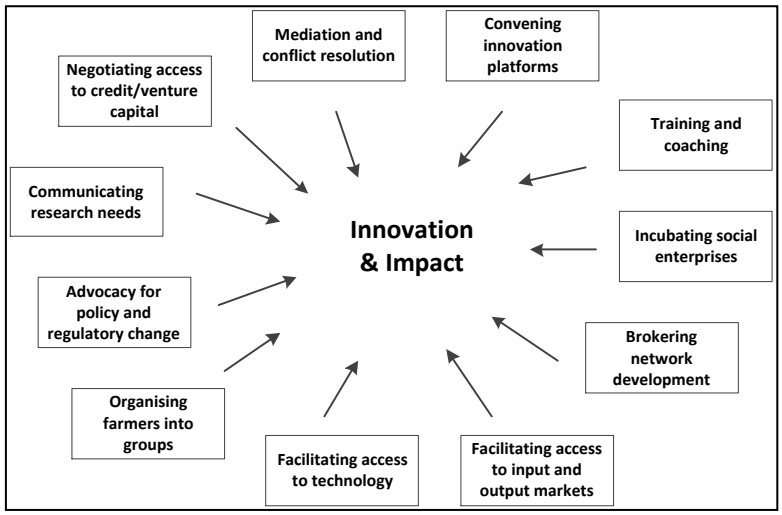
Collaborative efforts, including co-innovation processes, are gaining more attention. And it is in these kind of efforts that we see a scope for an effective role of knowledge institutes. When browsing through various studies on the future of food and agriculture, whether in Europe, or Africa, or globally, it is clear that more of a concerted effort across different levels will be needed to deal with issues that are expected to increasingly weigh down food systems. This may play at a very localised level just the same as at global level. Multi-stakeholder processes will need to feature high in this. Alternative futures will need to be explored and debated. To go short: there will be a need for a lot of *informed* facilitation of interactive processes between all players up and down the food chain, while at the same time those players/stakeholders will need to be kept well-informed from multiple perspectives to be able to find common ground and shared strategies.

The innovation process support role

In an important reconsideration of the role of research, the World Bank concluded that there is a need to move from research systems to innovation systems, broadening the scope of what to consider and who to involve in agricultural innovation processes (The World Bank, 2007). They conclude that:

1. Research is an important component - but not always a central component - of innovation
2. Competitiveness depends on collaboration for innovation
3. Social and environmental sustainability are integral to economic success and need to be reflected in interventions
4. The market is not sufficient to promote interaction; public sector has a central role to play
5. Interventions are essential for building the capacity and fostering the learning that enable a sector to respond to continuous competitive challenges
6. The organization of rural stakeholders is a central development concept. It is a common theme in innovation systems and in numerous agricultural and rural development efforts.
7. Actors that are critical for coordinating innovation systems at the sector level are either overlooked or missing
8. A wide set of attitudes and practices must be cultivated to foster a culture of innovation
9. The enabling environment is an important component of innovation capacity
10. The ability to agree on the innovation challenges of a sector is much greater when effective (…) coordination is in place.

Figure 38: Highlighting the range of roles needed in successful innovation processes (adapted from Sulaiman et al., 2010)



This call for innovation coordination relates to issues around innovation governance for overcoming a lack of horizontal coordination (departmentalization) and institutional fragmentation, as discussed by Edler, Kuhlmann and Smits (2003). They also relate to more informal processes of innovation facilitation such as the reflected in studies on knowledge/innovation brokers. These studies suggest that innovation systems depend on intermediary organisations to facilitate interaction or access to technology and information, and also depend on coordinating bodies to help integrate the activity of different actors in a sector (e.g. Leeuwis, 2010, Kilelu et al., 2011). Klerkx & Leeuwis (2009) have discussed the concept of "innovation intermediation" (which includes the concept of innovation brokers), which seems to relate closely to the ideas on facilitating collaborative innovation that we have discussed before. They argue from Dutch cases that government is in a good position for making it possible for innovation brokers to operate. In relation to such innovation brokers, they indicate that it is difficult to assess the impact of their work, that it is difficult to establish their mandate (as it is more of an informal role) and that there is the danger of losing independence due to resource dependency. The first two concerns can be seen to relate to the informality of their role, which is a key strength (no bureaucracies involved), but also a vulnerability in terms of this role getting acknowledged as essential. Governments should consider more carefully whether they should perhaps provide innovation support by supporting such roles of innovation intermediaries more actively. Figure 39 provides an overview of the broad array of important intermediary roles, which include:

- brokering between people (stakeholders, chain parties, disciplines, donors),
- bridge gaps and divides between groups/sectors/culture,
- knowledge brokering (e.g. demand and supply articulation),
- mediation,
- facilitation of learning & visioning,
- help platforms to perform and be adaptive, and
- advocacy

(Kilelu et al., 2011; Klerkx, 2010). A larger print version of the picture can be found in annex 5.

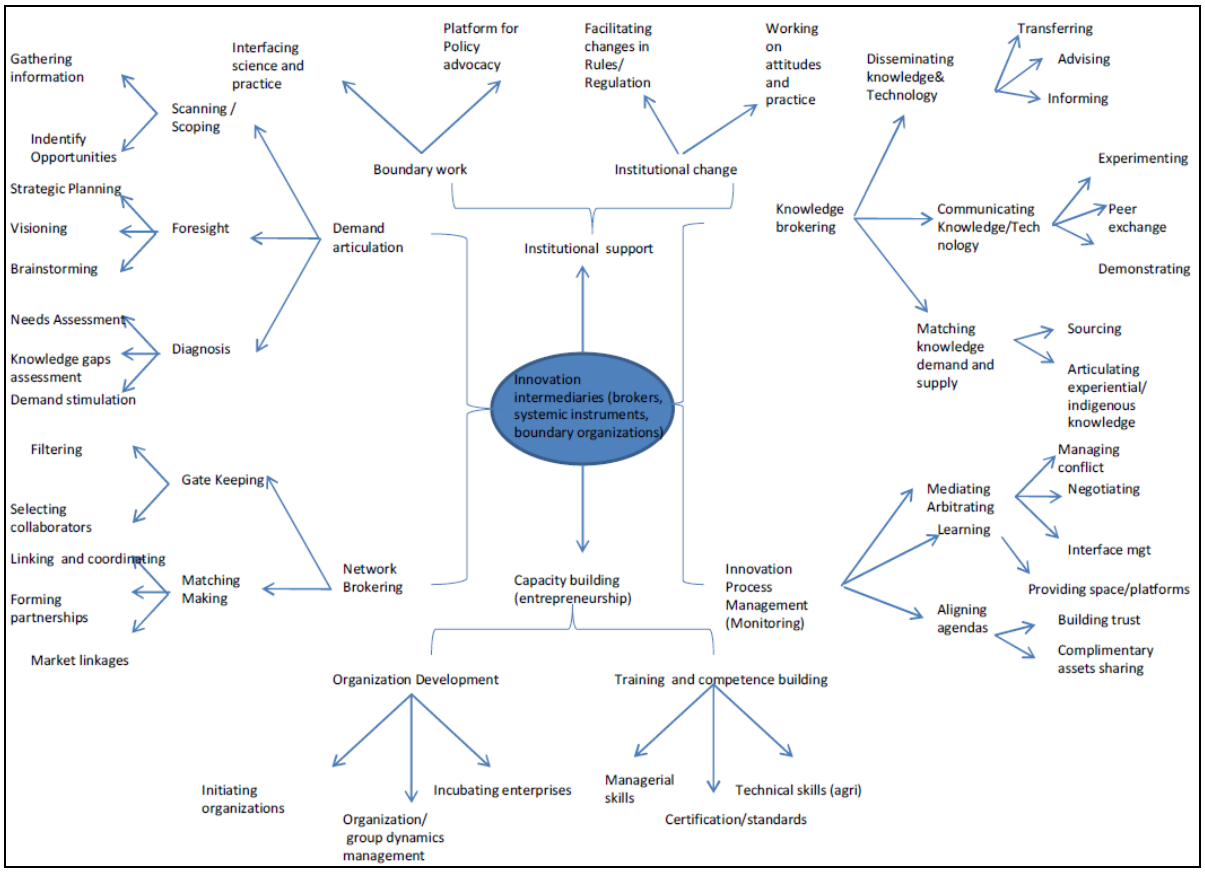


Figure 39: Roles of innovation intermediaries Source: Kilelu et al., 2011

Interactively playing the role of innovation intermediary together with innovation entrepreneurs requires learning to work with other actors along the lines of "bridging professionals" as discussed by the STEPS Centre (2010).

5 Conclusions and recommendations

Food and nutrition security imperatives deserve all our attention. The task ahead is urgent. According to the Africa Review Report on Drought and Desertification Africa may be able to feed just 25% of its population by 2025 if soil degradation on the continent continues at its current pace, according to a water expert presenting at an upcoming United Nations University (UNU) conference on desertification in Algiers, Algeria. Karl Harmsen, Director of UNU's Ghana-based Institute for Natural Resources in Africa, says that should soil conditions continue to decline in Africa, nearly 75% of the continent could come to rely on some sort of food aid by 2025 (UN Economic Commission for Africa, 2008).

At the same time, we need to act strategically in the face of the complexities involved in broadening the basis for food & nutrition security. Such complexities only increase when we move our eyes from the Dutch 'gouden driehoek' to African conditions. A perspective of innovation systems responsive to food and nutrition security is helpful in identifying interactive roles to be played in improving food system performance. A range of actors need to not just play their respective roles, but play their roles in interaction with and tuned to how other actors play their role. It is not the sum of different roles that is needed, but the synergy of roles. This role-play needs to be appropriately 'orchestrated', which relates to the need for both appropriate innovation governance (more formal and sometimes regulatory) and innovation intermediation (more informal and usually advisory).

The role that knowledge institutes can play partly depends on how other actors play their role and the extent to which other actors maintain opportunities for knowledge institutes to contribute up to their potential. As they are often dependent on funding by some of those other actors, this is a sensitive situation, which, if not carefully governed, may jeopardise the unique (relatively objective) role that knowledge institutes can play. That would not be just bad news for knowledge institutes, but for the whole of food system governance and its resulting effectiveness.

Knowledge institutes usually focus on their role of providing education and research services. However, in complex innovation processes, such as related to global food & nutrition security, they need to be more flexible. Due to their comparative objectivity, these institutes are often in a unique position to play other roles as well, such as facilitating public-private partnership platforms, connecting essential players to innovation processes, and linking actors across policy levels. The nature of their work provides them with a view on the 'bigger picture' of A&F system dynamics. Where knowledge institutes are able to play these flexible roles in innovation processes, this can help in catalysing, facilitating and supporting collaborative innovation. The 'flexible' in this context means appropriate in context and also

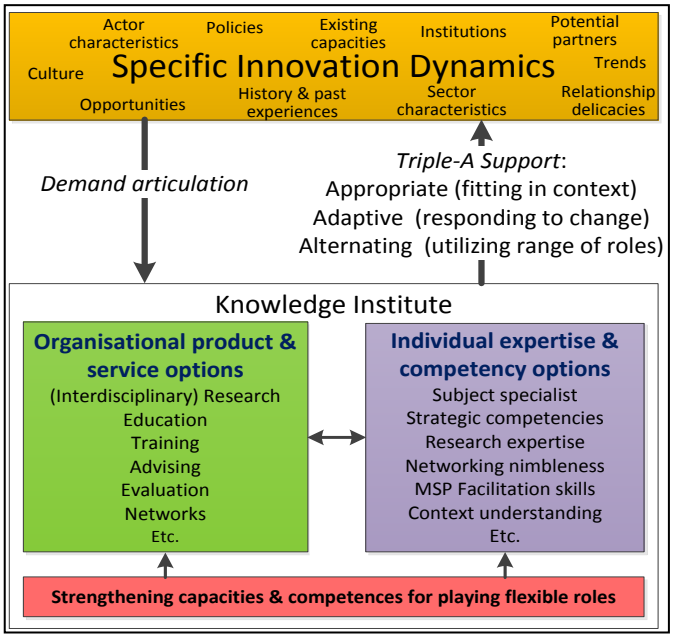


Figure 40: Strategic and flexible positioning of knowledge institutes to play effective roles in public-private partnership processes.

adaptive in response to change throughout the process and alternating options as fits the particular situation. Such practice has been illustrated through five cases from which we have shared some highlights only (Boxes 6-10). As short as the examples are, they are pointers to a practice of the flexible roles of knowledge institutes in support of public-private partnership for food security & nutrition, which we would like to see grow to fruition in Africa.

