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Working Methodology Report of developed principles for CONVERGE -

tested with a range of stakeholder groups participating at Group Model Building workshops, including a methodology report for group models

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CONVERGE 227030

Rethinking Globalisation in Light of Contraction and CONVERGEnce

Working Methodology Report of developed principles for CONVERGE, tested with a range of stakeholder groups participating at Group Model Building workshops, including a methodology report for group models

WP3 - D20

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[Environment Including Climate Change]

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1 Background

With the three earlier deliverables (D17, D18 and D19) Work Package 3 (WP3):

1. provided an overview and comparative assessment of some of the more commonly used internationally accepted sustainable development indicator frameworks, as well as some of the key indicators and indices for measuring progress towards sustainable development (D17);
2. proposed a systems science based and stakeholder participative Converge indicator framework that can be applied on any spatial scale and focus on any sector/theme for comparing multi-dimensional policy strategies (D18), as an integral part of the overarching Framework for Convergence (D35) developed under Work Package 7 (WP7); and
3. documented the application of the Converge indicator framework – as a part of the overarching Framework for Convergence (D35 by WP7) – in Iceland, Bristol-UK and Tirunelveli-India case studies on a selected focus area of food system and developed models enabling decision support for complex multi-dimensional policy strategies (D19, as well as complementary seven extra deliverables).

2 Introduction

Sustainable development indicator (SDI) frameworks help to develop sets of indicators providing the necessary information for policy makers. The policy makers use this information in assessing the success level of formerly implemented sustainable development policies, as well as to develop and implement new ones. Hence, it is of great importance that the "right" indicators are identified and selected with such frameworks.

WP3's earlier analysis provided with D17 pointed out that to develop the "right" indicators with the existing SDI frameworks is challenging due to following three issues:

1. The majority of indicators developed by existing SDI frameworks provide information only covering individual issues, sectors or topics from disconnected three "pillars" of sustainable development – namely; environment, economy and society. These indicators are pillar-specific and do not provide information on interlinkages between different pillars. The capital/domain-based framework, for instance, is centred on the economic and environmental pillars, where as causal frameworks (Pressure-State-Respond and its variations), are limited mostly to the environmental pillar of sustainable development. Moreover, most indicators developed by the existing SDI frameworks (except for, partly the casual frameworks) lack the explicit interlinkages and cause effect relationships between each other even if they cover the same pillar of sustainable development and are sorted out under same issue, sector or topic;
2. Cases where stakeholder participation in developing indicators with existing SDI frameworks are still limited and none of the frameworks considers a design for stakeholder participation process in its structure; and
3. The existing SDI frameworks do not consider the representation of the dynamic relationships between indicators. Indicators developed by these frameworks are static in nature and lack interactivity. They provide information about the system only considering the current situation, not changing conditions in time. That is why these indicators are intended to be measured regularly and frequently to gather the information for monitoring the performed progress in the past and also assess the current situation.

To address the above three issues, WP3 proposed a stakeholder participated and systems science based Converge indicator framework, which is in fact, a generic group-modelling process and can incorporate all other types of existing SDI frameworks (i.e. theme based, sector based, causal base, goal base etc.) in its structure (see Figure 2.1).

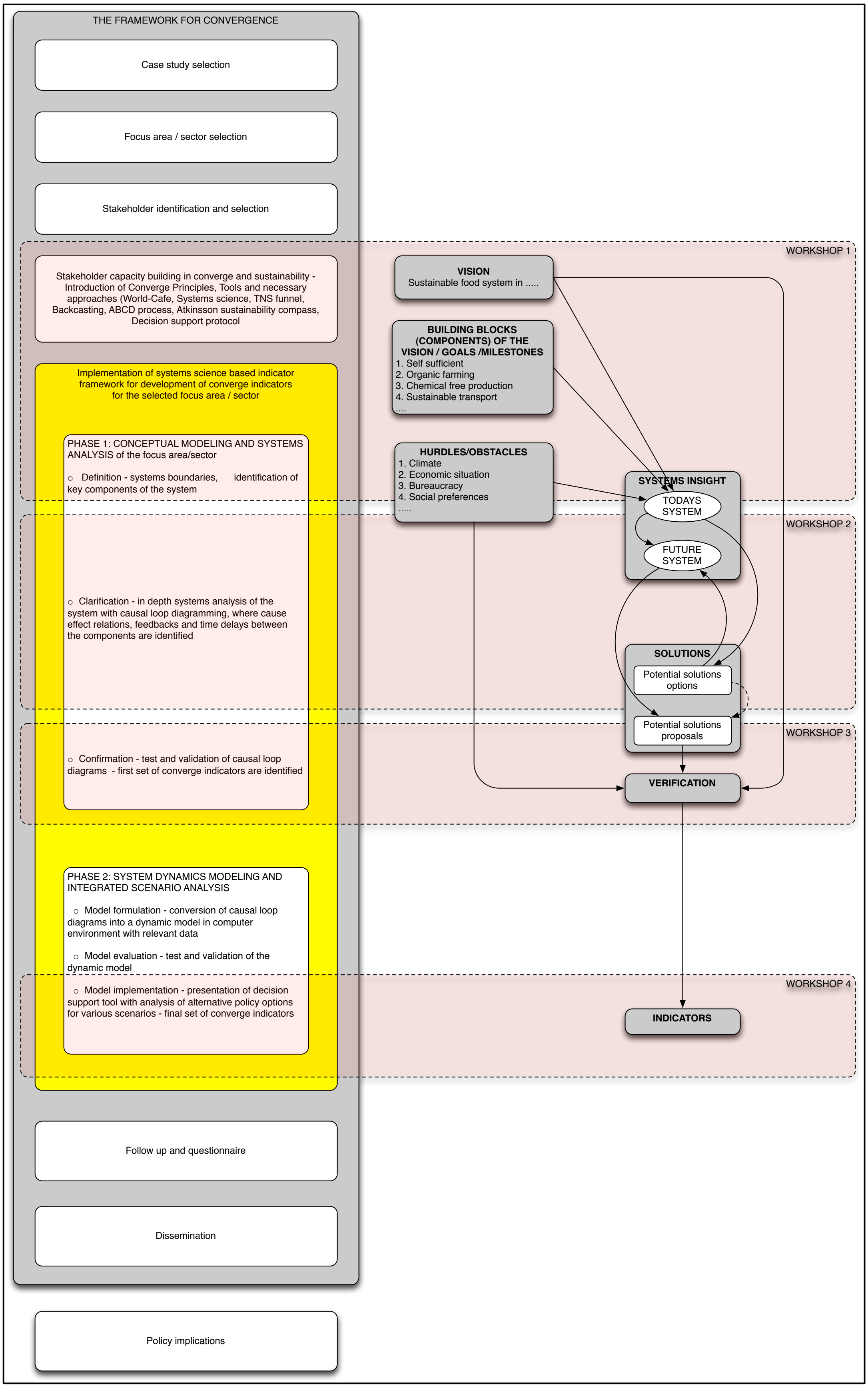

Figure 2.1. Converge indicator framework (in yellow) as an integral part of the overarching Framework for Convergence.

The proposed framework was described in detail in D18, but concisely it considers:

1. broad **stakeholder participation** for enabling discussions on trans/inter/cross disciplinary issues and ensuring exchange of knowledge for a better understanding of complex sustainability issues;
2. **systems thinking, conceptual modelling** and **systems analysis** for introducing causal loop diagramming methodology as a common communication tool among stakeholders. Conceptual modelling over a series of group workshops and systems analysis help to identify interlinkages (cause effect relations and feedback loops) for a better understanding of the complex human, nature and the support/build systems; and
3. **system dynamics modelling** and **integrated scenario analysis** for developing numerical models to capture the dynamic complexity, and to test and experiment alternative potential policy options under different future scenarios. Such models allow the user to see dynamic relationships between indicators as well as to analyse the relevance and sensitivity of indicators.

Having the methodologies to deal with the above-mentioned issues in its structure, we believe, the proposed framework not only improves the identification, selection and monitoring processes of indicators, but it also serves as a stakeholder capacity enhancement tool for analysing dynamic complex sustainability issues.

The intention with this deliverable – D20, is to provide a full documentation of the working methodology for Converge indicator framework while developing the converge indicators within selected three case studies. Sections 3, 4 and 5 describe in detail the working methodologies carried out in Iceland, Bristol-UK and Tirunelveli-India case studies respectively.

3 Working Methodology for Converge Indicator Framework – Iceland Case Study

This section of the report describes the working methodology on practical application of the Converge indicator framework on Icelandic food system with a series of group modeling workshops.

3.1 Iceland Group Modelling Workshop 1

3.1.1 Implementation of Converge indicator framework in Iceland: Phase 1 – Step 1

Implementation of Converge indicator framework started with the 1st workshop and covered the first step (Definition) of phase 1 (Conceptual Modelling and Systems Analysis). Following a series of lectures and exercises aiming for the capacity building of stakeholders in converge and sustainability (as described in detail in D35), the stakeholders started the group-modelling process.

Phase 1: Conceptual Modelling and Systems Analysis

Step 1. Definition

Defining a vision, building blocks (components) of the vision/goals/milestones

In this step, first the stakeholders were asked to define a vision and discuss how food system in Iceland will look like when that vision has been reached. It was reminded the stakeholders that their vision should be in line with converge, where ecological limits to growth are recognised and equity at a global scale is valued. Second, the stakeholders were asked to define the building blocks (components) of the vision, the goals and the milestones. Having clear vision, its building blocks, goals and milestones the workshop facilitators aimed to avoid unnecessary discussions among the stakeholders, while defining the problem(s), analysing the system and identifying the potential key indicators during the next steps.

Defining the problem

The very first step of most common problem solving approaches is to identify the problem(s). By taking into the stakeholders' perspectives, the workshop facilitators asked the question "what are the obstacles on the way to reach a sustainable food system in Iceland?" to state explicitly the purpose and objectives of the modelling process. Potential hurdles and obstacles to reach the goals and the vision were discussed and identified among the stakeholders.

Setting the system boundaries

Based on the vision and problem definition the temporal and spatial system boundaries were set.

3.1.2 Outcomes of Iceland Group Modelling Workshop 1

During the 1st workshop the stakeholders were divided into 3. Tables showing the vision-building blocks-obstacles, as well as the diagrams attempting to show the causal interlinkages between the components of the Icelandic food system are given below for each of the 3 groups. It should be noted that the tables present the views of the individual groups and not interpretation of the results by the researchers. It should also be noted that at this very early stage of the group modeling process, the stakeholder were not expected to come up with fully correct causal loop diagrams. They were free to use figures, flow charts, causal loops to express their understanding and show the interlinkages between different components of the food system in Iceland. All information from individual group's work were noted at this stage and synthesized later by the WP3 researchers (see section 3.4).

Iceland Workshop1 – Group 1 results

Table 3.1

Vision	Goals, Milestones, Practicality tools, skills, knowledge etc.	Hurdles, obstacles
A sustainable Iceland – food vice	Public awareness – children education	Lack of proactivity
Self sufficiency of food	Political awareness	Lack of political will (on all levels)
Exports = imports	holistic strategy & leadership	Lack of awareness & knowledge
Raw material efficiency – closed material loops – life time – no waste – valuable by products	Skills and knowledge	Political neglect (->why?)
Carbon neutral food production	Technological innovation	Lack of longterm vision & planning (due to the 4 year term)
	Holistic action plan	
	Valuable by-products	
	Closed material loops	
	Mapping "waste" and pollution in our national food value chain	

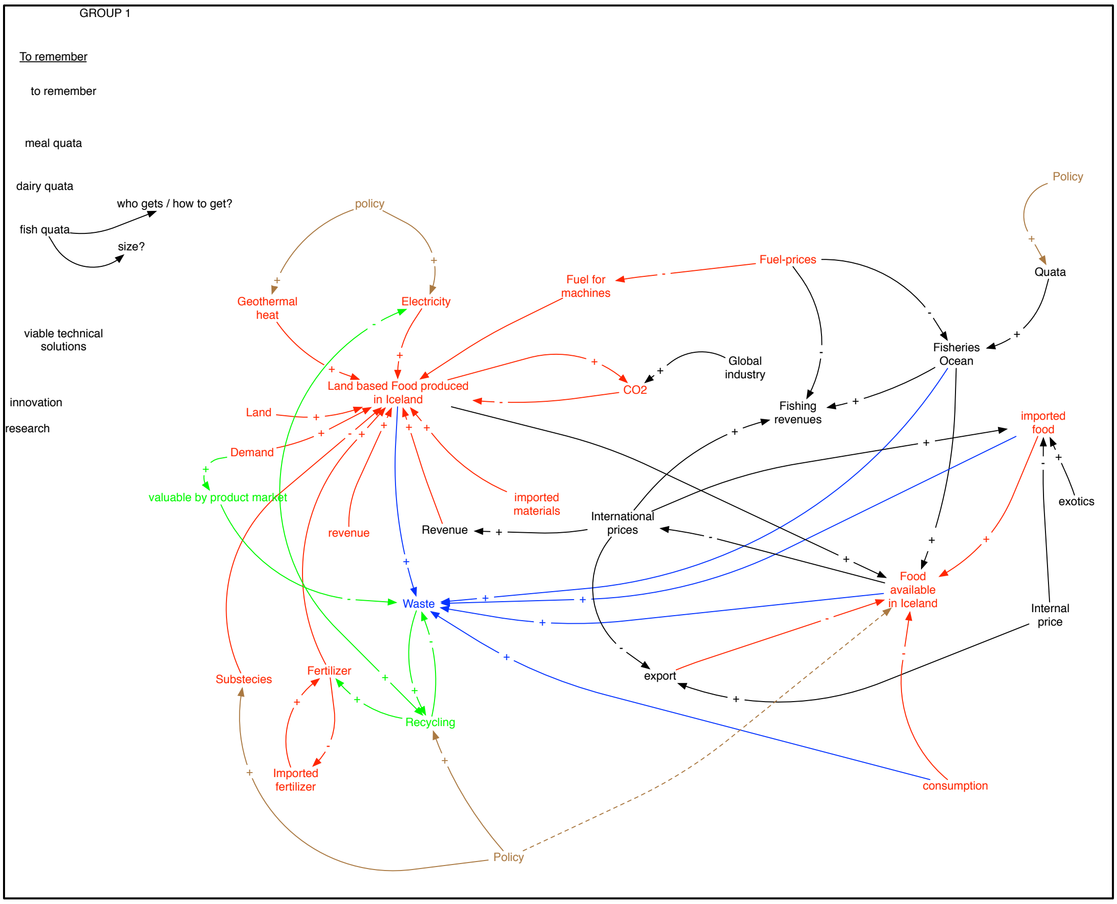

Figure 3.1. Land based food, ocean fisheries and imported food constitute the food available in Iceland. The more the land/ocean based food production and the imported foods are, the more will be the amount of available food in the market. Export and the consumption of food reduce this amount. Imported fertilizer, fuel and other materials, as well as arable land, electricity and geothermal heat are required in land based food production. Waste generation occurs during the food production, import and consumption phases. Policies on the fishing quota and the agricultural subsidies affect the food production. Recycling of fertilizer reduces the amount of imported fertilizer, where recycling of waste and market for valuable by-products reduces the waste in general. International and national food prices, as well as the production costs affect the fishing and agricultural revenues.

Iceland Workshop 1 – Group 2 Results

Table 3.2

Vision	Goals, Milestones, Practicality tools, skills, knowledge etc.	Hurdles, obstacles
Sustainable – not just sufficient food system, but healthy and good		
Decide on what we really want		
Achieve on goals by reconsidering the system		

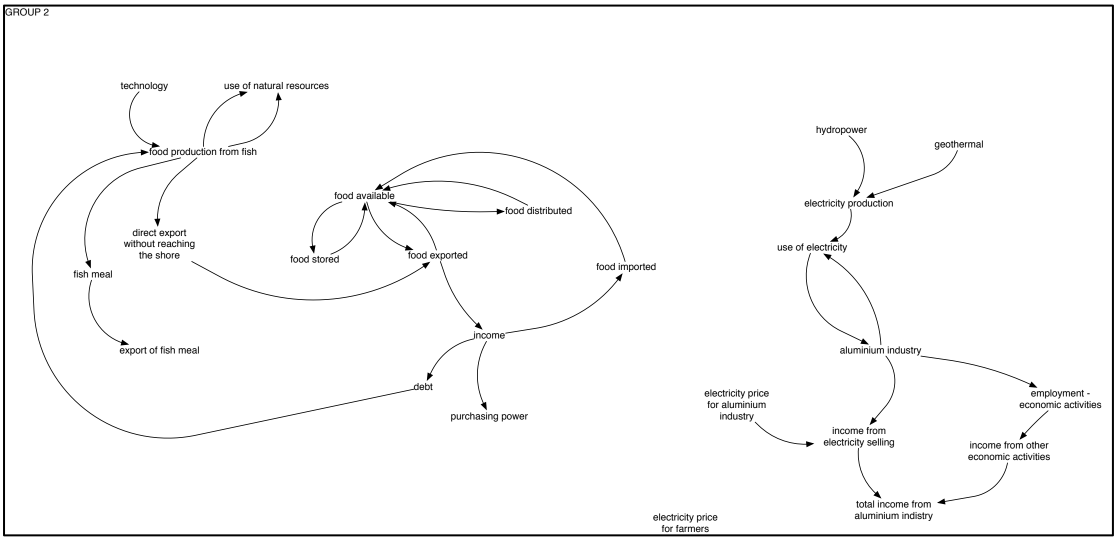

Figure 3.2. Group 2 highlighted that debt controls the fishing amounts. With less income and increased debts, fishermen try to catch and export more to make money. The more the fishing amounts the less will be the fish stocks in the oceans. Fish caught in Iceland is stored and/or distributed to internal market as well as stored and/or exported to other markets. Subsidies in electricity price for the aluminum industry indirectly affect the farmers and the food production. With subsidized prices, the electricity produced by hydropower and geothermal is hugely consumed by the aluminum industry and this generates an income to the government from both the selling of the electricity, as well as other employment and economic activities dependent on the aluminum industry. Farmers, on the other hand, cannot take advantage of the subsidized electricity prices and have to pay much higher, which reduces the incentive for farming and in turn the agricultural production.

Iceland Workshop 1 – Group 3 Results

Table 3.3

Vision	Goals, Milestones, Practicality tools, skills, knowledge etc.	Hurdles, obstacles
Sustainable food production	Strong leadership	Lack of holistic strategy pubic- private
Have food surplus	Open "boxes" to work together	Assessment – follow up needed
Regional diversity within and between	Long term plan of land use	Strong leadership
Self sufficient in energy / efficiency use	Long term holistic strategy of industry, energy, food production, environment, society	Disconnection between producer and consumer
Organic production Iceland	Create good role models	Lack of education
Complete internalization of externalities		Status quo
Policy		Greed
Strong leadership		Human self destruction
Democracy		Present day financial system
Preserve pure air, water, energy and be true		Foreign ownership of land and interior
Icelandic ownership of land		Prostitute way of thinking
		Oligopoly

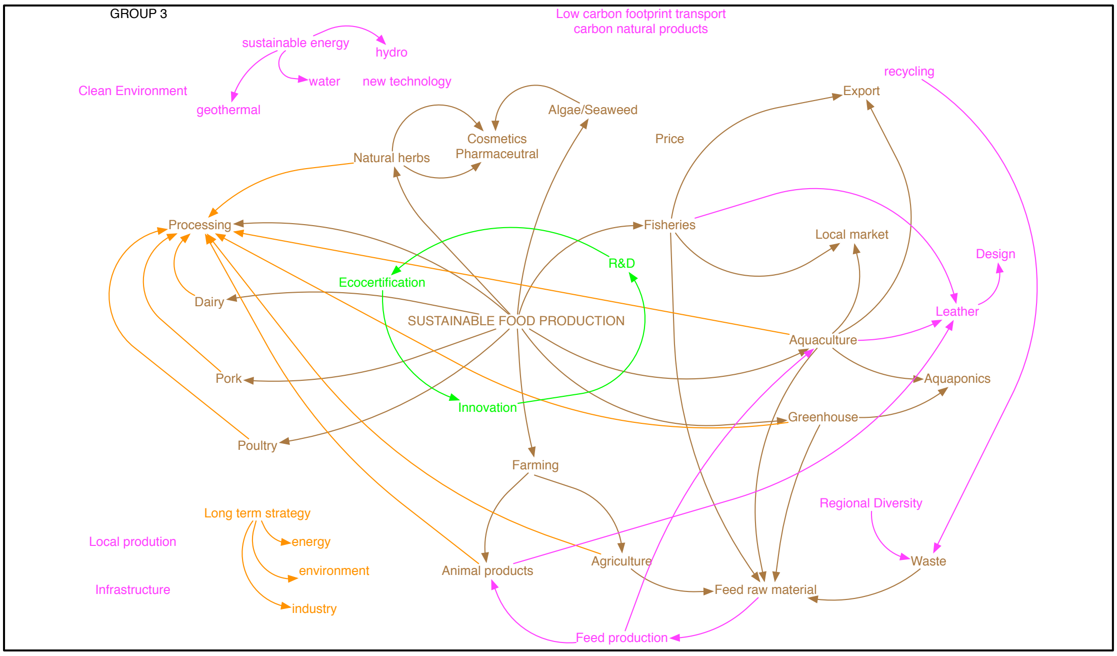

Figure 3.3. Group 3 discussions mostly focused on future sustainable food production in Iceland. In addition to today's conventional/greenhouse agriculture, animal production (including dairy, pork and poultry), and fisheries along with the associated processing industries, the group discussed about the future potential ways of food production such as from aquaculture, aquaponics, natural herbs, and algae/seaweed. Waste from food production can be recycled as feed raw material to close the loop. Leather as a waste product from animal production, aquaculture and fisheries can also be recycled and reused in fashion and design industries. In the future sustainable food system of Iceland, clean energy produced from geothermal and hydropower should be used and carbon neutral products should be transported with low carbon footprint. This requires local production with eco certification, R&D, innovation, and necessary technology and infrastructure.

By the end of the workshop 1, the stakeholders started to have a systems insight to how the food system in Iceland looks like today and how it should ideally look like in the future.

3.2 Iceland Group Modelling Workshop 2

3.2.1 Implementation of Converge indicator framework in Iceland: Phase 1 – Step 2

Following a short debriefing through which stakeholders were informed about the outcomes of the first workshop, the group modeling process continued. During the 2nd workshop phase 1 (Conceptual Modelling and Systems Analysis) and step 2 (Clarification) of the Converge indicator framework was implemented

Phase 1: Conceptual Modelling and Systems Analysis

Step 2. Clarification

The aim with this step was to bring all stakeholders together for discussions and exchange of information with each other to develop a better understanding of the sustainable food system and its components in Iceland. In this step, the stakeholders were introduced to systems thinking, systems analysis and causal loop diagramming concepts.

Listing relevant system components and identifying the key ones

Having the vision, goals, obstacles defined and the system boundaries in mind from the previous workshop, the stakeholders were asked to create a list of all components representing the Icelandic food system. The stakeholders were then asked to list these components in the most relevant and important order in order to identify the key ones.

Identifying the interlinkages between the key components and building a conceptual model

The stakeholders were divided into three thematic groups to analyse the three sectors in the food system:

1. Agriculture
2. Ocean fishing / Aquaculture
3. Greenhouse agriculture

Causal loop diagramming was used as a "common language" among all the stakeholders with different backgrounds. Stakeholders built causal loop diagrams identifying the interlinkages, cause effect relations, and the reinforcing and balancing feedback loops between the key components of the food system within these themes.

Having systems insights

During the workshop 2, the stakeholders started to see the bigger picture with a holistic manner. They understood how todays' food system looks like and how the desired future system should look like by starting to use causal loop diagrams within an iterative process. Some potential solution options and proposals were suggested by the stakeholders in this step.

3.2.2 Outcomes of Iceland Group Modelling Workshop 2

CLDs created by the 3 thematic groups are as follow:

Iceland Workshop 2 – Results of Thematic Group 1: Agriculture

With two different causal loop diagramming trials, this group focused on food production (Figure 3.4) and food processing (Figure 3.5) with the highlight of the importance of professional knowledge and education on the entire food system.

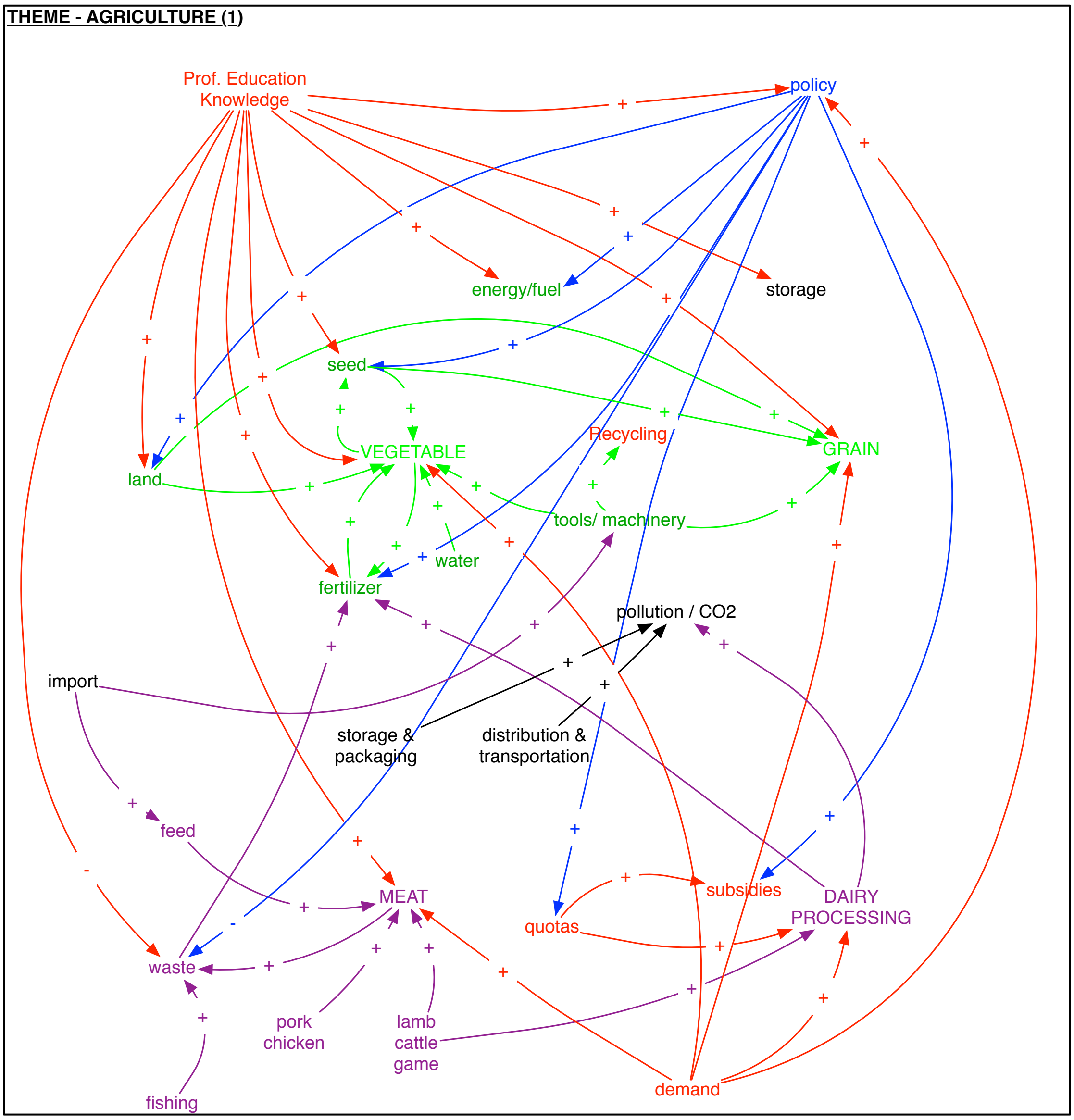

Figure 3.4. Land based food production was already discussed during the 1st workshop (see Figure 2). Based on the knowledge generated in the 1st workshop, the group focused on the production of vegetable, grain, meat and dairy products during this workshop. To grow vegetable and grain there is a need for fertilizer, land, seed, water tools/machineries and energy/fuel. Iceland is hugely dependent on imported fertilizer, oil, seed and tools/machineries. The number of animals (pork, chicken, lamp, cattle, game), feed they get (imported feed for pork and chicken, where as free grazing for others) and the quotas on meat and milk determine how much meat and dairy products will be produced in Iceland. Pollution and CO_2 emissions increase with increased production, processing,

storage, packaging and distribution of food. Production of food is mainly driven by the consumer demand. Professional knowledge and education, as well as the right policies are required to use resources more effectively and sustainably for food production. Waste from fishing industry, for instance, was suggested by the group be used as fertilizer in agriculture, which can reduce the dependency of Iceland on imported fertilizers.

