TRANSITION AGENDA
CIRCULAIR ECONOMY | 2018

BIOMASS & FOOD

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FOOD FOR THOUGHT.
APPETITE FOR ACTION.

SUMMARY

Biomass is at the heart of the circular economy. It is a renewable resource that captures CO_2 from the air and offers a broad range of applications. Biomass is the resource for food, animal feed, materials, transport fuel and energy, for example. Biomass is not a singular resource, but a collective name for a range of agricultural crops, wood, grasses, water-grown crops such as algae and weeds, and residual streams that form in the chain from harvest to consumption and final processing. Products from animal residual materials are also considered to be biomass.

Food is mankind's basic necessity of life. Our current food system is not yet sustainable. Important issues regarding food supply revolve around how we can continue to feed the growing world population as well as around healthy and safe food, healthy food patterns and sustainable, circular production systems. Food waste and protein provision are two important bottlenecks.
Globally, about one-third of all the food in the entire chain is wasted; from waste during harvest to food that is not consumed. The production of animal feed uses more than half of all agricultural land. And this entire chain, from production to consumption, causes serious ecological disruptions.

When looking at the wide range of applications for biomass, there is a great sense of urgency for creating circular production and well-considered application of the relatively scarce biomass in our economy. Due to the growth of the global population and the increase of the level of prosperity worldwide, the need for biomass for food production and other applications increases significantly. At the same time, the ecological capacity of the earth has already been exceeded; consider the deforestation, the decrease in biodiversity, the disrupted nitrogen, phosphate and carbon cycles, and the decline of soil quality.
Furthermore, there is a level of competition between the various functions of biomass, including the use of biomass for achieving climate policy goals.

In order to face these challenges and create opportunities, the following four central strategic goals are key:
1. Sustainable/regenerative production of sufficient biomass with an extensive closing of nutrient cycles at a geographic scale that can be so small or as big as is necessary. Such cycles are already in place, at land-related livestock farms, among others.
2. Optimum use of biomass and food. All resources and (semi-finished) products will stay in the cycle as long as possible in as high a quality as possible through full use of resources, high-grade use of biomass, and recycling of residual streams. This also includes dealing with biomass as efficiently as possible (cascading and multifaceted valorisation) by, among other things, countering (food) waste, preventing waste substances, the dosed application of synthetic fertilizers, and efficient incineration.
3. Reducing utilisation and replacing of non-renewable resources with renewable ones (recyclate and sustainably produced biomass).
4. Developing and implementing new ways of production and consumption that lead to improvements and departure from past trends in how biomass and food are handled.

To reach these goals, six intrinsic lines of action have been formulated alongside three preconditional ones:

Intrinsic lines of action.
- Increasing the supply of sustainably produced biomass.
- Circular and regenerative use of soil and nutrients.
- Optimum valorisation of biomass and residual streams into circular, bio-based products.
- Reducing food waste.
- The protein transition towards more vegetable proteins.
- Feeding and greening megacities as the Netherlands' revenue model.

Preconditional lines of action.
- Enhancing the investment climate for bio-based industry.
- Emancipation of regulations.
- Honouring (long-term) carbon sequestration in soil and products.

Executing this transition agenda also contributes to CO_2 reduction in the context of the climate policy. The annual savings may be about 10 Mt CO_2eq reduction. This figure relates to the direct reduction of emissions in the Netherlands.
Looking at the profit that can be achieved in the entire chain, the reduction is more than twice as large. This is because CE is taking action in the entire chain and the Netherlands is an importer of bio-based resources and an exporter of food and products. Moreover, measures focused on better forest and soil management and the increase of biomass production also contribute to CO_2 sequestration.
These measures are also part of the climate and energy transition agenda for agriculture and nature.

In the long term, a circular economy results in a lot of social profit in terms of jobs, innovation, environment, and climate. However, investments will be required to achieve this. Investments to speed up the transition by means of research and knowledge, for scaling up, through demonstration projects and first-of-a-kind plants and to facilitate with specific programme-based investments, such as behaviour campaigns.
Governments, the business community, trade unions, social organisations and citizens face this challenge together. A budget has been set for the coming years from 2018 to 2021 of about 570 million euro, 125 million of which consist of public funds.

The transition towards a circular economy will affect everyone. From citizens we require an adjustment in their diet, their purchase behaviour, their attitude with respect to how products are handled, and their willingness to carefully handle residual streams and waste.
For the business community the transition will lead to a strong decline of activities focused on processing fossil resources because of the climate policy. Within the food system there is also an impending decline of activities that are too risky for the health of people and animals and have very negative impact on our ecosystem. At the same time we have very competitive ports, a strong agricultural food cluster, frontrunners in the chemical industry regarding bio-based economy and recycling, and a very strong logistics sector. This gives the Netherlands an excellent starting position for, among other things, initiating the transition to a circular, bio-based economy in time and making it a success.
This transition can only succeed, however, if we have broad support for the intended changes in society, take the required competencies of employees and employers into account, and anticipate risks and opportunities with respect to shifts in employment.

The transition towards a circular, bio-based economy occurs at all geographical levels. The Netherlands is both a major importer and exporter of biomass and food. Major changes are required at all levels. This will only be possible if there is intensive cooperation within and between chains and if there is inclusivity: apart from the established chain parties it is also important to involve new innovative players, social organisations, citizens, and decentralised authorities. An optimal choice in scale will differ for each (sub)sector or stream: small enough to close cycles and large enough to be efficient.

A lot comes together at the regional level. Companies that take initiatives and enter into talks with local authorities about permits and interpretation of regulations, for example. Citizens who have questions or concerns about new activities. Municipalities and provinces who are looking for their part in the transition to a circular economy themselves.

It is necessary to conduct the search that is linked to a transition process together with administrators and civil servants in the regions. A process in which people need to dare take sensible risks and are allowed to make mistakes. The goal is to learn from them. Local practice will result in best practices that can be scaled up to a national level. And at the national level, vision and government incentives need to create the conditions to boost, facilitate and speed up the transition to a circular bio-based economy.

The biomass and food transition team worked on drawing up this transition agenda with a lot of enthusiasm and commitment. There is a high level of willingness to set out the agenda in more concrete terms with respect to the execution phase.
Each line of action can be started from the current work group structure, which can be expanded into inclusive partnerships between all the required stakeholders in the execution phase.

This Transition Agenda was drawn up in a multi-stakeholder dialogue between experts from the business community, non-governmental organisations (NGOs) and authorities, and also fed by the input of other relevant stakeholders through organised stakeholder meetings and networks. The Biomass and Food transition team was appointed by the signatories of the Raw Materials Agreement. This agenda describes the transition team's recommendation to the signatories of the Raw materials Agreement.

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1. SCOPE

Biomass is at the heart of the circular economy as a supplier for renewable resources, for food, animal feed, medication, materials, transport fuel, and energy. The food system is an important part in the entire biomass field. The issues regarding food supply revolve around how we can continue to feed the growing world population as well as around healthy and safe food, healthy diets, and sustainable, circular production systems.

When looking at biomass in a broad sense, we are aiming for an ecologically sustainable production and consumption system that handles its resources, energy, water and nutrients sparingly and efficiently. A system in which natural capital and biodiversity are taken into account. Biomass is not a singular resource, but a collective name for a range of agricultural crops, wood, grasses, water-grown crops such as algae and weeds, and residual streams that form in the chain from harvest to consumption and final processing.
Products from animal (residual) materials are also considered to be biomass. Biomass distinguishes itself from other resources, because by nature it is a circular, renewable resource that sequestres and holds CO_2 from the air.
The need for biomass will strongly increase in the decades to come, both in the Netherlands and globally. The use of biomass for the production of chemicals, materials, transport fuel and energy also to a large extent contributes to the realisation of the goals in the climate policy.

This transition agenda addresses both the issues around using biomass in a circular economy as well as related aspects of the food system. More specifically, this transition agenda discusses:

- **SUPPLY:** availability of sufficient sustainably produced biomass, while taking into account the geopolitical issues with respect to that availability in the long term and the Dutch dependency on import.
- **SUSTAINABLE PRODUCTION SYSTEMS:** preventing waste, losses in the chain and optimal valorisation of biomass, closing nutrients cycles and maintaining soil quality.
- **CONSUMPTION PATTERNS:** creating departures from past trends in the demand for sustainable and circular food and products.
- **REVENUE MODELS:** improving the investment climate, competitive power, and reinforcing the export position of companies with circular revenue models.

The transition agenda primarily focuses on the non-energy applications of biomass. With regard to the energy applications, separate agendas are elaborated for the new energy and climate policies. These will be brought into alignment with the transition agenda in the execution phase.

The transition towards a circular economy occurs at all geographical levels. The Netherlands is both a major importer and exporter of biomass and food. Major changes are required at all levels. This is only possible if there is close collaboration within and between the chains and if there is inclusivity. Apart from the established chain parties, involving new innovative players, social organisations, citizens and decentralised authorities is also required.
The optimum scale level will differ for each (sub)industry: as small as possible and as large as is required.

2. VISION

2.1 URGENCY

The urgency of introducing circular economic principles increases exponentially as a result of climate change, the growing global population, the increase in prosperity, and global trends such as urbanisation. Biomass is and becomes an increasingly essential part of the circular economy and, apart from food and animal feed, it also provides renewable resources that may contribute to the far-reaching replacement of primary resources in other sectors.