Knowledge institutes have an important role to play in public-private partnership for food security in Africa but as yet, their potential has not been fully realised. The institutes need to look beyond traditional roles and explore alternative roles more seriously. However, this is not an issue of just starting to play such roles. It will require strategic efforts to strengthen organisational capacities and individual competences for engaging effectively in innovation processes. Where there is a need for fundamental research they should be ready to identify this and deliver the required research in an accessible form to the other partners. However they also need to be able to quickly shift gears and to be able to facilitate public-private partnership platforms or link knowledge and information across decision-making and policy levels. Such ambitions need to inform curriculum development and competency-based training as well, thereby broadening the range of opportunities for knowledge institutes to play effective roles vis-à-vis societal concerns. As roles are interconnected, they will be partly dependent on other actors (e.g. government and private sector) to support them in playing such roles.

Examples of flexible roles to play by knowledge institutes going beyond research and technology development:

- Strengthening innovation processes by facilitating
  - Multi-actor collaboration
  - Bigger-picture overview creation
  - Strategic foresight capacity
  - Cross-'cultural' communication (where cultural can also stand for disciplinary or organisational).
- Connecting (potential) innovation partners (networking)
- Facilitating and coaching collaboration and meeting processes
- Catalysing innovation connections
- Action research

In this report we have zoomed in on potential other roles for knowledge institutes than the roles traditionally associated with universities and research organisations. This is not to say that 'traditional' roles labelled as 'science & technology' in this paper are less important; on the contrary. However, being able to adopt more flexible roles in innovation processes will enhance what knowledge institutes can contribute through such playing such 'traditional' roles, but also enhance what other key players (including private sector actors) can contribute.

Recommendation related to an effective role of knowledge institutes in innovation systems responsive to food & nutrition security

1. Policy making in relation to food & nutrition security needs to be informed by enough of an idea of the bigger picture of food systems to prevent lopsided strategies and a search for 'silver bullets'. This is an important part of playing an effective role in food system governance. Such bigger picture needs to be kept alive and knowledge institutes can play a key role in supporting policy makers in this.
2. Food & nutrition security status and stability are an outcome of how food systems are functioning. The food system is therefore a more effective policy reference framework than 'food & nutrition security' as it provides more clues on what is involved in making food & nutrition secure for all.
3. Policy making in relation to food systems needs to optimise trade-offs between economic viability, social equity/propriety, and environmental integrity. Leaving any one of these out of the equation puts the sustainability of the system at jeopardy.

4. Similarly, knowledge institutes also influence the extent to which other actors can play their role up to their potential. The often quoted 'ivory tower' syndrome is equally undermining for food system effectiveness.
5. A well-recognized role for knowledge institutes lies in the field of science (research) & technology contributions. Given the complex dynamics of food systems, science (research) & technology needs to enhance truly interdisciplinary efforts (within the science community) as well as genuine integrated efforts (with other actors, most notably the private sector).
6. An underexposed role that knowledge institutes can play in innovation systems responsive to food & nutrition security, relates to the role of innovation intermediation/brokering. It is a crucial role to be played in food system innovation over the years to come as challenges to the system are expected to increase. Policy makers should make more use of the opportunity of using knowledge institutes to play such role.
7. Knowledge institutes should more pro-actively strengthen competencies of their staff to perform such role of innovation intermediation/brokering effectively and appropriately. Such competences cannot and should not be assumed to be in place given the nature of current academic education curricula.
8. Within knowledge institutes more attention should be paid to the different roles that their staff can play in innovation systems responsive to food & nutrition security. Fundamental science, technology development and innovation intermediation (to mention just a few fields of work), relate to very different kinds of roles to be played. Actively mapping competencies and roles to play and creating synergy between those competencies and roles, will enhance the value of the contribution of knowledge institute as a whole (vis-à-vis addressing food system challenges). This includes making more internal use of innovation intermediaries within knowledge institutes to support interdisciplinary and integrated efforts (interdisciplinary relates to work within the knowledge institute and integrate relates to work that knowledge institutes do with private sector and other actors.

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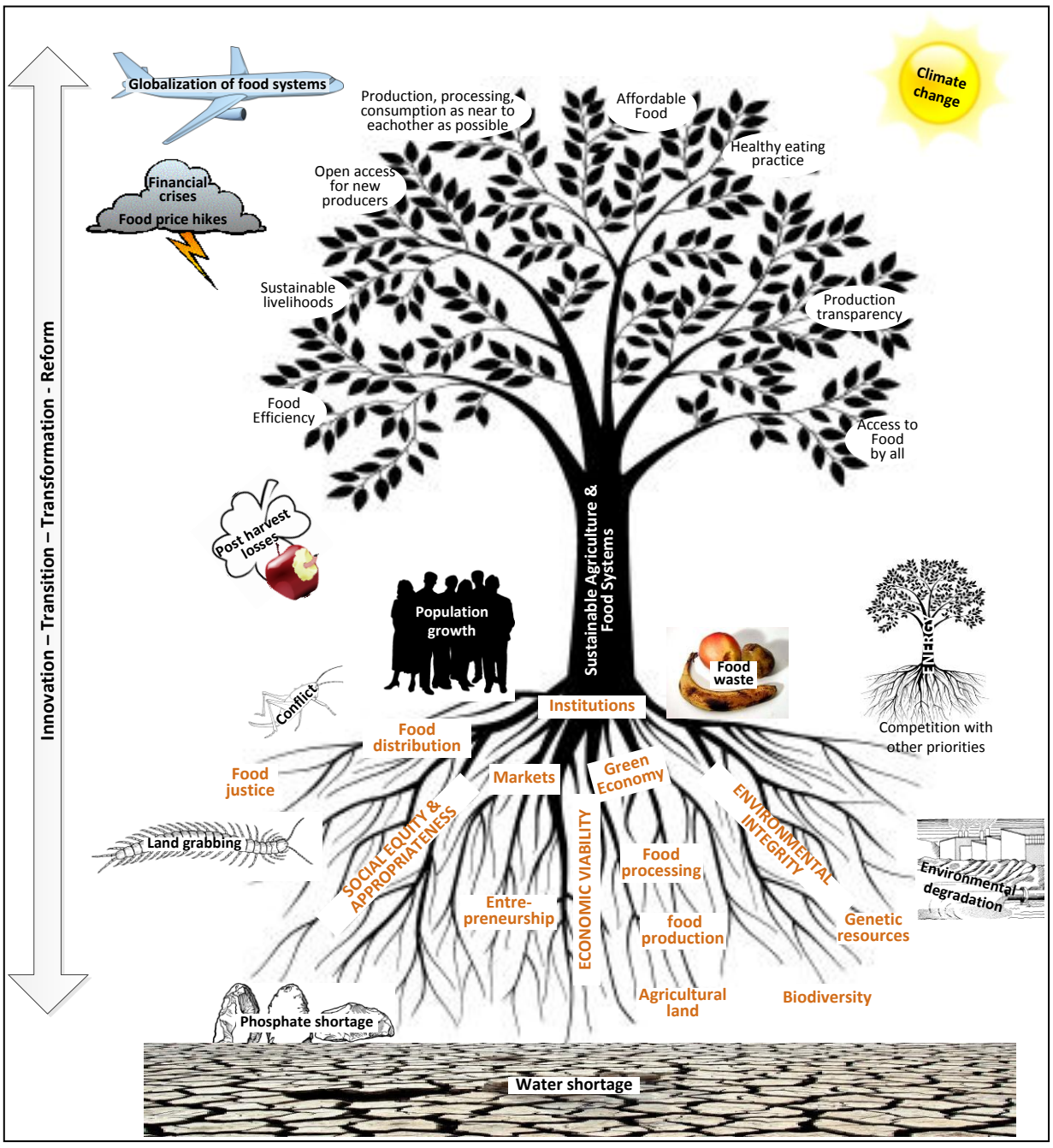
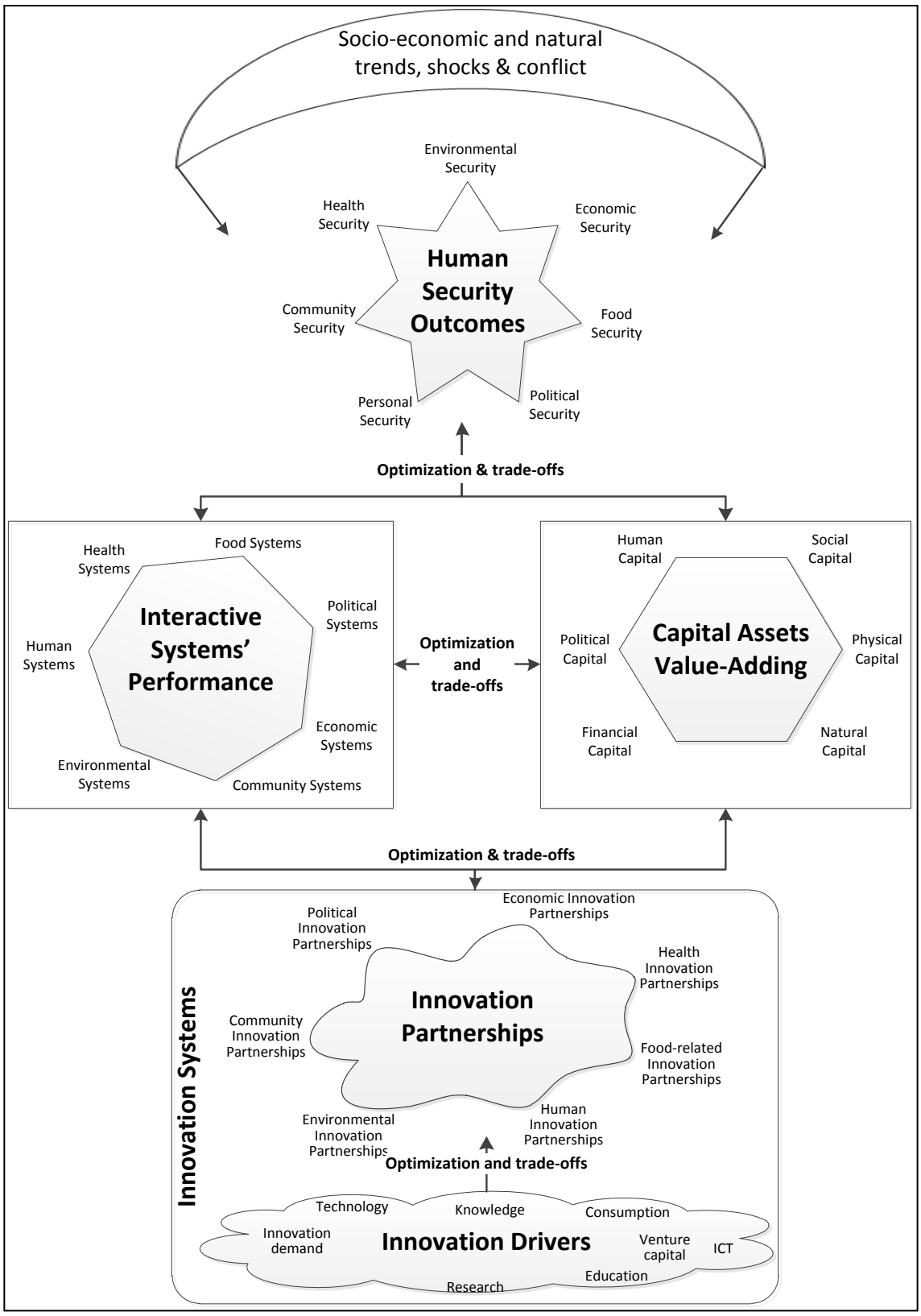
Annex 1: Roots & fruits of sustainable agriculture & food systems

(and conditions affecting them)



Annex 2: Food & nutrition security in the context of other human securities



Annex 2: Food & nutrition security in the context of other securities

Annex 3: Future-oriented studies, initiatives and action plans

Over the past few years and as we are writing, future-oriented studies have been and are being conducted in large numbers. This probably has to do with the fact that there are so many factors and dynamics involved in food & nutrition security, many of which we have no clear idea of how they will play out and especially how they will interplay. Let us have a look at a number of those analyses and policy recommendations:

European Commission (2011). Sustainable food consumption and production in a resource-constrained world. EU, Brussels. This study focuses on updating critical driving forces and on the transition towards a sustainable agri-food sector, acknowledging constraints in resources. They conclude that there are three 'transition pathways' to work on: consumption-driven transitions, technology-driven transitions and organisational-innovation driven transitions. The report lacks a clear focus and essentially sums up a range of issues to address and options to consider, including in the field of a required policy environment. This can be understood from the perspective that this study is meant to provide options for preparing to deal with those resource constraints and environmental limits, with particular attention for guidance on agricultural research in the EU. This will be part of what feeds in to a 'European strategy and action plan for a sustainable bio-based economy by 2020', to be adopted in November 2011.

