Circle Scan:
Current state and future vision
Agri & Food sector
This document serves as a background report to the Circle Scan analysis that was performed by the Circle Economy on the Agri & Food sector (hereafter A&F). This analysis is part of the Circular Economy Journey as organized by Rabobank in collaboration with De Lage Landen, Royal Haskoning DHV, Circle Economy, MVO Nederland. It provides background to the system maps of the current A&F sector and the future vision.

The Circle Scan methodology is an evaluation method developed and used by the Circle Economy to quickly assess and identify opportunities for moving towards circularity within the broader value chain of organizations. By taking a systems perspective, we develop a quick understanding of the main components and impact areas within a system. Hence the Circle Scan provides a framework and becomes a decision making tool for action. The outputs of the Circle Scan serve as inspirational and knowledge source for the participants of the Rabobank Circular Economy Journey to develop circular business models.

Because the A&F sector has largely become a globalized industry, we have zoomed out to worldwide level to understand the current situation and hotspots in the sector, illustrated by a system’s map. As most participants on the Rabobank CE Journey are actors in the AGF chain (potatoes, vegetables and fruits) we’ve also analysed the Dutch AGF chain. The final section of this report provides a circular system vision in which we will touch upon opportunities to reduce negative environmental, economic and social impacts and to translate these into opportunities for circular business models in the Dutch AGF sector.
The A&F chain has become long and complex. It comprises of farmers, processors, distributors, wholesalers, traders, purchasing companies, supermarket chains, retailers, and consumers all around the world. Most food products end up far from where they are produced, either preserved fresh or processed. From the total global consumption of resources this internationally oriented system is responsible for 70% of the total water usage, as well as for 40% of the land’s surface area, 30% of the energy used and 70% of all fertilizers used. Moreover, along this chain 30-50% of the 4 billion tonnes of food totally produced is wasted while 2 billion people suffer from one or more micro nutrient deficiencies.
The visualized A&F chain already highlights a number of hotspots that relate to energy use (fossil fuel and associated emissions), material use, impacts on biodiversity and ecosystems, on society as a whole and on individual health/happiness. In this section some of these impacts are further addressed.

Energy and Material impacts
• Throughout the chain, processes related to harvesting, processing, transport, storage, and fertilizer production rely heavily on fossil fuel inputs, causing the A&F sector to account for 22% of the global GHG emissions, with 14.5% of the global GHG emissions coming from livestock.

• Fresh food products need to be preserved throughout storage and transportation stages, and processed food needs to be conserved for pretty much indefinite time. This requires intensive heating and cooling, the use of preservatives and packaging, and thus the input of scarce materials.

Biodiversity and Ecosystem impacts
• Vast amounts of freshwater and land surface and being used for crop and meat production, putting a strain on the competition for water in water scarce areas and land that would otherwise be available for natural ecosystems and native communities. Nowadays agriculture is responsible for 75% of global deforestation.

• Current crop production systems comprise 90% monocultures and require continuous inputs of artificial fertilizers, pesticides, herbicides and insecticides, contaminating surrounding land and water bodies.

• Meat production requires 50% of all the crops produced as feed input and strongly relies on the usage of antibiotics in the generally densely packed stables, leaving only half of the crops for human consumption and animal welfare and antibiotic resistance as a global issues to deal with.

• The fossil fuel intensive wild fish capture has resulted in 70% of the world’s fish species to be either fully exploited or depleted, and goes hand in hand with 8% of the fish wasted by throwing back millions of tons of dead, dying and unusable fish.

• For the production of 1kg of farmed fish 5kg of wild fish is caught for fish feed, and 10-100gr of antibiotics is used. Pesticides and and toxins as arcene, PCB’s, dioxins, FF-B, AM1 etc. are being used to kill the parasites and worms attracted by the high concentration of feces in the densely packed basins, and to create artificial flavours.

• Access to food and water is skewed, causing about 1 billion people to be overweight and over 860 million people to be food insecure. Beyond the social cost, the cost to the global economy caused by malnutrition could account for as much as 5% of global GDP. This equals about US$3.5 trillion per year.