This is why the global demand for biomass will increase strongly towards 2050, and whether or not the supply of sustainably produced biomass can grow at the same rate as the demand remains to be seen. Furthermore, there is a level of competition between the various functions of biomass, including the use of biomass for achieving the climate policy goals regarding the reduction of CO_2. Finally, we can conclude that the current ecological capacity of the earth has been exceeded significantly, for example with the large-scale deforestation, decrease in biodiversity, climate change, and the reduction of soil quality.

In 2009, in Nature magazine, Johan Rockström, together with a group of scientists including Dutch Nobel Prize winner Paul Crutzen and Dutch ecologist Marten Scheffer, introduced the term planetary boundaries. They identified nine planetary boundaries within which humanity needs to stay in order to continue to use the earth's resources sustainably. The disruption of the carbon cycle is approaching the planetary boundary for climate change as well as the boundary for changes in land use. The boundaries for the nitrogen cycle, phosphorous cycle and biodiversity have already been exceeded.

The use of fossil resources must be reduced significantly as a result of climate policy. The availability of a number of critical and fossil resources is limited (phosphate, a number of critical resources, such as rare earth metals).
Another reason for limiting the use of these resources is that they result in geopolitical risks, because they can only be extracted in a handful of countries.

From an economic perspective, a transfer to a circular economy is also very urgent. The Netherlands may gain a competitive advantage in case of a quick transition. After all, the Netherlands depends on the import of resources to a large extent, which means the time to make the switch to sustainable and circular revenue models is now.

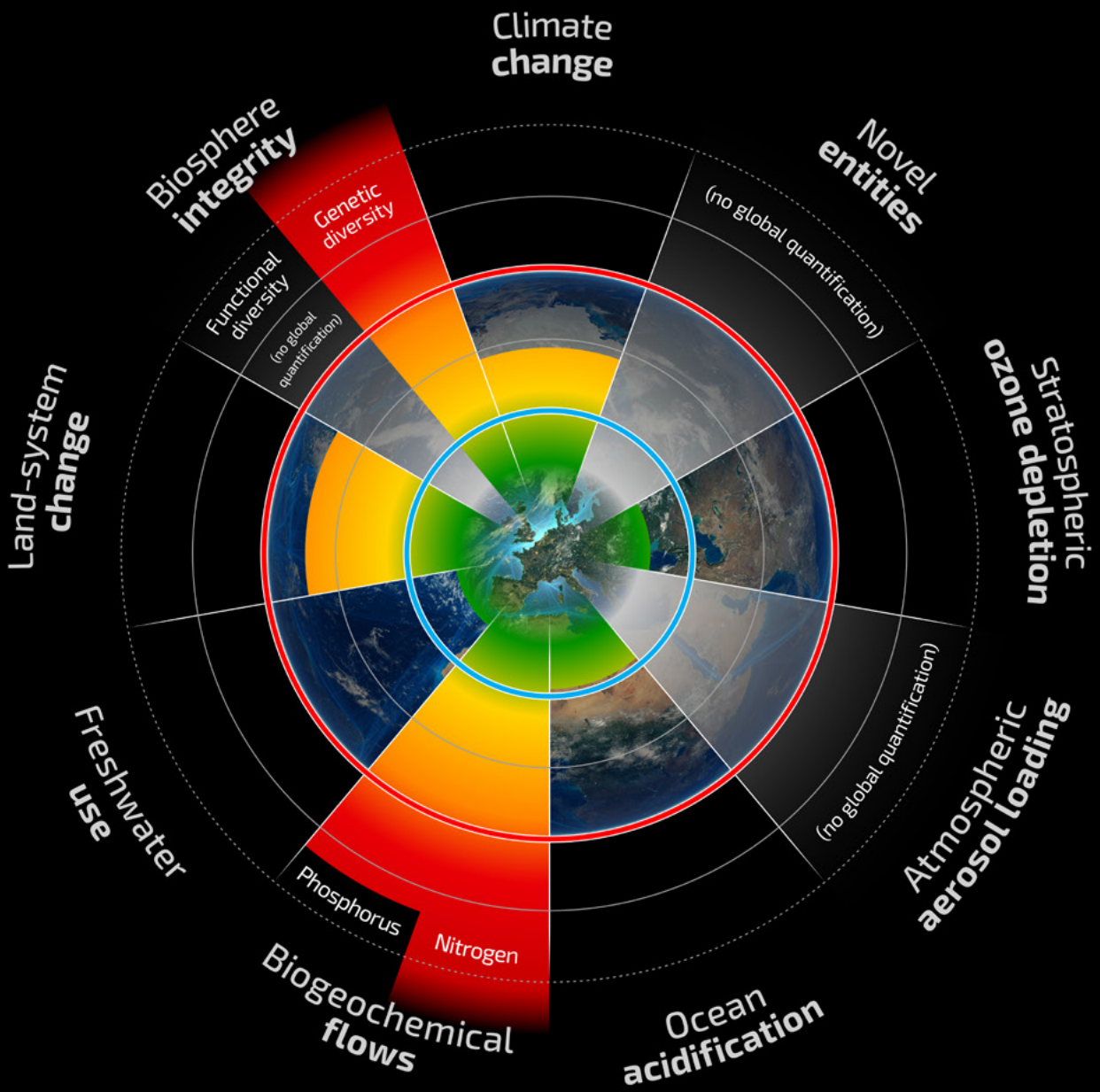
This can be rewarding, too. It turns out, for instance, that employment in the environment sector between 2001 and 2015 increased by almost 14%, whereas employment as a whole decreased after 2008 [1]. Investments in this period doubled as well.

Despite the level of urgency most companies still operate linearly, for which there are two explanations. Firstly, it is not in the short-term interest of most companies to work in a circular manner for the simple reason that they still function normally using the linear method. Secondly, another factor could be that it is not in their power or sphere of influence to work in a circular way, because they are part of a multinational with different priorities, or because they depend on cooperation with other companies in the region in which they operate.
In short, the economic incentives are working against, instead of in favour of, companies, for now. Moreover, the economic institutions (agreements on how actors act with respect to each other) are still tailored to the linear economy.

[1] *Statistics Netherlands (CBS), Green Growth, 2017.*

Planetary Boundaries

A safe operating space for humanity



- **Beyond zone of uncertainty** (high risk)
- **In zone of uncertainty** (increasing risk)
- **Below boundary** (safe)
- **Boundary not yet quantified**

Source: Steffen et al. Planetary Boundaries: Guiding human development on a changing planet, *Science*, 16 January 2015.
Design: Globaïa

Illustration: F. Pharand-Deschênes/Globaïa

2.2 VISION

Our current food system is not sufficiently circular yet. All around the world, about one-third of all the food in the chain is wasted, from harvest to food that is not consumed. This waste not only relates to food, but also to agricultural land, other resources, water, and energy.

The food that is lost now is responsible for 8% of the total emission of greenhouse gases in the world!

EOne of the major sustainability issues in the coming decades concerns a sustainable provision of proteins. Proteins are vital building blocks for our body. The proteins in our diet consist of both animal (60%) and vegetable proteins (40%). The global land use for the production of animal feed is larger than the land use for all other applications of biomass together (food, materials, energy). Moreover, the global disruption of the nitrogen cycle is a significant problem. Nitrogen is an essential building block of proteins, but not even 25% of the nitrogen added by agriculture ends up in food for people. Moreover, the production of animal proteins contributes massively to the emission of greenhouse gases.

In order to achieve a circular food system, a departure from past production and consumption trends is required. Preventing food waste and limiting losses in the chain as well as making the production of (animal) proteins sustainable are important. Adjusting the diet in the Netherlands , i.e. consuming slightly less animal proteins and comparatively more vegetable proteins, may be an important contribution. Consumers play an important part in the transition through their consumption behaviour. That is why it is important to include consumers in the philosophy of a circular economy. We need to encourage them to take into account preventing waste and selecting sustainable, circular products in both their diet and the purchase of products.

Apart from food, the production or cultivation of biomass provides the circular economy with renewable resources that can replace finite and critical resources. This especially includes fossil resources. Correspondingly, the production of biomass also makes an important contribution to the reduction of CO_2 emissions. In a circular economy we strive for closed carbon (C) cycles in which CO_2 from the air that is sequestered in crops is held as long as possible, preferably for decades, from the atmosphere by, e.g. sequestration in construction materials. So far, the climate policy has mainly focused on limiting emissions (chimney approach) and the short carbon cycle, but not on long-term carbon sequestration. From 2021 onwards, carbon sequestration in long cycles, e.g. forests and soils, will be included in the climate policy (LULUCF [2]). However, tools need to be developed to achieve this.

In the use of biomass for energy purposes CO_2 is released directly, but from a cascading and circularity perspective it would be better to first sequester biomass in the shape of materials and products that can eventually be turned into energy after several recycling cycles.
Naturally, this will only make sense if the use of biomass in materials and products leads to avoided CO_2 emissions because other more CO_2-intensive materials do not have to be used. Cascading and circularity require a focus on carbon preservation instead of CO_2 emissions.

The large demand for biomass based on the climate policy may, in the future, lead to competition with other biomass applications, including food, if there is insufficient focus on sustainable production methods, efficient use of biomass, and increasing the supply of sustainable biomass. The demand can be reduced by, where possible, looking at sustainable alternatives for biomass, such as solar and wind power, for the production of electricity.