Another notable study is done by Agrimonde (Paillard, Treyer and Dorin, 2011). It is a book summarizing the report on the **Agrimonde foresight study** initiated by CIRAD and INRA on global agriculture and food between now and 2050. It states that the 21st century faces a triple challenge in terms of agriculture and food: food security, environmental conservation, and a shortage of fossil fuels. With this in mind, INRA and CIRAD launched the initiative, in 2006, to develop a foresight project for analysing issues pertaining to the world's food and agricultural systems on the 2050 timeline. The resulting book provides a synthetic presentation of the main conclusions that this foresight project has yielded. First, it recapitulates the main statistical references for the period 1961 to 2003, before going on to describe the Agribiom simulation tool used to calculate food biomass resource use balances. Two scenarios on the 2050 timeline are then considered: Agrimonde GO is a trend-based scenario that bets on economic growth to feed the world, in a context where environmental protection is not a priority; in contrast, the idea in Agrimonde 1 is to feed the world while preserving its ecosystems. Whilst the trend-based scenario, Agrimonde GO, allows it to happen at the cost of environmental degradation, the change-based scenario, Agrimonde 1, shows that it can be achieved in a sustainable way, if three main conditions are fulfilled:

1.The current food model of industrialized countries must not be generalized. For example, excessive food consumption should be reduced, as should losses and waste that occur at the distribution stage, and at the time of final consumption (estimated at around 25% in the OECD zone).

2.Productive and ecological agriculture becomes the chosen priority. This notably refers to the development of a more productive agriculture, which is simultaneously more economical in fossil energies, and more respectful of the environment. This type of agriculture makes the best of agricultural processes. It stimulates and exploits synergies between plant and animal species. It benefits from scientific progress, whilst exploiting existing knowledge and traditional methods.

3.International exchanges of agricultural and food products need to be more secure. The necessary and foreseeable growth of agricultural exchanges coming from OECD countries, the ex-Soviet block and Latin America and going towards Africa, Asia and the Middle-East needs to be stabilized and regulated.

The World Economic Forum (World Economic Forum (2011) has done a more comprehensive and integrated analysis of anticipated trends and developments. They positioned trends, developments and risks on a map in relation to perceived likelihood for it to occur in the next ten years and the perceived impact in billion US$. Among the very likely and big impact scenarios are climate change, fiscal crisis and economic disparity. Food security does not rank among the top risk scenarios in this analysis though the highest risks appear to have indirect effect on food security, which may mean that food security risks may only rise later in time.

In another part of their analysis they point out this interactive risks associated with the water-food-energy nexus. Food security, water security and energy security all respond to the same drivers of insecurity (most notably population & economic growth, and environmental pressure). This exacerbates the effects. In view or risks of global governance failures and economic disparity, this may create an explosive combination, increasing the risk of geopolitical conflict.

The report therefore calls for tough trade-offs to be made between energy, food and water in terms of resource allocation and planning. They realise that the key challenge is to incorporate the complex interactions between energy-, food- and water-related risks into response strategies that are integrated and take into account the many relevant stakeholders. The need for multi-stakeholder resource planning will need to be facilitated appropriately.

The deep-digging foresight study on **the future of food and farming** (Foresight, 2011) comprehensively assesses important drivers of change affecting the food system. The trends regarding these drivers are then translated into a set of challenges and options for addressing those are discussed.

They argue that we live in a unique time in history: For the first time there is a high likelihood that growth in global population will cease (towards the middle of the century or shortly after that), human activities have become a dominant driver of the Earth system, and there is a developing global consensus along the lines of the Millennium Development Goals that it is everyone's duty to try to end poverty and hunger around the world.

They conclude that ***interacting*** drivers of change will converge in the food system over the next 40 years. In order to manage future risks, careful assessment of the implications of these drivers will be essential. They consider six drivers of change to be the most important ones:

1. global population increase,
2. change in size and nature of per capita demand of food (more and other (e.g. meat) food will be asked for),
3. future governance of the food system, both at national and international levels,
4. climate change,
5. competition for key resources,
6. changes in values and ethical stances of consumers.

This, in their assessment, boils down to five key challenges to face over the next few decades:

1. Balancing future demand and supply sustainably
2. Addressing the threat of future volatility in the food system
3. Ending hunger
4. Meeting the challenges of a low emissions world
5. Maintaining biodiversity and ecosystem services while feeding the world.

They go on to suggest twelve key priorities for action for policy makers:

1. Spread best practice.
2. Invest in new knowledge.

3. Make sustainable food production central in development.
4. Work on the assumption that there is little new land for agriculture.
5. Ensure long-term sustainability of fish stocks.
6. Promote sustainable intensification.
7. Include the environment in food system economics.
8. Reduce waste – both in high- and low-income countries.
9. Improve the evidence base upon which decisions are made and develop metrics to assess progress.
10. Anticipate major issues with water availability for food production.
11. Work to change consumption patterns.
12. Empower citizens.

Reading the report will be a good investment of time for policy makers interested in the future of food and farming. They also constructed a number of alternative scenarios (The UK Government Foresight Project, 2011).

The **International Food Policy Research Institute** (IFPRI) is an organisation at the forefront of discussions and information sharing on food & nutrition security. Their study on scenarios and policy options in relation to **food security, farming and climate change to 2050** (Nelson et al.,2010) is taking less of an integrative perspective than some of the other studies referred to in this chapter in the sense that they focus on climate change effects on farming and food security. They conclude that a combined biophysical-socioeconomic modelling on food security and climate change is still in its infancy. Which means that any kind of scenario analysis and prospect studies will be limited as regards their reliability due to uncertainties and sheer unknowns. They therefore ask to treat tentative findings with caution, which probably should be applied to other future-oriented studies in this field as well. Putting many studies together will help to get a "higher resolution" picture. That is precisely what we are trying to assert to in this chapter. They nevertheless come up with a number of main messages:

> "Our analysis suggests that up to 2050, the challenges from climate change are "manageable" (…), but the challenges of dealing with the effects between 2050 and 2080 are likely to be much greater (…)" Nelson et al., 2010.

- Broad-based economic development is central to improvements in human well-being, including sustainable food security and resilience to climate change.
- Climate change offsets some of the benefits of income growth.
- International trade plays an essential role in compensating for various climate change effects.
- Properly targeted agricultural productivity investments can mitigate the impacts of climate change and enhance sustainable food security

Another IFPRI initiative is the formulation of 7 action points for preventing recurring food crises[44]:

1. Curtailing subsidies and reforming policies, particularly in the United States and Europe, to minimize biofuels' contribution to volatility in food markets.
2. Creating or strengthening social protection for women, young children, and other especially vulnerable groups—something few countries have done during or since the 2007-08 crisis.
3. Improving the transparency, fairness, and openness of international trade to enhance the efficiency of global agricultural markets.
4. Setting up a global emergency grain reserve to handle food price crises.

[44] http://www.ifpri.org/sites/default/files/publications/7actionpoints.pdf

5. Pursuing policies and investments to promote agricultural growth, in particular smallholder productivity, in the face of climate change.
6. Investment by national governments in climate change adaptation and mitigation using the full potential that agriculture offers.
7. Establishing an international working group to monitor the world food situation and trigger action to prevent excessive price volatility.

The **FoodWeb 2020** on Forces Shaping the Future of Food (Avery, Kreit and Falcon, 2010) basically takes on a food chain perspective. As they approach food systems from quite a different angle than many of the earlier mentioned initiatives, they come up with a different analysis of what is going to make a difference in food systems. The eight forces that they highlight are:

1. New taste imperatives
2. Growing food (safety) fears
3. New attention to health impacts
4. Upsurge of food rights activism
5. Increasing cost (price) volatility
6. Cascading environmental emergencies
7. Growing demand for sustainability metrics
8. Expanding push toward carbon neutrality

These forces, or disruptions as they call it, lead them to forecast five key shifts in direction in food systems:

- Competing transparencies – from blind trust to value-based choice
- Diverse growth – from global standardization to local differentiation
- Decentralised access – from fragile dependence to urban autonomy
- Resilient life cycles – from efficiency to flexibility
- Collaborative capacity – from development economics to open sustainability

As part of their suggestions on how to "weather the storm", they define eight "resilience principles" that should guide how to deal with changing imperatives for sustainable food systems: **Flexibility** (be ready for a change of plan), **diversity** (do not rely on a single kind of solution), **decentralization** (centralised systems, if they fail, they fail catastrophically), **redundancy** (secure backup/reserves), **collaboration** (in technology, communication and information), **transparency** (to speed up finding where a problem may lie**), foresight** (you can't predict, but can be more prepared) and **graceful failure** (be ready to deal with (system) failure).

Obviously, **FAO** is very much engaged in looking at the future of food and farming. However, the report on **World agriculture: towards 2030/2050** (FAO, 2006) and the High-Level Expert Forum on **How to Feed the World in 2050** (FAO, 2009) provide limited substance regarding how to deal with anticipated challenges. In that respect, the conference on "Climate-Smart" Agriculture (2010), although limited to the future of agriculture in view of climate change, provides more clues as to how to address future challenges:

- Agriculture in developing countries must undergo a significant transformation in order to meet
- the related challenges of food security and climate change.
- Effective climate-smart practices already exist and could be implemented in developing country agricultural systems.
- Adopting an ecosystem approach, working at landscape scale and ensuring intersectoral
- coordination and cooperation is crucial for effective climate change responses.
- Considerable investment is required in filling data and knowledge gaps and in research and
- development of technologies, methodologies, as well as the conservation and production of suitable varieties and breeds.

- Institutional and financial support will be required to enable smallholders to make the transition to climate-smart agriculture.
- Strengthened institutional capacity will be needed to improve dissemination of climate-smart
- information and coordinate over large areas and numbers of farmers.
- Greater consistency between agriculture, food security and climate change policy-making must be achieved at national, regional and international levels.
- Available financing, current and projected, are substantially insufficient to meet climate change and food security challenges faced by the agriculture sector.
- Synergistically combining financing from public and private sources, as well as those earmarked for climate change and food security are innovative options to meet the investment requirements of the agricultural sector.
- To be effective in channelling fast-track financing to agriculture, financing mechanisms will need to take sector-specific considerations into account.
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The **UNEP/GRID-Arendal** future-oriented study (Nelleman, Christian et al. (eds), 2009) on the interplay between environmental security and food security is significant. They point at the trend of levelling yield increases in parts of the world and even yield declines as regards fisheries and crops in drought-prone areas. They question whether needed yield increases to feed the extra 2.7 billion people as we move to 2050, will be feasible at all. They emphasise that part of the increased yields came at the cost of environmental degradation. They continue to drive the point home that the natural environment comprises the entire basis for food production through water, nutrients, soils, climate, weather and insects. Furthermore, the argue that a reduction of availability of cropland required to secure food availability due to conversion to non-food production, will further exacerbate the problems. If that was not enough, they point at the risk of large portions of Himalayan glaciers melting due to climate change, disturbing monsoon patterns, resulting in increased floods and seasonal drought on irrigated cropland in Asia.
The analysis of what we may need to face in increasing measure as we move to 2050 results in seven options for improving food security, distinguishing between options with short-term, mid-term and long-term effects:
Options for the short term:

- To decrease the risk of highly volatile prices, price regulation on commodities and larger cereal stocks should be created to buffer the tight markets of food commodities and the subsequent risks of speculation in markets.
- Encourage the removal of subsidies and blending ratios of first generation biofuels, which would promote a shift to higher generation biofuels based on waste (if this does not compete with animal feed), thereby avoiding the capture of cropland by biofuels.