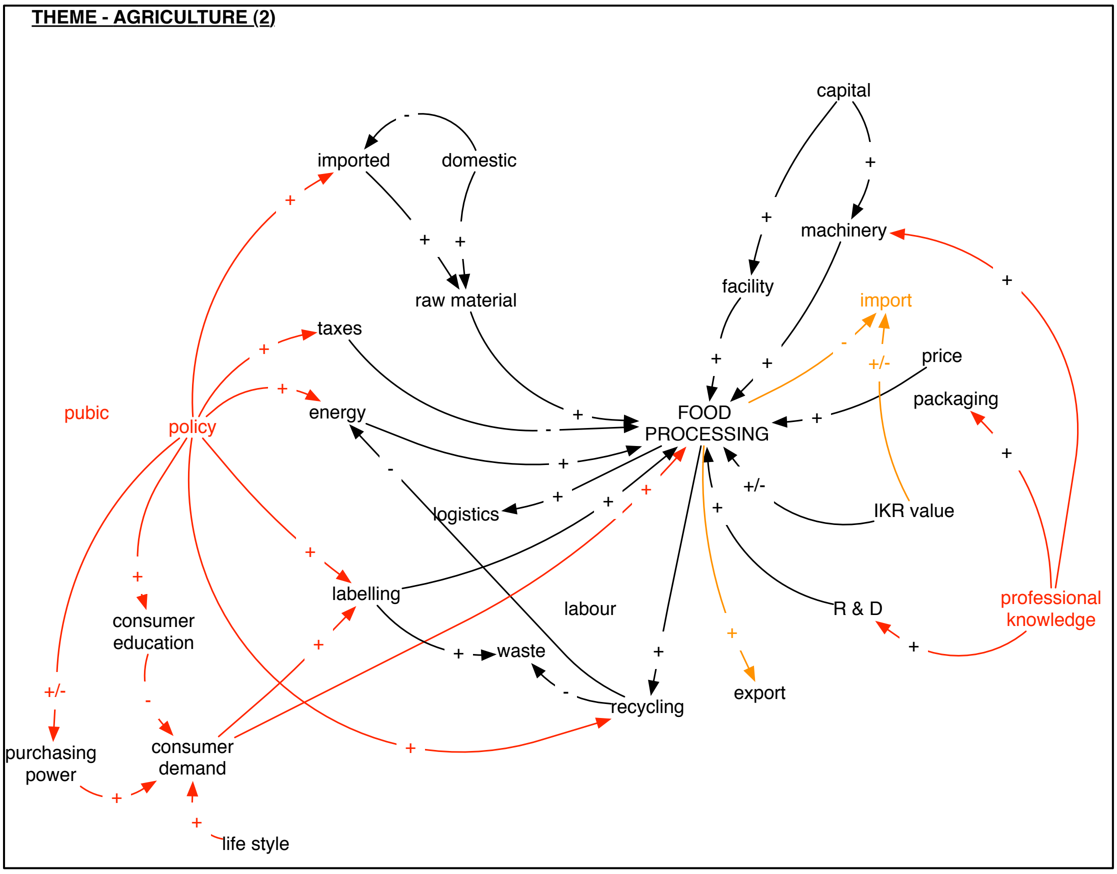

Figure 3.5. The group identified capital (for the facility and the machinery), raw material (both imported and domestic), labour, energy and R&D as required items for the food processing. Like in food production, the main driver for the food processing is the consumer demand, which is driven by the level of education of consumers, their life style and the purchasing power. Right policies targeting on increased consumers' education level and recycling rates of waste were found to be important by the group.

Iceland Workshop 2 – Results of Thematic Group 2: Ocean fishing / Aquaculture

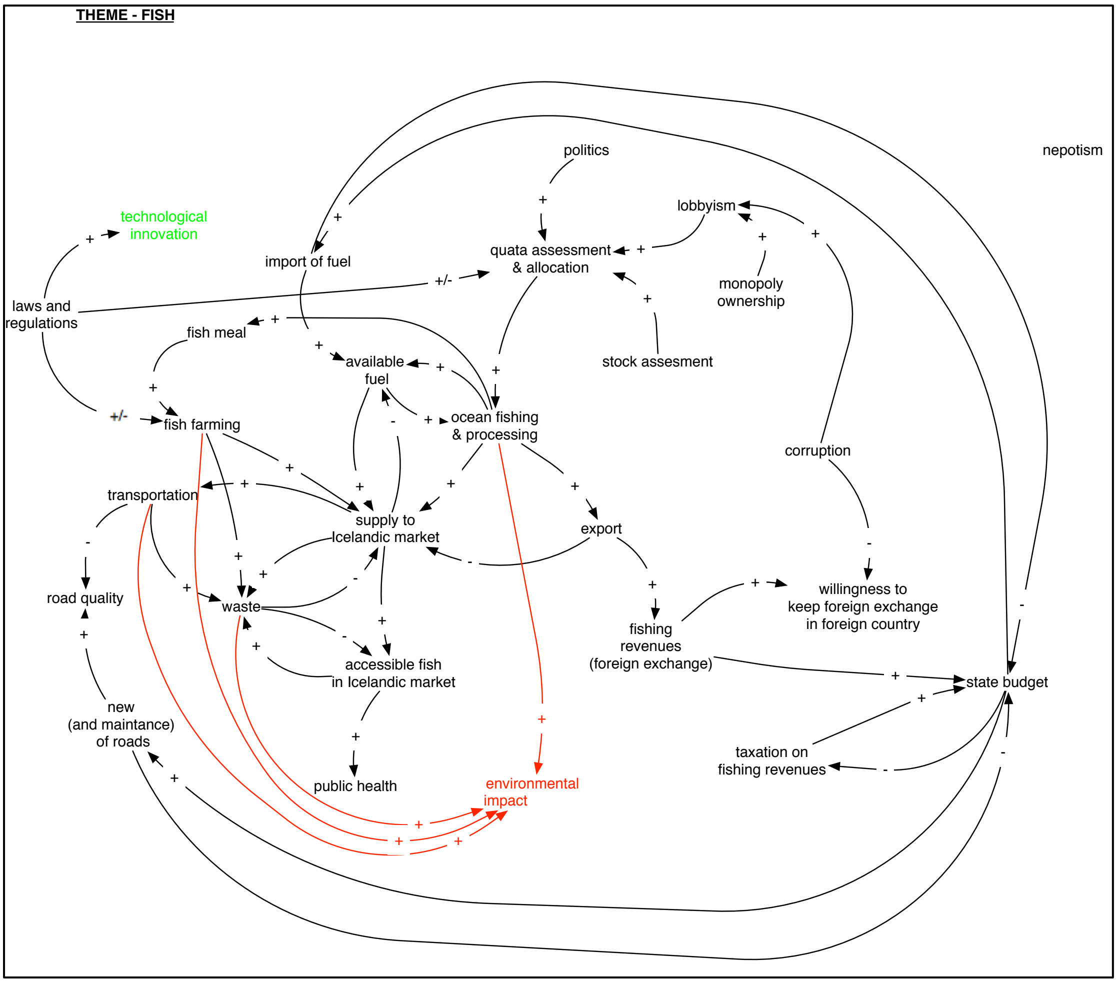

Figure 3.6. Group no 2's discussions focused on the ocean based food production. Ocean fishing, processing and the supply of the fish to the domestic market require imported fuel. Waste is generated and CO_2 is emitted during these phases, both of which have negative impacts on the environment. Consumption of fish has a positive impact on the public health. Waste generated by the fish processing industry is used as fishmeal in fish farms. However, the percentage of fish farming is almost negligible as compared to ocean farming in Iceland. Fishing revenues from the export of ocean fishing, along with the taxation rate on that, determine the inflow of money to the state budget. When the fishing companies prefer to keep foreign exchange in a foreign country rather than bringing it back and pay the tax in Iceland, less money goes into the state budget. What takes money out from the state budget are the import of fuel, and construction and maintenance of roads. The quota on fishing is normally allocated based on the scientific assessments, but there is often a strong lobbyism and political will to increase the quota.

Iceland Workshop 2 – Results of Thematic Group 3: Greenhouse agriculture

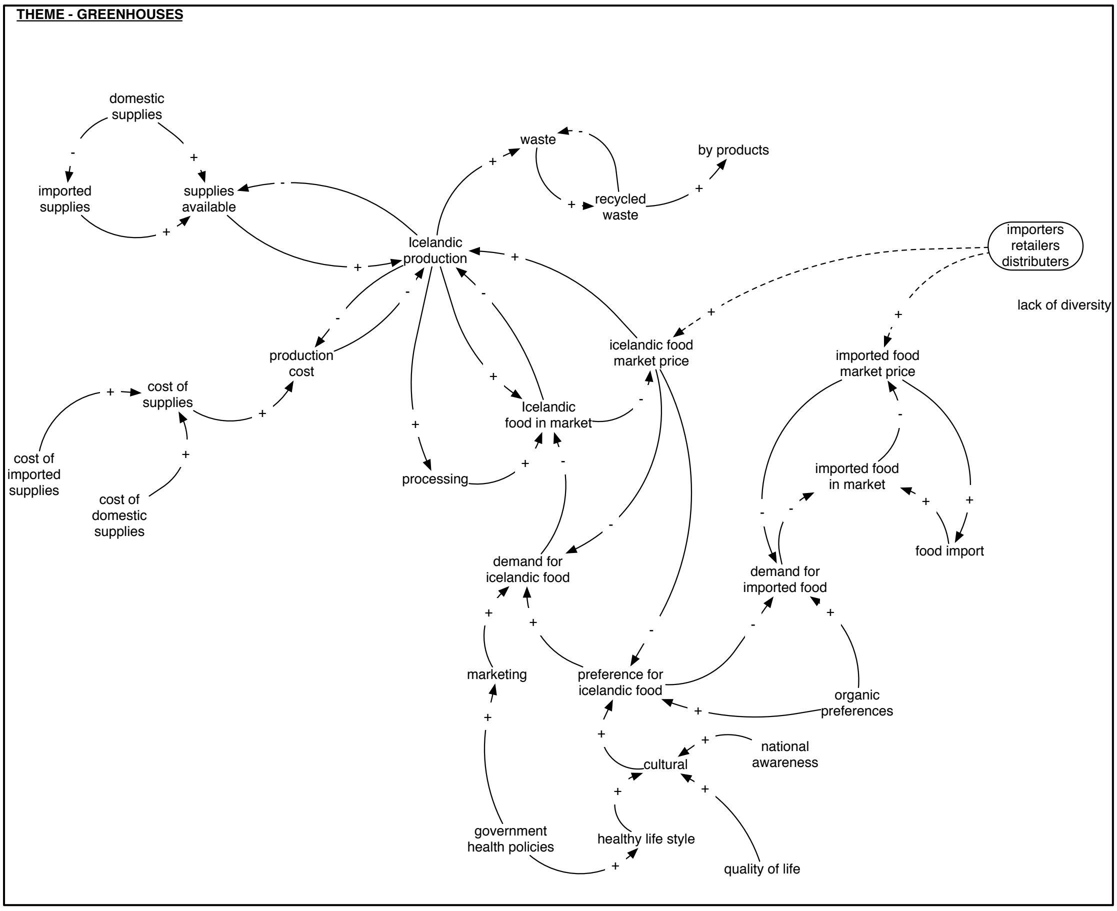

Figure 3.7. Group 3 had a closer look into the food production from greenhouse agriculture in Iceland. With the necessary domestic and imported supplies (mainly oil and fertilizers) the food production increases. With increased cost of these supplies, on the other hand, total production costs get higher, which affects the production in a negative way. The more the food produced and processed, the more will be available in the market and this will in turn reduce the market prices. The group also discussed the impact of the amount and price of imported food on Icelandic food prices, but agreed on leaving them outside the system boundaries. The higher the Icelandic food prices are, the lower will be the preference for Icelandic food and the demand for cheaper imported food will grow. To increase the demand for Icelandic food, the group suggested that there is a need for increased marketing and public preference for Icelandic food. Government's sustainable health policies for a healthy life style, the quality of life and national awareness are some of the cultural factors that can increase the preference for Icelandic food.

3.3 Iceland Group Modelling Workshop 3

During the 3rd workshop, the third step (Confirmation) of phase 1 (Conceptual Modelling and Systems Analysis) was covered.

3.3.1 Implementation of Converge indicator framework in Iceland: Phase 1 – Step 3

Implementation of Converge indicator framework continued with the 3rd workshop.

Phase 1: Conceptual Modelling and Systems Analysis

Step 3. Confirmation

After setting the vision, defining the goals, identifying the hurdles in the previous 2 workshops, the stakeholders had an insight of the existing food system in Iceland. To a certain extent, the stakeholders also came up with potential solutions to overcome the existing problems and have a sustainable food system in Iceland. During the 3rd and the last step of the Phase 1: Conceptual Modelling and Systems Analysis, the stakeholders were expected to continue working with causal loop diagramming methodology. All causal loop diagrams, stock flow diagrams and other sketches generated during workshops 1 and 2 constituted the starting point for the workshop 3.

Having a consensus on the final version of conceptual model

Causal loop diagramming is an iterative process and it requires several iterations before all stakeholders agree on the final version of a causal loop diagram. The stakeholders were divided into two groups and asked to come up with a final version of CLD combining the previously created CLDs during the workshop 1 and 2. The stakeholders tried to identify missing links to close the loops, take away repeated wrong connections, and keep the CLD as simple, yet covering most of the important aspects in the Icelandic food system.

Analysing the loop behaviour over time

One way of checking the reliability of the casual loop diagrams generated is to compare the graphs of Reference Behaviour Pattern (RBP) with Observed Behaviour Pattern (OBP) as previously described in D-18. Due to lack of time, this was not done during the workshop 3, instead the WP3 researchers analysed the loop behaviours after the workshop 3.

Identifying a draft set of convergence indicators

As it was described in D18, ideally, an initial set of converge indicators should have been ready by the end of workshop 3, once all stakeholders agreed on a final version of the CLD showing key components of the sustainable food system in Iceland with linkages, as well as the feedback loops they belong to. However, in Iceland case study, even though there were discussions around potential converge indicators, it was not possible to come up with a proper draft list of indicators. This was mainly due to lack of time. The indicator selection was performed after the workshop3 by the WP3 researchers. (See section 6).

3.3.2 Outcomes of Iceland Group Modelling Workshop 3

Findings of the two stakeholder groups are as follow:

Iceland Workshop 3 – Results of Group 1

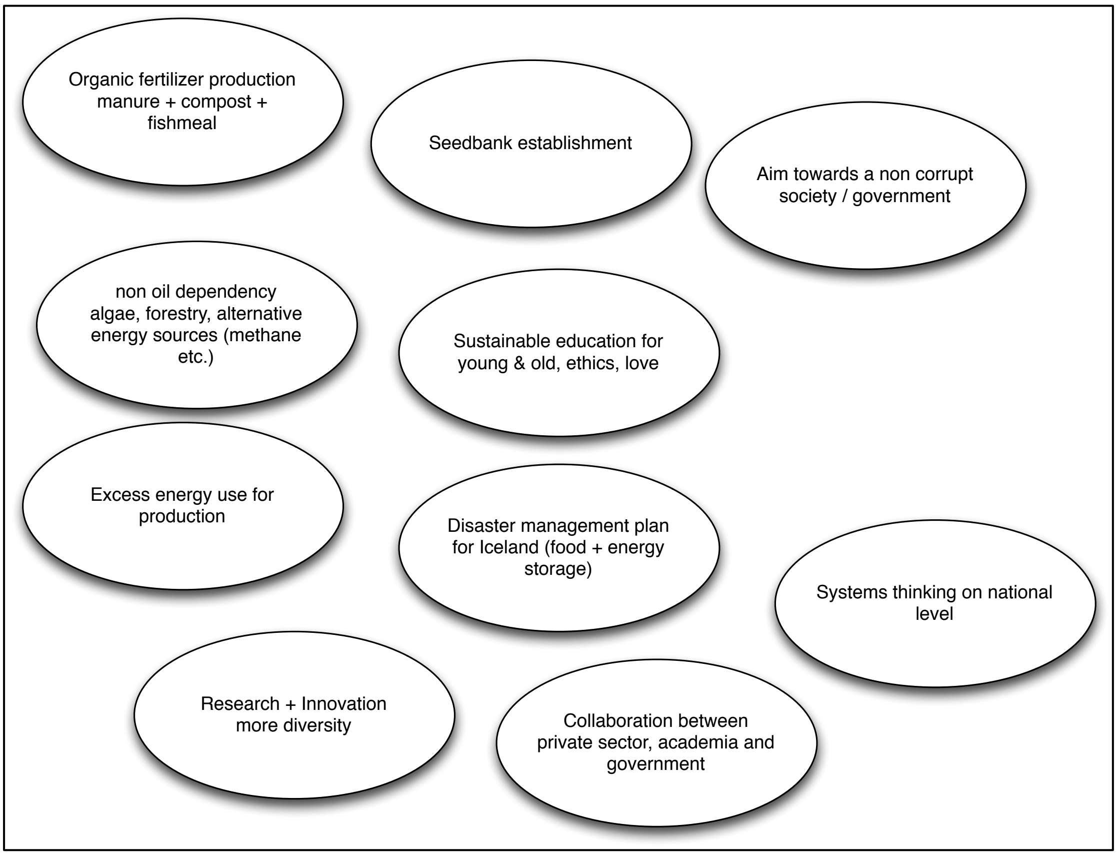

Figure 3.8. Some of the potential solutions proposed by the first group for a sustainable food system in Iceland.

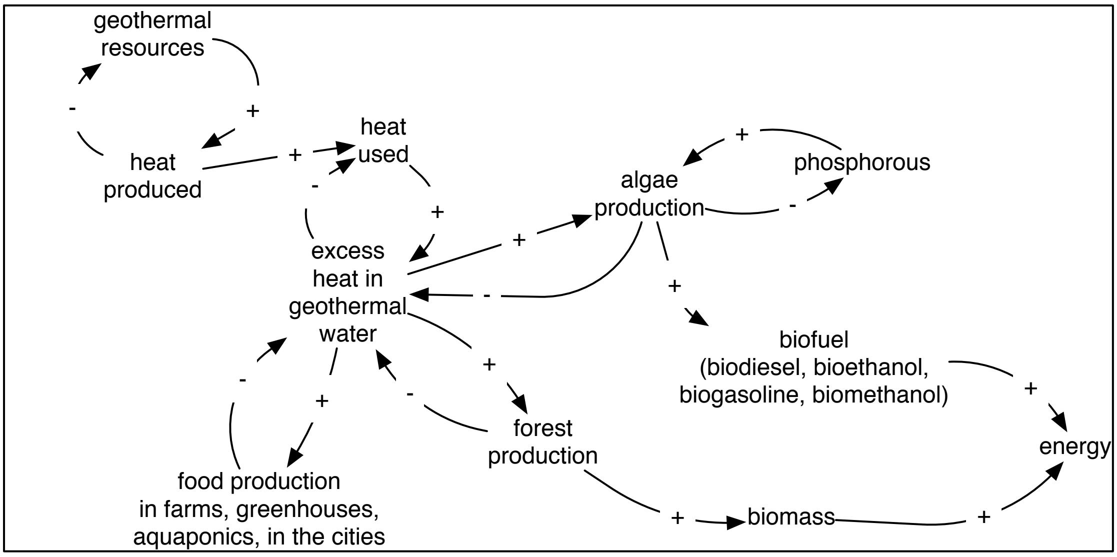

Figure 3.9. When heat from geothermal resources is used, excess heat remains in geothermal water and currently almost all is wasted. The group suggested that this water can be used in food production in farms, greenhouses, aquaponics and

in the cities. A pilot study in Iceland had shown that excess hot water from a greenhouse can be used to heat the soil through pipes and the carrot production increases by 100%. Similarly, excess heat in the water can be used to grow seedlings in forestry and to produce algae. Biomass from algae and forests can be used to produce biofuel and energy, which is of great importance in an imported oil dependent country like Iceland.

Iceland Workshop 3 – Results of Group 2

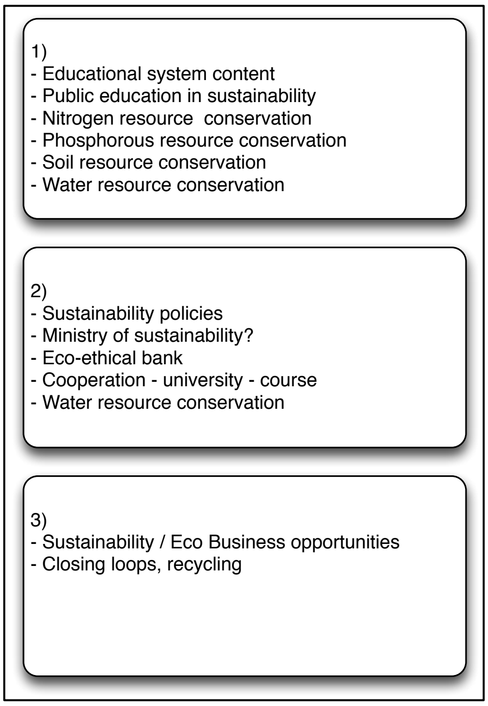

Figure 3.10. Some of the potential solutions proposed by the second group for a sustainable food system in Iceland.

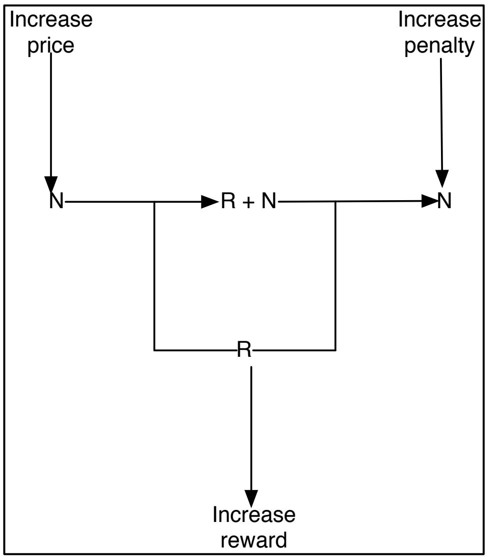

Figure 3.11. Diagram drawn by the second group showing how to encourage people to reuse resources with the example of nitrogen (N). It basically shows that in a system where nitrogen prices are high, and there is penalty on lost

nitrogen and reward for recycled (R) nitrogen, it is possible to minimise the loss of nitrogen and push the system towards a closed one. Such a system can be applicable to any resource including phosphorous, water etc. In this respect, the group suggested that more farming subsidies can be allocated to farmers who recycle more.

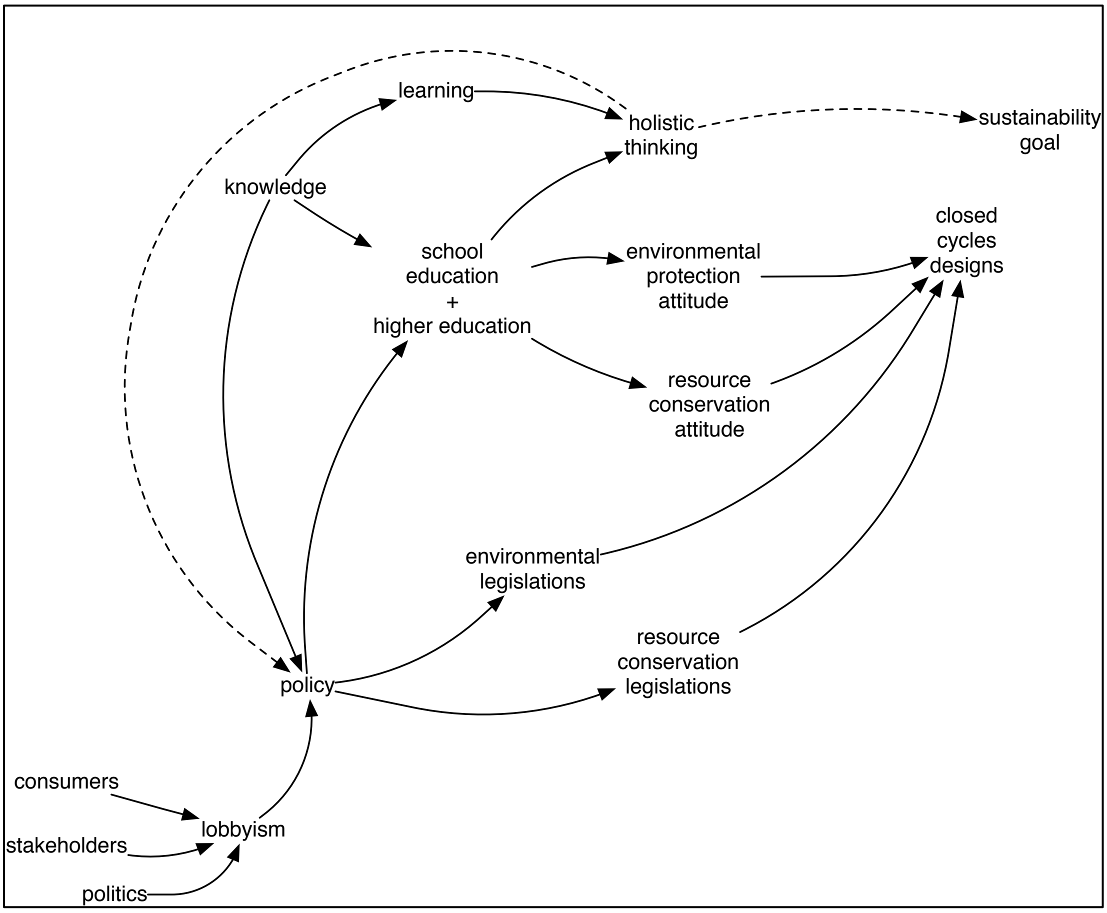

Figure 3.12. In relation to Figure 11, the group discussed the importance of bottom-up movements (arising from stakeholders i.e. consumers, general public, business etc.) in forming policies for closed cycle designs in a sustainable food system in Iceland. Environmental and resources conservation legislations, and an education system that promotes environmental protection, resource conservation and holistic thinking have great importance on forming such closed cycle designs in a sustainable food system.

3.4 Synthesis of the 3 Group Modelling Workshops in Iceland

Through out the three group modeling workshops, the stakeholders exchanged information and developed a good understanding of the sustainable food system in Iceland by applying causal loop diagramming methodology and systems analysis in a participatory manner. All individual diagrams as outcomes of each thematic groups' work were combined into a complex whole as shown in Figure 3.13. The CLD contains a rich amount of information about the key issues and their interactions with each other in the Icelandic food system as discussed during the three group modeling workshops.

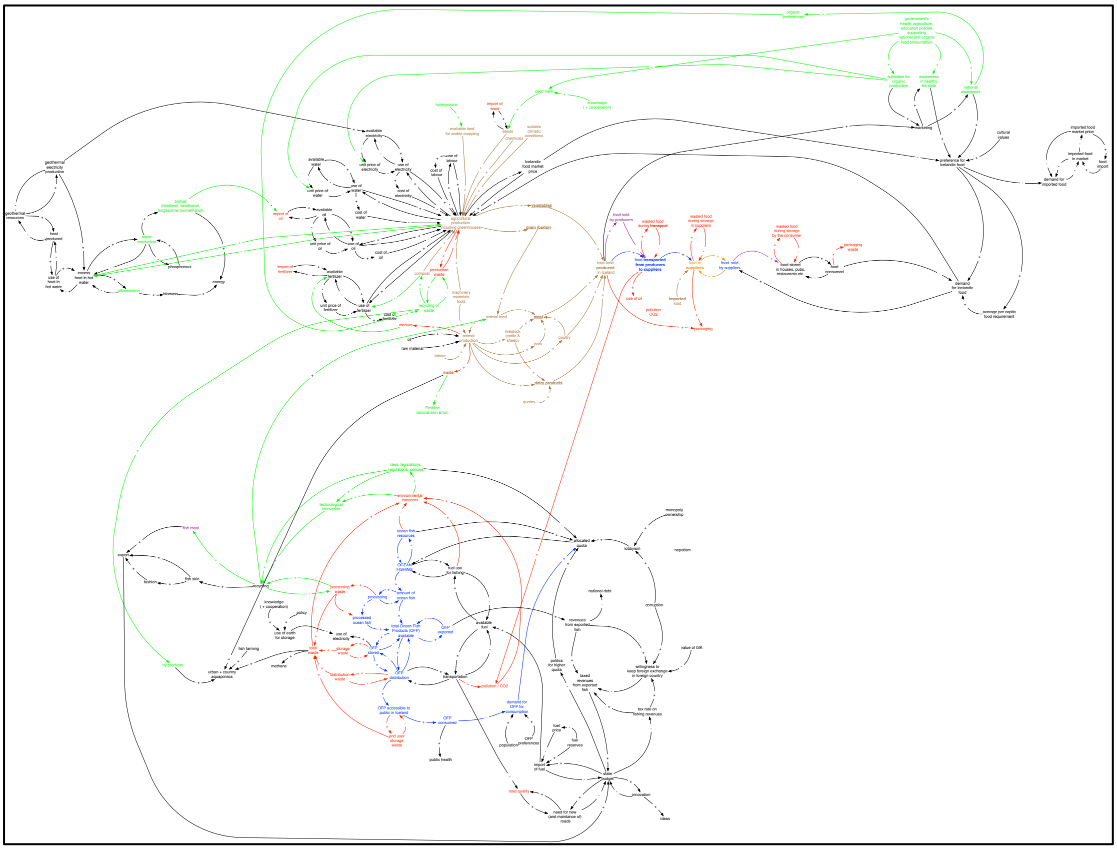

Figure 3.13. The CLD summarizes all the workshop discussions on how the overall food system looks like all the way from natural resources supply for food production (crop, meat, dairy as well as fish products), transportation and distribution to the final consumption phases. Waste generation in all of these phases and the dependency of the whole food system on imported oil seem to be the most important sustainability challenges for the Icelandic food system. The figure also outlines potential alternative policy areas, which target these challenges. Alternative way of energy production from algae and in the long run from forest biomass, use of excess geothermal heat in food production, and waste recycling practices are among the others that were discussed during the workshops.