Societal impacts
• From the 4 billion tonnes of food produced between 30-50% is lost throughout the chain. This percentage equals an economic value of €550-€850 billion. In industrialized countries more than 40% of losses happen at retail and consumer level, while in developing countries 40% of losses occur at post-harvest and processing levels. If only 25% of these food losses could be saved, this would be enough to feed the 860 million hungry people in the world.

• Besides the many different channels throughout the chain which cause little room for profit margins, purchasing companies and supermarket chains have enormous buying power due to the consolidation of the chain, causing farmer prices usually to be far less than 30% of the consumer prices.
ZOOMING IN: THE DUTCH FRUIT AND VEGETABLE CHAIN

Production Fruit & Veg (NL) (5.41 million Kg)

Purchasing (5 Buyers)

Retail (83%)
Supermarket Chains (25 Chains)

Markt

Consumers (7.5 million households)

Businesses

Transport

Foodservice/Bulk (17%)

Wholesale & Trading (1,164 Suppliers)

Import (4.5 million kg)

Export (6.2 million kg)

Total Food Waste (30 - 35%)

Production Waste (2 - 10%)

Processing Waste (1 - 2%)

Trade Waste (2 - 10%)

Transport Waste (2 - 5%)

Market Waste (2 - 6%)

Consumer Waste (10 - 15%)

ENVIRONMENTAL IMPACTS OF IMPORT & EXPORT ABROAD

GERMANY (38%)

ENGLAND (17%)

FRANCE (5%)

BELGIUM (7%)

OTHER (35%)

Global Nutrient Displacement & Leaks

Land, Energy, Water Resource Inputs

Transport Means: Large Impacts Across the Board

Shift to Hybrid Consumer Patterns

Use of Harmful Pesticides

Low Profit Margins for Producers

Environmental Impacts of Import & Export Abroad

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The Dutch A&F sector makes up approximately 10% of the Dutch economy and provides an equal percentage of the total jobs in the Netherlands. Over 50% of the total added value of €52 billion is related to the handling, processing and export of imported goods. This percentage has been steadily increasing at the cost of the contribution of the primary sector. This sector, consisting of almost 70,000 farmers, accounts for only 22% of the total added value and 13% of the jobs in the Dutch A&F sector.

Netherlands one of largest exporters of agrofood products
In 2012, total value of A&F exports was €76.2 (+4.4%), accounting for 20% of the total export value, and imports had a value of €52.3 billion (+5.7%), resulting in a trade surplus of €24.9 billion. It is clear that major part of the economic interest of the Dutch A&F sector is in the processing and throughput of imported goods. This is not surprising as the Netherlands is known for its highly productive, cost efficient and technologically advanced A&F chain. Nowadays the Dutch A&F sector is one of the world’s largest exporters of agrofood products, ranking second after the US. Germany is the most important trading partner to the Netherlands as it is responsible for 26% of the agrofood export and supplies 19% of total import. It is mostly fruit, vegetables, horticulture, dairy, eggs and meat that are being imported. Other important trading countries are Belgium, France and the UK which together with Germany cover 60% of the total Dutch export. The EU has a total segment of 80% in the Dutch agrofood export, and 60% in the import. Eventough the efficiency of nutrient use in Dutch agriculture between 1990 and 2010 has increased significantly, from 50% for both nitrogen and phosphor to 84% for phosphor and 60% for nitrogen in recent time (CSB, 2012), the nutrient cycle still shows significant leaks and causes large imbalances worldwide, leaving other lands depleted.

Main hotspots in the Dutch AGF chain
As a result of the large amount of import and production for the export market (almost 5 times as much as Dutch consumption), the Dutch AGF chain is responsible for a significant amount of impacts in the areas of fossil fuel use (and associated greenhouse gases), nutrient displacement, water use and areable land use across the world but also in the Netherlands.

Global nutrient displacement and leaks
Three fertilising nutrients are essential to agricultural production: nitrogen (N), phosphorus (P) and potassium (K). Large amounts of nutrients are imported into the Netherlands either as a mineral, fertilizer, as a food or feed, and ending up in the environment at some point and depleting soils elsewhere on the globe. Eventhough the efficiency of nutrient use in Dutch agriculture between 1990 and 2010 has increased significantly, from 50% for both nitrogen and phosphor to 84% for phosphor and 60% for nitrogen in recent time (CSB, 2012), the nutrient cycle still shows significant leaks and causes large imbalances worldwide, leaving other lands depleted.