Options for the middle term:

- Reduce the use of cereals and food fish in animal feed and develop alternatives to animal and fish feeds.
- Support farmers in developing diversified and resilient eco-agriculture systems that provide critical ecosystem services (water supply and regulation, habitat for wild plants and animals, genetic diversity, pollination, pest control, climate regulation), as well as adequate food to meet local and consumer needs.
- Increase trade and improved market access can be achieved by improving infrastructure and reducing trade barriers, which does not imply a completely free market approach as price regulation and government subsidies are crucial safety nets and investments in production.

Options for the long term:

- Limit global warming, including the promotion of climate-friendly agricultural production systems and land-use policies at a scale to help mitigate climate change.
- Raise awareness of the pressures of increasing population growth and consumption patterns on sustainable ecosystem functioning.

The related website[45] is an excellent source of information on environmental information for policy makers. They have an accessible data base of *2124* graphics[46], which is extremely useful in really getting **the picture** of environmental shifts and implications for such policy area as food systems and related food security concerns.

UNDG's thematic paper on MDG 1 (UNDG, 2010) is focusing on hunger and poverty. This leads to a different angle on food security, where the focus is on fighting hunger, which has to include emergency response. The paper identifies a number of critical gaps in nutrition-based interventions:

- Lack of priority. Of 60 PRSPs reviewed, few included nutrition as part of strategic and budgetary priorities.
- Lack of resources.
- Unclear ownership and accountability as food security, hunger and these type of goals relate to the work of a range of departments. They include women's unequal access to land and property rights as a gap to address in relation to ownership, having severe economic consequences in relation to achieving MDGs.
- Inadequate capacities and undeveloped systems.
- Inadequate scales of achieved successes (remains too much of small-scale successes that cannot be scaled up).
- Insufficient information, monitoring and evaluation for strategic guidance.

Based on these identified gaps, they have a list of priority actions they recommend. These recommendations include:

1. Raise food and nutrition higher up on the political agenda.
2. Focus on hunger hotspots and vulnerable populations.
3. Unify national strategic frameworks for food security. One national plan, one budget, one legal, policy and institutional framework and one reporting mechanism should be in place for a harmonized, streamlined effort to enhance food security.
4. Strengthen social protection, including food and nutrition safety nets
5. Invest in smallholder agriculture

Another interesting source of ideas on drivers of change regarding the future of food is the set of cards developed by Arup Foresight[47]. The subject that are briefly outlined include Affluent taste, satellite sensing, power players, soil depletion, crop diversion, farmers, hunger, convenience, leftovers, hydroponics, engineered seeds, fertiliser, fishing, diversity, livestock, water, cheap calories, supply chain, fast-food outlets, supermarkets, self-sufficiency, safety, labelling, and agri-investment.

The **UN High Level Task Force on Global Food Security** (2011) developed a comprehensive framework for action, which highlights four key issues for action:

- Smallholders, particularly women, need to be at the centre of actions.
- There needs to be an increased focus on resilience of household livelihoods.
- As for making improvements, not only more, but also and better investments need to be made.
- A key conditions for global food security is formed by open and well-functioning markets and trade.

[45] http://www.grida.no/

[46] http://maps.grida.no/

[47] http://www.driversofchange.com/food/

The processes and mechanisms by which these actions are meant to be guided would need to include the following principles:

- Multi-stakeholder and multi-sectoral partnerships.
- Sustained political commitment and good governance
- Country leadership with regional support.
- Accountability for results.

Strategic initiatives that respond to current and anticipated challenges

The following is an overview of international responses to the challenge to sustainably provide nutritious food to 9 billion people in 2050. This is where forward thinking gets translated into concrete action (though some initiatives are less informed by futures thinking than others).

- Feed the future (http://www.feedthefuture.gov/) USAID. Initiative launched by president Obama in 2009, endorsed by the G8, the G20 and the entire membership of the FAO. The US government has committed to invest $3.5 billion of three years in this initiative. Other members of the G20 have committed an additional $18.5 billion.
- Studies in Global Food and Farming Futures (UK Government Office for Science). http://bis.ecgroup.net/Publications/Foresight/GlobalFoodandFarmingFutures.aspx
- The Millennium Project's Threshold 21 (T21) is a dynamic simulation tool designed to support comprehensive, integrated long-term development planning. T21 integrates economic, social, and environmental factors in its analysis, thereby providing insight into the potential impact of development policies across a wide range of sectors, and revealing how different strategies interact to achieve desired goals and objectives. It was also used for the UNEP report (Nellemann, 2009) to show that greening the economy across the agriculture, buildings, energy, fisheries, forestry, industry, tourism, transport, waste management and water sectors can drive economic recovery and growth and lead to future prosperity and job creation, while at the same time addressing social inequalities and environmental challenges. http://www.millennium-institute.org/
- Future Agricultures, a research programme. "the Future Agricultures Consortium (is) a dynamic partnership between leading African and UK institutions, developed a strong evidence base for policy influencing around a set of themes and engaged with agricultural policy processes at global, national and local levels. http://www.future-agricultures.org/.
- UN High Level Task Force on the Global Food Security Crisis. Comprehensive framework for action. The High-Level Task Force "is working to ensure that the UN system, international financial institutions and the WTO are ready to provide robust and consistent support to countries struggling to cope with food insecurity. This is a long-term effort (…)" http://www.un.org/issues/food/taskforce/.
- Global Food Security – Strategic Plan 2011-2016. The UK's main public funders of food-related research and training are working together to meet the challenge of providing the world's growing population with a sustainable, secure supply of good quality food from less land and with lower inputs. http://www.foodsecurity.ac.uk/
- The Comprehensive Africa Agriculture Development Programme (CAADP). CAADP focuses on improving food security, nutrition, and increasing incomes in Africa's largely farming based economies. It aims to do this by raising agricultural productivity by at least 6% per year and increasing public investment in agriculture to 10% of national budgets per year. http://www.nepad-caadp.net/
- "L'Aquila" Joint Statement on Global Food Security[48]. At the G8 Summit in L'Aquila, Italy, in July 2009, 26 nations and 14 international organizations launched the 'L'Aquila Food Security Initiative'.

[48] http://one.org.s3.amazonaws.com/pdfs/Agriculture_Accountability_Report_ENGLISH.pdf

They pledged USD 20 billion over three years and agreed on a comprehensive and coordinated approach, partnering with countries to help implement their national food security strategies. The approach is spelled out around 5 principles: 1. Investment in country-led plans; 2. A comprehensive approach that includes support for humanitarian assistance, sustainable agriculture development and nutrition; 3. Strategic coordination of assistance; 4. A strong role for multilateral institutions, 5. Sustained commitment of financial resources. They also promised to do the following: (1) deliver the funds within three years; (2) agree to a set of principles to guide how they would spend this money; and (3) remain transparent and accountable on their commitments. This is being monitored by various parties, most notably by ONE International (http://www.one.org/c/international/hottopic/3934/).

– More food security related initiatives are outlined in the Farming First's guide to Food Security Initiatives at www.farmingfirst.org/foodsecurity.

Annex 4: References and further reading organised along the lines of subject matter

The majority of the following resources can be easily retrieved from the internet by copying the title in a search engine.

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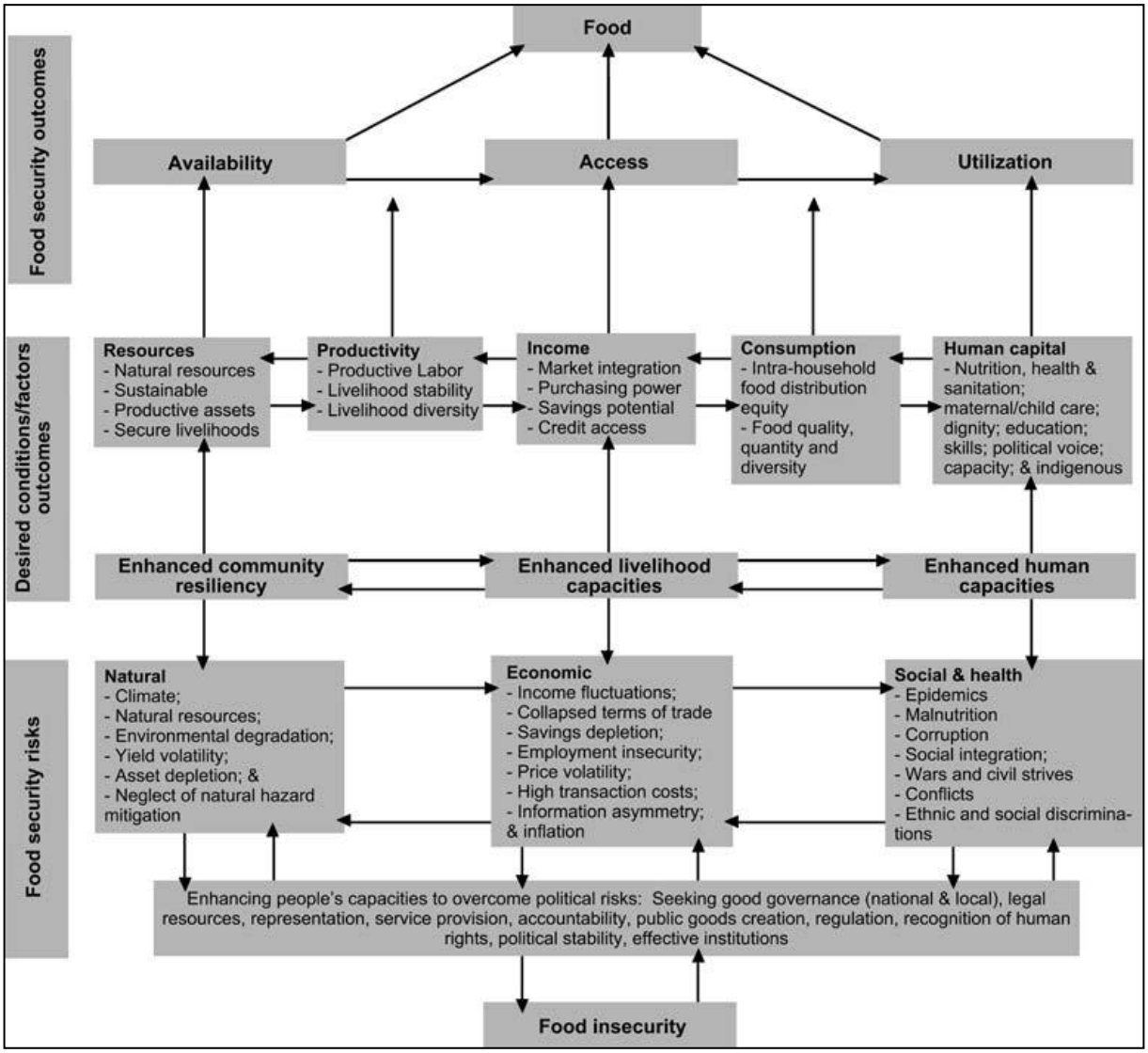
Annex 5: Compilation of visualised conceptual frameworks