The demand for biomass is increasing strongly at a global level as well. And even though making the biomass production more sustainable and greener is strongly focused on in various international partnerships, we also must conclude that deforestation still takes place at a large scale (for mining and the production of soy, palm oil, and paper) and that there is a decrease in biodiversity.
Moreover, the disrupted nutrient cycles and the reduction of the soil quality are worrisome.
Because the Netherlands depends on the import of biomass for achieving our goals in terms of sustainable and healthy food, energy, climate and circular economy, we need to focus simultaneously on:

- limiting the demand for biomass for energy by focusing on saving energy and electrification, where possible.
- reducing (food) waste and losses in chains.
- shifting the food pattern to more vegetable and less animal products and a more efficient production of animal proteins.
- cascaded use of biomass.
- increasing the supply of sustainably produced biomass at all geographical scales.
- closing nutrient cycles and regenerative use of the soil.

Depending on the development of the international agricultural productivity and the global food demand, hard choices regarding the use of biomass in 2050 will have to be made in the future. Using biomass for food, animal feed, energy, resources and maintaining soil fertility. It is logical that the use of biomass for electricity production will decrease. Biomass will especially play a part in energy applications for which few other sustainable, renewable sources are available, such as biofuel for the aviation industry, the shipping industry, and possibly for high-temperature heat for the industry.

[2] *LULUCF stands for Land Use, Land Use Change and Forestry.*

SUGAR BEETS

About 85,000 sugar beets per year are used to produce sugar. The largest waste stream that results from this, beet pulp, is used in the animal feed industry. Waste streams that do not have any other useful application are fermented to generate energy. The beet leaves remain on the land to provide the soil with organic matter and to recycle the nutrients. In order to acquire more valorisation from the residual streams of the sugar production, biorefinery is used to separate part of the beet pulp into high-grade fibres, special sugars, saccharin acids, and oligosaccharins. These semi-finished products can be used, among other things, for food, polymers, cosmetics, coatings, and composites, replacing non-renewable resources in turn. The beet pulp provided to the animal feed market ensures that nutrients are kept in the cycle, because they return to the land through manure. This way sugar beets can be used in multiple ways in a circular, bio-based economy.

The transition from finite to renewable resources will result in a reduction of activities in the field of fossil resource processing. This affects the energy industry, petrochemical industry, and the bulk chemical industry, that are large and leading industries in the Netherlands compared to other European countries. Striving for circular production systems also requires major adjustments in the (intensive) livestock industry. This will also lead to scaling back production. For instance, a gentle restructuring of the pig-farming industry in burdened regions is announced in the coalition agreement.

At the same time we have very competitive ports, a strong agricultural food cluster, frontrunners in the chemical industry regarding bio-based economy and recycling, and a very strong logistics sector. This gives the Netherlands an excellent starting position for initiating the transition to a circular economy in time and making it a success. Dutch companies are part of the global frontline in the field of sustainability. A top-ten ranking of the most sustainable companies in the world drawn up by Corporate Knights and presented during the World Economic Forum in Davos in 2017 contains no less than three Dutch companies: ING, Philips, and DSM.

There are also prospects for the energy industry and the petrochemical and bulk chemicals industries if these industries increase the speed at which they use renewable resources and recyclate. Based on past experiences, we know that industries that are forced to make significant transitions often end up stronger. For instance, the Dutch horticultural industry, forced in part by all sorts of crises, developed itself into a highly innovative and sustainable industry in which concepts as 'the greenhouse as an energy source' and vertical farming were developed.

SHIFT

The transition to a circular economy requires a shift in thought, action, and organisation. A shift among consumers, who need to adjust their consumption pattern and way of life [3]. A shift in the design of regions and the constructed environment, as well as the industrial sector. Whereas agriculture and the agricultural industry are now primarily viewed as suppliers of food, they are in fact chains in a network in which many chains are linked to each other. Together with forestry, public green spaces, aquaculture and nature they are sources of biomass for food, animal feed, medication, chemicals, fibres, materials, and fuel.

Using biorefinery, biomass can also be fractioned into components that are applied directly or are converted into new molecules through (bio)chemistry, which in turn serve as a resource or semi-finished product for other applications.

In a linear economy, we think in terms of products, residual streams, and waste. In relation to a renewable resource, such as biomass, the usual distinction between main streams, by-products, residual streams and waste streams is deeply anchored in society and regulations. However, this does not fully reflect the fact that all biomass components already have a function for a specific application.

In a circular economy we consider biomass to be a collection of ingredients, such as fibres, sugars, carbohydrates, protein, oils, lignin, and micronutrients. Every crop or residual stream contains a number of these ingredients in specific amounts and qualities. And each of these ingredients consists of combinations of basic elements: carbon, nitrogen, oxygen, hydrogen, phosphorus, and a number of micronutrients. The composition, purity and volume in which a residual stream becomes available is decisive for the question of what applications this stream can be used for.

This shift will not happen automatically. The current legislative system in which substances and materials are classified and qualified either as a product, resource or waste material is not properly attuned to the circular economy. Different interpretations on the part of legislators and supervisors can lead to uncertainty and inequality among both private and public stakeholders. That is why it is important to adjust the waste regulations and product regulations.

[3] *Zie hiervoor ook de transitie-agenda consumptiegoederen.*

2.3 CRITICAL FACTORS

To an important extent, responsible production and application of biomass contribute to the goals in terms of food, circular economy and the climate. However, there are also a number of critical factors that need to be taken into account: the (global) availability of sustainably produced biomass, the necessity of creating far-reaching closure of critical cycles, the necessity of drastically reducing waste and losses, and the focus on cascading biomass. These factors will be described below.

AVAILABILITY OF SUSTAINABLY PRODUCED BIOMASS NOW AND IN THE FUTURE

The Netherlands requires biomass for food and animal feed. Moreover, it is necessary to use biomass for the production of materials, transport fuels and energy to realise the Dutch climate goals. The Netherlands depends on the import of biomass, but also exports food, materials, and energy.

There are major uncertainties regarding the future global supply of biomass. There seems to be a sufficient supply to meet the expected demand up to 2030. In the longer term, this still remains to be seen. A growing global population and an increasing level of prosperity irrevocably lead to a sharply increasing demand for biomass. Simultaneously, research shows that land degradation is a global problem[4]. In the Biomass 2030 Vision, a meta-analysis of studies into the availability of biomass was used to conclude that potentially sufficient amounts of biomass can become available[5] to meet the Dutch needs in terms of food, animal feed, materials, transport, and energy if there is sufficient focus on increasing the supply of sustainable biomass and optimum use of that biomass.
The national Food Agenda for safe, healthy and sustainable food adds that a change in diet is also required to meet the increasing demand[6].

The Dutch Foundation for Nature Conservation and Environmental Protection calculates in its biomass vision that a maximum of 200 PJ[7] of biomass will be available in 2050, on top of the biomass required by the Netherlands for food, animal feed, and construction wood (circa 52 Mt). In the Biomass 2030 Vision, a bandwidth of 11-753 PJ is used for the calculations. Because the Netherlands depends on the import of biomass – it is estimated that the Netherlands can provide for up to a maximum of 200 PJ of biomass itself – it depends on other countries to take measures focused on limiting losses and increasing the supply of biomass (through productivity increases, use of degraded lands and new sources, such as aquatic biomass).

The conclusion of the Biomass 2030 Vision is that without specific policies focused on increasing the biomass supply this supply will be at the lower end of the bandwidth in 2050. At the same time, it has been calculated that to achieve the Dutch goals in terms of energy, biofuels, chemicals and materials between 430-600 PJ of biomass are required in 2030 and between 1000-1600 PJ of biomass in 2050 [8].

This means that there is a risk that there will be insufficient biomass to meet the full future demand for food, animal feed, energy, biofuels, chemicals, and materials. A strong focus on sustainable alternatives and savings will therefore be needed.

In terms of food and animal feed the need mostly consists of proteins, carbohydrates, and oils and fats. The chemicals and materials field mainly require carbohydrates – which can also be extracted from non-food plants, such as wood and grass – and vegetable oils (to a lesser extent).
In terms of energy, ideally only residual streams are used that cannot be processed in any other way. Often these are mixed and impure fractions and lignin-rich streams. This means that macro-estimates on how much biomass can become available still do not provide any guarantee that the supply actually will meet the needs per application.

The large demand for biomass can lead to competition in land use if there is insufficient focus on efficient use of biomass and increasing the supply of sustainable biomass. It is important that the possibilities for multi-purpose land use are looked into properly. Windmills, for example, can fairly well be combined with agricultural land use; however, this does not apply to solar panels.

4 PBL, Exploring future changes in land use and land condition and the impacts on food, water, climate change and biodiversity - Scenarios for the UNCCD Global Land Outlook, 2017.

5 Domestic biomass and imported biomass. Government Biomass Vision 2030, December 2015.

6 https://www.rijksoverheid.nl/actueel/nieuws/2016/11/21/voedselagenda-nederland-internationaal-koploper-in-gezonde-en-duurzame-voeding.

7 In literature biomass is usually expressed in Joules. As a calculation factor to mass, an average value if 17 GJ/ton can be used.

8 Estimates based on PBL (Biomass, wishes and limits, http://infographics.pbl.nl/biomassa/# and Compendium for Living Environment 2014). In the context of the Energy Transition, goals for 2050 are detailed for energy and biofuels; VNCI works on the roadmap for Chemicals 2050). These figures were unavailable at the time of publication.