After the workshop 3, implementation of the Converge indicator framework on Iceland case study continued with step 1 (Model formulation) of Phase 2 (Dynamic modelling and integrated scenario analysis). During this step an attempt was made to build a dynamic model for the Icelandic case study based on the conceptual model developed and a first version of D19 – Models that enable decision support for complex multi-dimentinal policy strategies – was submitted. However, it was realized at this stage that there was a lack of case specific data, which was required to run the dynamic model that had been developed. Generally, main reasons behind the lack of data include:

- it is not possible to measure some parameters;
- some parameters are not measured due to lack of knowledge;
- some parameters are measured but not shared (or partly shared if paid)

Under these circumstances and after consultations with the project coordinators, WP3 decided not to continue with dynamic modelling of the specific food systems in particular case studies (Iceland, Bristol-UK and Tirunelveli-India), rather focus on the dynamic modelling of the key natural resources that are common to the all case studies and have crucial impacts on the food system on global level. Thus, WP3 performed dynamic modeling studies looking at key minerals and metals in food production and supply chain. The results were provided with seven extra deliverables replacing the final version of D19.

4 Working Methodology for Converge Indicator Framework – Bristol-UK Case Study

4.1 Bristol Group Modelling Workshop 1

4.1.1 Implementation of Converge indicator framework in Bristol: Phase 1 – Step 1

Implementation of Converge indicator framework on Bristol food system started with the 1st workshop covering the first step (Definition) of phase 1 (Conceptual Modelling and Systems Analysis) of the framework. Following a series of lectures and exercises aiming for the capacity building of stakeholders in converge and sustainability (as described in detail in D35), the stakeholders started the group-modelling process.

Phase 1: Conceptual Modelling and Systems Analysis

Step 1. Definition

Defining a vision, building blocks (components) of the vision/goals/milestones

First, the stakeholders were asked to identify a vision of sustainable food system in Bristol and to elaborate on how the system will look like when that vision has been reached. It was reminded the stakeholders that the vision should be in line with converge, where ecological limits to growth are recognised and equity at a global scale is valued. Second, the stakeholders were asked to define the building blocks (components) of the vision, the goals and the milestones. Having clear vision, its building blocks, goals and milestones the workshop facilitators aimed to avoid unnecessary discussions among the stakeholders, while defining the problem(s), analysing the system and identifying the potential key indicators during the next steps.

Defining the problem

The very first step of most common problem solving approaches is to identify the problem(s). By taking into the stakeholders' perspectives, the workshop facilitators asked the question "what are the obstacles on the way to reach a sustainable food system in Bristol?" to state explicitly the purpose and objectives of the modelling process. Potential hurdles and obstacles to reach the goals and the vision were discussed and identified among the stakeholders.

Setting the system boundaries

Based on the vision and problem definition the temporal and spatial system boundaries were set.

4.1.2 Outcomes of Bristol Group Modelling Workshop 1

During the 1st workshop in Bristol, the stakeholders were divided into three groups to start working with the vision of "Sustainable food system in Bristol".

They were asked to identify and note building blocks and goals of the vision, as well as potential obstacles and hurdles on the way reach the vision and the goals. They were also asked to use illustrations to show how different components of the Bristol's food system are interlinked to each other. Tables given below summarize each of the groups' work with overlaps between them. It should be noted that the tables present the views of the individual groups and not interpretation of the results by the researchers. It should also be noted that at this very early stage of the group modeling process, the stakeholder were not expected to come up with fully correct causal loop diagrams. They were free to use figures, flow charts, causal loops to express their understanding and show the interlinkages between different components of the food system in Bristol. All information from individual group's work were noted at this stage and synthesized later by the WP3 researchers (see section 4.4).

Bristol Workshop1 – Group 1 results

Table 4.1

Vision of sustainable food system in Bristol	Building blocks	Hurdles
Make use of existing rail network	Food policy + projects Council with teeth	Traditional business interests (insufficient incentives for change)
Ecologically produced and supplied locally	Local food economy (local currency supported, employ + skills, infrastructure, land	Local government's need for control "business as usual". Won't hand over land to projects
Fair trade at home and overseas	Ecological foot print of food items Percentage local/nonlocal Clearly defined and communicated	Local food supply vs local food demand (chicken and egg)
Different ethical brands / local brands (utilize this to support a movement)	Social movements • Community food groups • Advocacy, knowledge transfer • Civic pride Grassroots become a political force	Currently wholesale fruit and vegetable supply is dwindling!
Participation in a local movement	Clear city leadership • Public and private work together for public good	Gap between talk (strategy + policy) and action

	• Clear collaboration with 3rd sector and grassroots Beacon for local food	
Local currencies (recovery pound, black pound)	Branding / marketing / consumer awareness Clear localized brands linked to sustainability and social justice	
Seasonal food (accepting less choice)		
Economic opportunities for local business		
Farming support and education future farmers with farming skills		

Bristol Workshop 1 – Group 2 Results

Table 4.2

Vision of sustainable food system in Bristol	**Building blocks**	**Hurdles**
Local food	Local diversity in high streets	Fragmented waste collection and distribution
Cooperative infrastructure	Public contracts choosing local suppliers	Existing waste contracts "boxed off"
Ability to feed everyone	"Compulsory" Food education (eg. visits to food production facilities)	Common agriculture policies
Fair trade	Access to public land	WTOs
Low carbon	Community eating mentality	Single European markets
More people in food production	Integrated local distribution	Cheap foods from abroad
Low reliance on fossil fuels	Diverse crops and species	Framework agreements
Low use chemicals	National industrial	Privatization of public

	symbyosis	land
Equitable shares	Small scale local food days (eg. Celebration of apples) neighborhood partnership	Central distribution
Inclusive	Better access to information	Limited species (monoculture)
Equitable access to market by producers	Representation of all areas of society (inclusivity)	Consistency price of product
Well informed and real connection with food – making it real		Lack of sign up (lack of recognition of sustainability)
Resilience in face of extreme weather event (flood, wind, rain, drought). • More robust soils • Food storage • Use of varieties which are though Better seasonal weather forecasting (for better planning strategies)		Lack of transparency (poor access to local and national government)
Edible landscapes including buildings		Lack of general power of local government (misunderstanding)
Good soil (minimal ploughing, composting, active rotations, green manures)		
Highly regulated – economically. (how food comes to the market place)		
A balanced and varied diet for all		
Carnivores valuing meat production		
Self organized		
Permaculture principle (biodiversity, closing the loop)		
Attract participation		

through action

Bristol Workshop 1 – Group 3 Results

Table 4.3

Vision of sustainable food system in Bristol	Building blocks	Hurdles
Organic • localness, Britishness (story of where it comes from) principled values, naked food (less packaging)	Organic / non-conventional farming (crop rotation, environmental building blocks, farmers)	Realize the change
More vegetation less meat	Infrastructure (markets, vegetable boxes, local currency, transport system eg. bus lanes for food)	Transport, distribution, logistics
Localize " shake the hand that feeds you"	Community development (network- social enterprise, small businesses)	Regulations in farming and producing
Interconnected transport (pick up points, food hubs, buying groups)	Food culture in communities (meals, cooking from scratch)	Barriers to get started: usually money in farming and in general (capital), possibilities for people to get involved / to find connection to food
Efficient	Health	Too less investment in food enterprise. Only small amounts needed for the start
Diverse	Education (through doing, schools playing a role: cooking, production)	Disconnection (branding) between producers and consumers (ideological and geographical). Between ideas and actions = convenient consumption. We need to make other forms than supermarkets convenient
Community development	Policy (land reclamation, plan from	Employment in the agricultural sector =

	toher/older societies)	British employees are hard to find
Advertising and marketing for sustainability brands	Investment (time, money, human resources)	Using the existing potential, interest, engagement people show
	Collaborative consumption	Not easy for companies to invest into sustainable development. Should be more approachable
		Profit margins are vey small in food industry = food is too cheap
		Power of supermarkets

Bristol Workshop1 – Results of Thematic Group 1: Food Production

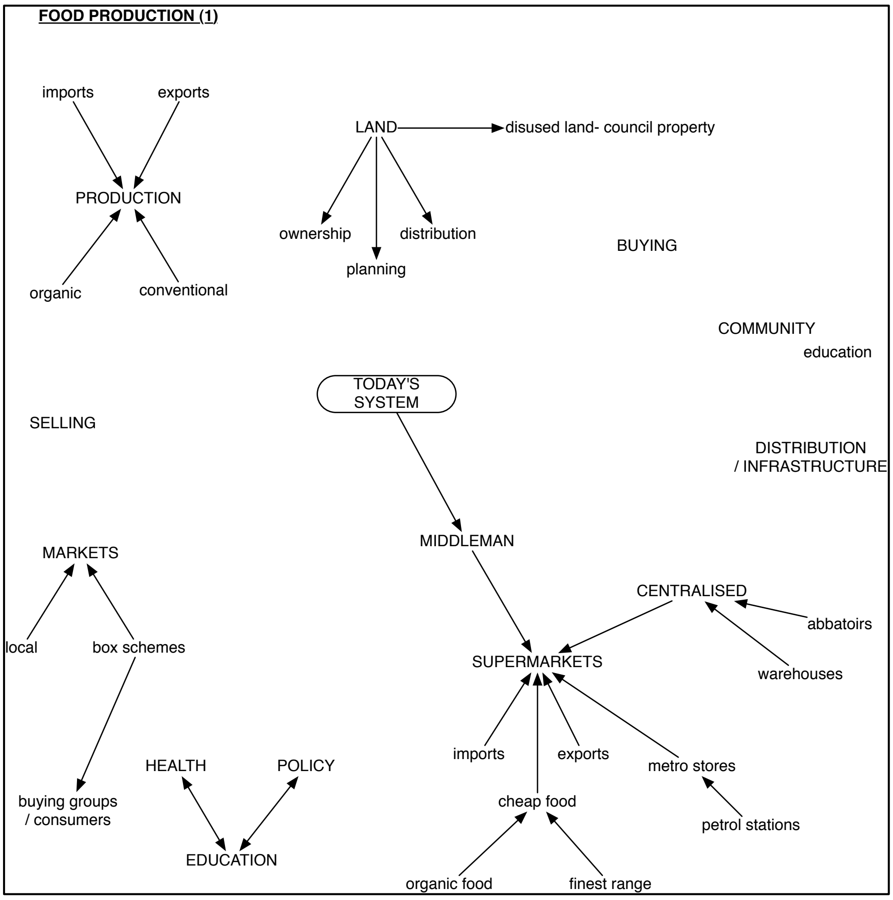

Figure 4.1. Thematic group 1 started the group modeling process with brainstormings around how food is produced locally (both organic and conventional way), and together with flows of imports and exports how the total production can be determined. Various food distribution channels, as well as the

importance of health, education and policies on a sustainable food system were explored during the discussions in workshop 1.

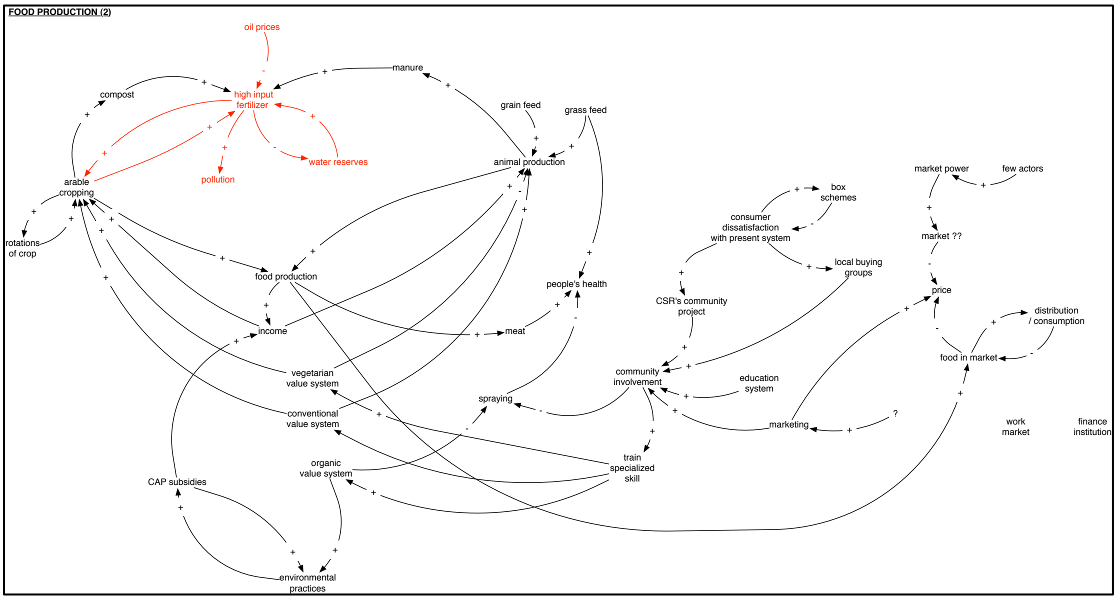

Figure 4.2. In their second sketch, the thematic group 1 looked deeper into the food production. The group identified arable cropping and animal production as the two main components of food production in Bristol. Extensive use of fertilizers in crop production and the problems associated to that (e.g. soil and water pollution, dependency on oil etc.) were discussed. Use of both compost from crop production and manure from animal productions as natural fertilizers were suggested as two practices to minimize the use of oil based fertilizers. The impacts of vegetarian, conventional and organic value systems on food production were also discussed. With increased levels of education, the community can be better informed and get more involved in food production, which can result in increased training of specialized skills in food production and implementation of better environmental practices.

Bristol Workshop1 – Results of Thematic Group 2: Logistics and distribution

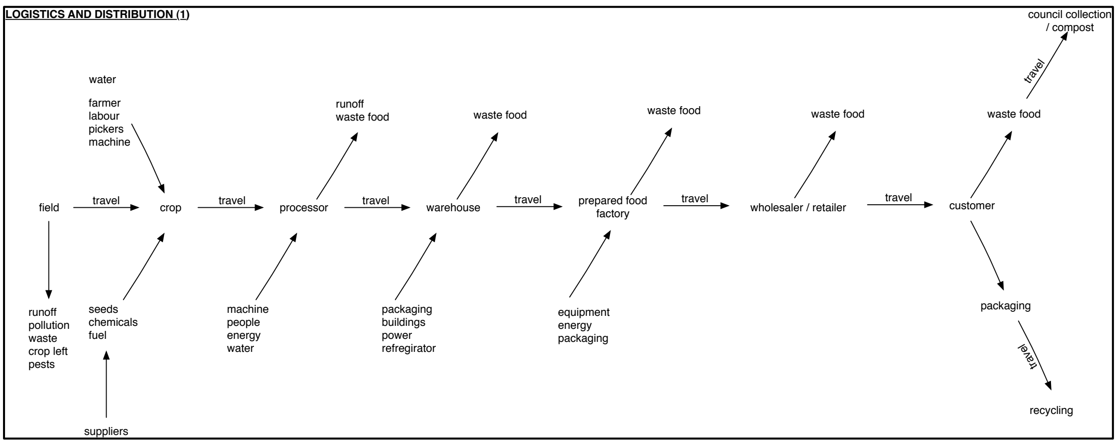

Figure 4.3. Thematic group 2 first looked at the logistics and distribution of food in Bristol with a flowchart showing how food travels all the way from field to fork.

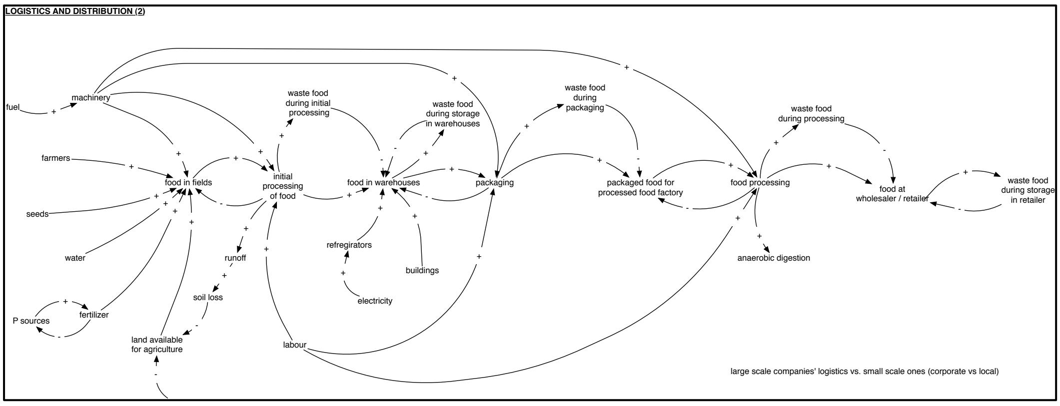

Figure 4.4. With a causal loop diagram, the thematic group 2 tried to show linkages in the local food production - supply chain. The CLD shows how resources like fuel, machinery, farmers, seed, water, phosphorous and land are required to produce food in the fields. Once the food is produced it is then processed, stored, packed and transported. The more the food production and processing, the more will be the waste generation and the use of resources through out these phases.

Bristol Workshop1 – Results of Thematic Group 3: Consumption and values

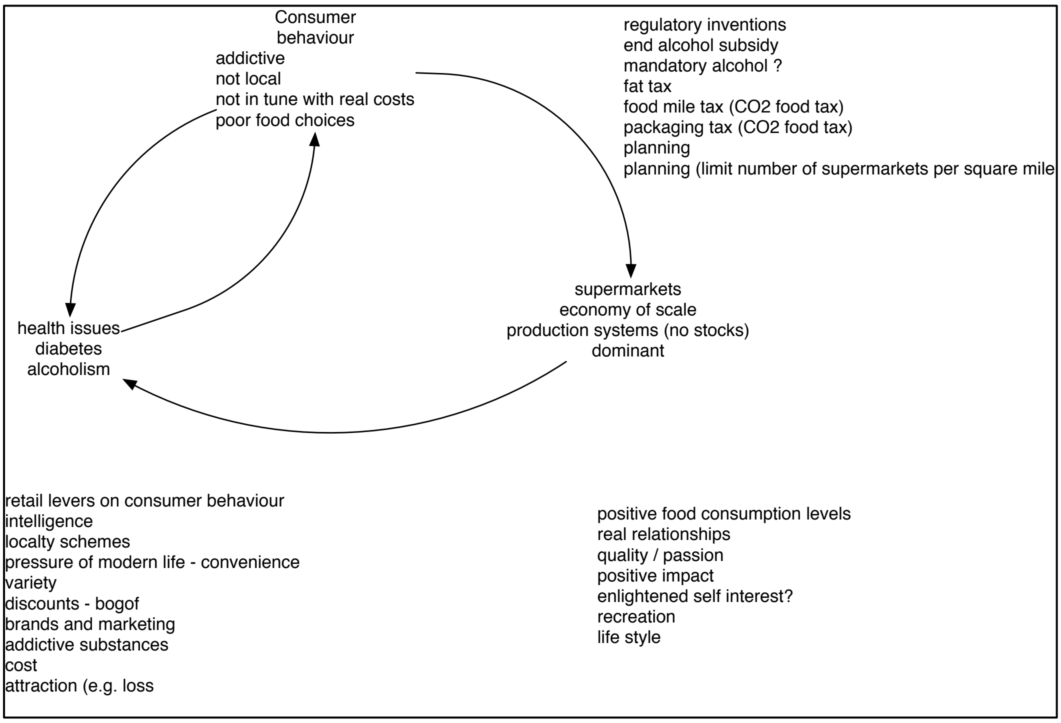

Figure 4.5. Thematic group 3 explored the consumers' behavior in the food system. The group discussed how the behavior of consumers is driven by retailers and how it effects the food production and consumption. The group agreed that big supermarket chains are the biggest and the most dominant processors of consumer behavior. These supermarkets (even if they are unethical or bad retailers) are driven by the economy in the form of branding, wide choice of products, discounts and selling products containing addictive

substances (i.e. sugar, coffee etc.), which have severe negative impacts on the society in Bristol (i.e. supermarkets taking over the market and putting smaller retailers out of business, health issues etc.). The group also discussed alternative measures to change the behavior of retailers i.e. introducing a mandatory tax system on CO_2.

By the end of the workshop 1, the stakeholders started to have a systems insight to how the food system in Bristol looks like today and how the sustainable food system should ideally look like in the future.

4.2 Bristol Group Modelling Workshop 2

4.2.1 Implementation of Converge indicator framework in Bristol: Phase 1 – Step 2

Implementation of Converge indicator framework continued with the 2nd workshop, in which the second step (Clarification) of phase 1 (Conceptual Modelling and Systems Analysis) was covered. A CLD synthesizing the main outcomes from the 1st workshop was presented to the stakeholders to serve as a starting point for the continuation of the group modeling process.

Phase 1: Conceptual Modelling and Systems Analysis

Step 2. Clarification

The aim with this step was to bring all stakeholders together for discussions and exchange of information with each other to develop a better understanding of the sustainable food system and its components in Bristol. In this step, the stakeholders were introduced to systems thinking, systems analysis and causal loop diagramming concepts.

Listing relevant system components and identifying the key ones

Having the vision, goals, obstacles defined and the system boundaries in mind from the previous workshop, the stakeholders were asked to create a list of all components forming the Icelandic food system. The stakeholders were then asked to list these components in the most relevant and important order in order to identify the key ones.

Identifying the interlinkages between the key components and building a conceptual model

The stakeholders were divided into four thematic groups to analyse the three sectors in the food system:

1. Consumer choices
2. Economy
3. Health
4. Supermarket logistics

Causal loop diagramming was used as a "common language" among all the stakeholders with different backgrounds. Stakeholders built causal loop diagrams identifying the interlinkages, cause effect relations, and the reinforcing and balancing feedback loops between the key components of the food system within these themes.

Having systems insights

During the workshop 2, the stakeholders started to see the bigger picture with a holistic manner. They understood how todays' food system looks like and how the desired future system should look like by starting to use causal loop diagrams within an iterative process. Some potential solution options and proposals were suggested by the stakeholders in this step.

4.2.2 Outcomes of Bristol Group Modelling Workshop 2

CLDs created by the 4 thematic groups during the 2nd workshop are as follow:

Bristol Workshop 2 – Results of Thematic Group 1: Consumer Choices

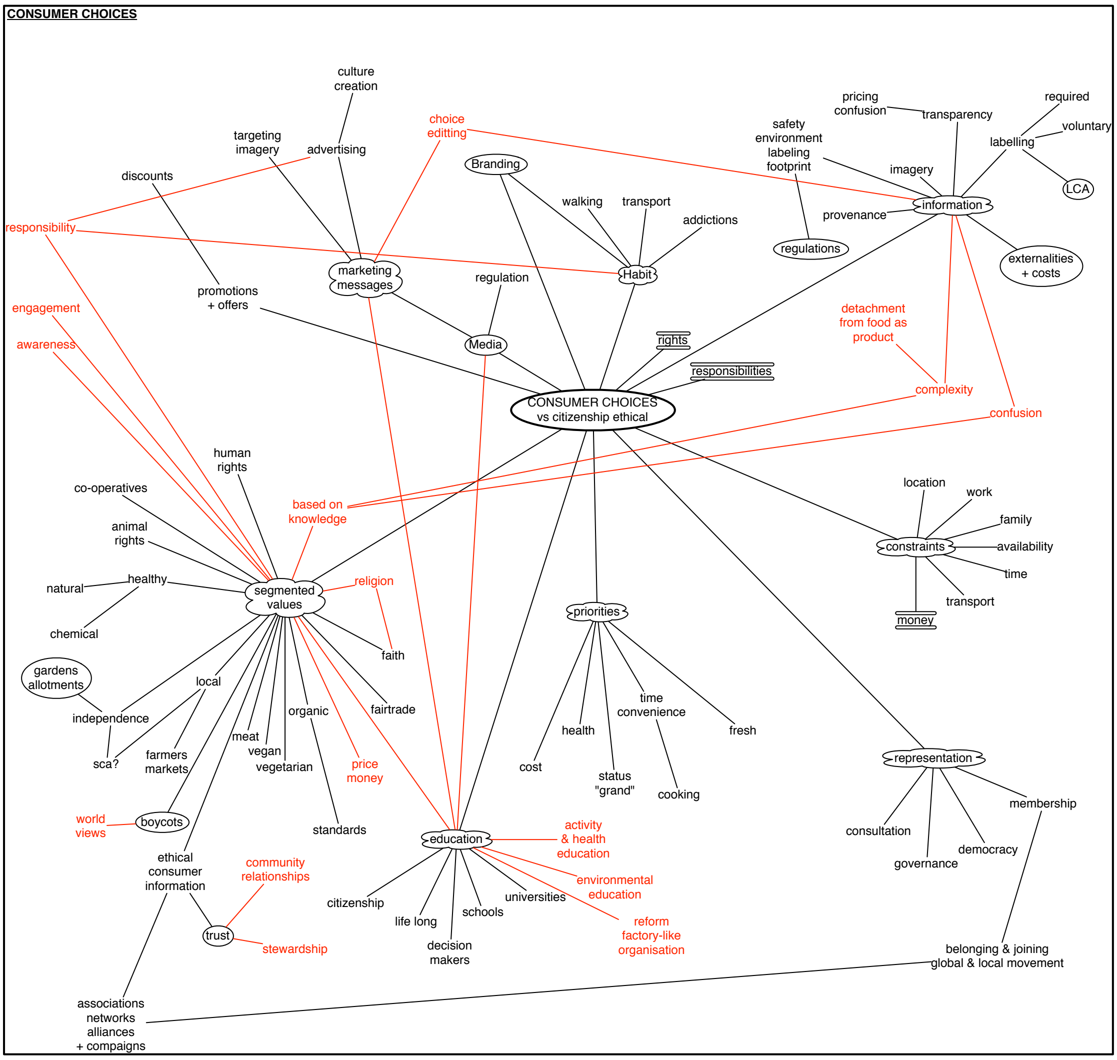

Figure 4.7. The thematic group 1 explored issues around consumers' choices. They looked at how segmented values, education, priorities, representation, constraints, information, habits, marketing are linked to consumers' choices. The group moved in a fragmented way around the food value chain, and discussed a variety of issues like trust, human rights, citizenship, issues around schools, cooking, cost, democracy, governance, regulations, price and confusion in transparency, branding of food, addictions and media. The group highlighted the importance of marketing in the food system and its role on creating a culture to capture passive consumers.