Challenges in the production and supply of the nutrients differ, while phosphorous is a finite mineral mined in a few places globally, nitrogen is an abundant element that however requires a lot of energy to be fixed in a usable form. Challenges in the production, availability and supply of these nutrients are widely different.
The effects of other inputs are also large

Although it is difficult to make exact estimations about the combined fossil fuel use of both Dutch production and import, as well as the associated greenhouse gas emissions, land use and water use, it is clear that the effects can be significant. For example, a large amount of the Dutch fruits is imported from countries that inherently require impactful transport, such as from South Africa and countries in South America. According to an extensive study of CE Delft (2010) about environmental impacts of Dutch import & export activities, transport mileage is the largest climate impact. In terms of impacts of land use and water use, regional difference of course come in to play as not all international production takes place in areas in which there is water stress and/or land-use effects. Nevertheless, as we could see from the global F&A analysis, the impacts on biodiversity (deforestation mainly) and native populations (water scarcity) can be significant.

Food waste

In the Netherlands over 30% of all the food is wasted. This equals an amount of 1.4-2.5 billion kg and an economic value of € 4.4-7.8 billion. Most food is wasted at point of production (31%) and at consumer level (31%). Supermarkets and retail account for 4%, processing and packaging for 5%, and storage and logistics for 1% of all the food wasted. Diversification practices in the last three years mainly focused on social activities as daycare (+19%), education (+24%) and care farms (+230% since 2003), but also on energy production and supply to third parties (+39%). Food waste in the AGF chain mainly occurs in ground bound production (5-10%) and at the consumer (>10%).

Harmful pesticides

Dutch use of pesticides and herbicides is, despite significant reductions, highest in the EU with 11 kg active substance per hectare and still below policy standards for safeguarding environmental impacts on ground water quality, drinking water quality, health safety through food residues (Compendium voor de Leefomgeving). The average in the EU is around 3.5 kg/ hectare. The use of pesticides for the production of apples and pears has the highest environmental impact (Spruijt et al., 2011). Most of the emission of pesticides in the Netherlands
According to a trends analysis by Rabobank, the hybrid consumer is increasingly dominating the Dutch Market. On the one side of the spectrum, consumers are looking for low cost, high quality standard products and at the other side the demand is growing for added value, trends suggest a rise of 7% per year of both sides of the consumer patterns over the coming 5 years. At the same time, the middle spectrum of the market of with straightforward products for straightforward prices is expected to decrease by 2% (Rabobank, 2014).

Part of the premium products are organic and fair (sustainable) products. The total consumer expenses on sustainable food in the Netherlands has increased by 10.8% in 2013. The market share of sustainable food has increased from 5.5 to 6.1% (Monitor Duurzaam Voedsel, 2013).

Low profits primary producers
Next to the environmental hotspots in the AGF chain, we can also distinguish various economic hotspots. One of them is reduced margins for primary producers. In the Netherlands there are only 5 large buying companies and 25 supermarket chains. As about 80% of the food is sold through supermarket chains, from which only three chains hold 85% of the total market share, these chains together with the buying companies have enormous buying power. The large scale production of food has caused a supply surplus and as supermarkets have difficulty differentiating they are instead competing on price, causing price reductions throughout the chain with the lowest profit margins for primary producers. Due to these developments farming has become more uncertain and unattractive for next generations, causing 21% of the farmers to be 65 years or older (versus 9% in 1990) and an increasing number of agricultural farms to go out of business due to a lack of successors. Because of the way the chain is organized, industrial AGF production is less dependent on a volatile market than the fresh AGF market: industrial parties collaborate more closely with farmers to match demand with production capacities. This results in reduced food loss across the board and a more stabilized economic positions for the primary producers.

Changing consumer patterns
Other changes occurring in the economic spectrum of the AGF chain are changed consumer patterns. Consumers show increasingly hybrid patterns to two sides of spectrum: increasing demands for both low costs common products and premium products with emotional or social feel.
DEFINING PRINCIPLES OF A CIRCULAR ECONOMY

The circular economy is an economy that is regenerative and waste-free by design. We have taken these basic principles and further defined them into a set of six “features” of a circular economy. These are intentionally ambitious and broad, because they are meant to represent an ideal, theoretical end state. Such an end state is likely to be unachievable in practice, but at the very least, if we have agreement on this end vision, we can all set our compass in the same direction.