A recent Dutch development is that growers are offered rental prices if they make acreage available for the construction of solar panels. Rental prices that are higher than the maximum attainable crop yield per hectare are common. It is a multi-year risk-free income for a farmer, guaranteed for up to 15 years.

This means that for at least 15 years, no biomass will come from these hectares. This type of competition regarding the use of scarce fertile agricultural land is undesirable and should be ended quickly. In the Netherlands there are about 15,000 hectares of roof, just from industrial units and stables. It more useful to use that acreage for placing solar panels. In light of the uncertainties in the predictions on the one hand and the lack of sufficient sustainable and renewable alternatives to provide for our energy and material needs on the other hand, it is absolutely vital to act in different fields at the same time:

- Preventing loss and waste.
- The optimum (re)use of all biomass fractions based on the principles of cascading and multifaceted valorisation.
- Focusing on a more balanced, more vegetable diet in the Netherlands because of the scope of the land use for the animal protein chain.
- Focusing on increasing sustainable biomass production in the Netherlands.
- Improving the increase of the sustainable biomass supply at EU and global level through international cooperation.
- Keeping up with the state of the art to monitor developments in global supply and demand for biomass.
  This is the only way to anticipate impending shortages in time.
- Making hard choices regarding the use of the biomass, involving a strong reduction of the use of biomass for the generation of electricity towards 2050 and biomass will primarily be used for energy applications for which there are hardly any other sustainable, renewable sources, such as biofuel for the aviation and shipping industry and possibly high-temperature heat for the industrial sector.

Focusing on increasing biomass production cannot lead to deterioration of the soil quality, a decrease in functional biodiversity or degradation of protected nature reserves. Initiatives leading to improving soil quality and/or structural increase in biodiversity should receive credits.

CRITICAL CYCLES

The production and use of biomass are part of biotic cycles. Plants use carbon (C) and nutrients (phosphate, nitrogen, potassium and micronutrients, among others) to grow and create biomass. The biomass molecules consist of chains of C atoms linking to hydrogen, oxygen and nitrogen from the air, phosphate and other elements that give the biomass specific properties in the form of fibres, sugars, carbohydrates, protein, oils, and lignin. After harvesting, the biomass is directly used or processed into products. Depending on the application, the nutrients and carbon will be released back into nature after a shorter or longer period of time. For example, food is digested and the minerals end up in the sludge through the water purification system. Biomass can also be used for materials and chemicals. After use in products and multiple use through recycling, the nutrients can be retrieved for renewed use after biological, physical or chemical treatment. Composting or fermentation produces soil enrichers that return organic matter and nutrients to the land.

However, many cycles are not closed currently. Globally only 15-20% of the nitrogen and phosphate provided for the production of food end up on the consumer's plate[9]. Only a fraction of the minerals removed from agricultural companies returns. This means that every year there needs to be an input of nutrients, usually in the form of artificial fertilisers. These nutrients are extracted from mines (potassium, phosphate) or from the air by using a lot of energy (nitrogen). For the Netherlands especially, a lot of minerals are imported from elsewhere in the shape of agricultural products, such as grain and animal feed.

Within the overarching biotic cycle we can make another division based on the following critical cycles, which require a far-reaching closure in the context of a circular economy, so as to maintain soil fertility and ecosystem services in the long term.

[9] *UNEP Food Systems and Natural Resources. A Report of the Work Group on Food Systems of the International Resource Panel, 2016.*

Figure 1. Critical cycles for biomass applications.

Cycles can be closed at different levels , which 'as small as possible and as large as required' is aimed for. Benefits are: limitation of transport, cost efficiency, governance of the cycle, and transparency in the food chain. This requires:

- cherishing small cycles that are already/still there, for example within the land-based agricultural and livestock farms and through local and regional circular terrain management[10].
- for non or partially land-based livestock farms: closing cycles locally, if possible, e.g. between farms or agricultural companies in the form of feed and/or fertiliser contracts. Arranging this at a regional level where necessary.
- if possible, closing national cycles between the city and the countryside.
- countering large-scale geographical nutrient displacement as a result of commercial trade streams (regional exhaustion and accumulation elsewhere) through exporting reclaimed fertilisers to regions with nutrient shortages in addition to the priorities above.
- preventing contamination at the source to keep the cycle clean. This applies to purchased animal feed and artificial fertilisers, but also to recycled manure and soil enrichers, such as struvite, sewage sludge, and compost[11].
- acknowledging the value of biomass/stable organic matter for the soil in the cascading ladder.

[10] *Circular terrain management is defined as: Using grass clippings from roadsides, dykes and embankments in the rural area (immediately or after composting, for example) for soil enrichment or as a bio-based resource for the local industry.*

[11] *Commissioned by the European Commission and in the context of revising the European Fertiliser Regulation, JRC is developing criteria for the safe use of struvite, ashes and biochar as fertilisers ('Strubias project'). Products that meet these criteria lose their waste status and may be added to the Fertiliser Regulation as a CE-labelled freely marketable fertiliser and be traded within the EU.*

CIRCULAR BIO-BASED DEMO HOUSE

Everything is sustainable in the bio-based demonstration house. The wall finishing is chalk paint, the carpeting is made from old fish nets, and the electricity is generated from plants. The house primarily consists of renewable resources. The resources can be dismantled and thus be reused.

LIMITING LOSSES AND WASTE

The PBL emphasises the importance of a more efficient use of resources as a condition for a circular economy[12]. The UN Sustainable Development Goal SDG12.3 is aimed at achieving 50% less food losses and waste by 2030. The EU member states have also adopted this goal. The Dutch policy regarding this topic is part of the Food Agenda. In May 2017, a final balance of the ambition of the Dutch government to reduce the amount of food waste by 20% between 2009 and 2015 was made. This ambition was not achieved in spite of the many initiatives and the efforts of a range of different parties. The amount of food waste in 2015 for the entire food chain, including the consumers, amounted to between 1.7 and 2.5 million tons (circa 100-150 kg per citizen per year[13]), which is barely less than in 2009.

In January 2017, the Task Force Circular Economy in Food was formed. The business community, NGOs, the government and knowledge institutes work together in this Task Force to increase the circularity in the food chain, to limit food waste in the chain and among consumers to a minimum, and to become an international frontrunner in creating value from residual streams from the food chain. A primary ambition of the Task Force and a legitimisation of its creation is the necessity for speeding up the started actions, identifying and breaking down barriers, and achieving an economic and social impact.

CASCADING

It is important to create optimum valorisation for the various substances per biomass stream. Firstly by using the biomass as a whole, such as using wood in timber frame construction. Secondly, cascading is an important concept. In cascading all components of biomass, streams are used as well as possible. This can be achieved in multiple ways. There is cascading 'over time' when biomass is used for consecutive applications, such as timber that is later turned into chipboard and then into bio-energy. There is also cascading 'in function' when biomass is separated into functional components that are all used as optimally as possible.

In cascading discussions there is often talk of high-grade, optimum, or efficient use of biomass. All these terms, and thus the concept of cascading as well, are interpreted in various ways. In part, this is because there are three dimensions:

- Economic: added value.
- Social: social need, ethical desirability.
- Environmental: environmental burden (greenhouse gas) emissions, resource consumption (water, land), and effect on biodiversity and soil and water quality.

Depending on the interpretation, there are different orders of preference for the applications of biomass.
In a market in which the government does not aim to improve specific applications through specific interventions, the economy will determine which application will be assigned to a biomass stream. This does not necessarily have to be the application that is the most desirable from the perspective of a circular economy.

Often the concept of the value pyramid is used. Figure 2 shows the value pyramid as described in the Letter to Parliament 'More value from biomass through cascading'. The applications with the highest added value are relatively small in terms of market volume compared to low-grade applications, such as energy.

The value pyramid may be useful when striving for high-grade applications: meeting primary needs, such as medication and food are a priority, followed by material applications that sequester CO_2 for a shorter or longer period of time. Lastly, there is the use of biomass for transport fuel and energy, for the last two applications of which the priority lies with those fields where sustainability cannot be achieved by other means. This concerns, for example, kerosene for the aviation industry. For all applications of biomass, production and application themselves cannot lead to negative effects on sustainability, at home or abroad.