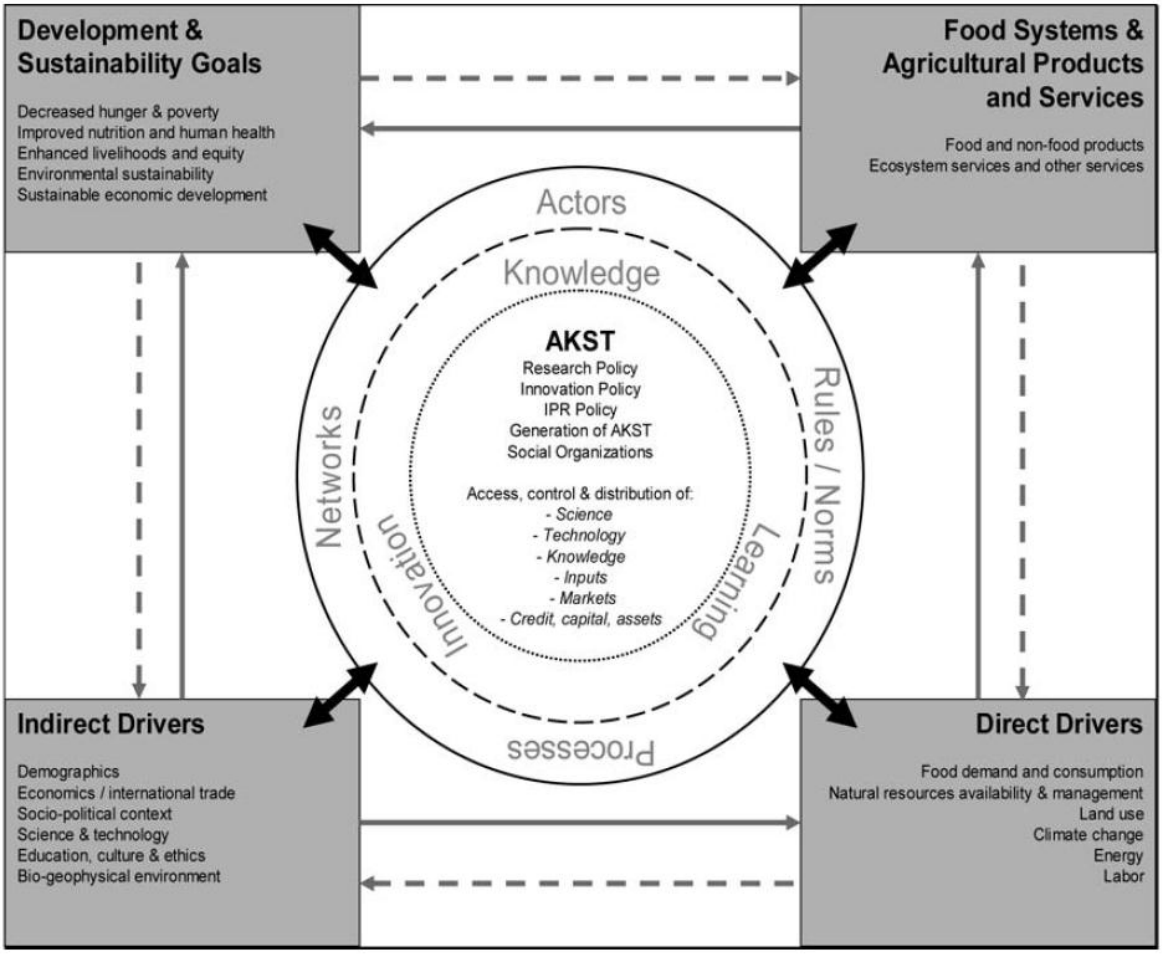
It is said in the context of change management that for coming up with a good idea it helps to have many ideas. George Box (statistician) stated that all models are wrong, but some are useful". Combining these two pieces of wisdom inspired us to compile a selection of visual models that try to depict some of the aspects of what we are discussing in this paper. It is the strength of models that they help create overview and make factors and links explicit. But the other side of the same coin relates to this very reduction of reality being their weakness. Pulling a series of models together may help to loose less in this process of reduction since different people will tend to highlight different aspects in their model.

Food Security Dimensions



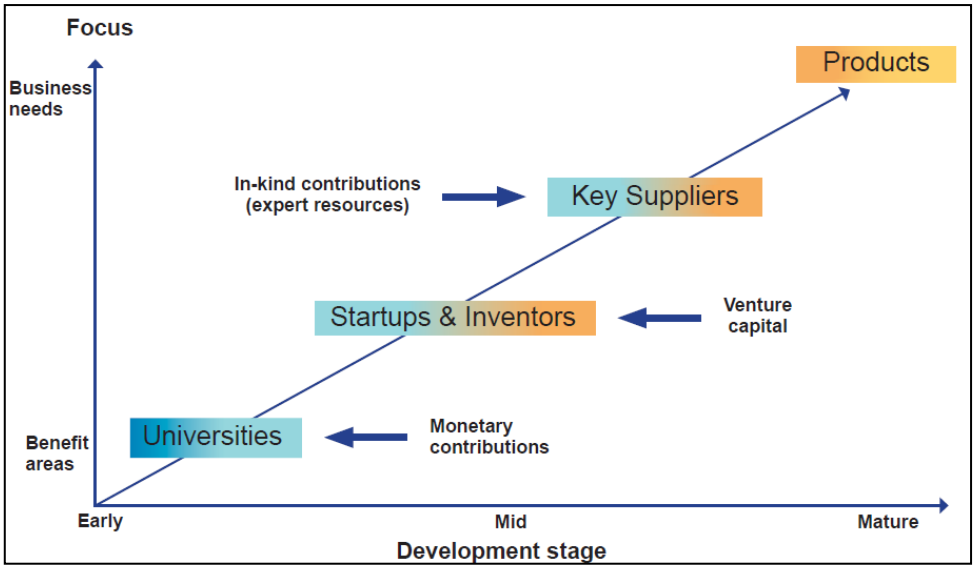
Source: Adapted from Webb & Rogers, 2003.

Conceptual framework of International Assessment of Agricultural Knowledge, Science and Technology for Development



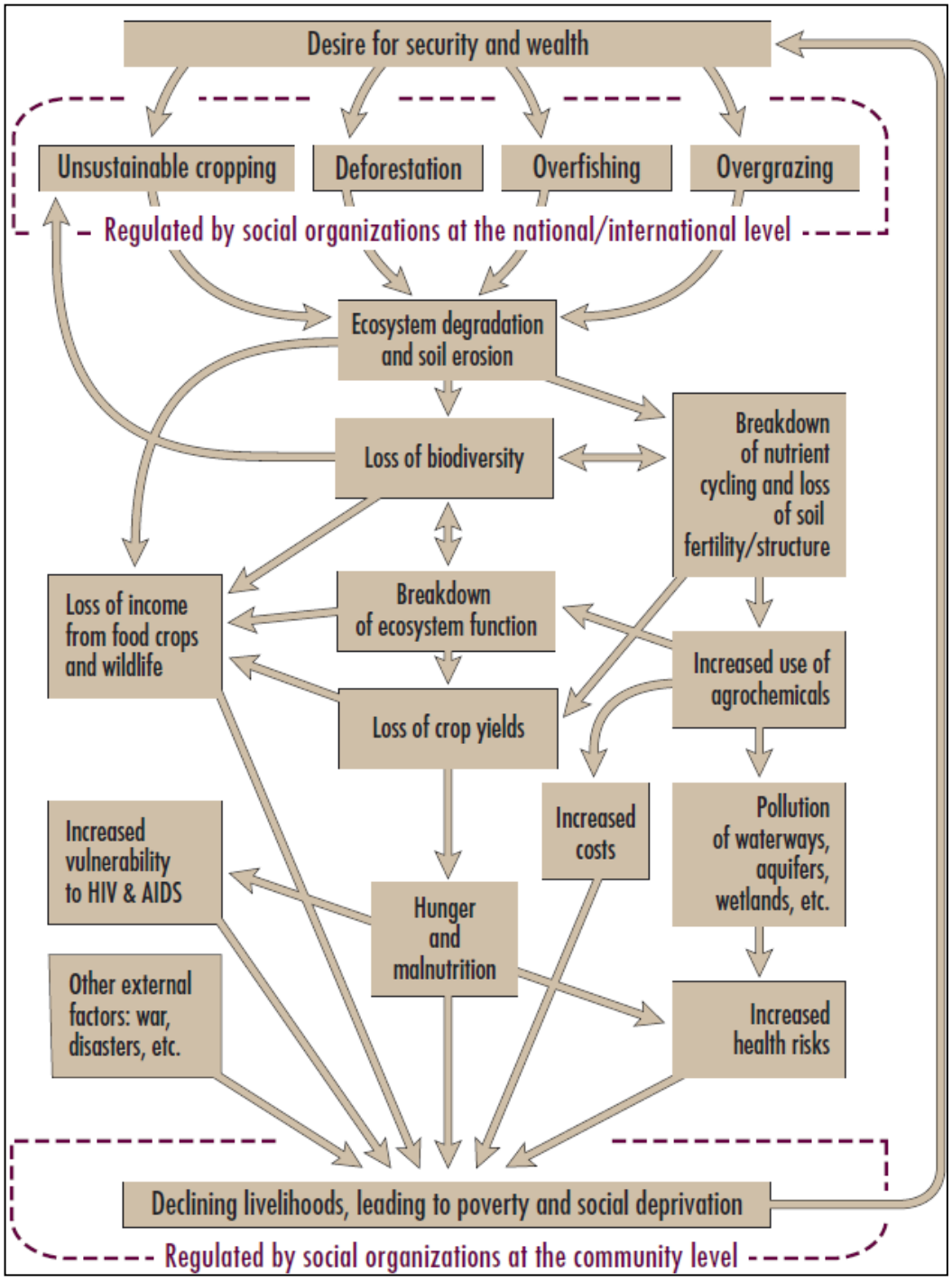
Source: McIntyre, 2009.

A traditional view of innovation partnerships



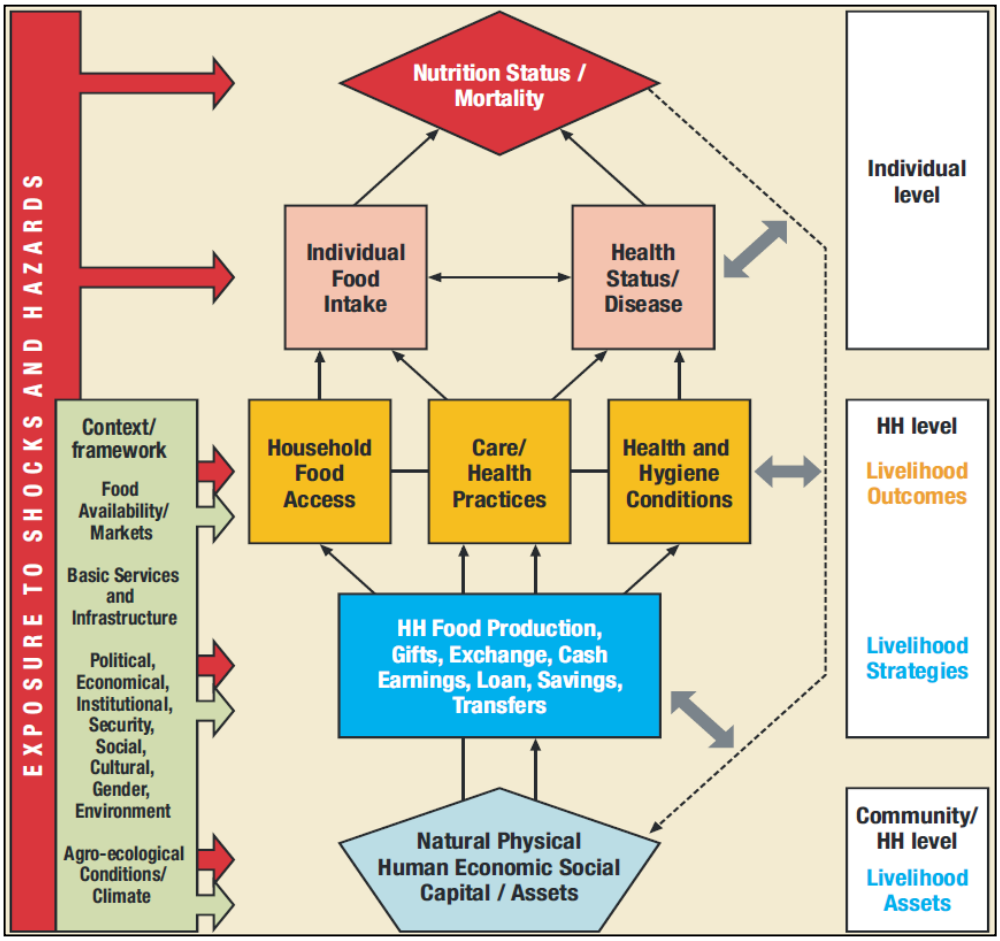
Source: Traitler and Saguy (2009)