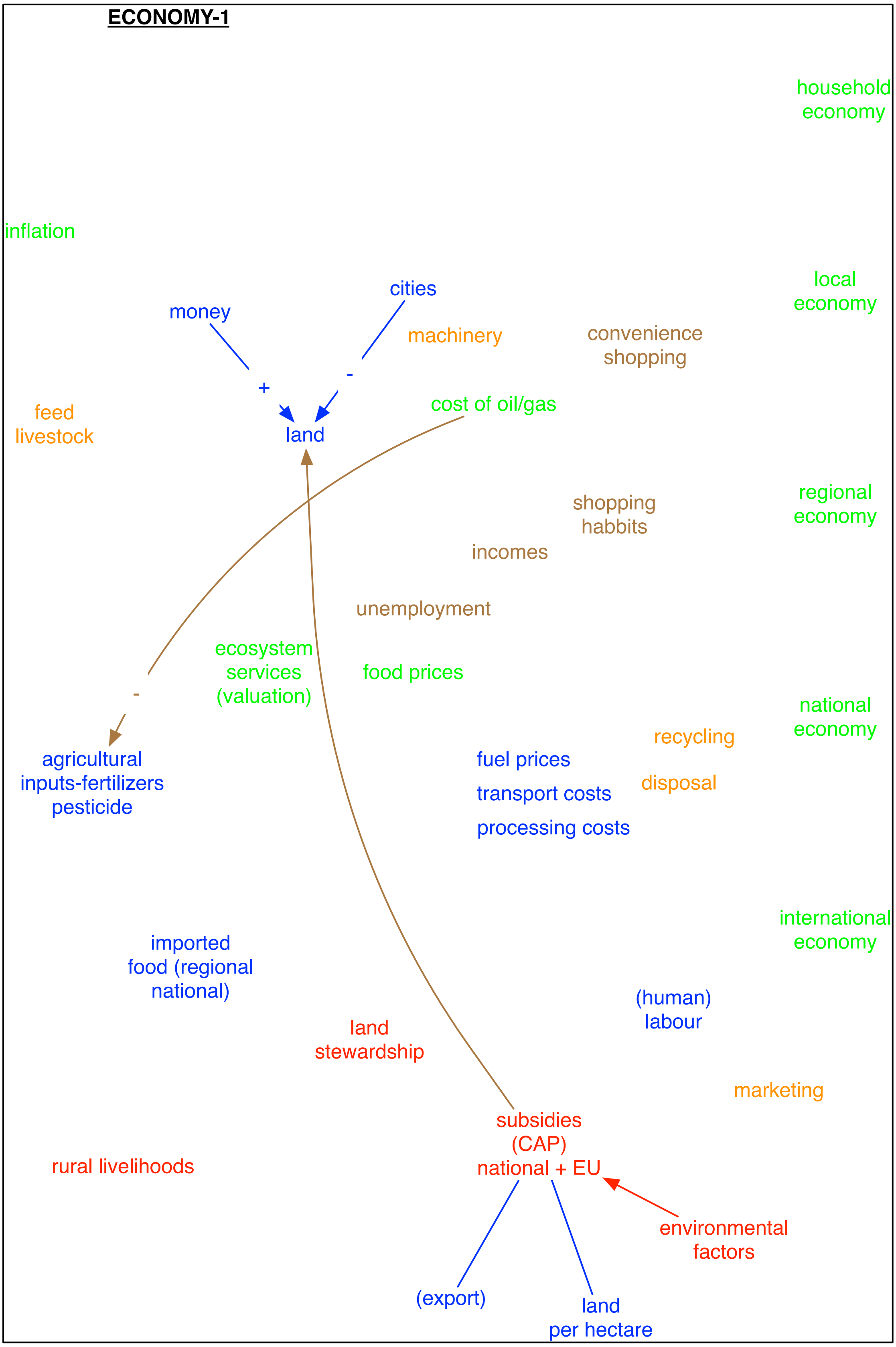

Figure 4.8. Thematic group 2 looked at money, inputs and outputs for Bristol. They grouped down household economy, local, regional, national and

international economy. There were also discussions around farmers' subsidies fuel prices, transport and processing costs. The group identified land as biggest cost and liked it with subsidies. It is difficult to get into farming without the capital for land. This is the reason why most young farmers do tenant farming.

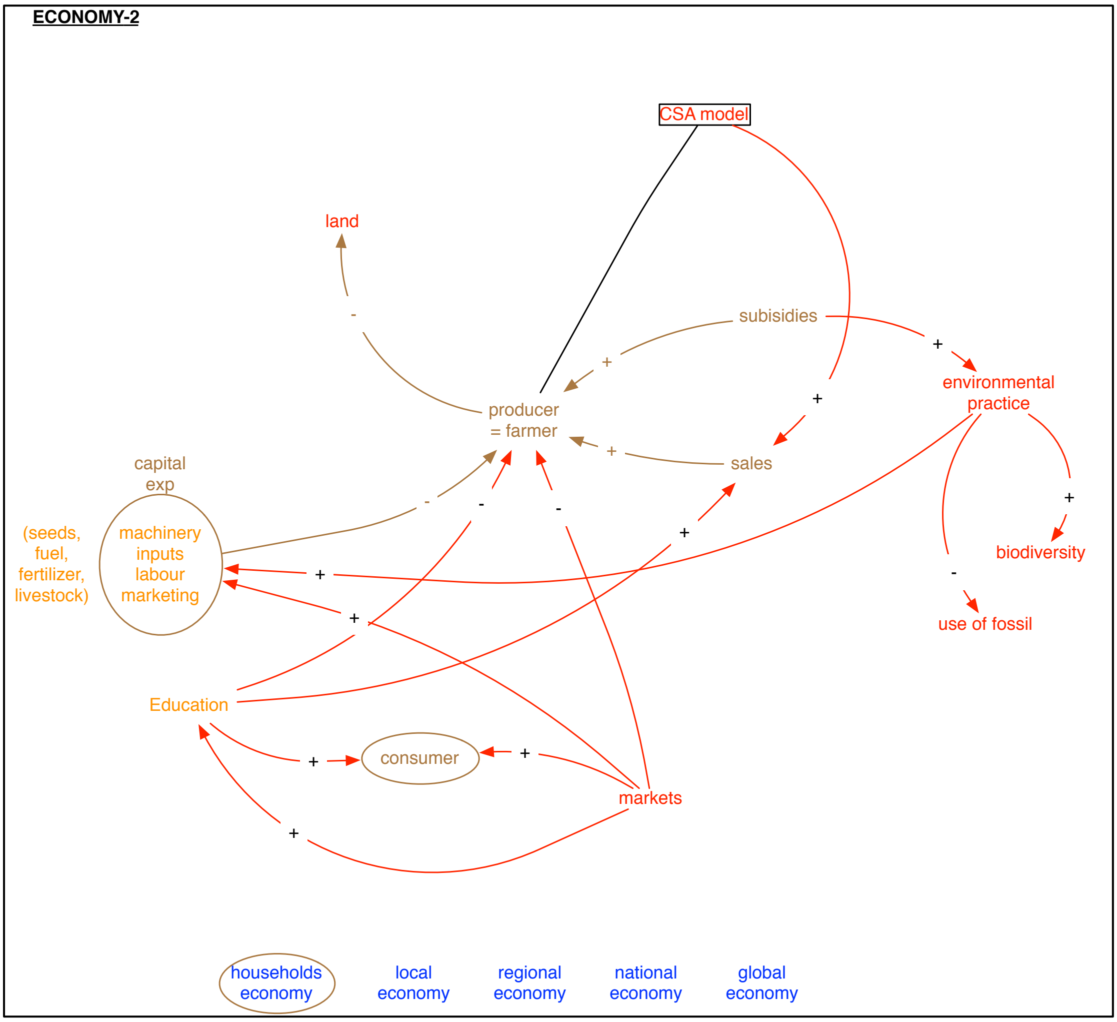

Figure 4.9. The group agreed that every farm or producer gets a huge amount of subsidies that could be linked to biodiversity and environmental practices. Without the subsidies the risk for going bankrupt is high. They also discussed that the farmers cannot be left to the market. The market doesn't govern things such as the landscape, whereby the beautiful countryside would be lost if it was all turned over to intensive agriculture.

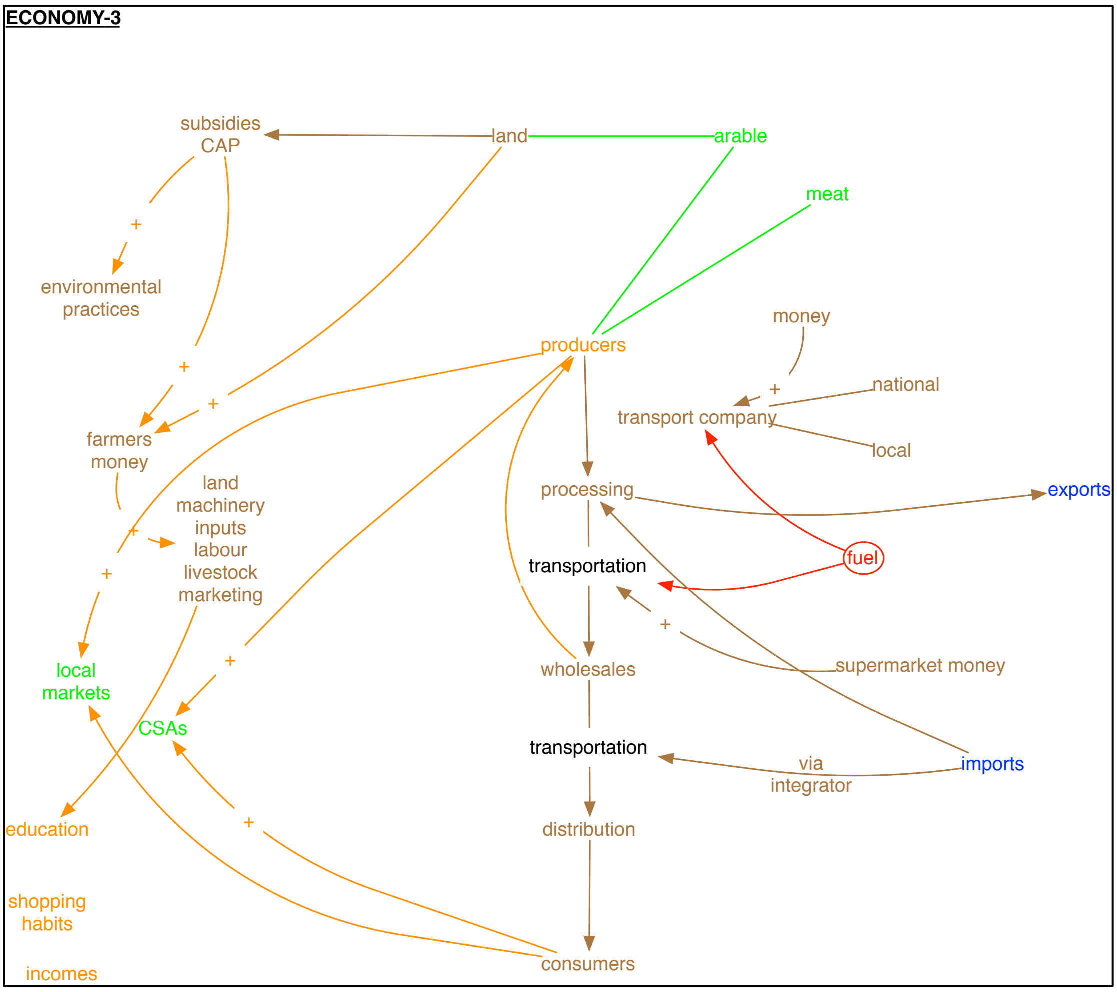

Figure 4.10. The group had more discussions around the Community Supported Agriculture (CSA), in particular the farmer's role. The consumer can buy from the farm directly and then get a relatively cheap product. As for labour, some CSA's use volunteers but a reflection was that one can seldom rely on volunteers. The group discussed the flow of money into the farm, land and machinery, fertilizers, fuel and labour.

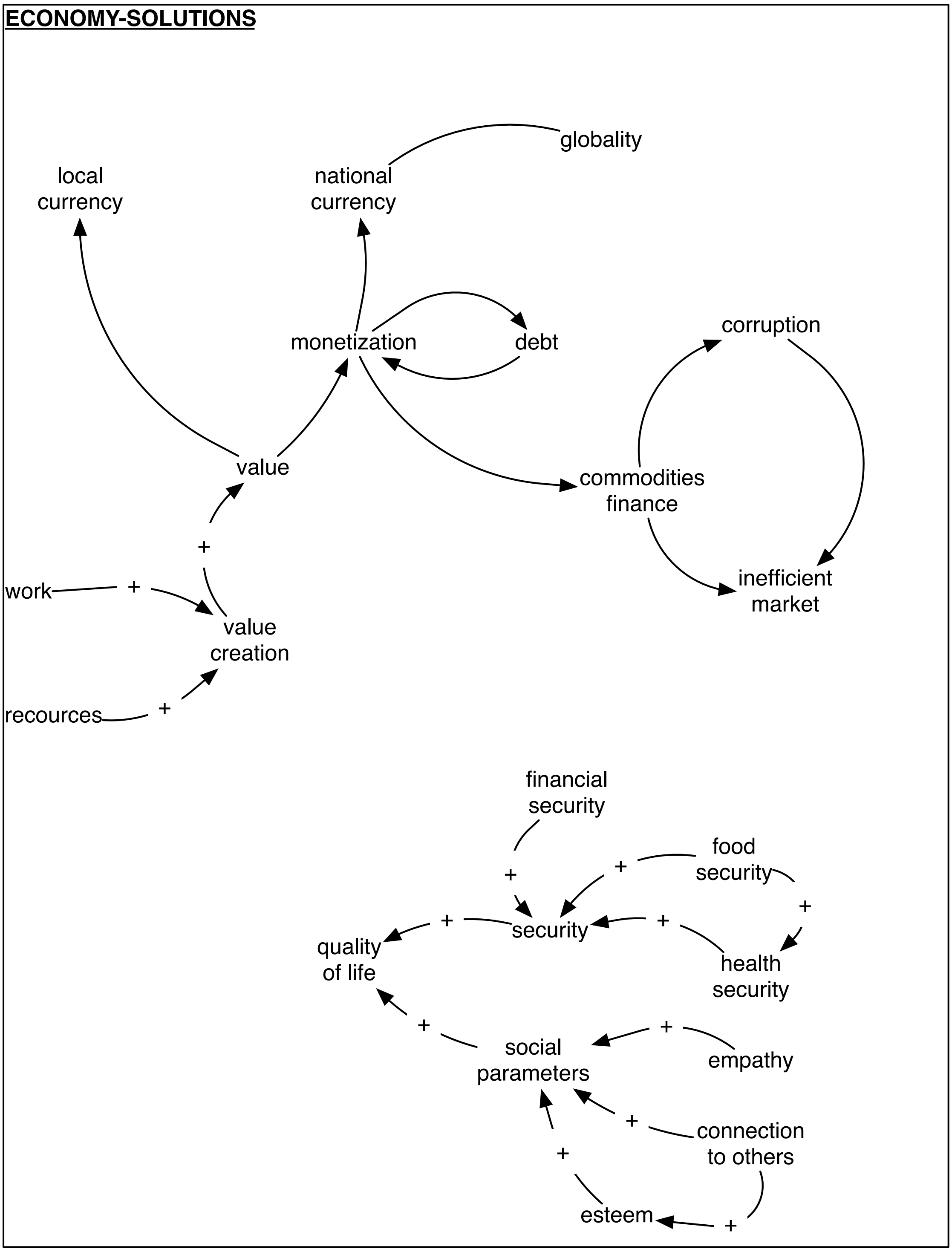

Figure 4.11. The group had discussions on local finance and local money, money systems on large national level and on a global level. They also discussed how money is created based on our ideas of the economic system and it is not held rigidly in reality. They also had discussions around how corrupt system can be perfectly legal. The group looked at issues on health as well as food security, which will be affected by the natural resource scarcity and increased costs of resources on the food sytem.

Bristol Workshop 2 – Results of Thematic Group 3: Health

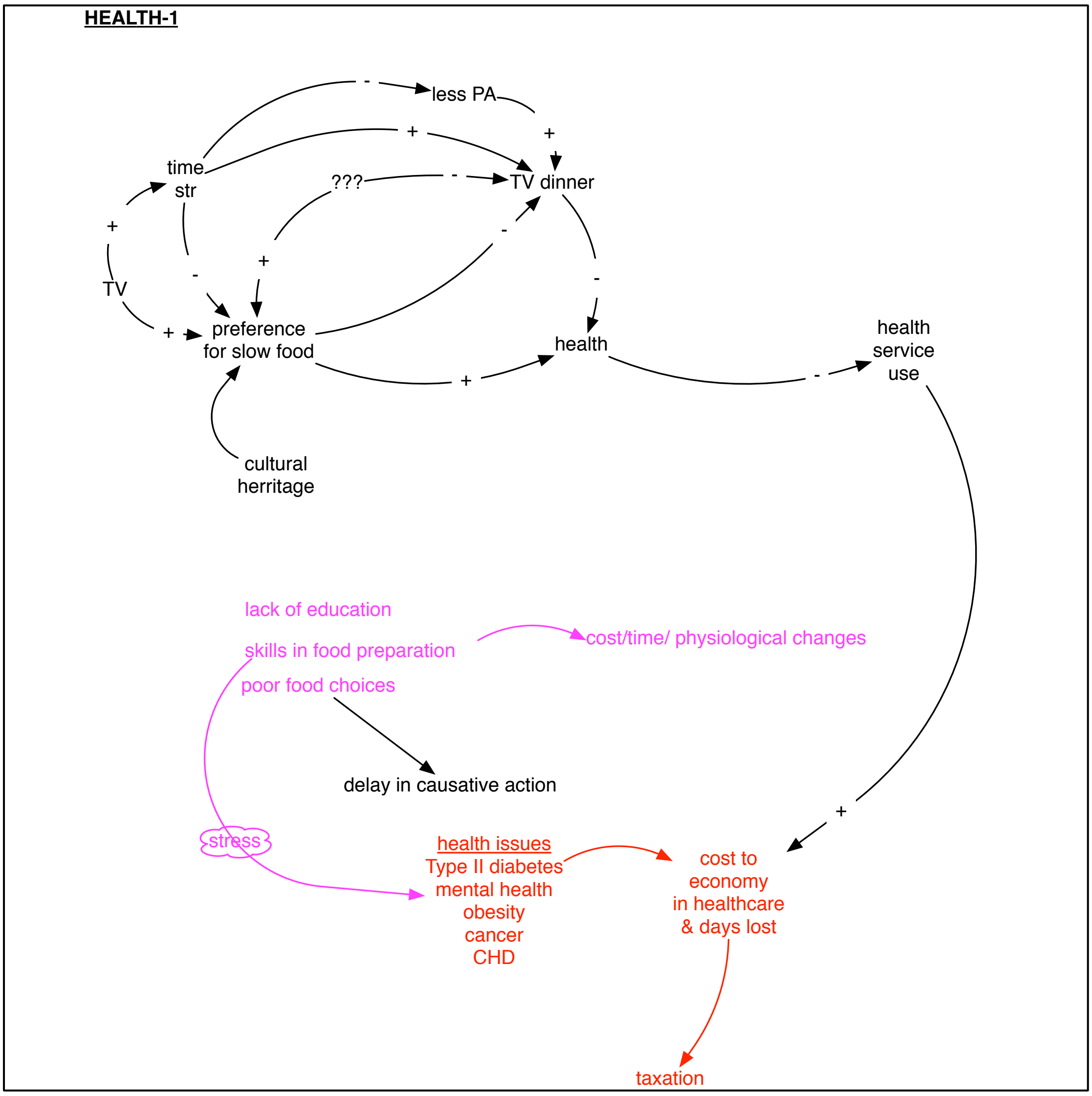

Figure 4.12. The thematic group 3 started the discussions by questioning consumer satisfaction, because they thought the majority of people in Bristol may be perfectly satisfied with supermarkets. The key health issues, such as diabetes, obesity, cancer, and heart disease, are all related to the food situation, including lack of skills in food preparation, lack of education and poor food choices. Education in school and at home, and creations of skills and habits require cost and time. People are stressed and worried about the cost of living, and they feel they don't have the time to prepare dinner, and therefore use ready-made food or food that doesn't need much preparation. Watching TV also causes people to eat more as the act of eating becomes unconscious and therefore not consciously regulated by the consumer.

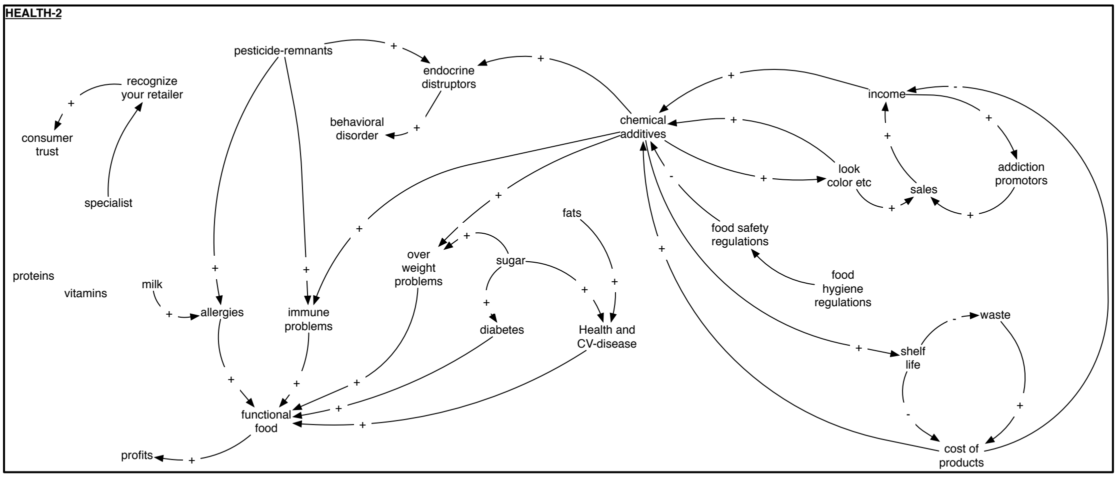

Figure 4.13. With this figure, the group focused on the role of using chemical additives, pesticides and sugar in the food system. Additives are made to increase the shelf life of food products, which leads to less waste and has positive impact upon profits. Similarly, the physical appearance and texture of food affects sales positively too. However, there is the other side of the coin with chemical additives i.e. health issues, such as allergies, obesity, diabetes and heart disease. Use of chemical additives creates immune and over weight problems. Similarly, use of pesticide-remnants creates allergies and immune problems. Use of sugar causes increased over-weight problems, diabetes and CV-diseases.

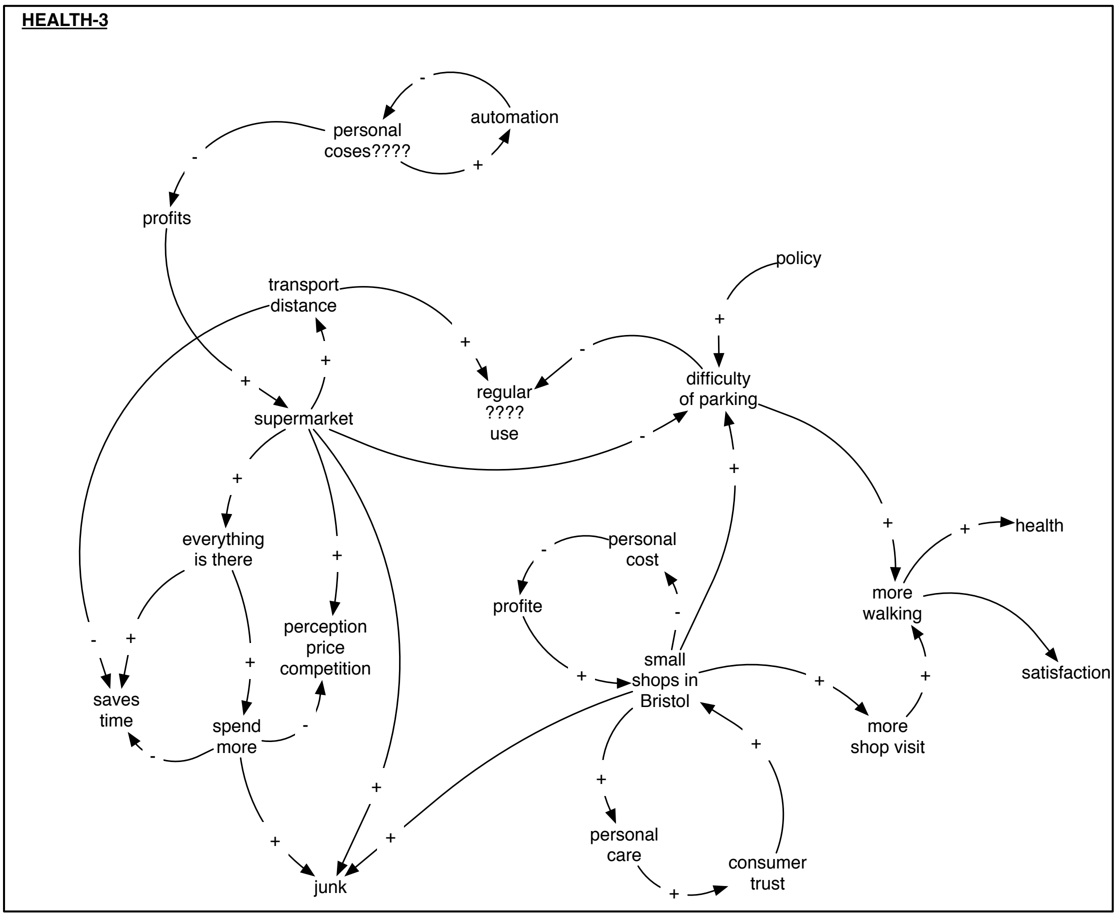

Figure 4.14. With this figure, the group looked at differences between shopping at small shops and supermarkets. At supermarkets everything is available at one place and supposedly saving time and cheaper. However, this may not always be the case. Having everything available in the same place my lead to more buying and resulting in more waste. In addition, it requires time and costs to travel to supermarkets. Generally, local policy favors large supermarket developments and parking is not a problem, but it is problematic when visiting the small shops. On the other hand, personal care that consumers receive in small shops make the small shops more attractive. More visits to small shops means more walking, which is good for the health and

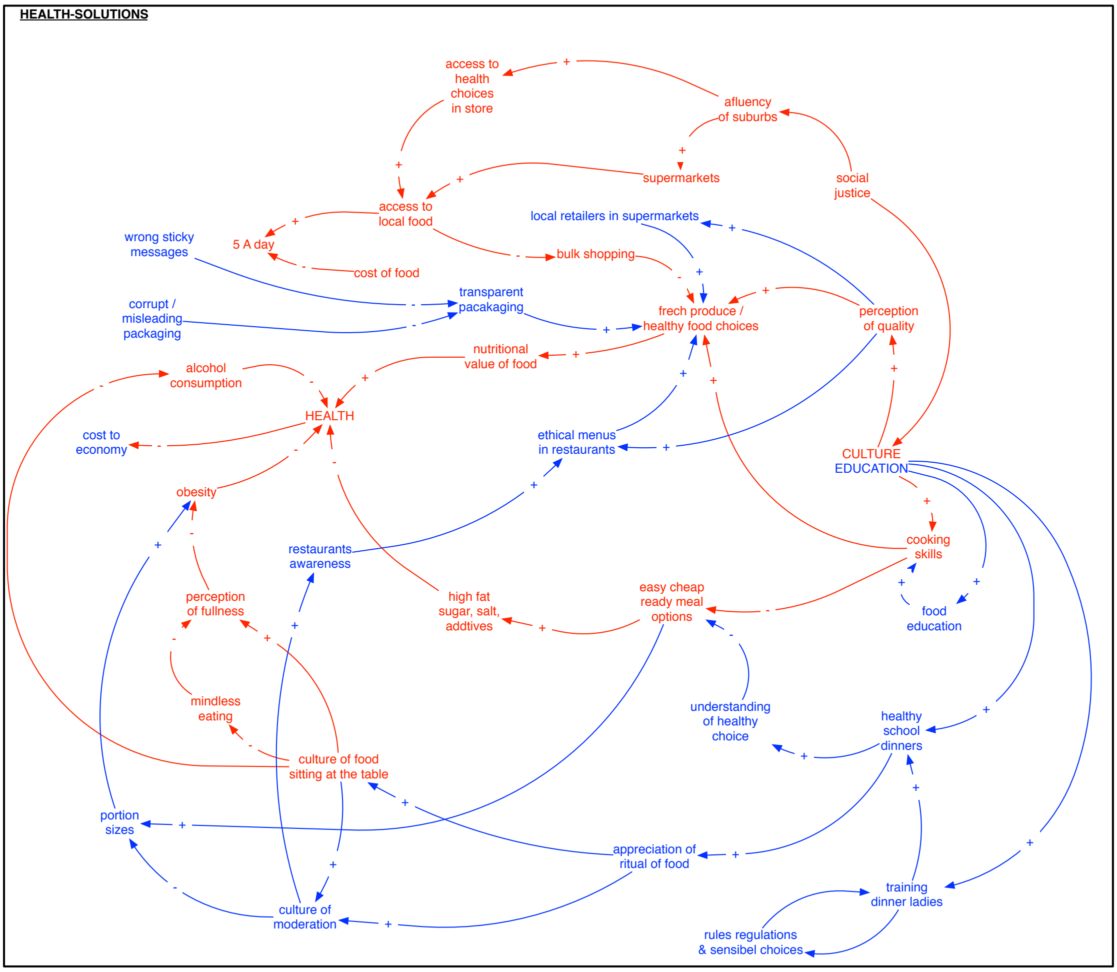

Figure 4.15. The group had general discussions around how to make healthy choices and have access to healthy food. They discussed the importance of transparent information on packaging and how labelling and packaging can manipulate (e.g. sizes can look deliberately small so the food looks healthier than it is or packaging can contain outdated information, messages that are now outdated by new research, i.e. butter being bad for your heart, or eggs for cholesterol). They also had talked about whether there is any scope for ethical messages on menus for example cases of restaurants making a big deal of using local food, but in reality not sourcing much locally. A culture having moved from sitting and sharing a meal at a table to eating in front of TV leads to overeating. The movement with school dinners has fallen back a bit and regulations in schools can be restricting, yet that it is in schools that people get a lot of their

information about health and food. Another element of sitting at the table is the consumption of alcohol, across Europe there is a culture of drinking alcohol with meals, whereas here in the UK we lack the association of alcohol taken with food and as a result we've got more problems. Consequentially food related health problems are huge cost to the economy, with costs typically recouped by the National Health Service in areas such as obesity, diabetes, vascular problems associated with diet, syndromes such as Multiple Schlerosis and mental health problems associated with diet etc

Bristol Workshop 2 – Results of Thematic Group 4: Supermarket Logistics

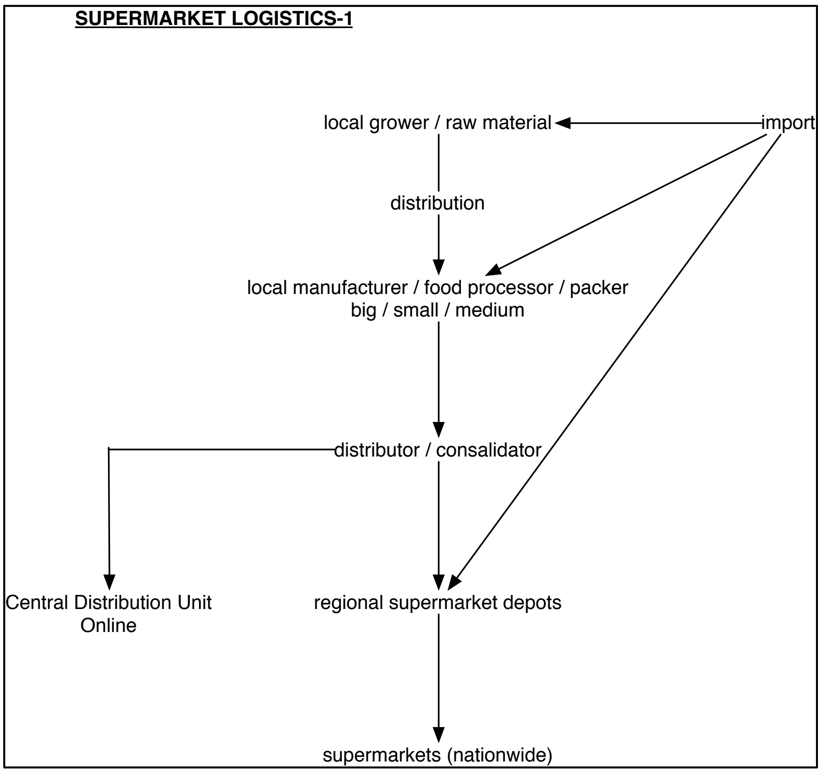

Figure 4.16. Flow chart showing the supermarket logistics

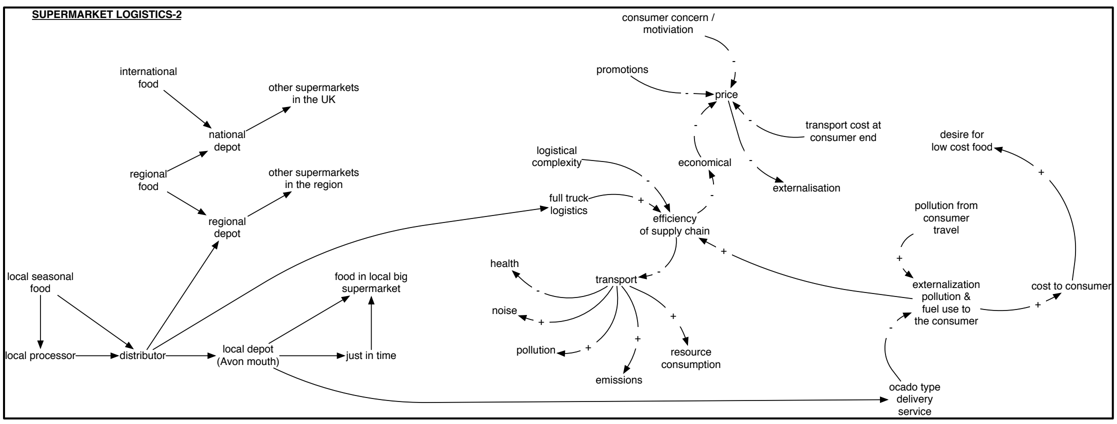

Figure 4.17. With this figure, the thematic group 4 discussed the supermarkets and how international food comes in through depots. Full truck logistics is a measure of their success, and can be used to control prizing. It must be kept in

mind that it is cheaper for the supermarkets to have the consumer pick up the things from one place. Waste is generated everywhere in the system.