[12] *http://www.pbl.nl/sites/default/files/cms/publicaties/PBL-2017-Food-for-the-circular-economy-2878.pdf*

[13] *Wageningen Food & Bio-based Research, Food Waste Monitor, update 2009-2015, report number 1747, 2017.*

[14] *Letter to Parliament, More value from biomass through cascading, 18 June 2014.*

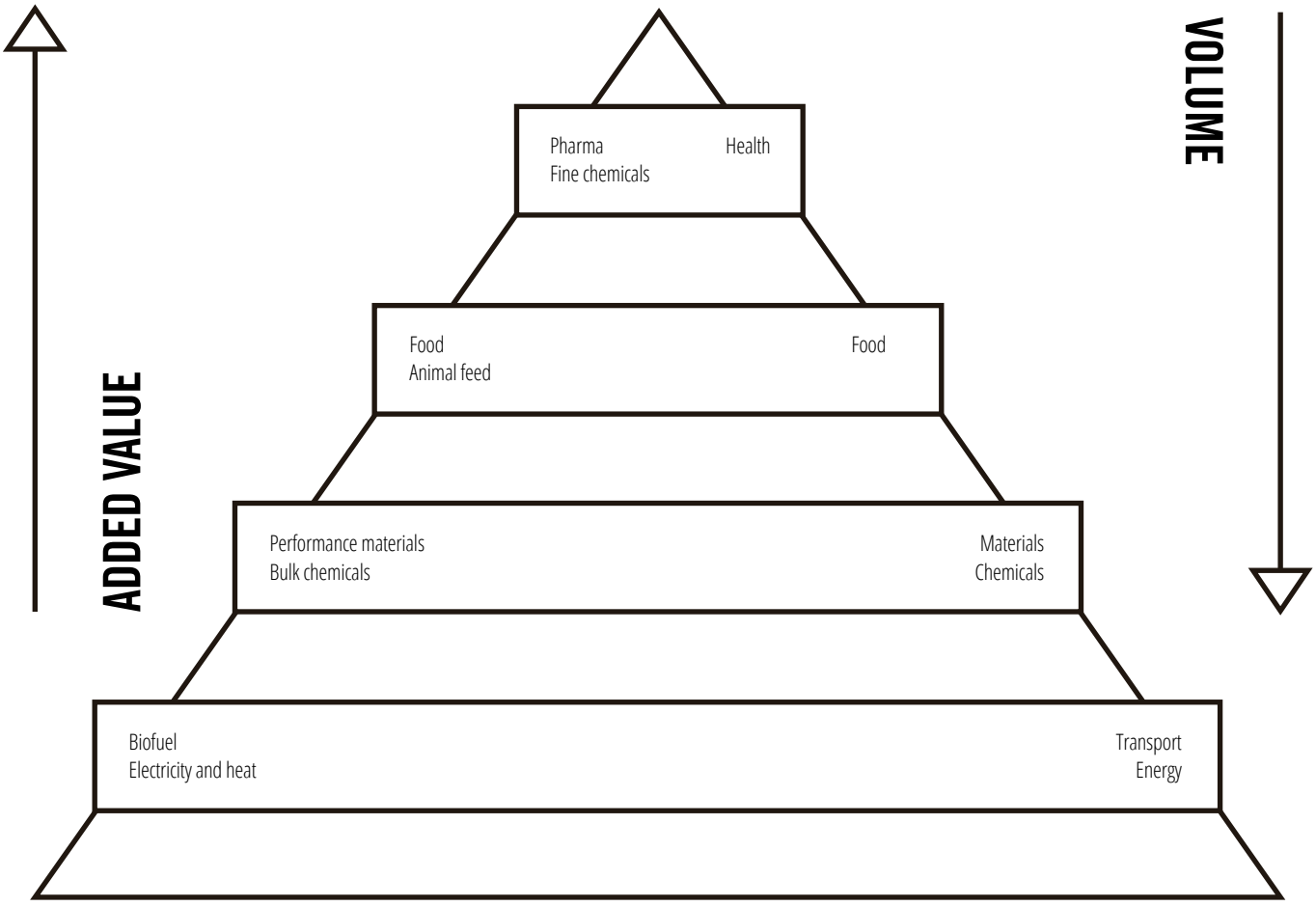


Figure 2 Value pyramid (More value from biomass through cascading, Letter to Parliament, 18 June 2014)

Cascading is an important goal in a circular economy, but one that cannot be pursued rigidly. When high-grade applications are (temporarily) not feasible because market demand is limited or the conversion routes cannot compete with the standard routes, for example, less high-grade applications in transport or energy, for example, can be a good alternative. There can also be multifaceted valorisation, in which both products and energy can be extracted from one biomass stream, such as manure.

However, we need to take care that there will not be a lock-in of less high-grade applications due to temporary incentives that will eventually have an adverse effect.

The current government policy in the context of the climate and sustainable energy policy stimulates the use of biomass for energy and transport fuel, but not as a resource for chemicals and materials. However, using it as such also saves on fossil resources and CO_2 emissions and may even lead to CO_2 sequestration in materials for a short or longer period. It can also prevent the production of specific chemicals and materials on the basis of renewable resources from costing more energy in the short term than the current production based on fossil resources. In the long term, though, it may lead to savings through optimisation. This may also apply to recyclate as a resource.

The Coalition Agreement announced that subsiding co-firing of biomass in coal plants will be stopped after 2024. This offers space to use the freed up biomass for applications higher up the value pyramid, such as for biomaterials that sequester carbon for a long period of time.

GREEN AREAS WITH BIO-BASED TREE ANCHORING

Natural Plastics developed the Keeper System, bio-based plastic ground anchors that keep young trees in place invisibly, because they are used underground. The plastic starts dissolving after three years and then serves as a nutrient for the tree. The base material is waste from the fries and crisps industry. Starch is extracted from potato peels and turned into bio-based plastic.

CIRCULAR BIOBASED ECONOMY MAKES AN ESSENTIAL CONTRIBUTION TO THE CLIMATE AND SDGS

As a successor to the Environment Goals, the United Nations formulated 17 Sustainable Development Goals, or SDGs. These entered into effect on 1 January 2016 and remain in effect until 2030. Actions based on these goals need to end, among other things, poverty, inequality, and climate change. Figure 3 shows an overview of the SDGs.

Figure 3. UN Sustainable Development Goals

A sustainable food system contributes to multiple SDGs, among other things food security (#2). Using sustainably produced biomass in which nutrient cycles are closed as much as possible contributes to realising a healthy ecosystem and sustainable production and consumption systems (#6, #12, #14, and #15).

Countering food losses in the chain and food waste among consumers is important for the realisation of sustainable production and consumption (#12). Apart from food and animal feed, cascading biomass also results in biomass that can be used for materials that can sequester carbon for a longer period of time and for the generation of energy (#7, #13). Finally, a circular bio-based economy contributes to economic growth and employment, both in the Netherlands and in countries where biomass is produced and processed (#8).

Aiming at increasing the supply of sustainably produced biomass must go hand in hand with strict preconditions. Conditions that prevent local food supply from being affected (#2). Conditions that ensure the careful and efficient use of resources like fresh water (#6), the soil, artificial fertilisers, and pesticides (#12). These ensure that the biodiversity is not damaged (#15) and that good working conditions are guaranteed (#16).

Good sustainability frameworks, that will continue to be developed in the years to come, have already been implemented on the basis of these basic principles for numerous biomass applications.

3. STRATEGIC GOALS AND LINES OF ACTION

STRATEGIC GOALS

The strategic goals in the national CE programme are translated as followed for the Biomass & Food Transition Agenda:

1. Sustainable and regenerative production of sufficient biomass with extensive closing of nutrient cycles at a geographic scale that can be as small or as big as is necessary. Such cycles are already in place, at land-related livestock farms, among others.
2. Optimum use of biomass and food. All resources and (semi-finished) products will stay in the cycle as long as possible and as high-grade as possible through full use of resources, high-grade use of biomass, and recycling waste streams. This also includes dealing with biomass as efficiently as possible (cascading and multifaceted valorisation) by, among other things, countering (food) waste, preventing waste substances, the dosed application of artificial fertilisers, and efficient incineration.
3. Reducing utilisation and replacing non-renewable resources with renewable ones (recyclate[15] and sustainably produced biomass).
4. Developing and implementing new ways of production and consumption that lead to improvements and departures from past trends in the handling of biomass and food. One example is the transition towards using alternative proteins.

LINES OF ACTION

The strategic goals have been defined in six substantive lines of action. Every line of action contributes to multiple strategic goals. Moreover, three preconditional lines of action have been formulated that are essential for the realisation of a circular economy. The schedule below shows an overview of the mutual relationship between strategic goals and lines of action.

[15] *Recyclate is not within the scope of this agenda, but is covered by the other transition agendas.*