Ecosystem determinants of food security



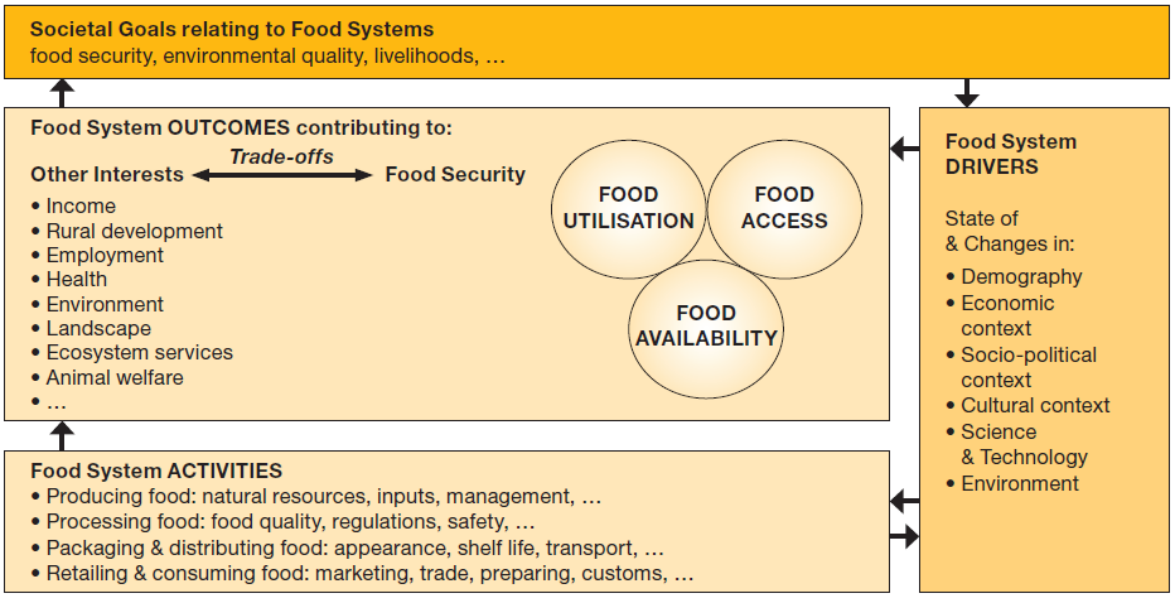
Source: Guillen Calvo et al. (2009)

Food and nutrition security conceptual framework



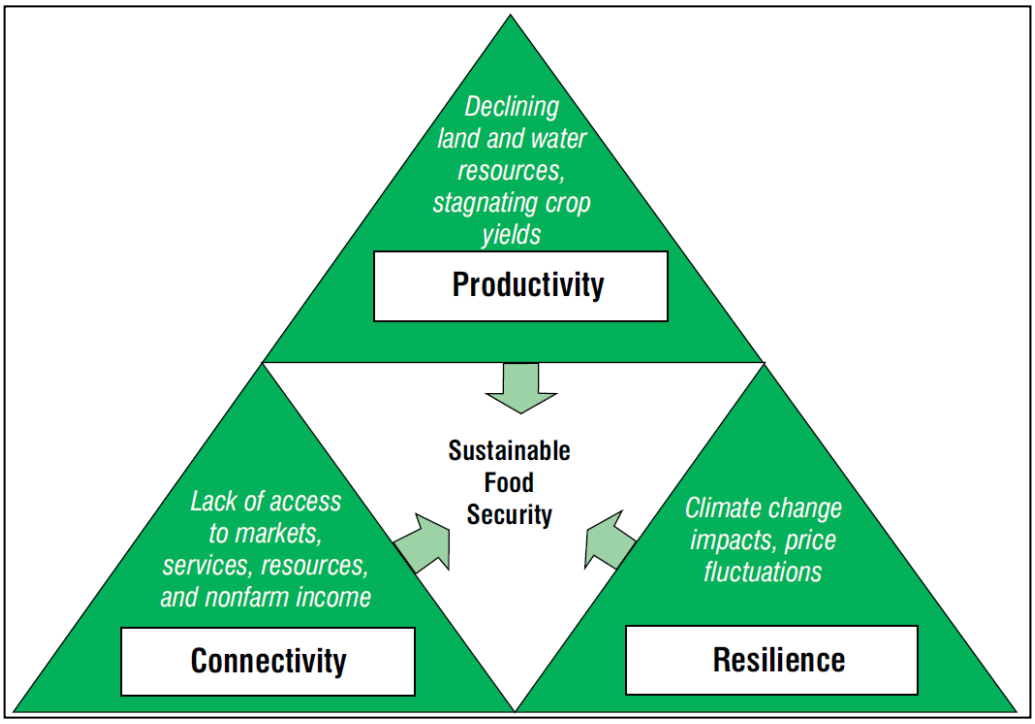
Source: WFP (2009)

Food system conceptual model



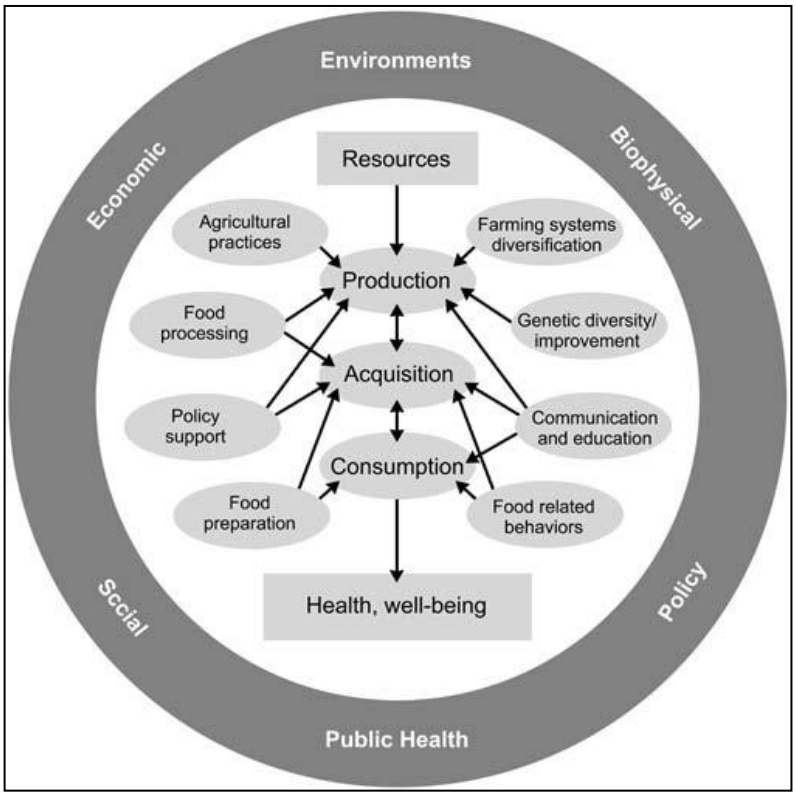
Source: Rabbinge and Linnemann, 2009 (adapted from Ingram, 2010).

Challenges to sustainable food security



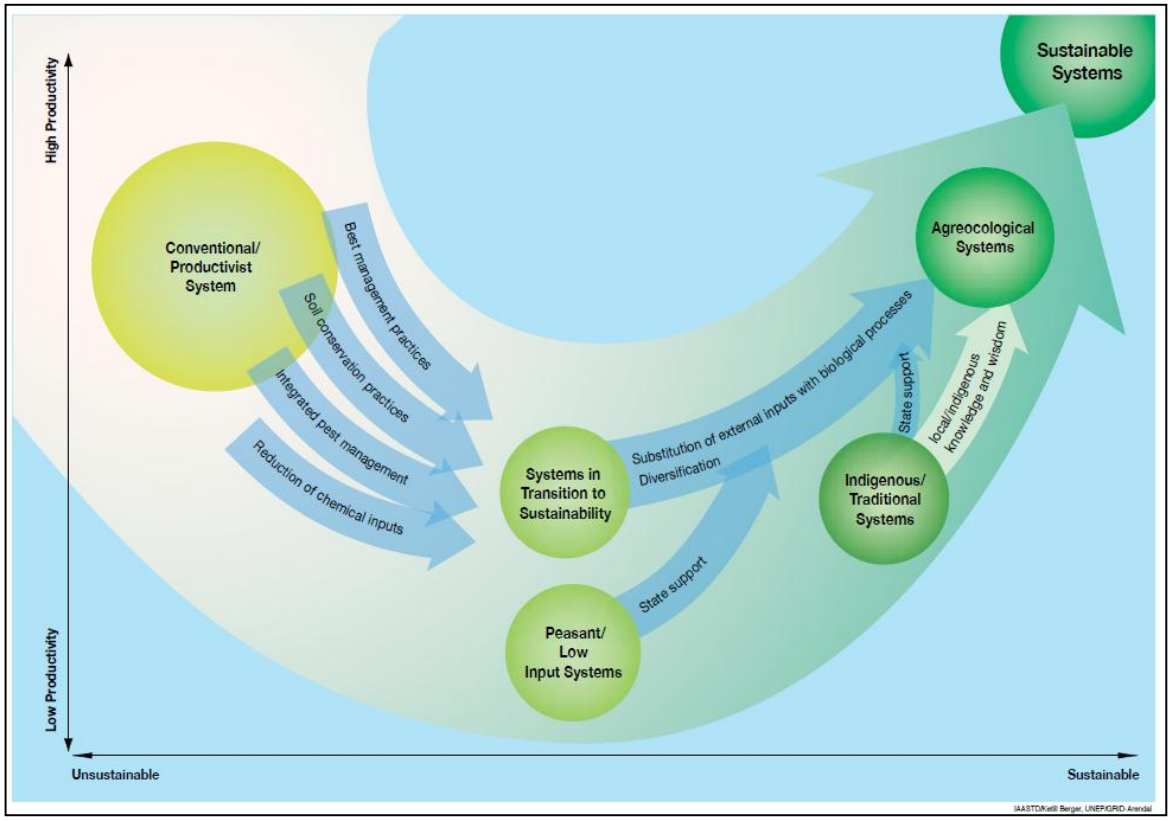
Source: Ingram (2010)

A value-chain linked food system



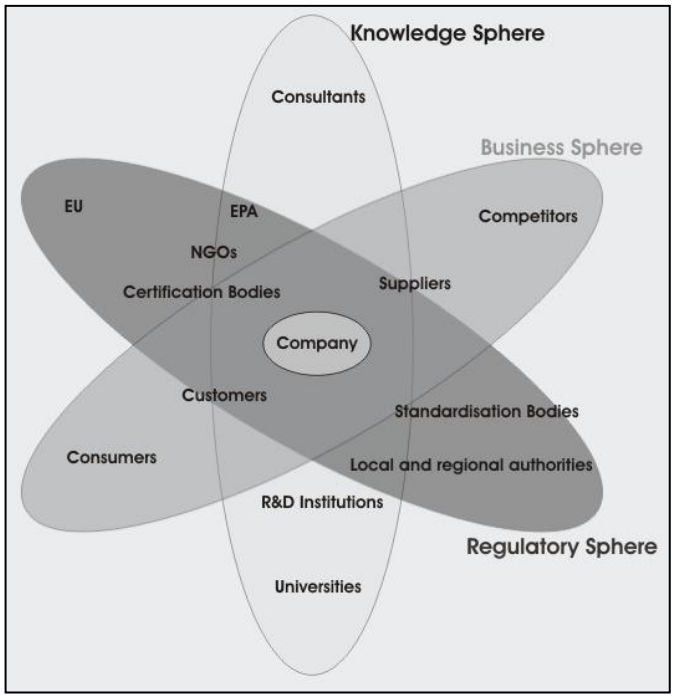
Source: Combs, et al, 1996.