In a circular economy:
1. All materials are cycled indefinitely
2. All energy is from renewable or otherwise sustainable sources
3. The integrity of the biosphere and its natural capital are supported and strengthened through human activities
4. Human culture and social integrity are supported and strengthened through human activities
5. Human health and happiness are supported and strengthened through human activities
6. Resources are used to generate value (recognizing a broad range of value beyond financial gains)

The overall objective that shines through these principles is an imperative to create an economy that will efficiently manage and recycle material flows and base its operations on renewable energy. In the next section we take these six principles and apply them to visualizing a true circular A&F system.
Based on the Circle Economy’s vision of a circular economy, the linear Food & Agri system as we know today will drastically change. A circular vision for the A&F sector is aimed at minimizing or ideally eliminating the current impacts as discussed in the current state, and at the same time to provide nutritious and healthy food for a growing world population. Core to this circular vision is more synergistic and recycled resource flows and more diversified chains to reduce energy, nutrient, water and land inputs and to eliminate waste.
If we fundamentally re-focus the current linear chain towards a more integrated, collaborative, regional, and circular AGF chain, we eliminate most of the current hot spots and open doors to new business opportunities. As we have seen in both the analysis of the global A&F chain as well as the Dutch AGF chain, the current linear systems result in problematic material, energy, biodiversity, and societal impacts. With a growing world population to feed we face the challenge of almost doubling food production capacity while halving the use of water, land, and other resources. Transitioning to a circular A&F sector, and AGF chain in particular, means therefore: producing healthy, nutritious food on arable lands without depleting resources (water, phosphorous, fossil fuels) and in absence of impacts on biodiversity and society. Here is a glance at a possible future of a more resource-efficient, waste-free, and resilient AGF sector.

CIRCULAR VISION: DUTCH AGF CHAIN

Based on the principles of a circular economy as described above, we can image how a circular Dutch AGF chain could look like and what key features it might have. At the core of a circular future we see a fundamental re-shift from a largely international focus to bio-regional clusters of integrated food production, food processing, and bio-processing in which flows of nutrients and water are efficiently cycled, and residual streams are valorized. A shift from global and international trade to more regional chains largely reduces the need for energy inputs for transport, as well as leading to reduced nutrient imbalances, and a diminished or eliminated need for artificial fertilizers. The Dutch climate, soils and water availability form perfect ingredients for ground-bound production, supplemented with highly efficient production systems and some imports of specialty crops. New and more diversified products address global issues such as the impact of the dairy and meat industry. Renewable energy replaced fossil fuels all along the chain. For ecosystem and human health harmful pesticides are eliminated as a result of the application of polyculture techniques in stead of unstable monocultures. Toxic materials, such as for packaging are eliminated, and packaging overall is reduced.
By definition, such a circular bio-region eliminates a lot of needs for synthetic inputs, chemical inputs, fossil fuel inputs for transports, and reduction of other impacts on human health and biodiversity. Let’s take a closer look at the sub-elements of the circular vision.

**From global to bio-regional**

Bio-regions are the basic feature of a more circular state of the A&F sector: these regional areas, varying in size, host most of the actors in the chain - from producer, processor to consumer/user. In bio-regions, resource flows are optimized in such a way that external inputs for fertilization, energy, water are sourced locally from renewable resources, and reduced where possible, and that waste outputs are eliminated. More regional production, processing and consumption largely decreases the need for long logistical chains that are energy intensive because of transportation and cooling. Within bio-regions a variety of business actors collaborate to optimally serve the local demands and create a resilient regional economy. A more fundamental point of this vision is that this might imply that Dutch consumer might not be able to eat year-round all exotic products or fruits and vegetables that are out of Dutch season, or require significant inputs (water, nutrients, energy) to produce in the Dutch climate.