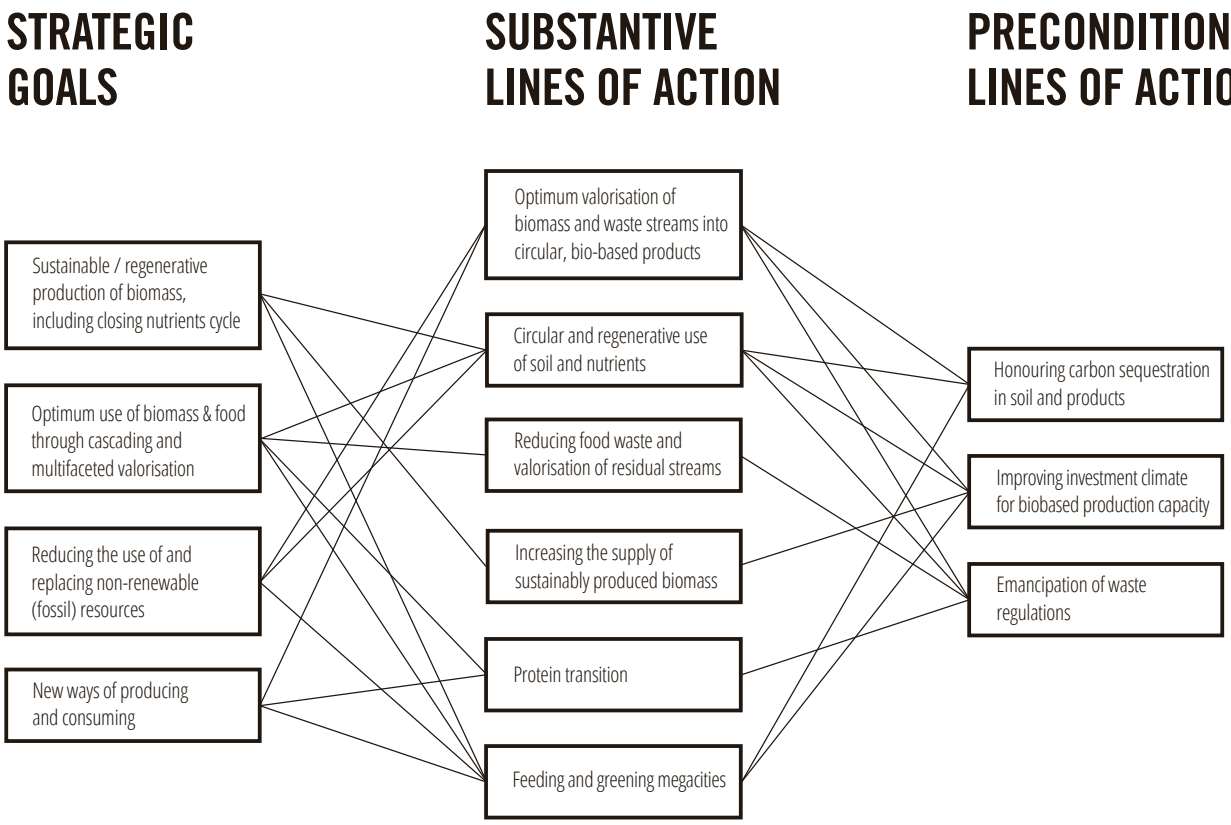


Figure 4 Overview of strategic goals and intrinsic/preconditional lines of action.

3.1 INTRINSIC LINES OF ACTION

3.1.1 OPTIMUM VALORISATION OF BIOMASS AND WASTE STREAMS INTO CIRCULAR, BIO-BASED PRODUCTS

The use of biomass as a resource for the production of, for example, construction materials to replace the currently used traditional fossil and non-recyclable resources can make an important contribution to the reduction of the use of fossil and critical resources. This also applies to processing residual streams in an as high-grade manner as possible.

Wherever possible, food waste streams are used for food applications again. If this is not possible, using it and/or upgrading it to animal feed (preferably) and bio-based products is the logical choice.

Producers of sustainable bio-based products indicate that the market demand is still lacking or is very limited. Reasons for this are, among other things, the market's unfamiliarity with new products and a higher cost price. Primary, usually fossil, resources are relatively cheap and the new production processes still have quite a learning curve to complete. The very slow increase of market demand also inhibits the development of bio-based products, which means market supply remains low.

This bottleneck also appears in the Plastics Transition Agenda (bio-based plastics) and the Construction Transition Agenda (bio-based construction materials). The construction industry mainly sees opportunities for bio-based materials for finishing and interior decoration; materials that are currently difficult to green. This includes insulation materials, plasterboard, and binding agents for green concrete, for example. Switching to more bio-based construction systems seems to be the more obvious choice, but this requires a transition in the chain.

Another factor that is slowing down the development of bio-based products is the fact that the government does stimulate biomass for energy applications due to the sustainable energy policy, but does not do the same for applications in products. From a CO_2 emissions perspective this does not make sense, because bio-based use renewable carbon and sequester this carbon for a longer period of time. This occurs either directly via products with a long lifespan or through the recycling of bio-based products, so the renewable carbon is retained.

A number of applications of bio-based products:

FOOD: high-grade food ingredients from residual streams, such as Solanic potato protein, mushrooms grown on coffee grounds by Rotterzwam.
PACKAGING: paper/cardboard, bioplastics (PLA, PBS, PEF), bio-based glues and inks.
CONSTRUCTION MATERIALS: wood instead of metal (e.g. timber frame construction), bio-composites, insulation (flax, bio-foam) façade cladding, construction materials, coatings, paints, glues, textile, tubes, pipes.
DETERGENTS: bio-based (ingredients of) cleaning agents, additives.
ELECTRONICS: bio-solvents (such as ethyl-lactate), used in the semiconductor industry and for the production of LCD.
AUTOMOTIVE: replacing bioplastics and bio-composites with traditional synthetics in cars.
MANUFACTURING INDUSTRY: PLA is one of the most-used polymers for 3D printing.
GREEN ARES: geotextiles, tree anchors, binders, plant pots, insecticides.

GOALS

- Halving food losses in the chain in 2030 (SDG 12.3) by preventing waste (also see action line 3.1.3) and applying more high-grade valorisation of residual streams.
- Governments and companies enter into chain agreements in which they undertake to replace increasing percentages of fossil resources in 2030 and 2050 with bio-based resources for plastics and construction materials. For plastics for the Dutch market, the goal is to replace 15% of fossil resources with bio-based resources by 2030 and to replace 30% by 2050. This also applies to imported plastics[16]. For the construction materials industry, the goal is that the use of bio-based construction materials has increased by 100% in 2030 and by 200% in 2050.
- Guaranteeing a level playing field for all applications. Policy interventions that provide more benefits for lower grade applications compared to high-grade applications will have been phased out in 2020. Or the more high-grade applications will be stimulated in a comparable way.
- Specific policy interventions will be used for cases in which the desired high-grade applications are not economically feasible, because the environmental costs have not been processed in the prices in the non-circular alternatives. For example, for keeping the soil quality at a good level.

[16] *The Plastics Transition Agenda's goal is that all plastics in 2050 are produced on the basis of renewable resources. This means that 70% recyclate and 30% bio-based resources are used in 2050.*

FROM WASTE TO ASPHALT

A section of cycling motorway has been constructed between Leeuwarden and Stiens in which toilet paper reclaimed from sewage water has been used. Cellulose is one of the main resources for a (bio-based) economy. Traditionally it is used in a large scale in the paper and cardboard industry. The sieved material (largely toilet paper) that is extracted in the sewage purification plants consists largely of cellulose. By using this reclaimed material as a binding agent in asphalt, waste water is turned into a resource again and makes a contribution to the circular economy.

REQUIRED ACTIONS AND INTERVENTIONS

The government can help the market get over this slump by making circular, bio-based products more attractive economically or by making the less sustainable alternative less attractive. For instance, by acting as a launching customer for new bio-based applications for which there is only little supply at the moment. Or as a circular procurer for product groups that are already widely available on the market. Finally, the government can also boost the market through obligations or prohibitions.

In 2018, the government will start two projects around bio-based product groups in the context of Socially Responsible Income: catering and construction materials. There is already quite some experience with bio-based procurement at a local level. For instance, the Province of Zeeland is currently one of the frontrunners of bio-based procurement in Europe. The Bio-based Economy Centre of Expertise has developed a bio-based product catalogue. See www.coebbe.nl/producten.

The business community will take the initiative to establish a CE Renewable Plastics Table and a CE Renewable Construction Materials Table. In the execution phase, there will be alignment with the Plastics and Construction Transition Agendas. Every 'Table' has its own representatives from the entire chain from suppliers of resources to buyers of the bio-based products. Moreover, the government will participate by providing expertise in terms of procurement (Pianoo), smart market incentives and financing, behaviour, and international cooperation. The participants of the Tables identify promising product groups, make voluntary chain agreements, and record them in a covenant or plan of action. The following parties from the Biomass and Food Transition Team have already indicated that they will participate in these Tables: Royal Cosun, Dutch Biorefinery Cluster, and VVNH. The commitment for participating in the Tables is growing, and we expect that more parties can be added to the Tables in the short term.

Bio-based materials have been used in large quantities in the maintenance of the N272 in North Brabant: organic fibre hectometre signs, road marking based on natural resin, guide rails and street furniture made from roadside clippings, green plants in biodegradable pots that provide nutrients upon decomposing, concrete consisting of glass foam and elephant grass.

Every Table then makes the required interventions more concrete. These may include the following types of interventions, for example:

INTERVENTIONS IN TERMS OF LEGISLATION AND REGULATIONS:

- Progressive standardisation: increasing percentage of renewable resources (bio-based/recycled materials) in product groups to be determined.
- Adjustment of the product policy, at EU level wherever necessary:
  - Phasing out hazardous substances (e.g. oxo-degradable plastics) and non-sustainable products (e.g. peat) if there is a good bio-based alternative.
  - stimulating safe biodegradable products in applications in which products leak out to nature, such as lubricants, agricultural plastics, drilling fluids, microplastic and nano-plastic particles in, among other things, scrubs, sun screen, toothpaste, dolly rope, trimmer wire for brush cutters, golf balls and synthetic granulate on football fields[17].
  - stimulating bio-based products that score better in terms of sustainability and health than their current alternatives. For example: PLA foam instead of EPS, plasticisers, ingredients for cosmetics and construction materials, packaging, and the automotive industry.
- Supporting and focusing on developing a working method and system, including removing legal barriers, for the safe and traceable use of more food-related by-products as a resource for animal feed in particular.
  The CE Tables will provide input with respect to which products are eligible.

The Netherlands imports about 4 million tons of peat annually, which is usually extracted with major environmental consequences in, among others, the Baltic states and Russia. It is mainly used for potting soil substrates for the professional (horticultural) and consumer markets. There are various bio-based resources that can at least replace part of the peat, such as high-quality compost. Countries like Germany and the UK have policies in place to reduce the use of peat in these applications in favour of bio-based alternatives.

INTERVENTIONS IN TERMS OF KNOWLEDGE AND INNOVATION:

- Stimulating the development of knowledge and applied research in terms of the high-grade valorisation of biomass, including pilots and demonstration projects.