Emerging modes of agriculture



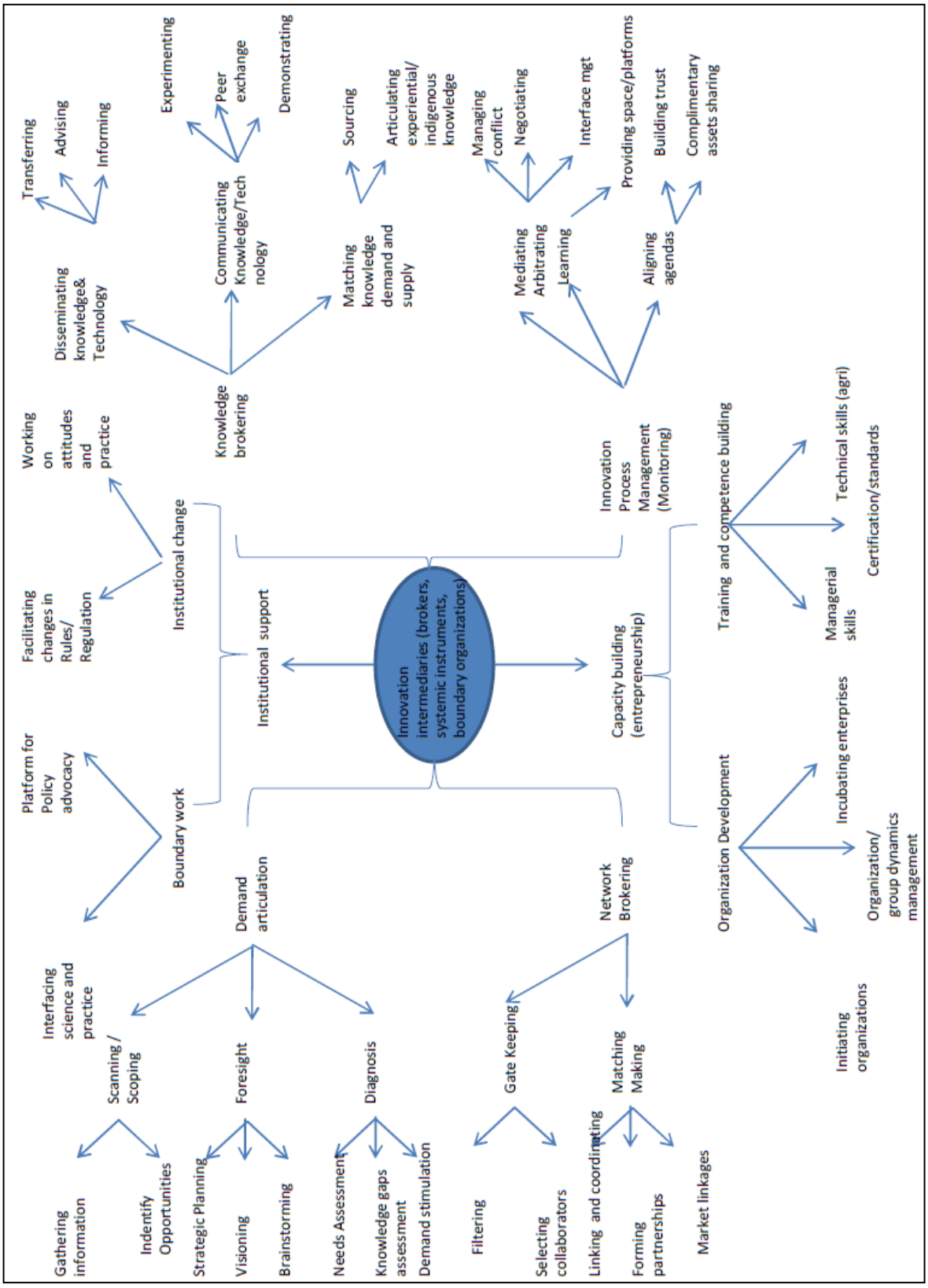
Source: IAASTD, (2009)

The company linked interplay of the business, knowledge and regulatory spheres

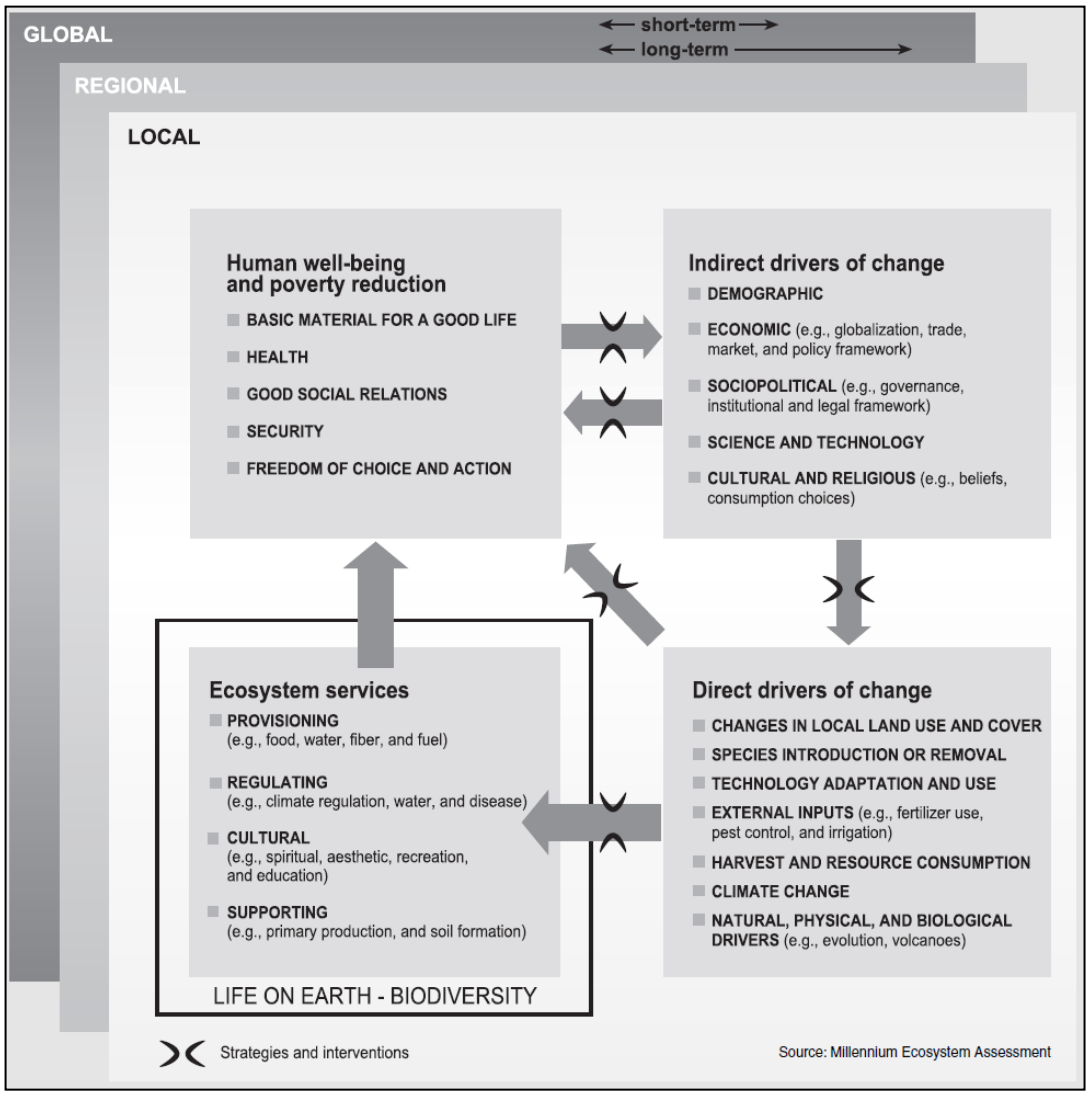


Source: Lehman, 2008.