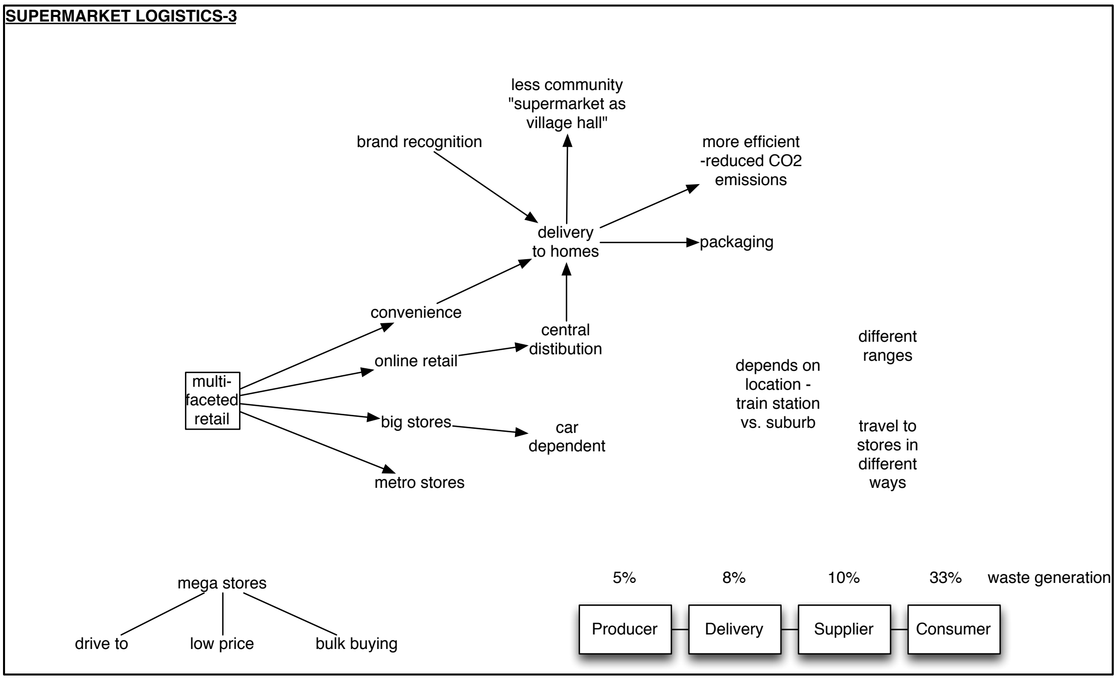

Figure 4.18. The group focused on online shopping in this figure. Supermarkets also serve as places to get socialize and this does not happen in online shopping. Another drawback with online shopping is that one cannot see the food physically. If more basic stuff is bought online (i.e. toilet rolls) and then there will be more time available for buying food from small shops.

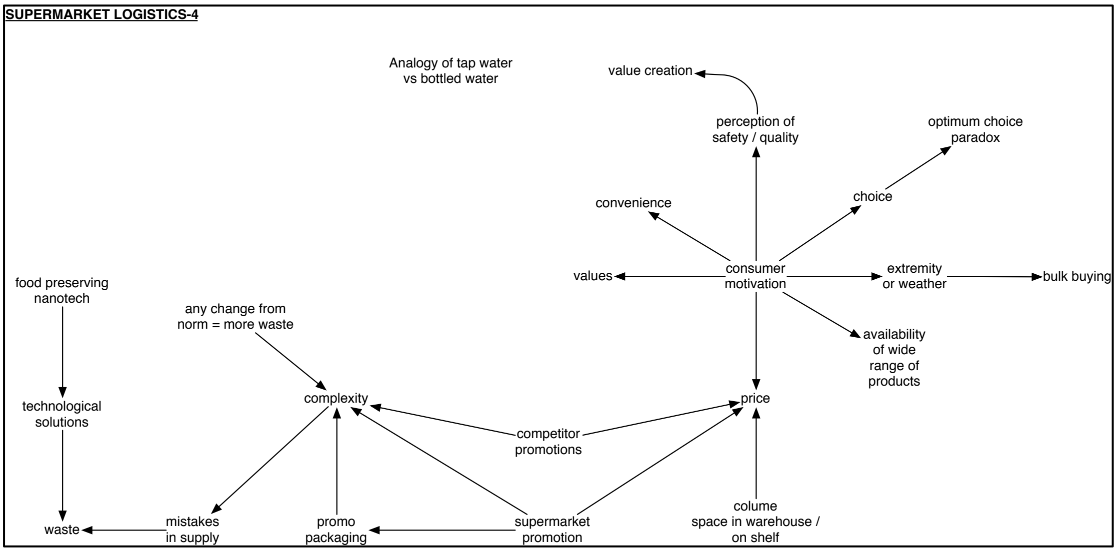

Figure 4.19. With this figure, the group looked at the marketing and pricing at supermarkets. Supermarkets have been known to overstock and then offer lower prices. If the supermarket can't sell a certain product, they can sometimes store it and sell it later, but not always. Supermarkets have also been known to tell a farmer that they're going to pay less than the farmer had expected for his product, and often they get away with it. At the producer end, if the products do

not meet supermarket standards, then the producer have to sell them cheaper. Supermarkets can also drive down the price from producers by buying in greater quantities than small shops can, which in turn means the product is cheaper at the supermarket than at the small shop, and small shops cannot compete with this. Customers tend to look critically on these more expensive, smaller shops and favor the cheaper prices of the supermarket. Hence, the small shops suffer from the situation created by the dynamics between supermarket and producer.

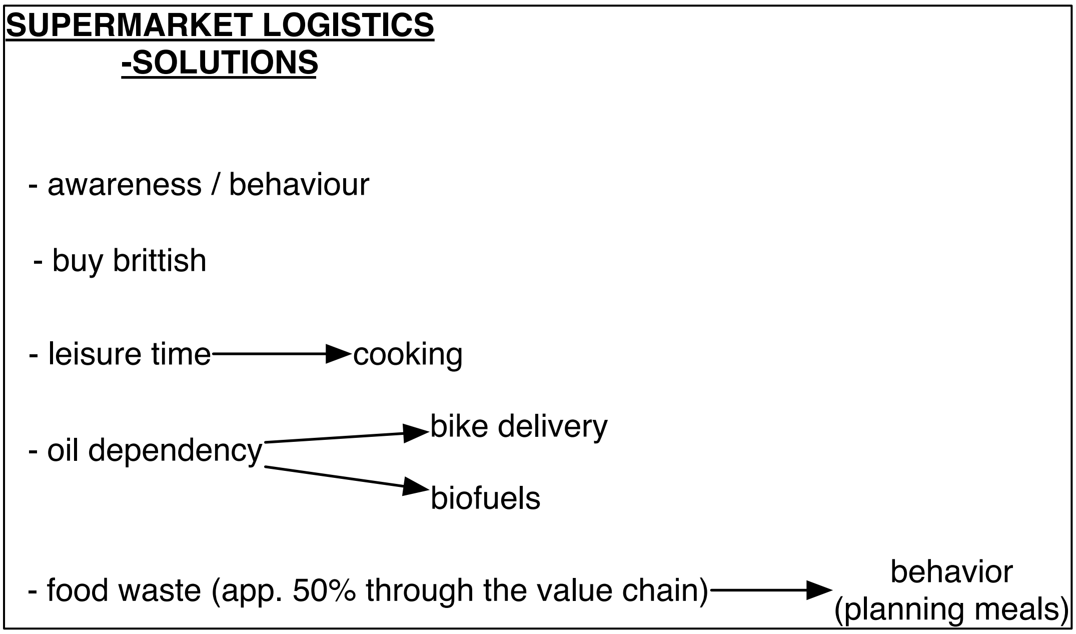

Figure 4.20. This figure shows some of the solutions that the group came up with. They suggested that people should be encouraged to buy British, and ready meals to start with. With increased awareness and changes in behavior, more time could be spent on cooking as a leisure time. A good example is offering a box of ingredients with a recipe that people can cook especially for students. Dependency on oil is a problem. Bikes can be used to distribute food around the city, which is sustainable and keep people healthy. Food waste is a big issue. People need to think about what's in their fridge before shopping. This can reduce the waste generation.

4.3 Bristol Group Modelling Workshop 3

4.3.1 Implementation of Converge indicator framework in Bristol: Phase 1 – Step 3

Implementation of Converge indicator framework continued with the 3rd workshop by covering the third step (Confirmation) of phase 1 (Conceptual Modelling and Systems Analysis)

Phase 1: Conceptual Modelling and Systems Analysis

Step 3. Confirmation

After setting the vision, defining the goals, identifying the hurdles in the previous 2 workshops, the stakeholders had an insight of the existing food system in Bristol. To a certain extent, the stakeholders also came up with potential solutions to overcome the existing problems and have a sustainable food system in Bristol. During the 3rd and the last step of the Phase 1: Conceptual Modelling and Systems Analysis, the stakeholders were expected to continue working with causal loop diagramming methodology. All causal loop diagrams, stock flow diagrams and other sketches generated during workshops 1 and 2 constituted the starting point for the workshop 3.

Having a consensus on the final version of conceptual model

Causal loop diagramming is an iterative process and it requires several iterations before all stakeholders agree on the final version of a causal loop diagram. The stakeholders were divided into two groups and asked to come up with a final version of CLD combining the previously created CLDs during the workshop 1 and 2. The stakeholders tried to identify missing links to close the loops, take away repeated wrong connections, and keep the CLD as simple, yet covering most of the important aspects in the Icelandic food system.

Analysing the loop behaviour over time

One way of checking the reliability of the casual loop diagrams generated is to compare the graphs of Reference Behaviour Pattern (RBP) with Observed Behaviour Pattern (OBP) as previously described in D-18. Due to lack of time, this was not done during the workshop 3, instead the facilitators analysed the loop behaviours after the workshop 3.

Identifying a draft set of convergence indicators

As it was described in D18, ideally, an initial set of converge indicators should have been ready by the end of workshop 3, once all stakeholders agreed on a final version of the CLD showing key components of the sustainable food system in Bristol with linkages, as well as the feedback loops they belong to. However, in Bristol case study, even though there were discussions around potential converge indicators, it was not possible to come up with a proper draft list of indicators. This was mainly due to lack of time. The indicator selection was performed after the workshop 3 by the WP3 researchers. (See section 6).

4.3.2 Outcomes of Bristol Group Modelling Workshop 3

Findings of the two stakeholder groups are as follow:

Bristol Workshop 3 – Results of Group 1

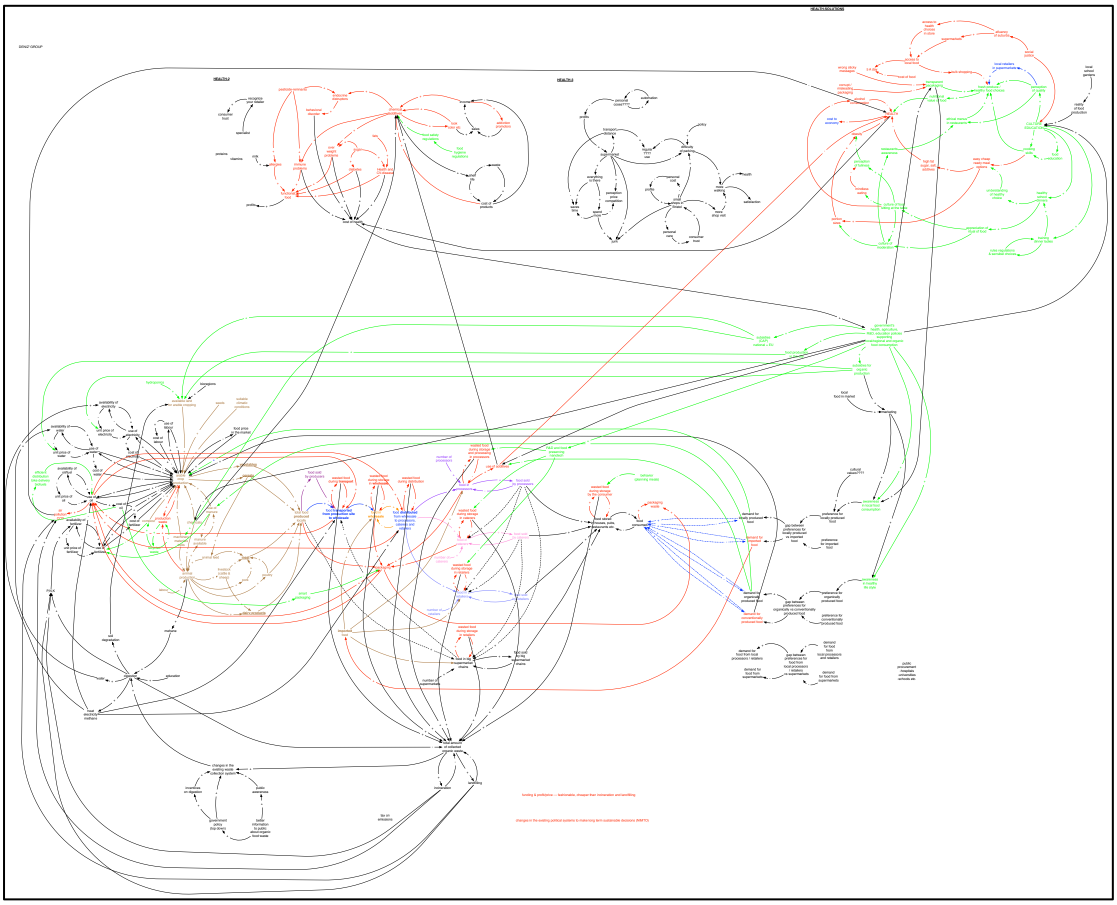

Figure 4.21. The first group focused mainly on nutrients and dependency on oil and how food waste can be collected and used, while now it is mostly being burned or goes into landfill. Right now, mechanisms are not in place to recover all the nutrients, but with changes, for instance, it is possible to produce methane and cut down on oil dependency. The group also discussed how the existing system can be changed and had consensus that change requires amongst approaches top down government policy, such as taxes or tax cuts. They also mentioned that phosphor is an upcoming problem and highlighted to importance of recycling. Health issues were also discussed among the group members i.e. how chemicals used in food processing create health problems. That in turn increases cost to the National Health Service and burdens the state budget. Policy interventions might help to make progress, but another possible solution is to increase knowledge of where the food comes from. If more time was spent on education, for example on how to cook your food, then people would be more inclined to make healthy food choices and be more aware of healthy life styles.

Bristol Workshop 3 – Results of Group 2

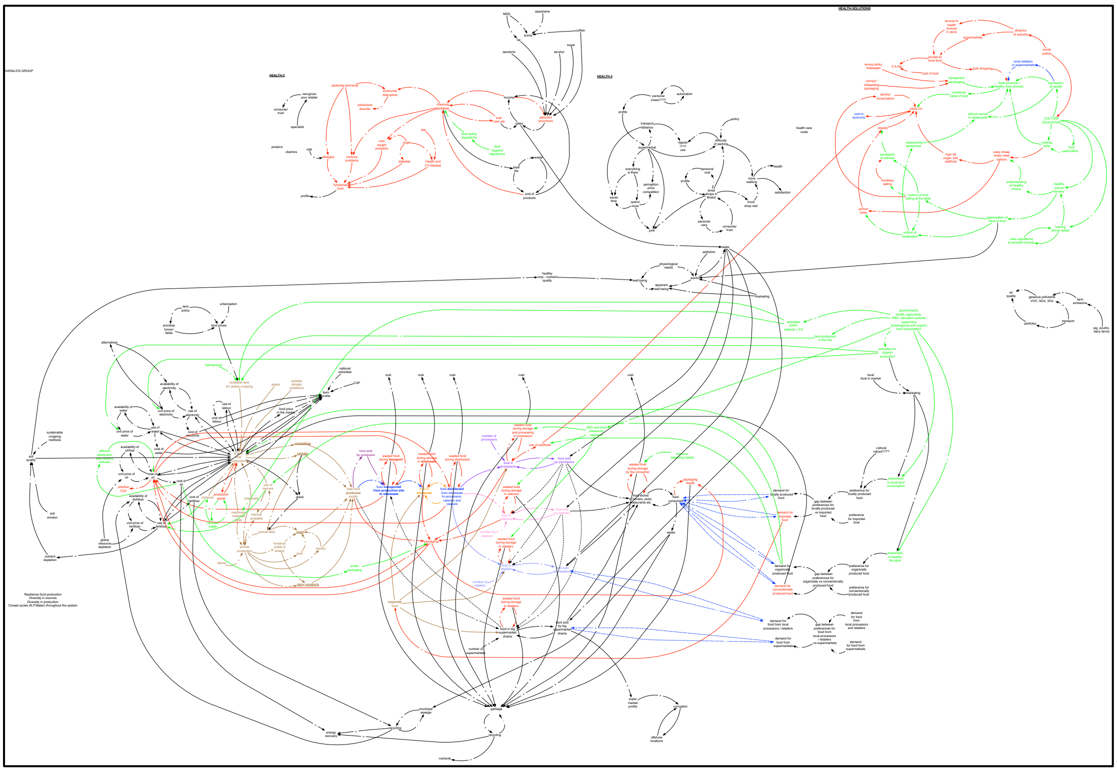

Figure 4.23. The second group highlighted diversity as a very important factor. For a resilient food system, there is a need for diversity in methods, crops grown, seeds and so on. Equally important is closed material loops, because closing loops means less input and better use of resources. It also increases efficiency. The group also discussed about soil management, soil erosion and more. Care has to do with wellbeing, which is affected by markets, addiction and physiological needs and which in turn have an impact on sales. All the waste is connected with recycling and the more the recycling is, the less will be the import of fertilizers. What is more, recycling keeps things robust and resilient and saves money.

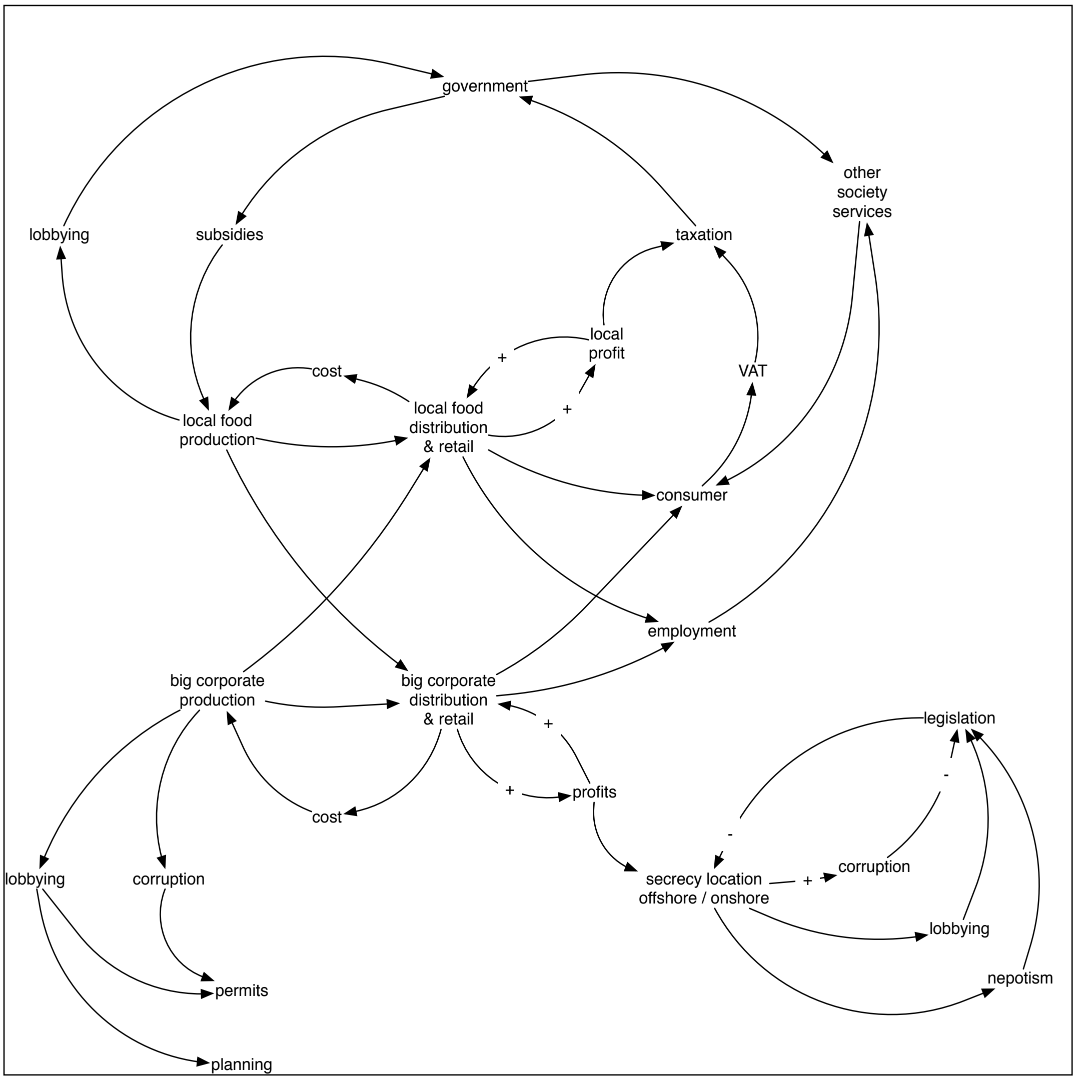

Figure 4.23. The second group also looked at the local versus big corporate profits. If local products are used locally, then the money stays local. Big corporations avoid paying tax in some instances, and by this avoidance, they don't contribute to the local society. This acts as a siphon, draining money from the local system. What is worse is that the government guides these tax breaks and facilitates tax avoidance for large businesses. This distorts the system, and gives big corporations unfair advantage in local business.

4.4 Synthesis of the 3 Group Modelling Workshops in Bristol

By applying systems analysis and CLD methodology with a participatory approach, the workshop participants were able to analyze the existing food system in Bristol. They also elaborated on how a sustainable future food system should look like, what goals need to be set, what key obstacles and priority issues, as well as the potential alternative solutions are. Figure 4.24 summarizes all of the issues around Bristol's food system as discussed by all of thematic groups during the three group modeling workshops.

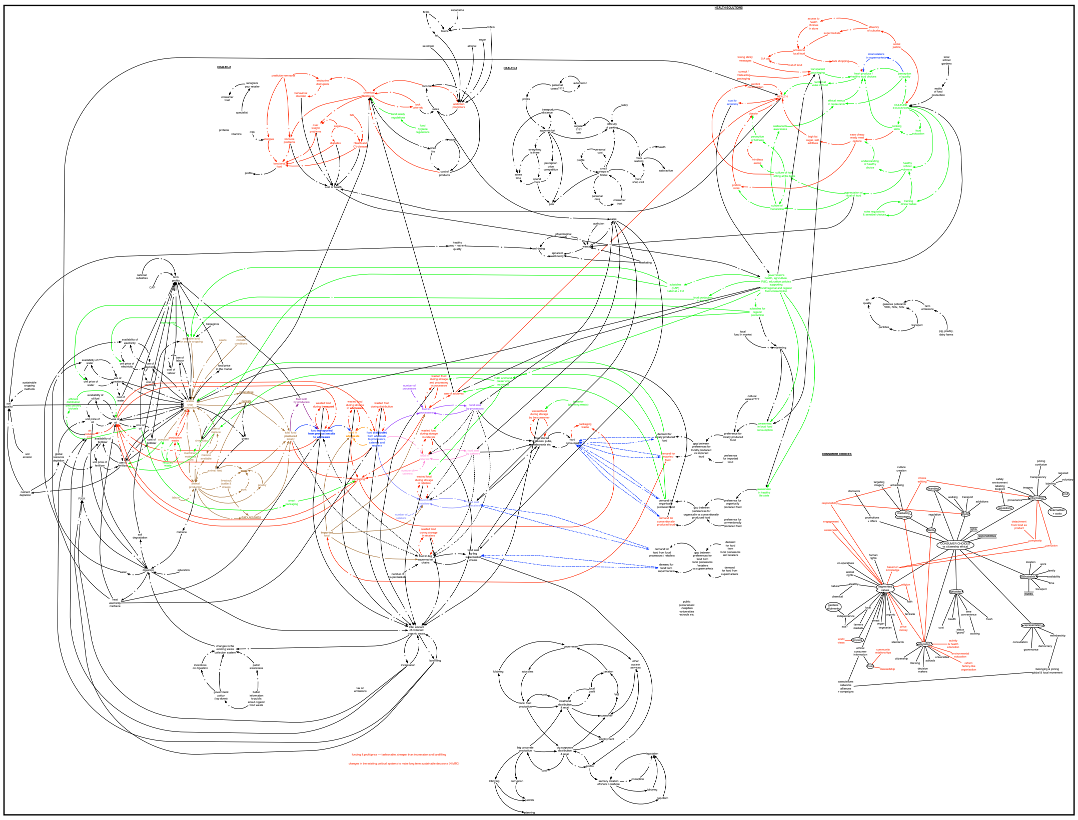

Figure 4.24. The CLD shows the food production, its distribution to different actors and consumption. The amount of food that is wasted through out these phases is one of the most important sustainability challenges for Bristol's food system. Other important challenges include the dependency of the whole food system on imported fertilizers and oil. Recycling of food waste to biogas and fertilizers is suggested as an important policy area targeting these challenges. The important role of consumers' behavior and preferences in a sustainable food system in Bristol is highlighted throughout the group modeling workshops. Improved education on food and cooking skills are suggested as important policy areas to reduce the unhealthy food consumption and in turn its negative health impacts and associated costs to national health service.