INTERVENTIONS IN TERMS OF BEHAVIOUR:

- Increasing familiarity with and the importance of bio-based concepts among producers, buyers, and consumers.
- Exploring influencing behaviour through other mechanisms, such as nudging.

[17] *An important condition is that the biodegradable plastics meet the degradation requirements of the environment in which they need to degrade (e.g. ISO 17556 for biological degradation in the soil).*

GROOT ZEVERT FERMENTATION

The company Groot Zevert Vergisting processes manure from FrieslandCampina dairy farmers into, among other things, biogas that is supplied to FrieslandCampina in Borculo through 5 kilometre-long transport mains. Here, energy for the production of milk powder and ingredients for baby food is generated from the biogas. A Green Minerals Plant at the fermenter ensures that nutrients and low-phosphate organic matter are reclaimed and supplied to farmers regionally.

INTERVENTIONS IN TERMS OF FINANCING AND MARKET INCENTIVES:

- Greening the tax system through a tax shift from labour to resources, materials, and waste. This fits with the PBL report regarding the greening of the tax system[18].
- A bonus/malus system, public or private, for renewable products (bio-based and recyclate): levy on, for instance, non-renewable plastics, the proceeds of which can be recycled to renewable plastics.
- Reduction of the rate for the waste management contribution in the Packaging Waste Fund for bio-based plastics. Note: There is a lower tax rate for biodegradable plastics currently, but not for bio-based plastics in the larger sense.
- The government as a launching customer for innovative bio-based concepts (innovative procurement).

3.1.2 CIRCULAR AND REGENERATIVE USE OF SOIL AND NUTRIENTS

An ecologically sustainable food production for the growing world population requires a transition towards circular and regenerative use of soil and nutrients. A properly functioning and healthy soil as the basis for crop production needs:

1. Prevention of soil degradation due to compaction, erosion, contamination, nutrient exhaustion, flooding, reduction of the organic substance level, reduction of soil biodiversity, pollution, desertification, salinization and acidification.
2. Availability of nutrients: both macronutrients and micronutrients.
3. Sufficient supply of stable and functional organic matter.

The ambition is to have closed nutrients cycles by 2050 and to have Dutch soils with optimum organic matter levels, so eco-system services are utilised maximally. The basic principle is: make the cycle as small as possible and as large as is necessary.

The four primary solutions to achieve this are:

1. Maximising the utilisation efficiency of nutrients and minimising losses to soil, water, and air.
2. Minimising the use of virgin inputs by using natural nitrogen fixers, recycling nutrients and minimising downstream nutrient losses.
3. Countering structural nutrient displacement.
4. Optimising the amount of organic matter in the soil.

A lot has been achieved regarding the first solution: the utilisation efficiency in agriculture has increased significantly since 1990 and the losses of nitrogen to the air, the groundwater and surface water have been reduced accordingly. The phosphate soil excesses have also strongly decreased and, in some cases, the crops even extract more phosphate than is released. There are also many recent initiatives focused on solutions two, three and four. However, we still have a long way to go towards truly circular and regenerative use of soil and nutrients.

Agrifirm has developed the AgriMineraal advice module that gives plot-specific fertilising advice to agricultural companies. The nutrients need of the crop is determined on the basis of the most up-to-date knowledge and insights in terms of crop growth, yield potential, and the quality desired by the consumers, while taking specific plot characteristics, soil type, soil analyses data, additional supply from previous crops, green fertilisers and the mineralisation of organic matter into account. Not only crop needs, but also especially maintaining the soil fertility is key. As a result, the agricultural entrepreneur will receive a full fertilising plan that includes as many organic fertilising agents as possible and, where necessary, is supplemented with inorganic fertilising agents.

[18] *PBL, Tax greening: tax shift from labour to resources, materials and waste, November 2017.*

GOALS

- The exact goals for 2021, 2030 and 2050 have been specified and quantified in accordance with science-based data. Furthermore, it has been determined how these goals can be achieved.
- The term 'land-based cattle farm' has been defined and the percentage of land-based companies has been stabilised and, if possible, increased.
- 60-70% use of nitrogen and >95% use of phosphate, potassium and micronutrients across the entire cycle in animal feed, fertilisers, foods and other nutrient products in 2050 by:
  1. maximising utilisation efficiency,
  2. corresponding decreased use,
  3. local closing of cycles through reuse of nutrient-rich residual streams and
  4. reclaiming any remaining nutrient surpluses from non-locally required manure and sewage sludge.
- Realising the remaining input of nitrogen into the agricultural system using as many natural methods as possible, such as nitrogen-fixing crops/bacteria combinations (percentage to be determined).
- Exporting nutrients reclaimed downstream from food processing, manure processing and waste, balanced with the remaining import, via cattle transport and artificial fertiliser, of virgin nutrients.
- Wherever necessary, reduction of the phosphate levels in Dutch soils to acceptable levels.
- Optimum levels of stable organic matter, minerals and micronutrients in the soil for sustainable soil management.

REQUIRED ACTIONS AND INTERVENTIONS

In order to realise our ambitious goals it is primarily necessary to speed up developments and bring them together in a comprehensive *'circular and regenerative use of soil and nutrients'* transition programme. This programme is to bring about a systemic change: from the current linear system to a system in which carbon and nutrient cycles are as small as possible and as large as is required, in which agriculture has a neutral or, if possible, positive impact on climate, soil, water, biodiversity and society, and in which one or more of these elements are no longer exhausted.
Proper governance must be put in place for the programme in the next six months, for which two basic principles are essential:

- Full and unambiguous chain responsibility.
- Inclusivity: cooperation between established chain parties and new innovative parties.

Included will at least be: producers of fertilisers, animal feed producers, the agricultural industry, especially arable farming and cattle farming cooperatives, food processors, including slaughterhouses and rendering plants, retail, waste collectors and processors, water boards, local, provincial and national governments. This group of chain parties will need to translate the vision and goals above into measurable goals for every link in the chain.
Subsequently, lines of action and interventions can be selected and developed to implement unified chain management for closing cycles and increasing soil fertility. Furthermore, one or more example projects can be selected for which breakthroughs are likely in the short term.

The proposed transition programme concerns six lines of action.

1. Development of a complete tool set that is accepted as the default as well as development of a fact base for measuring nutrient cycles and soil fertility.
2. Technological innovations for a continued closing of nutrient and organic matter cycles.
3. Development of business models for a continued closing of nutrient and organic matter cycles.
4. Living labs in which scalable solutions are developed and tested to continue closing nutrient cycles.
5. Education and dissemination of knowledge.
6. Comprehensive transition approach as an export model.

A cohesive package of government interventions will be required to support the above transition programme. This package needs to ensure that the rules of the game change to such an extent that circular and regenerative use of soil and nutrients becomes more attractive in an economic sense than the use of virgin nutrients and production methods that could affect soil quality.

[19] *In which regional tailor-made solutions are offered to bring the soil fertility to a good level and maintain it (instead of applying the same standards everywhere in Europe).*

The parties participating in the transition programme will design such a package together with the government's intervention teams. Possible interventions currently include the following potential game changers:

- Regulations to keep land-based cattle farming land-based.
- Blending obligation of reclaimed nutrients for fertiliser and animal feed suppliers.
- A ban on removing nutrients from the cycle for waste processors.
- Producer responsibility for suppliers of animal feed and fertilisers, which also involves charging a recycling contribution for the supply of virgin nutrients, possibly combined with a collective collection system for surplus manure.
- Exploring the integration options of a soil passport as the basis for valorisation of good soil quality for land transactions in either the Dutch policy or the EU policy. The idea is that government tool sets can be made conditional to sustainable soil management, far-reaching closing of cycles and ecosystem services, for example, by rewarding farmers for increasing stable organic matter in the soil via LULUCF/CO_2 credits).
- In addition to the soil passport another adjustment to the regulations might be required, so owners and lessees of agricultural land are stimulated to achieve long-term sustainable soil management, for which the value of the land reflects the long-term production value.
- Additional regulations to discourage the tearing of grass land might also be required to prevent the degradation of organic matter and greenhouse gas emissions.
- Adjusting the fertiliser regulations, so the supply of organic matter and sustainable soil management are stimulated. To this end, individual and area-specific customisation is possible.
- Attributing credits for the accumulation of organic matter in the system for trading in emission rights.
- Developing financial market incentives, such as a subsidy scheme for the production or use of Green Fertilisers (non-virgin fertilisers) analogous to the SDE scheme.

All participants in the nutrients and soil work group are prepared to cooperate in the further development of the line of action. Participating companies in the work group are already taking clear steps to execute the transition programme. For instance, FrieslandCampina and Royal Cosun recently submitted a joint project proposal with the Agriculture & Food top sector to, among other things, achieve a far-reaching closure of nutrient and carbon cycles between dairy farming, arable farming and primary processing of these sectors in accordance with the basic principle: 'make the cycle as small as possible and as large as is necessary.'