**Shorter and more transparent chains**

In bio-regions the food chain is becoming shorter and more transparent. Shorter and collaborative, transparent chains allow for more rapid adjustment of supply to demand, and give shared insight in specific product information, sales volumes, margins and food waste. Entrepreneurial producers will get more influence on the actual product display and composition at point of sales. These new chain configurations give opportunities for increasing overall sales and margins, and delivering high quality products and continuous supply, while reducing environmental impacts and financial costs related to transport, storage, food waste and the mismatch of supply and demand. In addition, shorter chains circumvent several chain partners that individually take part of the margin, leaving larger margins for primary producers. There is much less import and the import that does happen is for specialty crops that can not be grown locally. Fresh chain within AGF can learn from industry chain, in terms of backward demand optimizations. Currently still a niche-market but more prominent in a circular vision are the local for local chains, in which consumers get more integrated in the chain. Examples that are already around are the ‘groente box’ where primary producers sell their (in season) produce directly to consumers in a box delivered to their house, or local food coops which organize collective food purchasing from local farms.

**Cross-sectoral integration**

Another key feature of a more circular sector is cross-sectoral collaboration and integration. Primary producers collaborate with bio-refineries, other businesses and utilities to exchange and cascade resources that were previously regarded as wastes. Scarce and deetable resources like phosphate are recovered from waste water. Residual organic streams are upgraded in bio-refinery processes for example to lipids and acids that can serve the packaging industry to create packaging. Examples are already visible, such as tomato leaves or mycelium (the growbed of mushrooms) for packaging. From global to regional also means that end-users can become more engaged in the sector, through experiential programs, education, local foods stores, and self-cultivation technologies.

**Applying advanced agronomic techniques**

At the side of production, innovative cultivation techniques help increase the overall efficiency of production per m² while at the same time reducing the need for inputs such as nutrients, water, land and energy. Precision farming through balance fertilization, no or low tillage techniques, can increase nutrient cycling, reduce emissions and maintain soil fertility. Polyculture cropping, although increasing labor, further helps reduce inputs and eliminating pesticides. Renewable substrate based on techniques such as aquaponics and aeroponics are also essential in a circular future.

**Valorizing waste streams**

Bio-refining of residual waste flows to amongst others nutrients, chemicals and biogas offers large economic potential and eliminates waste from the AGF chain. Already existing are companies such as Waste2Chemical which are specialized in upgrading organic and agricultural residues into chemical substances.
Product diversification and innovation
To add more value and increase margins, primary producers are diversifying their product(s) portfolio's. Examples include the development of sweeter tomato varieties and re-branding them as a snack (‘snoeptomaatjes’) or the slicing and mixing of vegetables to cater to convenience seekers. Other examples include new breeds on the market containing elements with health benefits like bananas with more beta-carotene that the body transforms into vitamin A. Related are also genetically modified crops, such as ‘gentomatoes’, with contain anti-carcinogen substances. As we could see from the world analysis, the meat and fish industry causes the largest impacts across the board. Innovation in new protein meat replacements based on insects or mushrooms open doors to new markets.

Renewable energy opportunities
Currently using 132 PJ/year, mostly non-renewable, the AGF chain has tremendous potential to de-carbonize by utilizing geothermal energy or residual heat for heating, solar or wind energy, reduced or electrified food miles and reuse of CO2 for CO2 fertilization. Utilizing waste heat from industry is also part of the opportunities. Not only will the replacement of fossil fuel by renewable energy eliminate the emission of CO2, the financial savings potential is also large.

Packaging innovation
Innovative packaging solutions revolve around RFID tagging and bio-based packaging using crop’s waste to minimize food loss and eliminate waste. As mentioned before, waste streams such as tomato leaves, or mushroom mycelium, can form the ingredients for bio-based packaging (see the examples of Wageningen UR or Ecovative). Even new retail concepts such as the first ‘packaging free’ supermarket that recently opened in Germany are examples of innovative paths to explore.

MOVING TOWARDS CIRCULAR BUSINESS
At first sight, a more regionally concentrated AGF chain has large economical implications for a country such as the Netherlands that relies highly on international export. For actors in the current Dutch AGF chain this circular future means transitioning to accommodate fundamental shifts in primary production, transport, processing and retail solutions in one’s day to day business. At the same time, a circular future offers the perspective of robust and resilient business models through diversity and decreased dependency on resources that becomes more and more scarce or impactful.

It requires small and first steps that help one’s organization to move in the circular direction. Profitable interventions such as renewable energy, waste valorization or collaboration downstream can help finance additional transition steps. The CE Journey is meant to help further chart the path and discover new business opportunities along the way. Let’s explore the road together.
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