Innovation intermediation roles to play

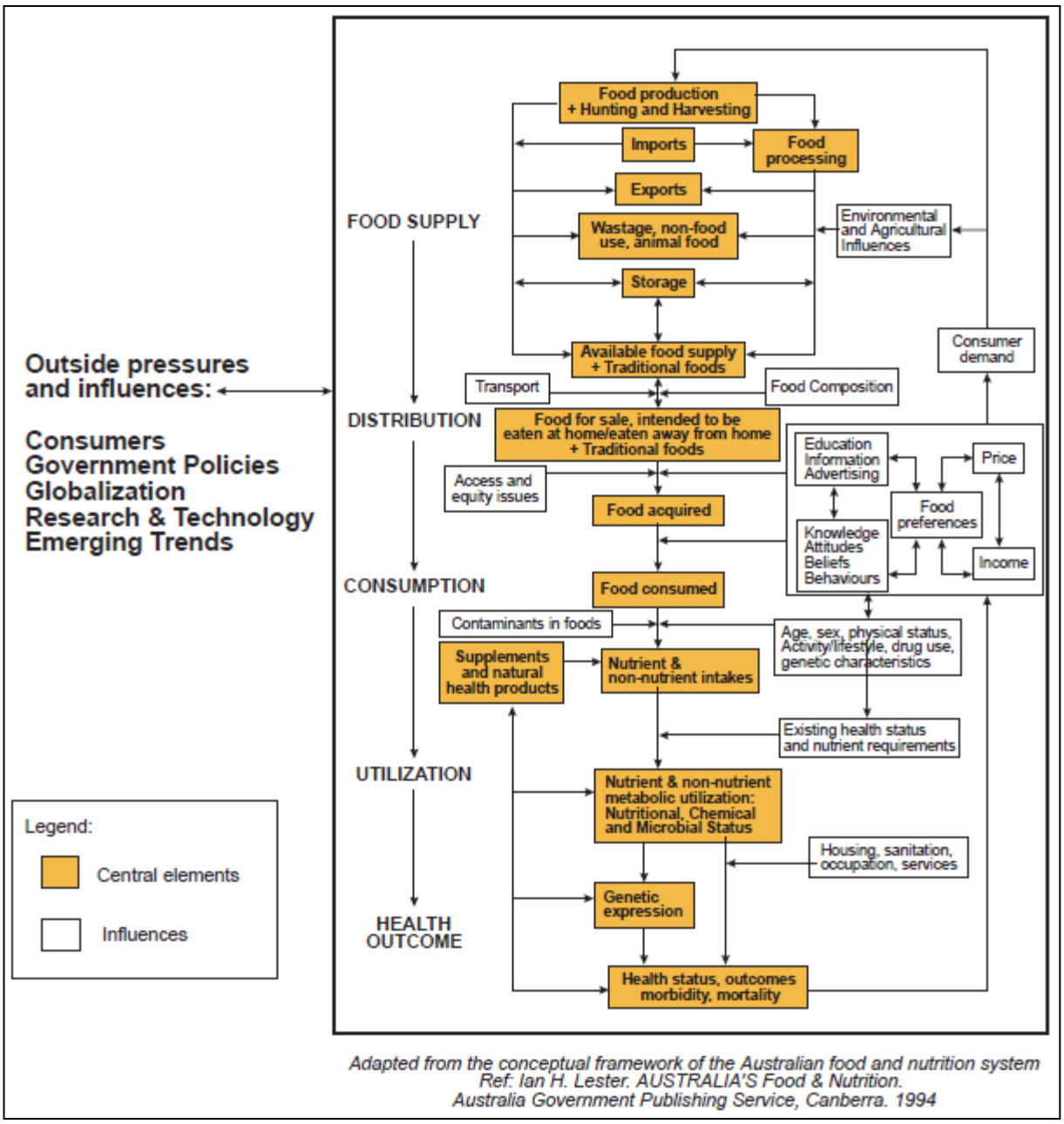


Source: Kikelu et al., 2011



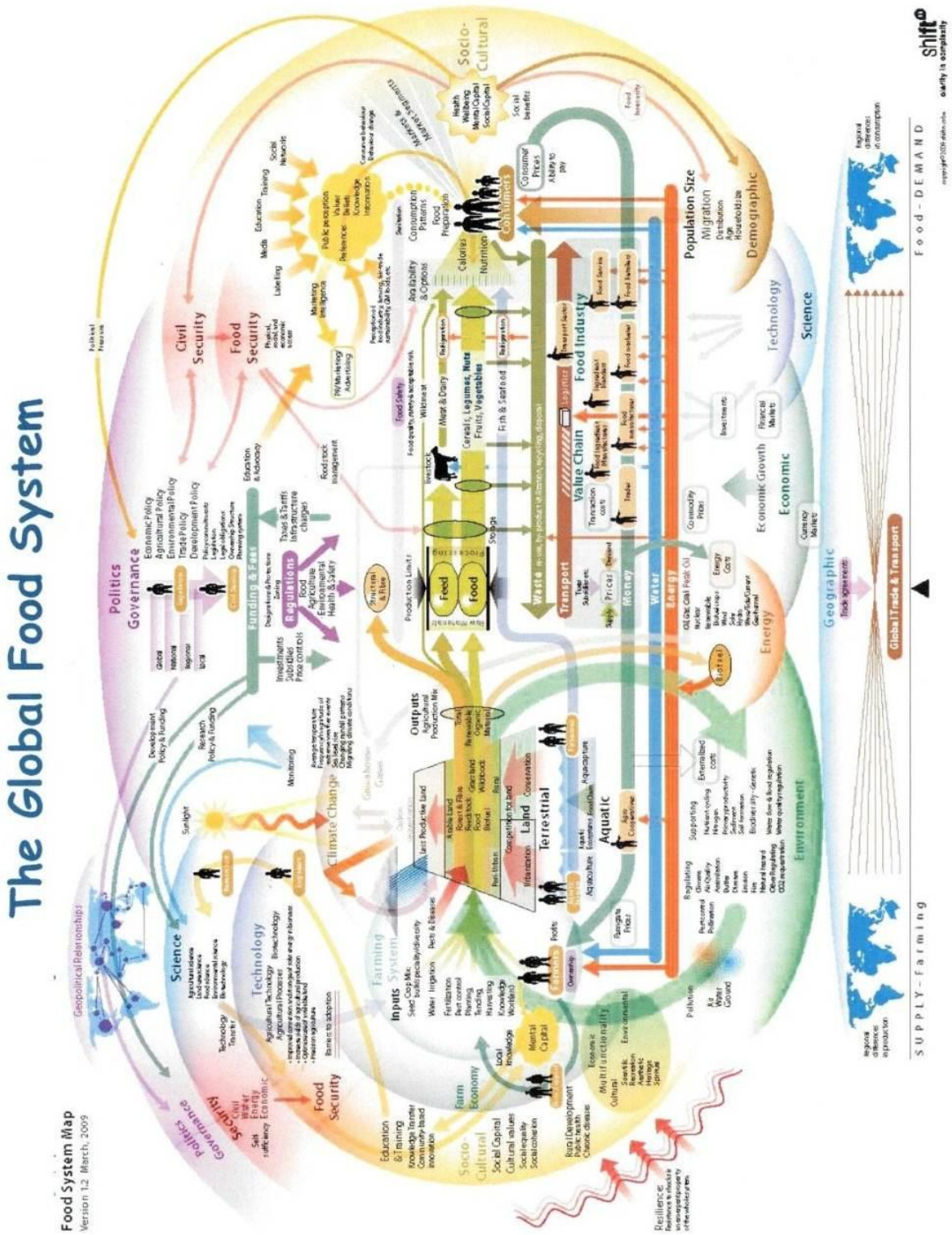
Millennium Ecosystem Assessment, Ecosystems and Human Well-being: A Framework for Assessment (Island Press, 2003),

Conceptual model for the Canadian Food and Nutrition System



Source: Health Canada: http://www.hc-sc.gc.ca/fn-an/surveill/conceptual_model-eng.php

The global food system map (authorship http://www.shiftn.com/)



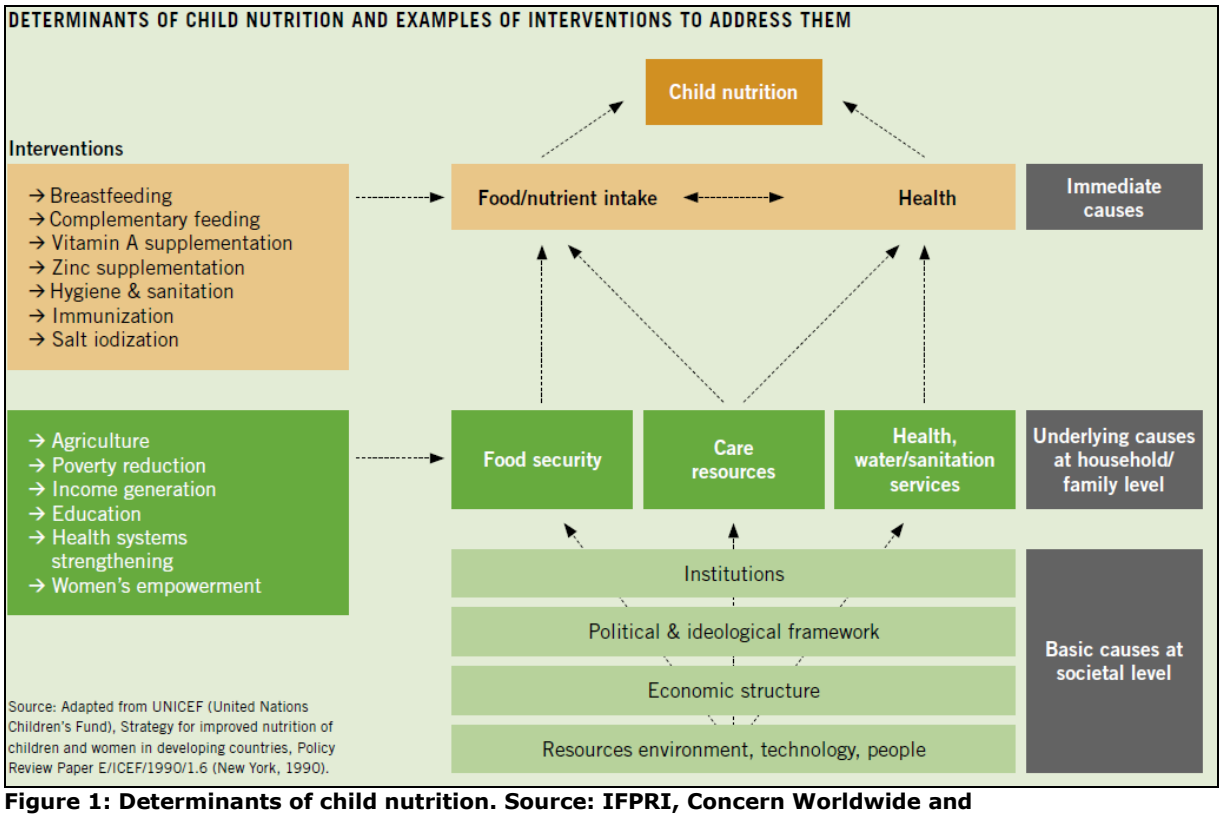


Figure 1: Determinants of child nutrition. Source: IFPRI, Concern Worldwide and Welthungerhilfe, 2010.

Annex 6: Selected past and future international conferences

Title	Year	Place	Organisation
e-Agriculture for Improved Livelihoods and Food Security in Africa	2012	Johannesburg	International Association of Agricultural Information Specialists
International Scientific Symposium on Food and Nutrition Security Information	2012	Rome	FAO, EU
Feeding the world – The nine billion people question	2012	Geneva	The Economist
World Nutrition Rio2012	2012	Rio de Janeiro	Rio de Janeiro State University
Urban Food Security in Africa: Multidisciplinary Perspectives, Global Dimensions	2012	Oxford	University of Oxford
Food Security through Sustainable Growth – Farming with Limited Resources	2012	Berlin	Global Forum for Food and Agriculture
4th McGill Conference on Global Food Security "risks and threats to food security"	2011	USA	McGill
Food Security 2011: Transforming the Food Production System	2011	London	Chatham House
Africa College International Conference on Food Security, Health and Impact	2011	UK	University of Leeds
ASEAN Conference on sustainable fisheries for food security towards 2020	2011	Bangkok	ASEAN-SEAFDEC
Expert Meeting "Who will feed the World?"	2011	Amsterdam	Agriprofocus/Oxfam Novib
Food Security, Water and Tropical Forests – Are we on the right track	2011	Ede	EL&I, Tropenbos, et al
Global Science conference on climate-smart agriculture 2011	2011	Ede	Wageningen UR, Dutch Ministry of Economic Affairs, Agriculture and Innovation, The World Bank
Global Food Security 'Food for Everyone – Towards a Global Deal'	2011	Brussels	European Economic and Social Committee
Global Forum for Food and Agriculture – Trade and Global Food Security	2011	Berlin	several German (semi) government groups
Investing in Sustainable Agriculture for Food Security and Poverty Reduction	2011	Bogor, Indonesia	CAPSA, Brighten Institute
Leveraging Agriculture for Improving Nutrition & Health	2011	New Delhi	IFPRI
The Water, Energy, Food security Nexus – Solutions for the Green Economy	2011	Bonn	German Federal Govt.
Transition Towards Sustainable Food Consumption and Production in a Resource Constrained World	2011	Budapest	EU et al.
Agribusiness Forum 2010 – Food Security: A Business Opportunity	2010	Kampala	EMRC
Africa Agriculture & Food Security Mega Conference and Expo - Sustainable Agriculture for Improved Food Security in Africa: Investing in people and livelihoods	2010	Durban	Foundation for Development of Africa
Agriculture, Food Security and Climate Change – "Climate-smart Agriculture", policies, practices and financing for food security, adaptation and mitigation	2010	The Hague	FAO
Biodiversity and Food Security – nourishing the planet and the people	2010	Canberra	Crawfurd Fund for a Food Secure World

Delivering Food Security with Supply Chain Led Innovations – Understanding supply chains, providing food security, delivering choice	2010	UK	OECD
Food Security and Climate Change in Dry Zones	2010	Amman	ICARDA
Global Food Security: The Role of Science and Technology	2009	Malaysia	UNCTAD
How to Feed the World in 2050 – High Level Expert Forum	2009	Rome	FAO
World Food Security: Can Private Sector R&D Feed the Poor	2009	Canberra	AGRA (Africa)/ Crawfurd Fund for a Food Secure World
World Summit on Food Security	2009	Rome	FAO
Food Security and Environmental Change Conference - Linking Science, Development and Policy for Adaptation	2008	Oxford	Global Environmental Change and Food Systems (GECAFS)
Climate Change, Energy and Food – High level conference on food security: the challenges of climate change and bioenergy	2008	Rome	FAO

The Dutch ‘gouden driehoek’ refers to successful partnership in agricultural development between government, sector and knowledge institutes. This has been key in securing food & nutrition in the Netherlands. Could this model be applied to African conditions and be the basis for similar success in relation to food & nutrition security? This report is part of the documentation of an exploration in relation to this question. It explores the global context of agriculture and food systems as well as current and anticipated challenges that these systems will be facing in the future. This sketches the backdrop for understanding the range of roles to play by various actors in innovation systems responsive to food & nutrition security. Public-private partnerships will need to feature prominently in this. But we need to explicitly consider the role of civil society and farmers & communities in (relation to) such partnerships as well. Harnessing the potential of what knowledge institutes have to offer, will need to involve looking beyond traditional roles, to include more flexible roles such as being innovation broker. A companion report documents five examples of such flexible roles in the context of agriculture and fisheries innovation in Africa. Strengthening capacities of African knowledge institutes for playing such flexible roles more effectively in innovation partnerships, will be an important contribution to improving conditions that shape the state of food & nutrition security in Africa.

More information: www.cdi.wur.nl

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