Like in Iceland case study, after the workshop 3, implementation of the Converge indicator framework on Bristol case study continued with step 1 (Model formulation) of Phase 2 (Dynamic modelling and integrated scenario analysis). However, it was realized at this stage that there was a lack of case specific data, which was required to run the dynamic model that had been developed. Generally, main reasons behind the lack of data include:

- it is not possible to measure some parameters;
- some parameters are not measured due to lack of knowledge;
- some parameters are measured but not shared (or partly shared if paid)

Under these circumstances and after consultations with the project coordinators, WP3 decided not to continue with dynamic modelling of the specific food systems in particular case studies (Iceland, Bristol-UK and Tirunelveli-India), rather focus on the dynamic modelling of the key natural resources that are common to the all case studies and have crucial impacts on the food system on global level. Thus, WP3 performed dynamic modeling studies looking at key minerals and metals in food production and supply chain. The results were provided with seven extra deliverables replacing the final version of D19.

5 Working Methodology for Converge Indicator Framework – Tirunelveli-India Case Study

This section of the report describes the working methodology on practical application of the Converge indicator framework on Tirunelveli food system with a series of group modeling workshops.

5.1 Tirunelveli Group Modelling Workshop 1

5.1.1 Implementation of Converge indicator framework in Tirunelveli: Phase 1 – Step 1

Implementation of Converge indicator framework through group modeling process started with the 1st workshop, in which the first step (Definition) of phase 1 (Conceptual Modelling and Systems Analysis) was covered. First, a series of lectures and exercises aiming for the capacity building of stakeholders in converge and sustainability (as described in detail in D35) was given. Following that stakeholders started to work in groups.

Phase 1: Conceptual Modelling and Systems Analysis

Step 1. Definition

Defining a vision, building blocks (components) of the vision/goals/milestones

In this step, first the stakeholders were asked to define a vision and discuss how food system in Tirunelveli will look like when that vision has been reached. It was reminded the stakeholders that their vision should be in line with converge, where ecological limits to growth are recognised and equity at a global scale is valued. Second, the stakeholders were asked to define the building blocks (components) of the vision, the goals and the milestones. Having clear vision, its building blocks, goals and milestones the workshop facilitators aimed to avoid unnecessary discussions among the stakeholders, while defining the problem(s), analysing the system and identifying the potential key indicators during the next steps.

Defining the problem

The very first step of most common problem solving approaches is to identify the problem(s). By taking into the stakeholders' perspectives, the workshop facilitators asked the question "what are the obstacles on the way to reach a sustainable food system in Tirunelveli?" to state explicitly the purpose and objectives of the modelling process. Potential hurdles and obstacles to reach the goals and the vision were discussed and identified among the stakeholders.

Setting the system boundaries

Based on the vision and problem definition the temporal and spatial system boundaries were set.

5.1.2 Outcomes of Tirunelveli Group Modelling Workshop 1

During the 1st workshop in Tirunelveli, the stakeholders were divided into six groups to start working with the vision of "Sustainable food system in Tirunelveli". They were asked to identify and note building blocks and goals of the vision, as well as potential obstacles and hurdles on the way reach the vision and the goals. They were also asked to use illustrations to show how different components of the Tirunelveli's food system are interlinked to each other. Tables given below summarize each of the groups' work with overlaps between them. It should be noted that the tables present the views of the individual groups and not interpretation of the results by the researchers. It should also be noted that at this very early stage of the group modeling process, the stakeholder were not expected to come up with fully correct causal loop diagrams. They were free to use figures, flow charts, causal loops to express their understanding and show the interlinkages between different components of the food system in Tirunelveli. All information from individual group's work were noted at this stage and synthesized later by the WP3 researchers (see section 5.4).

Tirunelveli Workshop1 – Group 1 results

Table 5.1

Vision	Goals, Milestones, Practicality tools, skills, knowledge etc.	Hurdles, obstacles
Sustainable food system	Land reforms (storage the water)	population
	Field exposure for school level	depletion of resources (water, minerals etc.)
	Adopt new technology	pollution (soil)
	Plan approval – agri activity	urbanization (conversion of agri lands into houses)
	Awareness	labour shortage
	Sewage water management – agri purpose (reuse)	lack of adequate technologies
	Agri-product to raise income	politics
	Food storage (small industrial & governmental)	climate change
	Power (EB) storage	attraction towards other sectors
	To follow up old traditions (moral	family set up

	education)	
	Law and order	industrialization
		less productivity
		lower income of the farmers
		globalization & modernization (western culture)
		reduced market price
		reduced infrastructure (godowns, warehouses etc.)
		migration
		relying on somebody
		food habits
		illiteracy / low awareness
		poor R&D

Tirunelveli Workshop 1 – Group 2 Results

Table 5.2

Vision	Hurdles, obstacles	Solutions
Sustainable future (education, equity) → Survey → create necessary database in all aspects (online) → Analysis → prior method of analysis & policy framing to be made → Trial & Test Implementation → Followup and feedback to Analysis → Implementation of Prior	Corruption	Strength the law *Transparency on all levels of governance including banks to fight corruption
	Water shortage & pollution	Compulsory rainwater harvesting structures Drainage management

		Purification Sewage treatment Effluent treatment Safe water Desalinization plant Recycle technology
	Power shortage	Renewable energy implementation
	Labour shortage in agriculture	Mechanization to maximum utilization of resources Need based training
	Technology reachability	
	Distribution hurdles	Distribution database & managing proper food storage and processing Market & consumer based planned cultivation Prior communication
	Fertilizers – inorganic	Composed → all type of waste including night soil
	Oil an coal shortage	Ethanol based fuel system (sugarcane) Gasifier system (with fuel wood) implementation Reducing oil consumption
	Political, social, economic and cultural aspects	Social change through; Group approach Cluster development Adopting apt policies Framing policy and procedures accordingly Equality in wealth and livelihood 100 % literacy with preferable education provided in different aspects Equal health care Balance in trade and payment
	Burning crop residues	

	Population (human, animal and cattle)	Migration from urban to rural by rural development Awareness of small family Encourage migration to less populated country Draught animal
	Money aspect	No black money Industries should invest on socio-economic cost Strict removal of monopoly Limiting monopoly corporate Minimizing capitalization Maximizing socialistic pattern Group and cluster development on corporate
	Pollution	Recyclable plastic to be used & plastic free zone Afforestation Waste management (animal & human) Polluting industry invests on socio economic costs and with huge tax burden
	Consumption culture	* Need base consumption Restriction of excess consumption

Tirunelveli Workshop 1 – Group 3 Results

Table 5.3

Vision	Hurdles, obstacles	Solutions
Sustainable food system in Tamil Nadu	Climate change (monsoon failure, erratic rainfall, high temperature)	Soil water conservation Draught tolerant & ephemeral crops Alternate agri related enterprises

	Soil fertility degradation	Use more organics Use human waste Grow catch crop Avoid high exhaustive crop Avoid mono cropping
	Mono cropping (rice)	Crop diversification Fallow IFS modules
	Increased use of pesticide & fertilizer	Use industrial waste, biogas waste Use compost, crop residue, farm waste, plant based extract like neem, ..gam leaf extract Reduce nitrogen source to crops
	Labour problem	Option for mechanization Grow less labour required crops
	Lack of improved technologies	Improve TOT system Create awareness
	Water scarcity	Alternative crop for rice & banana Crop diversification, IFS Mulching, ATP, MIS
	Non availability of organic sources	Encourage cattle population Effective utilization of crop residues, human and industrial waste Grow leguminous crops
	Change in food habit	Back to traditional food system
	Non availability of fodder crops	Allowment of separate land for grazing, fodder crops Alley cropping, lay farming Nutrient fortification
	Reduction in cattle population	Create awareness Rearing of crossbreds
	Lack of storage and processing unit	Construction of cold storage To develop PHT

			Value added products Promote ABC in regionwise
		Reduction in agricultural and cultivable land areas	Encourage multistoried buildings Strict governmental rules subsidies for agriculture Creating awareness about importance of food production

Tirunelveli Workshop 1 – Group 4 Results

Table 5.4

vision	goals	hurdles	solutions
Sustainable food system	Higher output in agriculture, fisheries, dairy and industry	Lack of awareness on utilization of human waste, biochar, biofertilizers	Creating awareness on the hurdles
	With less carbon foot print strategies	Lack of willingness	Forest cover Afforestation
	Sustainable soil fertility	Lack of conducive policy	Soil fertilization biofertilization
	Fish culture	Not involving the real stakeholders	Marine biodiversity
	Fodder cultivation	Lack of awareness on food waste	Integrated farming
	Using biogas		Increased use of biogas
	Collecting rain water		Rainwater harvesting
	Using solar power		Solar energy
	Minimizing resource use		Recycling all waste
			Protecting nature
			Cost effective mechanization
			Balance diet
			Less infant mortality
			Reasonable support price
			Export possibilities
			Good socio

			economic status
			Less water utilization
			No pesticide application

Tirunelveli Workshop 1 – Group 5 Results

Table 5.5.

vision	goals	hurdles	solutions
Reviewing traditional food practices and sustaining food system in Tamil Nadu	Educate farmers elementary level	Knowledge lost (ignorance of food sustainability)	Waste recycling – convert to energy
Provide balanced diet to all people			Education for sustainability starting from elementary level
Optimum use of rain water, solar energy, wind energy, and solid waste management	Seed village concept	Seed shortage (viable seed)	Introduce the traditional food system
Organic food production	Fixing fair price	Low price get the farmers	Storage for food
Avoid pollution	Integrated farming system	No facility to storage food grains	Balanced nutrition food
Tree planting	Village level value addition	No knowledge to value addition	Use of natural system (solar, rain, wind, organic manure)
		Use of plastic goods	Integrated farming system
			Limited usage of electricity & fuels
			Rain water storage
			High yielding seed production
			Grow horticulture trees and afforestation
			Fodder production

			Encourage poultry, goat, sheep, milk animal
			Pollution control
			Proper food processing
			Minimize the food waste

Tirunelveli Workshop 1 – Group 6 Results

Table 5.6

vision	goals	hurdles	solutions
Food security		Environment/climate changes	Afforestation, road side tree plantation Greenhouse facilities Shade net plants Irrigation → drip system
Good health system		Pollution	Biodiesel Bee keeping (pollination)
National growth		Resources (soil → fertility)	Organic agriculture Use of human waste / cawdoung Pro biotech
Good economy		Agriculture inputs (quality seeds)	Bio pesticides (neem products)
Integrated farming system (aqua, animal, waste)		Population pressure	Health education / Life expansion Storage facilities (grains)
		New life styles (pizza, more carbohydrates, junk fruites) Sedentary lifestyle Obesity	Balanced nutrition diet (mixed diet)
		Waste (domestic/industrial)	Composed yards Good transport
		Mentally challenged infants / deformities diseases	Medical awareness camps (for pregnant women, adult,

		old, adolescence girls)
	Birth death ratio	Reduce mortality rate
	Low birth weight / malnutrition	Nutrition education for pregnant women Importance of lactation
	Unhealthy people	Kitchen gardening Herbal gardens
	Land space	Organic gardens → balcony
	Lag of agricultural technologies	More agricultural & engineering colleges Farmers education (income, generation)
	Lack of awareness, no join families	Join family system (income, animal food services)

By the end of the workshop 1, the stakeholders started to have a systems insight to how the food system in Tirunelveli looks like today and how it should ideally look like in the future.

5.2 Tirunelveli Group Modelling Workshop 2

5.2.1 Implementation of Converge indicator framework in Tirunelveli: Phase 1 – Step 2

During the 2nd workshop phase 1 (Conceptual Modelling and Systems Analysis) second step (Clarification) of the Converge indicator framework was covered.

Phase 1: Conceptual Modelling and Systems Analysis

Step 2. Clarification

The aim with this step was to bring all stakeholders together for discussions and exchange of information with each other to develop a better understanding of the sustainable food system and its components in Tirunelveli. In this step, the stakeholders were introduced to systems thinking, systems analysis and causal loop diagramming concepts.

Listing relevant system components and identifying the key ones

Having the vision, goals, obstacles defined and the system boundaries in mind from the previous workshop, the stakeholders were asked to create a list of all components representing the Icelandic food system. The stakeholders were then asked to list these components in the most relevant and important order in order to identify the key ones.

Identifying the interlinkages between the key components and building a conceptual model

The stakeholders were divided into three thematic groups to analyse the three sectors in the food system:

1. Agriculture
2. Ocean fishing / Aquaculture
3. Greenhouse agriculture

Causal loop diagramming was used as a "common language" among all the stakeholders with different backgrounds. Stakeholders built causal loop diagrams identifying the interlinkages, cause effect relations, and the reinforcing and balancing feedback loops between the key components of the food system within these themes.

Having systems insights

During the workshop 2, the stakeholders started to see the bigger picture with a holistic manner. They understood how todays' food system looks like and how the desired future system should look like by starting to use causal loop diagrams within an iterative process. Some potential solution options and proposals were suggested by the stakeholders in this step.

The second workshop began with presentation of three diagrams that the WP3 researchers put together synthesizing the main outcomes from the 1st workshop (Figures 5.1, 5.2 and 5.3). Diagrams showing water resources, soil fertility and flow of the food in Tirunelveli were presented to the stakeholders to serve as a starting point for the continuation of the group modeling process.

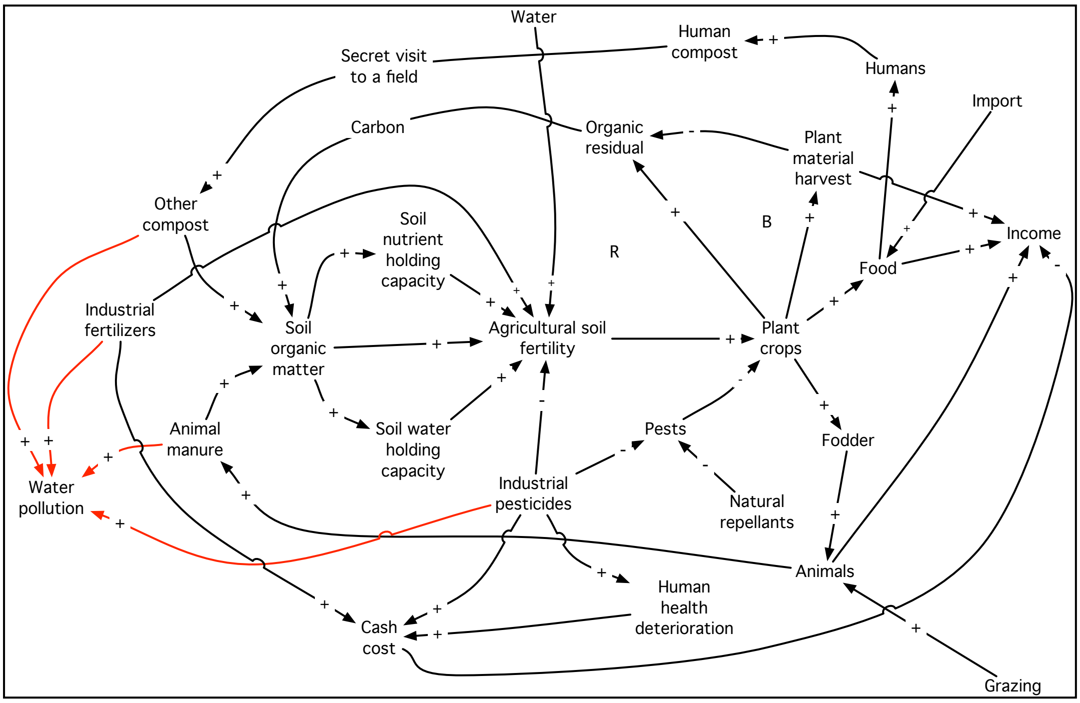

Figure 5.1 Soil fertility in Tirunelveli

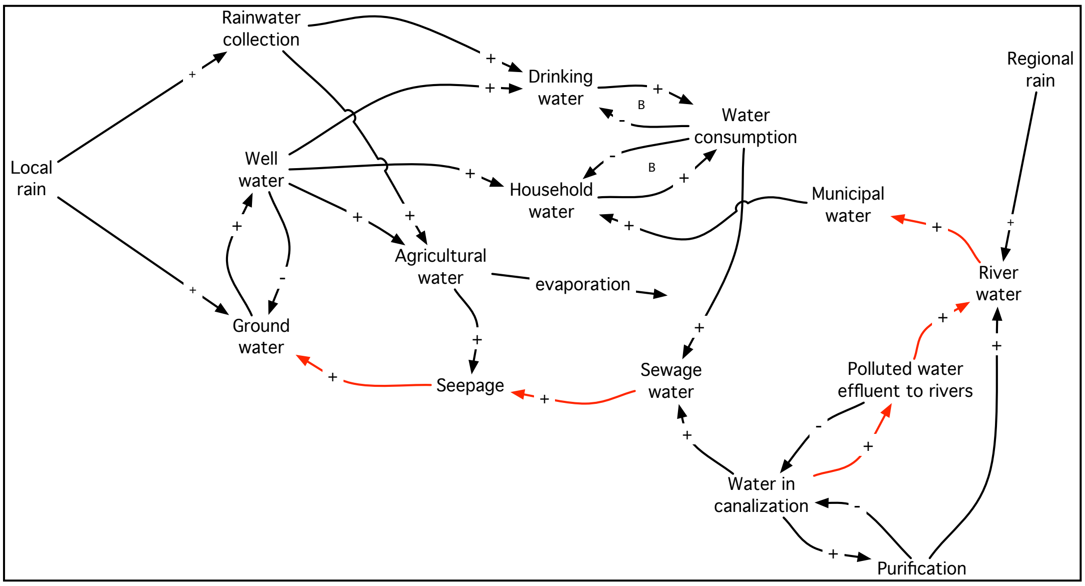

Figure 5.2 Water resources in Tirunelveli

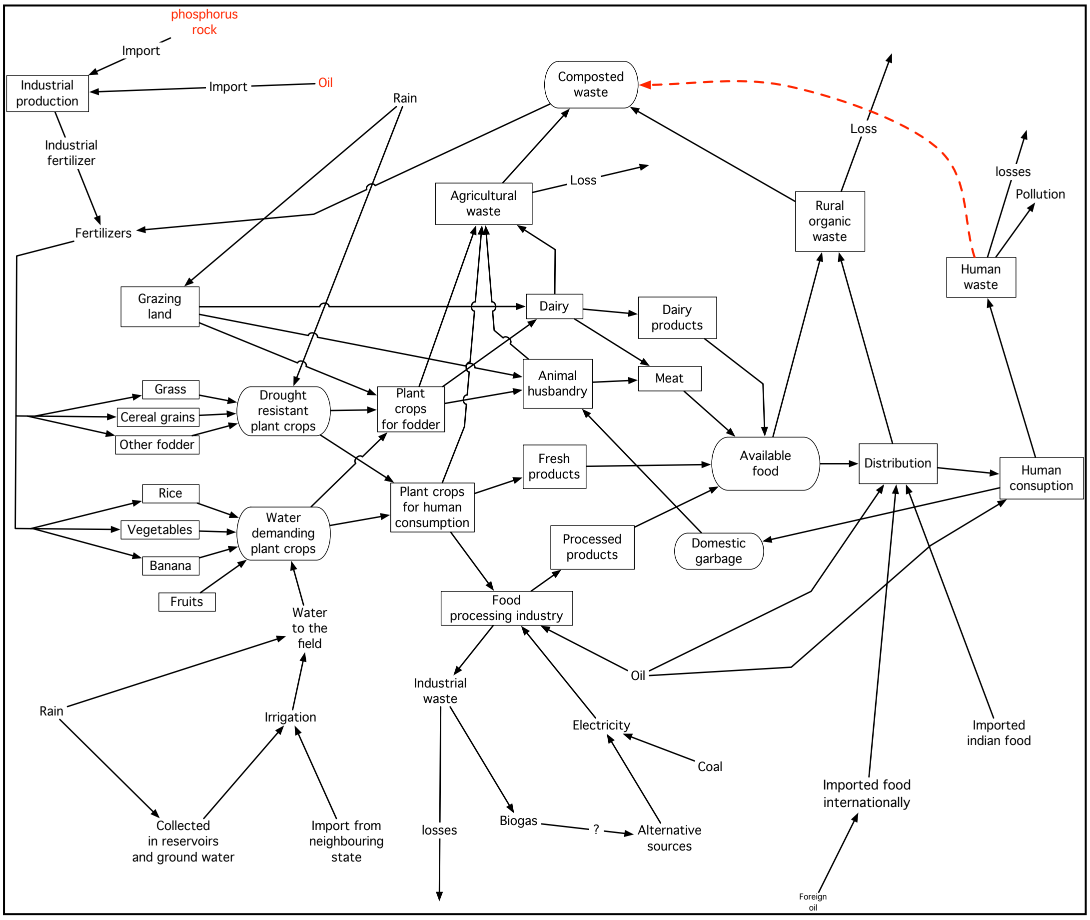

Figure 5.3 Flow chart of the food system in Tirunelveli

5.2.2 Outcomes of Tirunelveli Group Modelling Workshop 2

After the presentation of above figures, the stakeholders were encouraged to continue with their work with new diagrams. Figures created by the 6 groups are as follow:

Tirunelveli Workshop 2 – Results Group 1

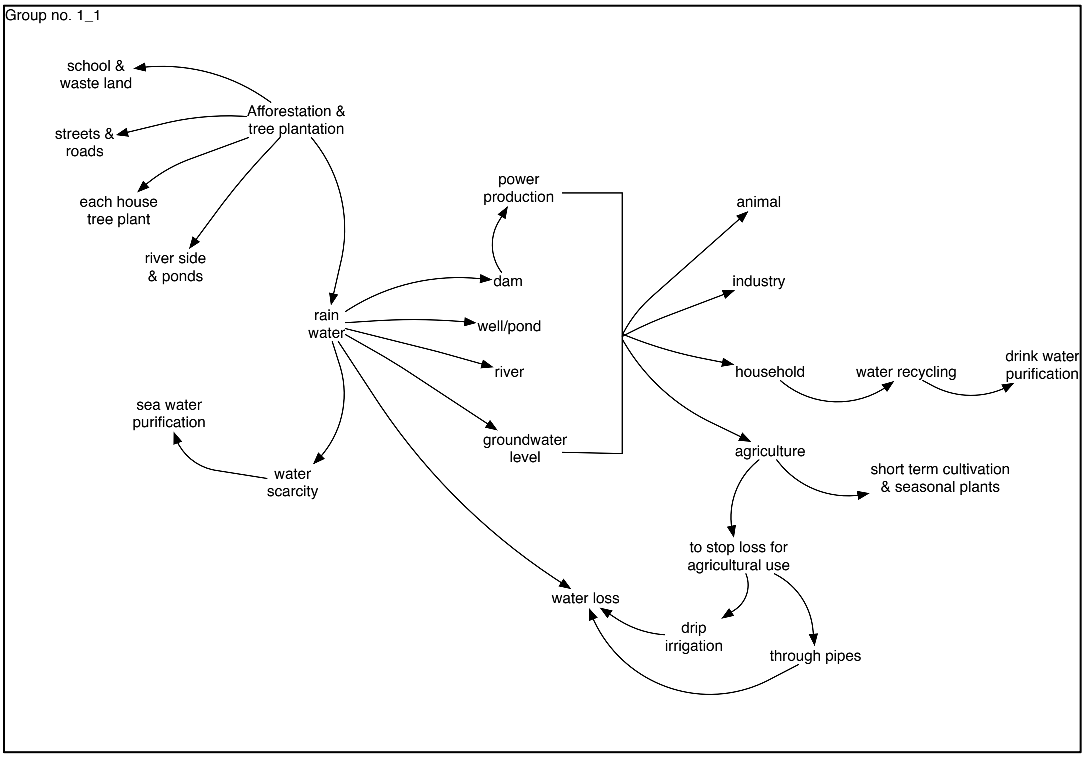

Figure 5.4. Group 1 focused on the availability of water resources. Rainwater is main source feeding dams, wells, ponds, rivers and the ground water. Afforestation is expected to bring more rainwater. In case of water scarcity seawater purification can provide the water needed. Water is used by agriculture, households, industry and animals. Loss in agricultural use can be minimized by drip irrigation.

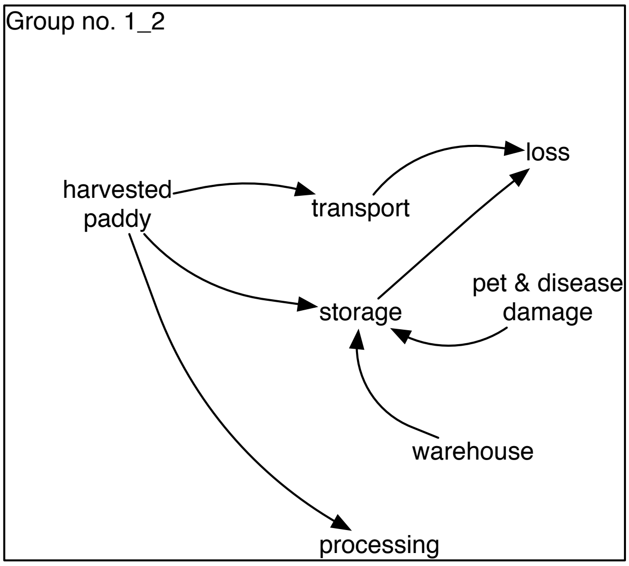

Figure 5.5. Group 1 also looked at rice production, distribution, storage and processing. Loss occurs mostly during transportation and storage.

Tirunelveli Workshop 2 – Results of Group 2

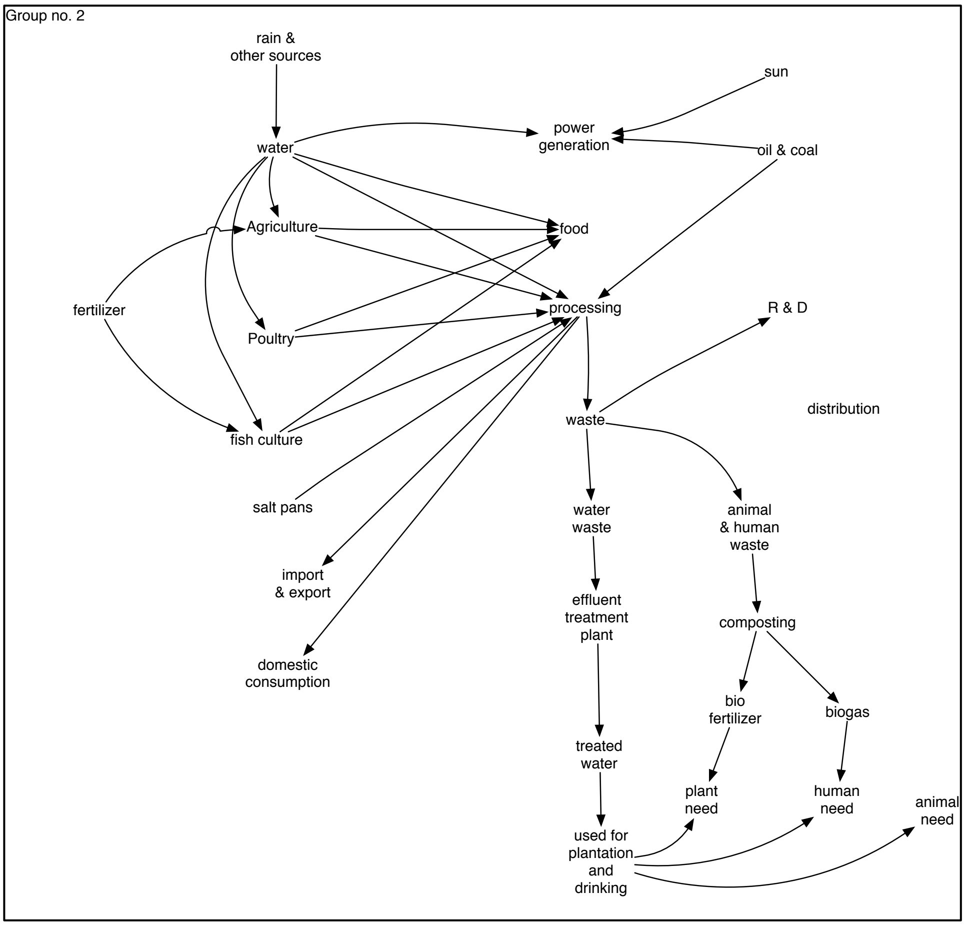

Figure 5.6. Group 2 looked at food production and processing. Agriculture, poultry and fish culture provides the food in the region. The importance of water and fertilizer use in food production, as well as oil and coal use in food processing phases were highlighted during the discussions. After composting, animal and human waste can be used as bio fertilizers and biogas.

Tirunelveli Workshop 2 – Results of Group 3

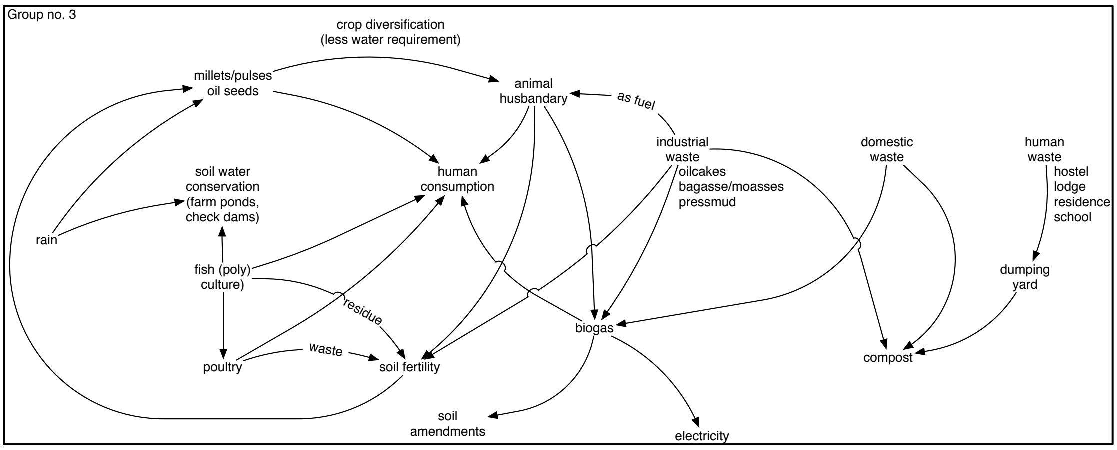

Figure 5.7. In group 3 the discussions centered on food production and waste. Millets/pulses, oil seeds, fish, poultry and animal husbandry constitute the food in the region. Residues from fish culture, waste from poultry, animal husbandry and industrial processes can be used to increase the soil fertility in the system. Biogas production from industrial and domestic waste was suggested as an alternative way for energy production.

Tirunelveli Workshop 2 – Results of Group 4

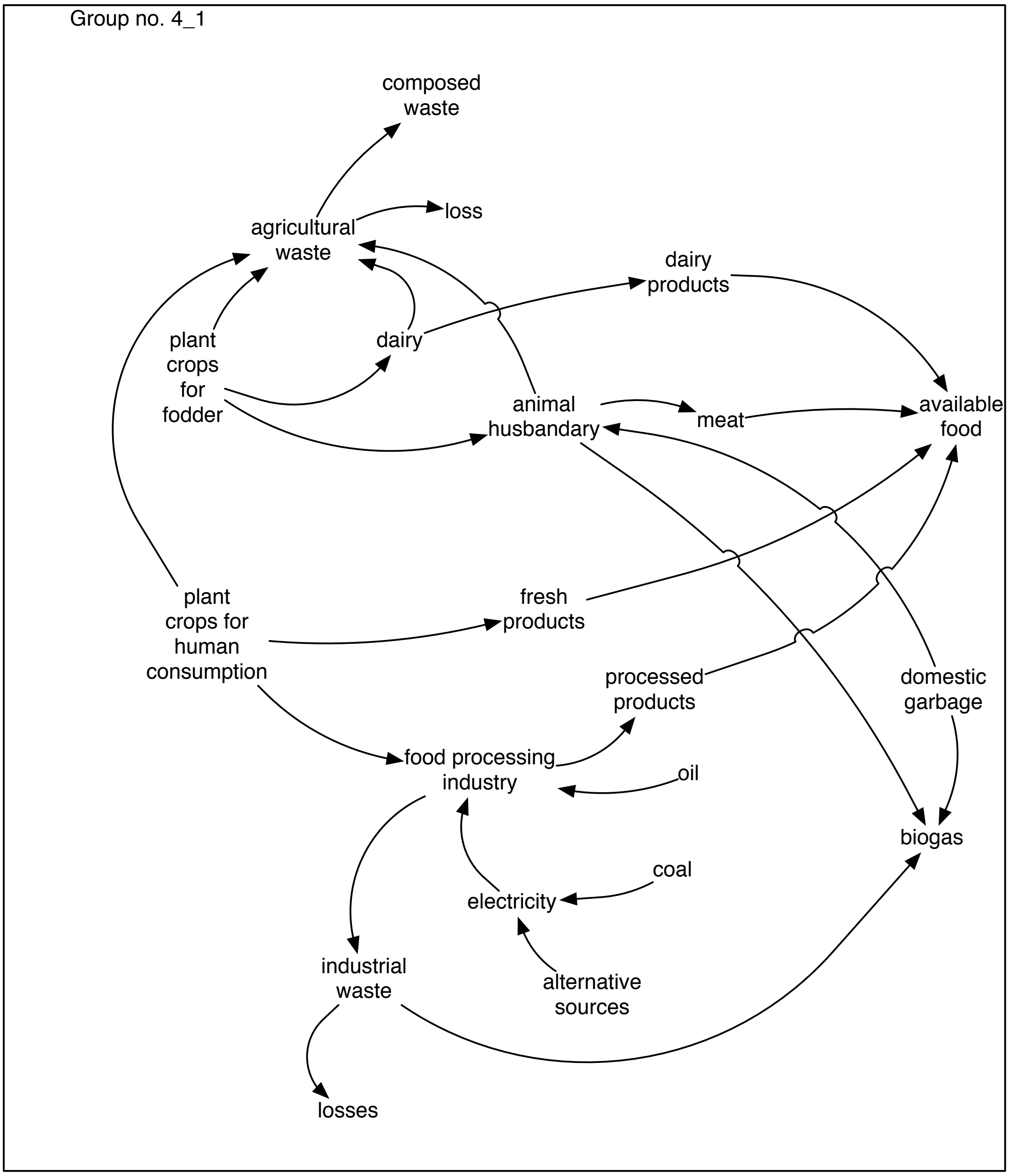

Figure 5.8. Group 4's work overlapped with other groups' work. They also focused on food production and waste generation. Crops as fodder to animal husbandry provide the meat and dairy products. In addition to these, crops for direct human consumption and processed crops constitute the available food in the region. An alternative to oil and coal used in food processing industry is the use of biogas generated from waste from animal husbandry and industry.

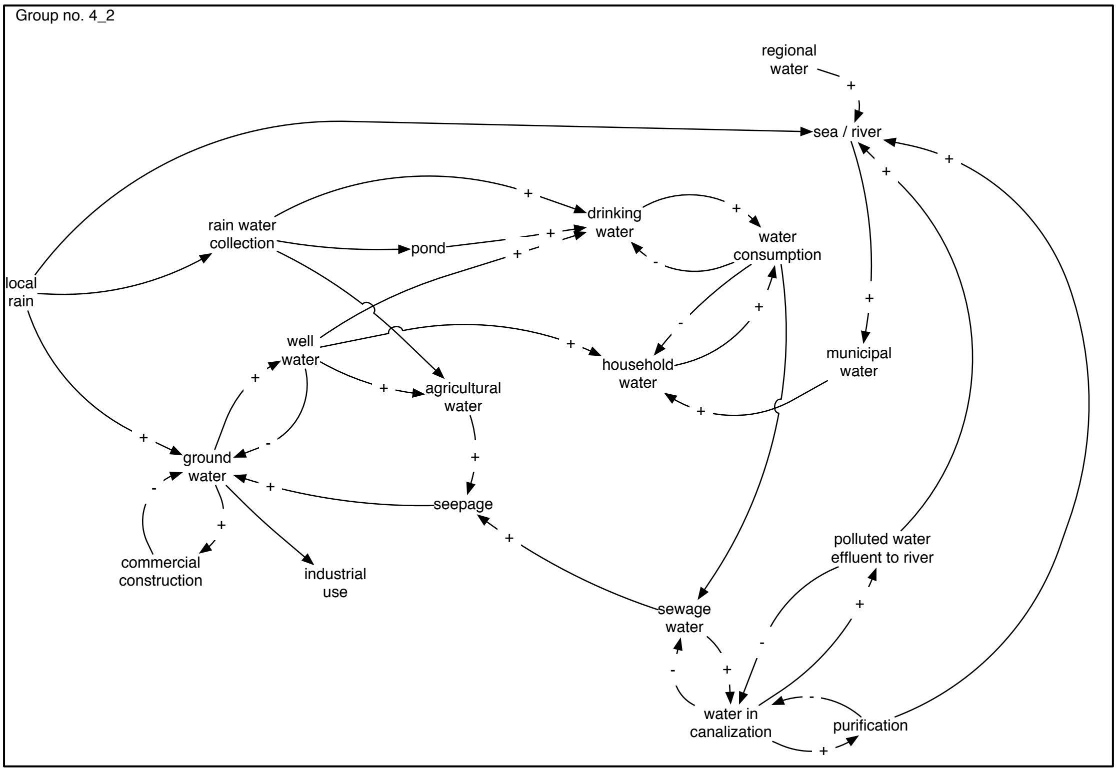

Figure 5.9. In this figure, group 4 focused on available water and its usage. Rainwater collected in ponds and ground water from wells provide the household water including for drinking.

Tirunelveli Workshop 2 – Results of Group 5

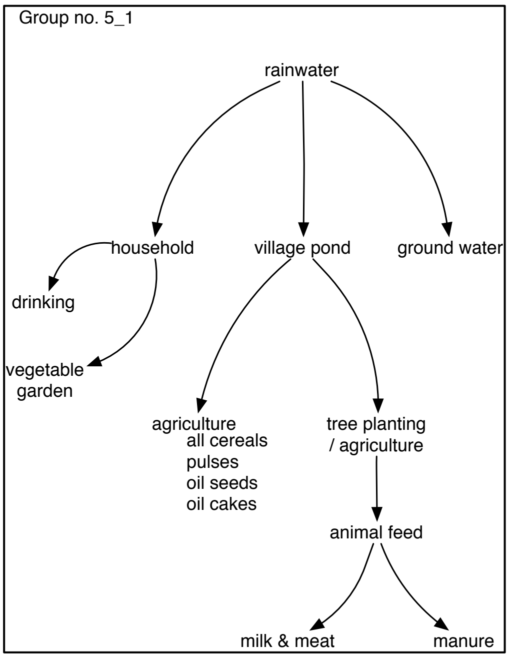

Figure 5.10. Similar to other groups, group 5 also discussed water resources and the use of water in households, agriculture and animal production.

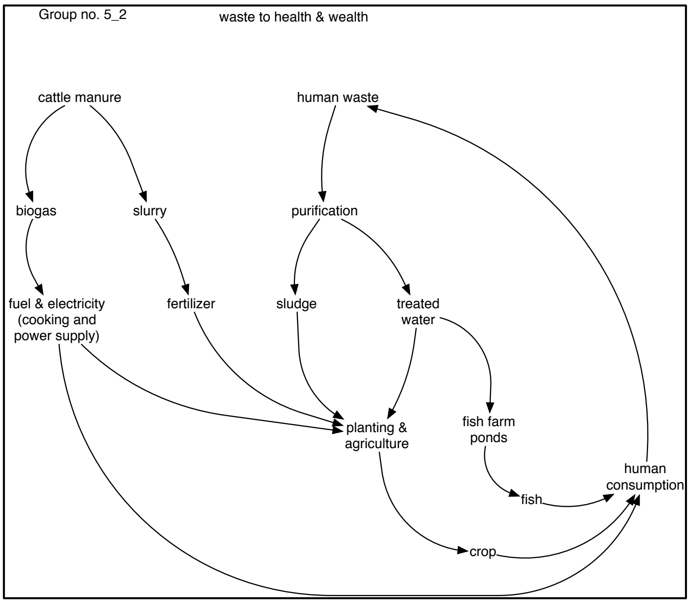

Figure 5.11. Group 5 suggested closed loop systems for the waste generated in the food system. Biogas produced from cattle manure for instance, can be used to produce fuel and electricity, which can provide cooking and power supply in agriculture. Again slurry from cattle manure can be used as fertilizer in agriculture to produce crop. This applies to human waste as well. Sludge from waste water treatment plants can be used as fertilizer and the treated water can be used in fish farm ponds to produce fish for human consumption.

Tirunelveli Workshop 2 – Results of Group 6

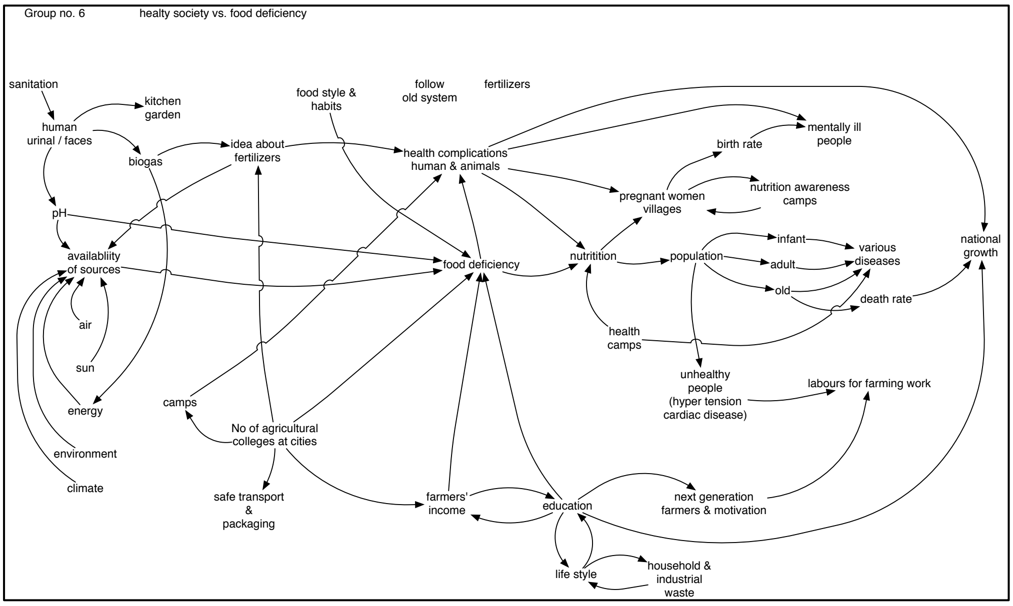

Figure 5.12. Group 6's discussions centered on healthy society and the food deficiency. Food deficiency related health complications have an impact on the population and national growth. To tackle the food deficiency availability of food sources can be improved with increased recycling of waste, better education, as well as food styles and habits.

5.3 Tirunelveli Group Modelling Workshop 3

5.3.1 Implementation of Converge indicator framework in Tirunelveli: Phase 1 – Step 3

Implementation of Converge indicator framework continued with the 3rd workshop by covering the third step (Confirmation) of phase 1 (Conceptual Modelling and Systems Analysis).

Phase 1: Conceptual Modelling and Systems Analysis

Step 3. Confirmation

After setting the vision, defining the goals, identifying the hurdles in the previous 2 workshops, the stakeholders had an insight of the existing food system in Tirunelveli. To a certain extent, the stakeholders also came up with potential solutions to overcome the existing problems and have a sustainable food system in Tirunelveli. During the 3rd and the last step of the Phase 1: Conceptual Modelling and Systems Analysis, the stakeholders were expected to continue working with causal loop diagramming methodology. All causal loop diagrams, stock flow diagrams and other sketches generated during workshops 1 and 2 constituted the starting point for the workshop 3.

Having a consensus on the final version of conceptual model

Causal loop diagramming is an iterative process and it requires several iterations before all stakeholders agree on the final version of a causal loop diagram. The stakeholders were divided into seven groups and asked to come up with a final version of CLD combining the previously created CLDs during the workshop 1 and 2. The stakeholders tried to identify missing links to close the loops, take away repeated wrong connections, and keep the CLD as simple, yet covering most of the important aspects in the Tirunelveli food system.

Analysing the loop behaviour over time

One way of checking the reliability of the casual loop diagrams generated is to compare the graphs of Reference Behaviour Pattern (RBP) with Observed Behaviour Pattern (OBP) as previously described in D-18. Due to lack of time, this was not done during the workshop 3, instead the facilitators analysed the loop behaviours after the workshop 3.

Identifying a draft set of convergence indicators

As it was described in D18, ideally, an initial set of converge indicators should have been ready by the end of workshop 3, once all stakeholders agreed on a final version of the CLD showing key components of the sustainable food system in Tirunelveli with linkages, as well as the feedback loops they belong to. However, in Tirunelveli case study, even though there were discussions around potential converge indicators, it was not possible to come up with a proper draft list of indicators. This was mainly due to lack of time. The indicator selection was performed after the workshop 3 by the WP3 researchers. (See section 6).

5.3.2 Outcomes of Tirunelveli Group Modelling Workshop 3

Findings of the 7 stakeholder groups are as follow:

Tirunelveli Workshop 3 – Results of Group 1 – Theme: Agriculture & Livestock

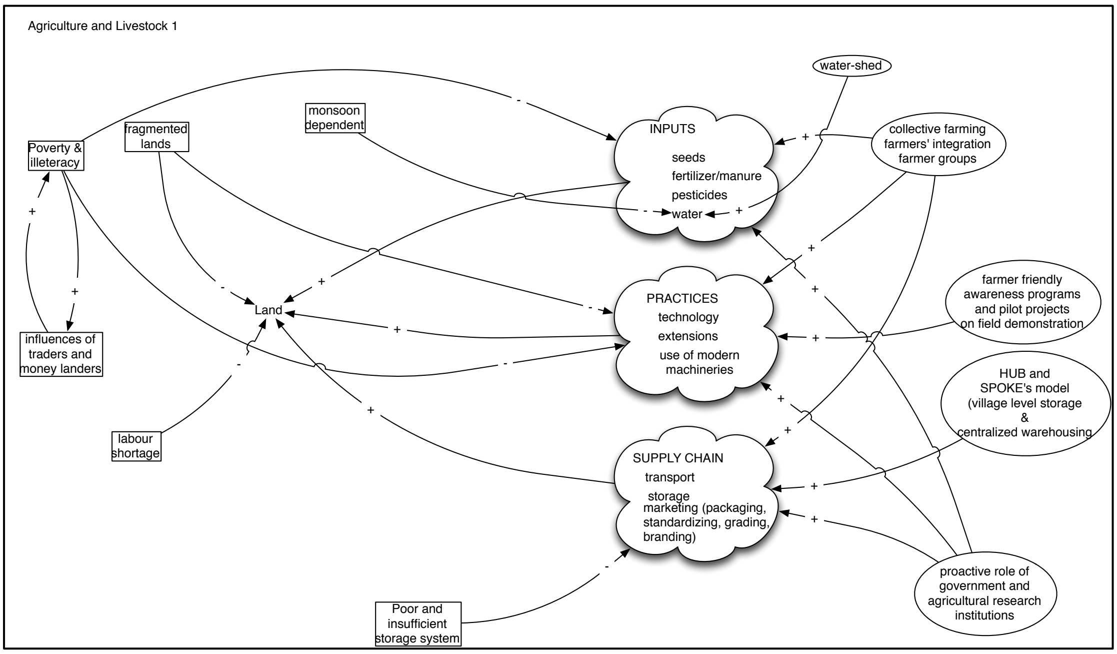

Figure 5.13. The thematic group 1 presented the agriculture and livestock system with three main compartments namely: inputs, practices and the supply chain. The group then identified problem areas (in rectangles) affecting the system and the potential solution areas (in circles).

Tirunelveli Workshop 3 – Results of Group 2 – Theme: Agriculture & Livestock

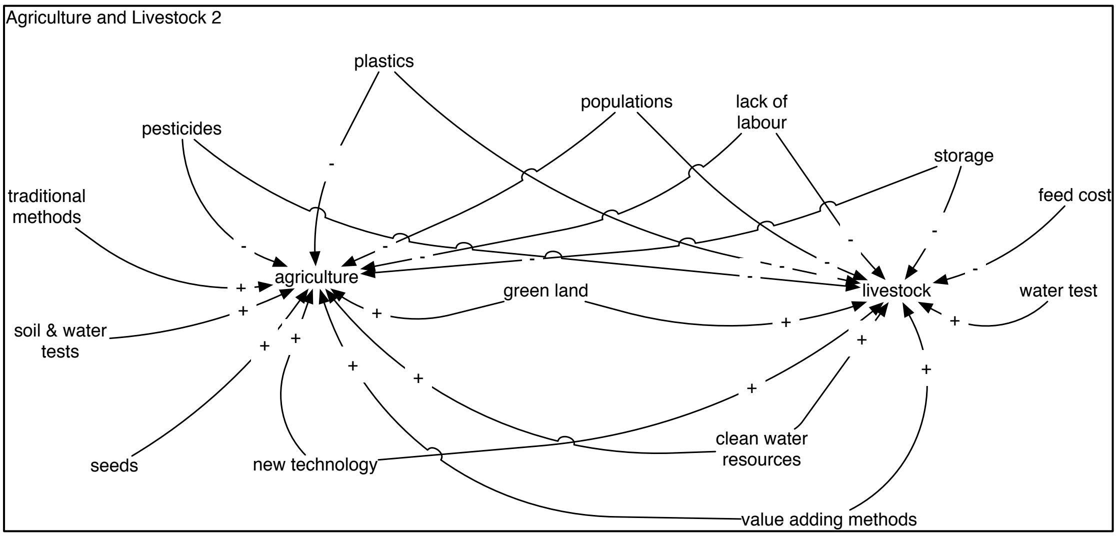

Figure 5.14. Group 2 also had the theme of agriculture and livestock to explore. They identified resources required for production (e.g. seeds, technology, water, land etc.), and the problems associated with extensive use of pesticides and plastics. High cost of feed, lack of labour and insufficient storage were also named as problematic areas in agriculture and livestock.

Tirunelveli Workshop 3 – Results of Group 3 – Theme: Fishery

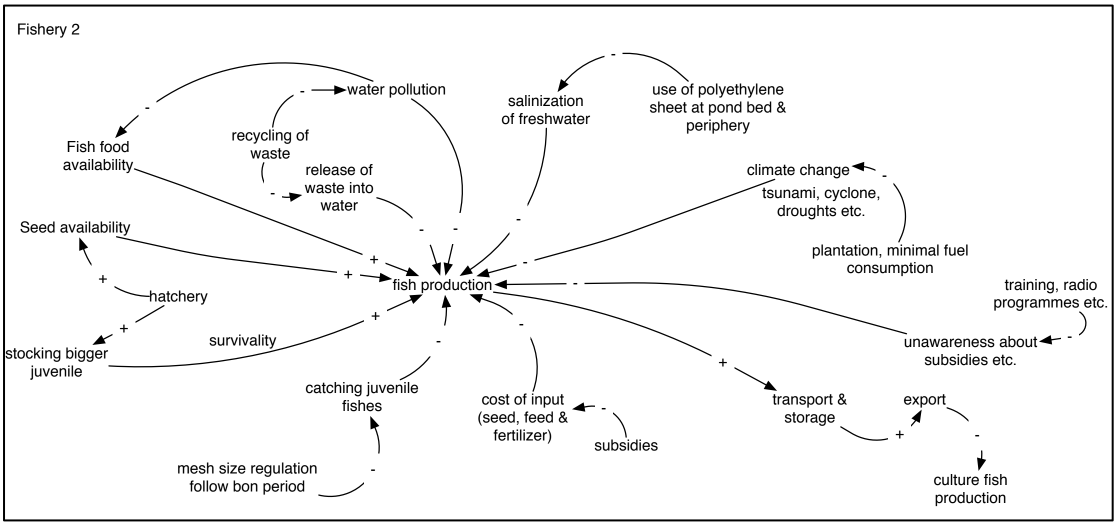

Figure 5.15. Group 3 explored the issues around fish production. With sufficient hatchery, seed availability and surviving juvenile fish the fish production increases. Water pollution negatively affects the fish food availability and in turn the fish production. Salinization of freshwater due to use of polyethylene sheet at pond bed and periphery has also a negative impact on the fish production. The high costs of seed, feed and fertilizers can partly be covered by subsidies, which are not really well known. Increased awareness about subsidies can be managed by training and radio programmes.

Tirunelveli Workshop 3 – Results of Group 4 – Theme: Health

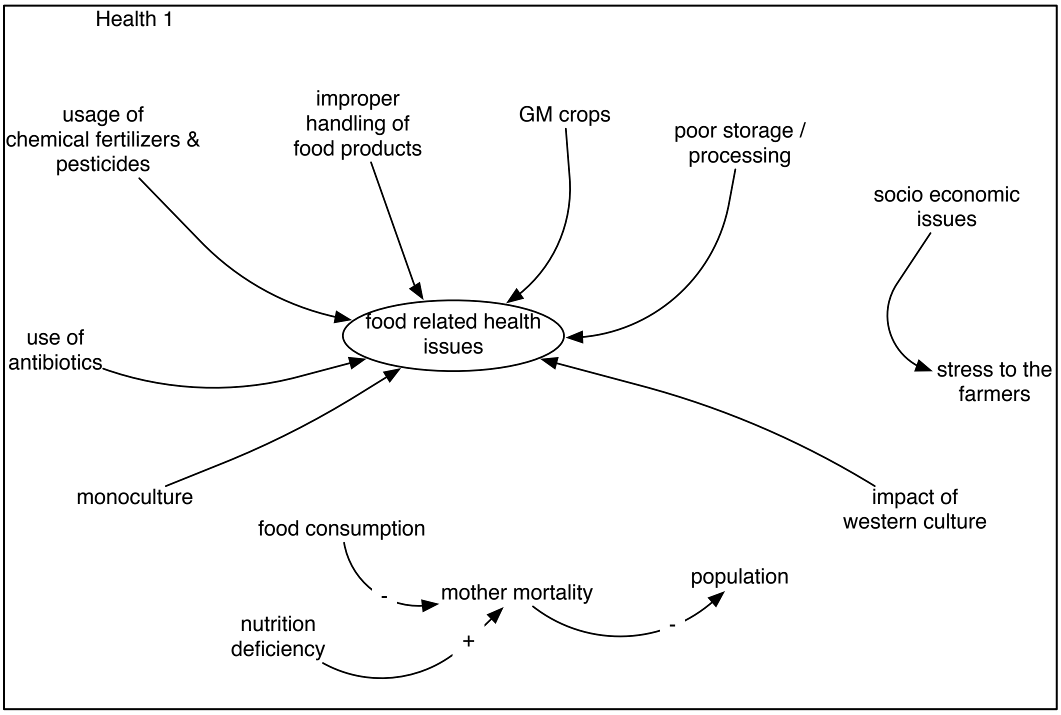

Figure 5.16. Group 4 looked at food related health issues and identified problems lying behind (i.e. use of antibiotics, chemicals and pesticides, GM crops, poor storage and processing facilities etc.)

Tirunelveli Workshop 3 – Results of Group 5 – Theme: Health

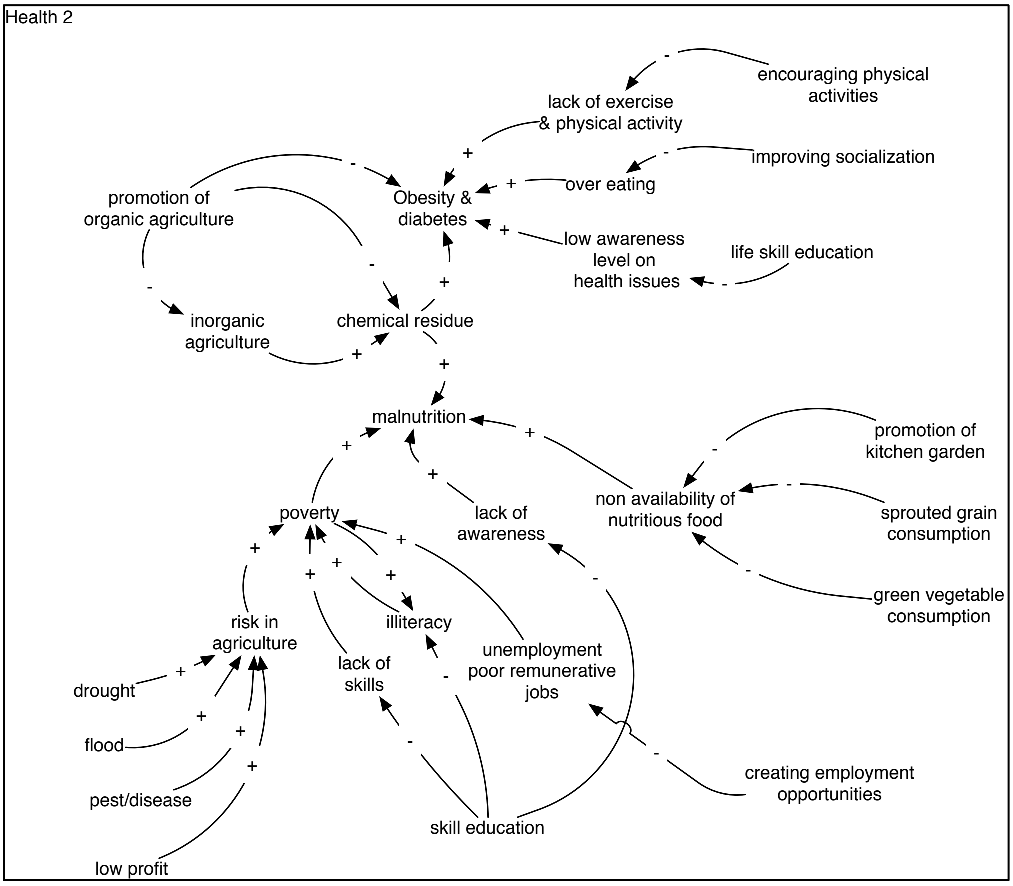

Figure 5.17. Group 5 also looked at food related health issues such as obesity and diabetes, and malnutrition. Some of the driving forces behind increased obesity and diabetes are lack of exercise and activities; over eating and lack of awareness on health issues. These can be improved by encouraging physical activities, socialization and increasing life skill education. When it comes to malnutrition, the main reasons behind it are non-availability of nutritious food, lack of awareness and poverty. Promotion of kitchen garden, increased sprouted grain and vegetable consumption can provide the nutrition needed. Malnutrition caused by poverty can be tackled by improved literacy and skill education as well as creating new employment areas.

Tirunelveli Workshop 3 – Results of Group 6 – Theme: Water

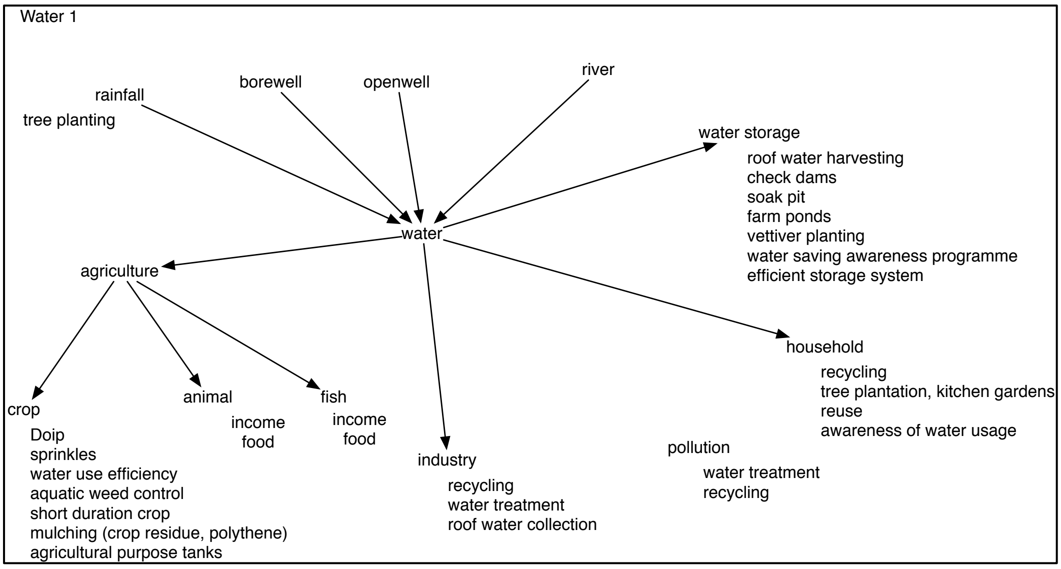

Figure 5.18. Group 6 looked at water issues and identified measures improving water storage efficiency, as well as usage efficiency in agriculture, industry and households.

Tirunelveli Workshop 3 – Results of Group 7 – Theme: Water

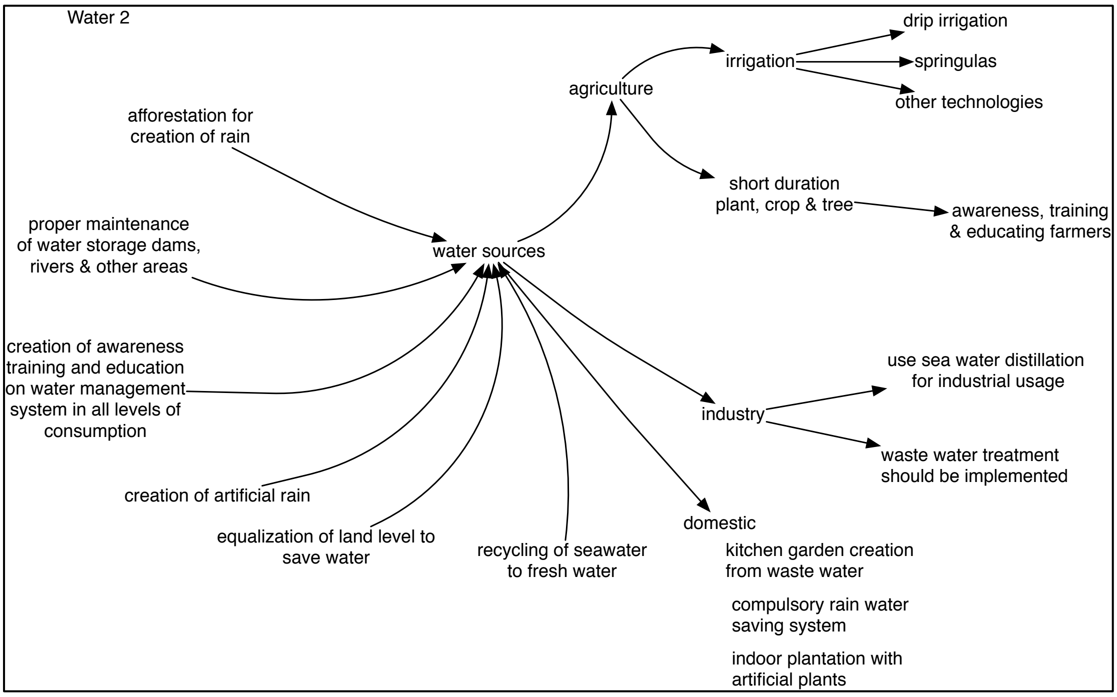

Figure 5.19. Similar to group 6, group 7 also identified practices improving the water availability, storage, and usage efficiency for agricultural, industrial and domestic purposes.

5.4 Synthesis of the 3 Group Modelling Workshops in Tirunelveli

All figures as outcomes of the group modeling work after the 3 workshops are summarized into a complex whole as shown in Figure 5.20. The CLD contains a rich amount of information about the key issues and the potential solutions to address them in Tirunelveli's food system.

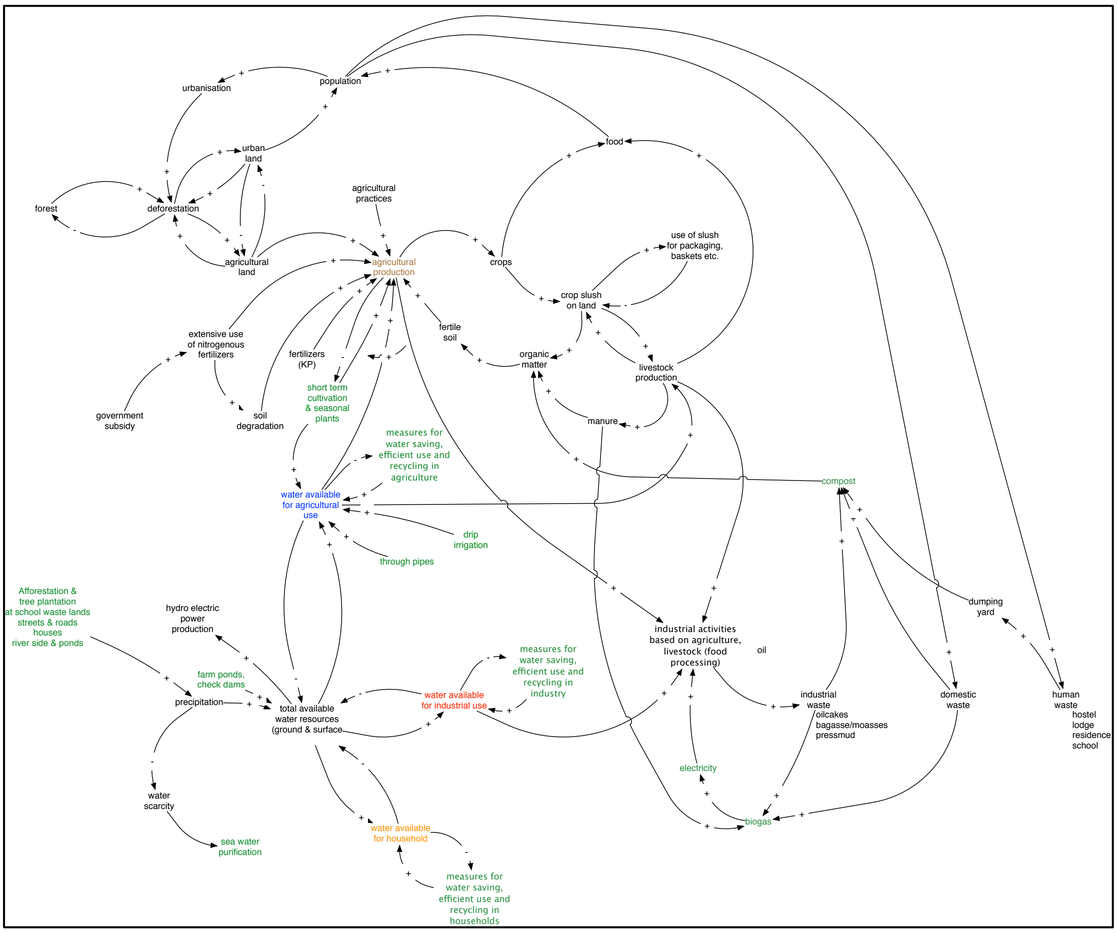

Figure 5.20. Water scarcity requires priority attention to secure sustainable food production in the region. Less available water not only limits the water use in agricultural (e.g. irrigation, livestock production) sector, but in residential and industrial sectors as well. This in turn negatively affects the socio-economic system in Tirunelveli. In order to cope with the future water related problems in the region, there is a need for transition to new adaptive water management measures/strategies. Construction of new water storage bodies, minimisation of leakages from the main water distribution networks were some of the suggested measures to increase the amount of total available water resources. Some of the suggested measures for saving, efficient use and recycling of water in agricultural sector include promotion of drip irrigation, rainwater harvesting methods and capacity building of farmers on best practices and techniques i.e. short term cultivation and seasonal plants. Similarly, there is a need for measures for saving, efficient use and recycling of water in residential and industrial sectors.

Like in Iceland and Bristol case studies, after the workshop 3, implementation of the Converge indicator framework on Tirunelveli case study continued with step

1 (Model formulation) of Phase 2 (Dynamic modelling and integrated scenario analysis). However, it was realized at this stage that there was a lack of case specific data, which was required to run the dynamic model that had been developed. Generally, main reasons behind the lack of data include:

- it is not possible to measure some parameters;
- some parameters are not measured due to lack of knowledge;
- some parameters are measured but not shared (or partly shared if paid)

Under these circumstances and after consultations with the project coordinators, WP3 decided not to continue with dynamic modelling of the specific food systems in particular case studies (Iceland, Bristol-UK and Tirunelveli-India), rather focus on the dynamic modelling of the key natural resources that are common to the all case studies and have crucial impacts on the food system on global level. Thus, WP3 performed dynamic modeling studies looking at key minerals and metals in food production and supply chain. The results were provided with seven extra deliverables replacing the final version of D19.

6 Converge Indicators for the Food Sector

Rich amount of information obtained from:

- the conceptual modeling of food systems within three case studies; and
- additional dynamic modeling of key mineral and metal resources

is summarized below with a series of CLDs presented by Figure 6.1 to 6.7. In these figures Converge indicators are identified and all presented in Table 6.1.

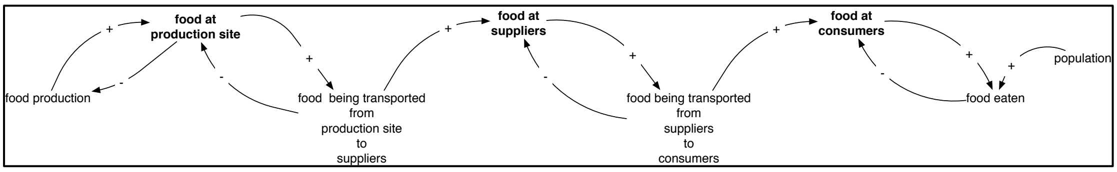

Figure 6.1 Simplified causal loop diagram of food production, supply and consumption phases. The more food is produced the more will be available at the production site, so that less will be produced. More transportation from production site results in less food at production site and more at the suppliers. Similarly, transportation of food from suppliers to consumers gives more food at consumers and less at suppliers. When the food is eaten then there will be less food at consumers.

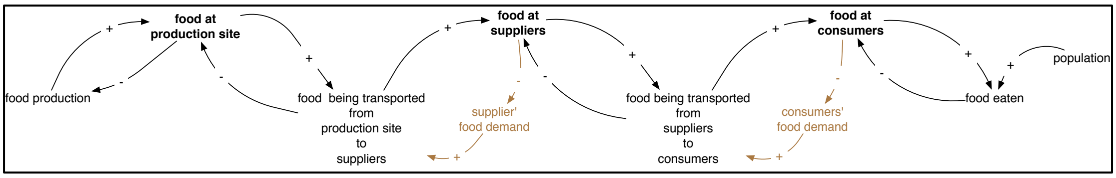

Figure 6.2 Once there is less food at consumers, their food demand increases and this results in more purchasing and transportation of food from suppliers to consumers. More food being transported from suppliers reduces the amount of food at suppliers, which in turn increases the suppliers' food demand and transportation from production sites to suppliers. This ultimately leads to more food production. A continues population increase causes more consumption, supply and production, which leads to depletion of resources.

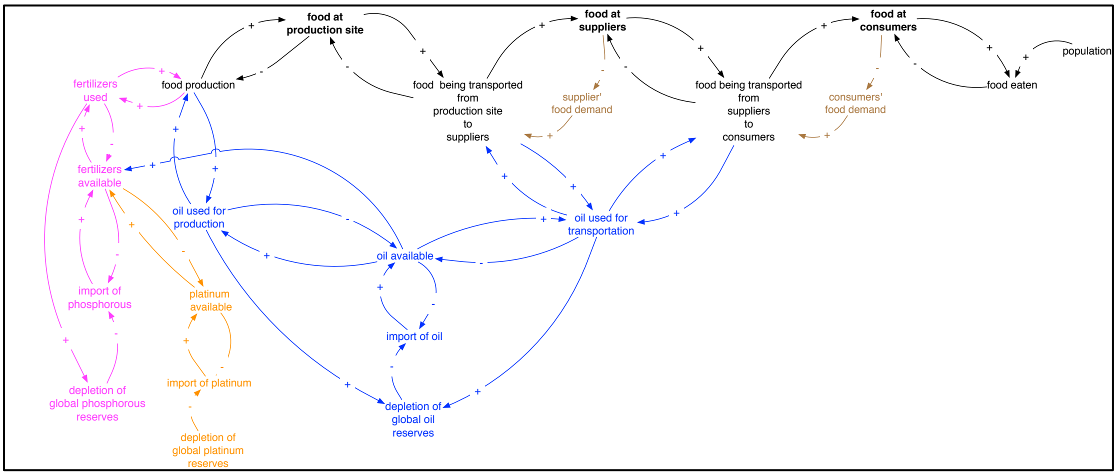

Figure 6.3 Use of fertilizers increases agricultural food production and the more food is produced, the more fertilizers are used. Availability of fertilizers depends on the import of phosphorous, oil and platinum, which are only available if the global phosphorus, platinum and oil reserves are not depleted. Oil is required not only as as fuel for producing fertilizer, but also during the food production and supply phases.

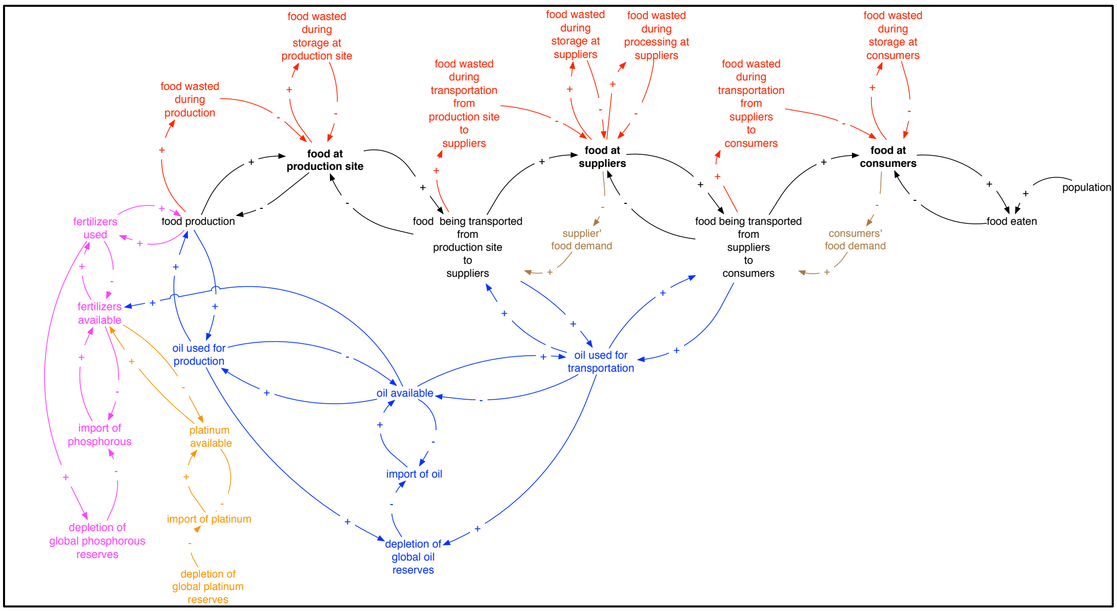

Figure 6.4 Food waste is generated during the food production, storage at production site, transportation from production site to suppliers, storage and processing at suppliers, transportation from suppliers to consumers and finally storage at consumers phases of the food production-supply chain.

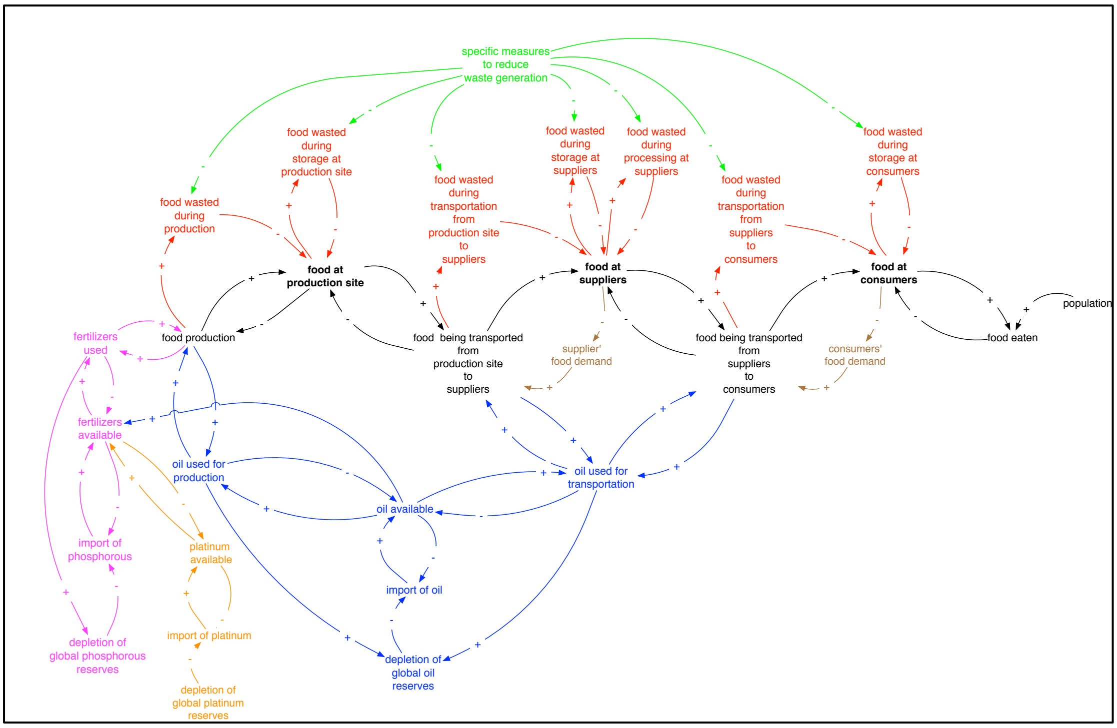

Figure 6.5 Specific measures aiming to increase the efficiency in production and reduce the amount of waste generation in an earlier phase of food production and supply chain automatically allows more food available in the next phase of the chain (e.g. effective processing technologies, new and better storage facilities, effective inventories, shipment and distribution systems etc.)

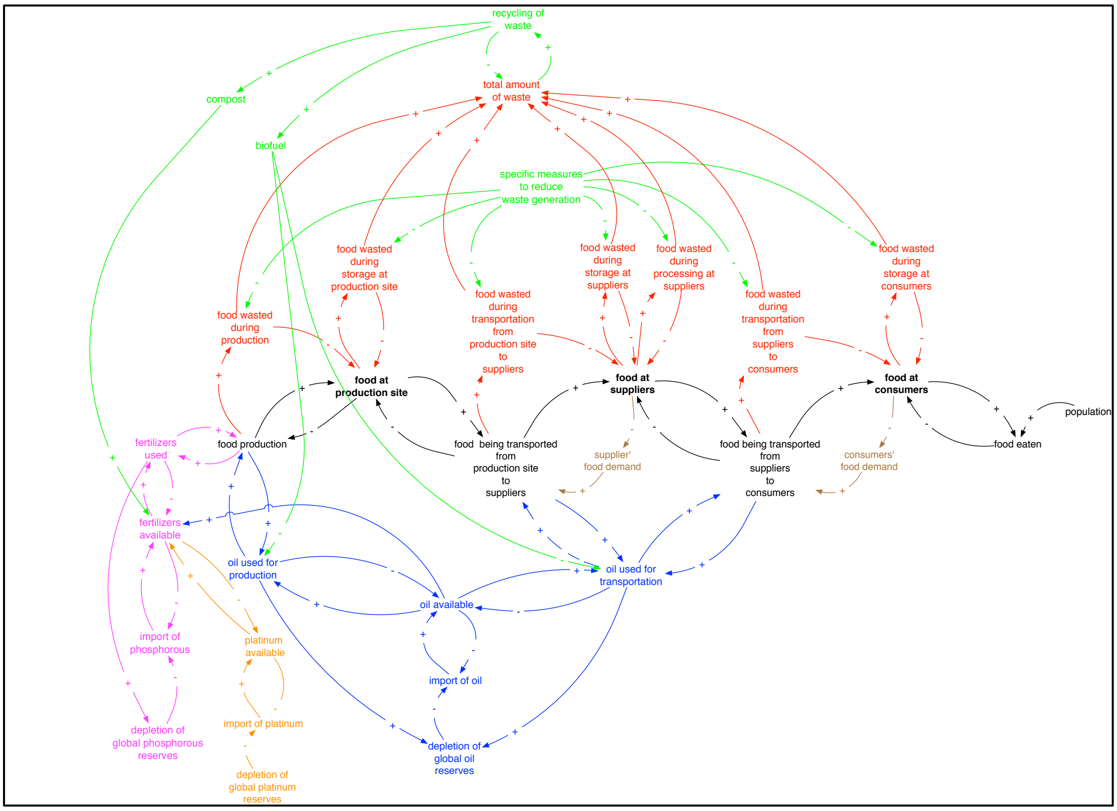

Figure 6.6 Recycling of total amount of waste by composting and producing biogas closes two loops in the system. First, nutrients in the compost can be used as fertilizer, which reduces the industrial fertilizer production from depleting resources. Second, biofuel generated from waste can replace oil in production and supply phases.

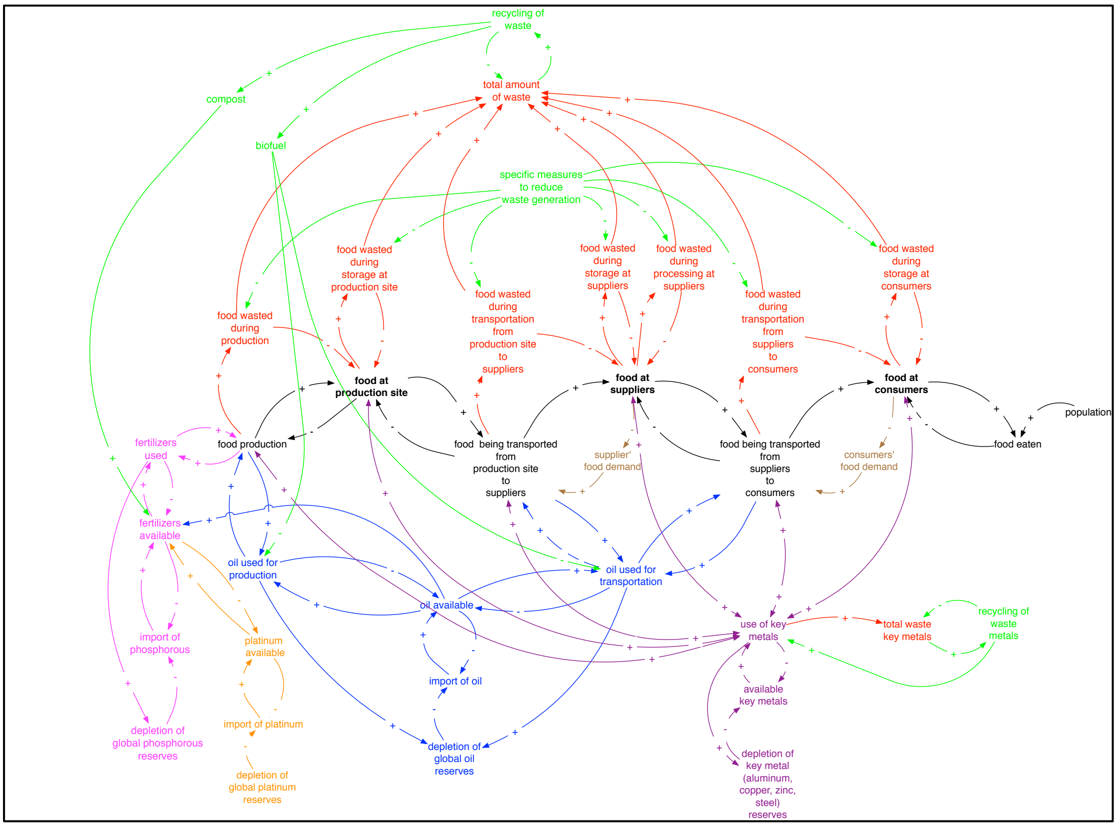

Figure 6.7 Some metals are essential for food production and food security. Steel is needed for tools and machinery for growing crops efficiently. It is also needed for the tools and machinery that mine phosphorus. Aluminum, copper and zinc are the three big metals for infrastructure, and they are essential for running an efficient society. They are used in tools, packing, transport, machinery and buildings throughout the food system. Similar to other natural resources recycling of these metals is required for a sustainable food system.

Table 6.1 Converge indicators for food system

	@ production	@ supply	@ consumption
phosphorous use rate (tonnes/yr)	X		
phosphorous recycling rate (%)	X	X	X
platinum use rate (tonnes/yr)	X		
platinum recycling rate (%)	X	X	X
other key metals (aluminum, copper, zinc, steel) use rate (tonnes/yr)	X	X	X
other key metals (aluminum, copper, zinc, steel) recycling rate (%)	X	X	X
oil use rate (tonnes/yr)	X	X	X
biofuel use rate (tonnes/yr)	X	X	X
geothermal energy use rate (for Iceland)	X		
electricity (geothermal based) use rate (for Iceland)	X	X	X
electricity (coal, oil based) use	X	X	X

rate (for india)			
water use rate	**X**	**X**	**X**
food waste generation rate (%)	**X**	**X**	**X**
food waste recycling rate (%)	**X**	**X**	**X**
GHG emissions	**X**	**X**	**X**
pesticides use rate (for India)	**X**		
fishing rate	**X**		
consumers' food demand (per capita)			**X**
population growth rate			

Table 6.1. shows the converge indicators developed for the food system within the three case studies. The table also shows at which phases of the food system (production, supply consumption) the individual indicators should be measured.