3.1.3 REDUCING FOOD WASTE

Reducing food waste is crucial in a circular economy. It ensures that biomass is used better and at a higher grade and thus contributes to food security. Moreover, it increases the availability of biomass for other applications, such as animal feed and renewable materials. It also strongly reduces the ecological impact (such as the use of water and land, biodiversity, etc.). In the Netherlands, the impact on climate change of food that is not consumed in the end amounts to16% to 22% of the total impact caused by food, which corresponds with about 5-8 Mt CO_2-eq per year.
In the 2009-2015 period, the government focused on reducing the amount of food waste by 20%. Even though a slight reduction of the amount of avoidable food waste by the consumer has been achieved, we still need to conclude that the amount of wasted food has hardly decreased at all. In 2015, food wasted by consumers amounted to 700 million kilos per year. In 2015, the total waste including food losses in the chain was between 1.77 and 2.55 million tons. The food wasted by consumers represents a purchase value of about 2.6 billion euro. That is about 350-400 euro per household! The value of the food waste in the entire chain is estimated to be at least 5 to 6 billion euro.

Moreover, there is also food waste as a result of government policy. This includes, for example, EU policy aimed at intervention measures for price support, such as milk powder. If stored milk powder can no longer be sold on the human food market, it can be turned into animal feed or incinerated. Calamities can also lead to food waste, such as the Russian boycott on agricultural products from the EU. This resulted in surpluses and product destruction.

Experiences gained in the UK show that the revenue model of the reduction of food waste among consumers is interesting. Every euro invested amounted to a reduction of 100 euro in food value at city level, and of 250 euro at a national level. ('Love Food, Hate Waste model'). This result is primarily related to fewer purchases of food by consumers. Furthermore, the evaluation showed that a part of the money saved was used to buy higher quality and more sustainable food.

THE WASTE FACTORY

Three-Sixty is the innovation centre for circular economy in Veghel where solutions against waste take centre stage. The former distribution centre is the thriving and inspirational hotspot where entrepreneurs, investors, researchers, students, social organisations and start-ups jointly develop concepts around the themes of wasted food and wasted talent. On this site, you can find 'De Verspillingsfabriek' (the waste factory) where, among other things, soup, sauces and ketchup are produced, by people with low employment prospects. from Products that would otherwise be wasted every day. An increasing number of organisations select Three-Sixty as their base of operations for their activities, including FoodWasteXperts, FoodSquad, Verspild Talent, Rabobank, WUR, Milgro, and MVO Nederland. The Task Force Circular Economy in Food has selected Three-Sixty as their home base.

In a broad sense, the food industry does not necessarily have an economic interest in reducing food waste by consumers. And, because food has always been cheap, saving 1 euro per day is not a strong incentive for the consumers themselves.
This clearly is a social challenge that requires an effort from the central government and local authorities.

There is an increase in momentum at all scale levels (global, national, regional, sectoral, local) to turn the tide and achieve an actual reduction of food waste. This requires broad support in order to achieve a change in mindset.
Moreover, cooperation between all actors needs to be reinforced, from operational execution all the way to the decision-makers.
In order to realise this situation, companies from the entire food chain and related industries teamed up in early 2017 to form the Task Force Circular Economy in Food (TCEF) to increase the circularity in the food chain and drastically reduce waste.
The Task Force aims to speed up the started actions, identify and break down barriers, and achieve an economic and social impact. To connect actors, in order to achieve an effective ecosystem for change and realising high-impact solutions, is key. Companies will take the lead, and other actors will take up a catalysing, supporting, and facilitating role.

GOALS

Food waste occurs where food intended for human consumption is not used for this goal. Secondary streams used for food, animal feed, bio-based materials and chemicals are not covered by the term food waste. A final proposal for a European Framework is part of the Circular Economy package that was published before the end of 2017.
Goals:

- Limiting food waste in the chain and at consumer level to a minimum (SDG 12.3). This will make a major contribution to countering climate change and guaranteeing food security. In 2030, food waste at consumer level, including food losses in the chain, will have been halved (SDG 12.3). Prevention, reduction and creating a higher value for residual streams in the Netherlands in the chain up to the consumer will reduce food waste to between 450 – 900 million kilograms. This will result in a reduction of at least 2-3 Mt CO_2 eq./year and a cost benefit of at least 1 billion euro.
- The intermediate goals for 2020 and 2025 were specified in 2018. Companies affiliated with the Task Force are committed to their own ambitions and the joint goals. From 2018 onwards, the affiliated companies will report on their own actions and progress annually.

REQUIRED ACTIONS AND INTERVENTIONS

The Combating Food Waste[20] report of the European Court of Auditors conveyed a clear message: the EU is not doing enough in its current policy. Only a more comprehensive, holistic policy will have sufficient effect. This means that a comprehensive, EU-wide strategy regarding food waste will need to be developed, in which agricultural and fishing policy, regional agriculture, honest trade practices between chain parties, and Europe's social agenda need to be included.

An increasing group of organisations and stakeholders are now convinced that there is sufficient momentum to act now. There are enough solutions to increase the scale and create both mass and impact. High ambition also makes a net positive contribution to the profit and competitive position of the Dutch business community and creates new activity and profit through innovation.
However, not everyone can be a winner in such a transition process. In the end it is about jointly realising such opportunities, in an open dialogue with a focus on the social interests and challenges.

[20] *European Court of Auditors, Combating Food Waste: an opportunity for the EU to improve the resource-efficiency of the food supply chain, report no. 34, 2016.*

A set of harmonised and coordinated actions is required to achieve these goals:

1. **MONITORING & ASSESSMENT OF FOOD WASTE AND RESOURCE EFFICIENCY**
   The EU will oblige the Netherlands to report bi-annually on the development of the amount of food waste from 2020 onwards (Circular Economy Package). Over the past five years, experience has been gained, a basic framework has been developed, and various reporting tools have been made available (Food Waste Monitor, FUSIONS). In order to create a more reliable overview, including insight per chain segment, this monitoring tool will need to be expanded through a methodology of self-reporting (by companies in the entire chain) and smart expansion of existing data collection methods. By order of Economic Affairs, two exploratory studies into the feasibility of such an approach were conducted in 2017. Moreover, WUR gained experience with pilots for self-monitoring. The goal is to start the implementation of an improved monitoring structure in 2018 together with the business community.

2. **A CHANGE IN AWARENESS AND THE MINDSET OF ACTORS**
   Waste can be regarded as a resource that still needs to find its route to its final destination.
   It helps companies to change their attitude and willingness to make a positive change if there is more transparency regarding their own goals and any progress made with regard to their actions. This works according to the 'target, measure, act' principle. Various companies – early adopters and early followers in particular – require supporting tool sets, such as vouchers, opportunity cards, process support, opportunity analysis tools, and expertise to create a primary business case in broad outline for the prevention and reduction of waste.

3. **'COUNTERING FOOD WASTE TOGETHER' ACTION**
   Developing a consistent, structural approach of consumer behaviour via a coordinated and harmonised public-private action 'SAMEN TEGEN VOEDSELVERSPILLING' (countering food waste together) that uses the principles of co-design and co-creation. The knowledge and experience of the successful 'Love Food, Hate Waste' campaign in the UK can be used. This campaign was designed with the current Zeitgeist in mind, together with the business community, and targeted the main consumer drives: (1) ethical aspects, (2) saving money, and (3) sustainability and climate. We view this as a joint campaign of the national government and the business community in cooperation with local partnerships and regional programmes at municipal and neighbourhood level.

4. **INNOVATION AND PILOTS**
   Especially regarding chain cooperation, breakthroughs and scaling up, start-up support (SBIR), accelerator and coaching programmes (combination of start-up and business community).

5. **LIVING LABS**
   Regional and national ecosystems, such as ThreeSixty/FoodWasteXperts, Brightlands, Bluecity, World Food Center) and field labs (supermarkets, restaurants and catering, waste collection/municipalities, kids' education, farmers markets/gentleman farmers).

6. **DESIGNING A PORTAL WITH BEST PRACTICES TO STIMULATE INTERACTION BETWEEN STAKEHOLDERS**
   This can be achieved by further developing existing digital platforms, such as www.refreshcoe.eu, www.nowastenetwork.nl, and the food waste community.

7. **SHARING KNOWLEDGE AND EXPERIENCE AT AN INTERNATIONAL LEVEL**
   Taking responsibility for international chains, implementing solutions locally. Moreover, positioning the Netherlands as a frontrunner. See the 'EU Platform on Food Losses and Food Waste', 'Holland Circular Hotspot', and the 'Champions 12.3 coalition'.

The Core Team of the Task Force Circular Economy in Food consists of representatives from the business community and has been complemented with members from public and social organisations. The Task Force is supported by Ambassadors[21] with a global focus towards a global responsible food system. These will form the link to the 'global Champions 12.3 coalition'. In the coming years more individual companies will join the Task Force voluntarily, either as Signatory or as Supporter (goal of 200 companies in 2019). Signatories support the ambitions of the Task Force, report transparently about their progress and actions in the field of reducing their food waste, and act as ambassadors within their sectors. If so desired, supporters are supported to develop themselves to become frontrunners in the field of the Circular Economy in Food (through a broad tool set tailored to the company). All partners in the Task Force make a visible contribution to the realisation of SDG 12.3.

[21] *The Ambassadors of the Task Force are Dick Boer, Feike Sijbesma, Hans Hoogeveen, Conny Braams, Hans de Boer, and Louise Fresco.*

3.1.4 INCREASING THE SUPPLY OF SUSTAINABLY PRODUCED BIOMASS

The demand for biomass around the world will increase significantly in the coming decades as a result of a growth in global population, an increase of prosperity, and the need for biomass to achieve climate goals. The available acreage for forestry and agriculture does not increase, however. That is why focussing on increasing the supply of sustainably produced biomass is a no-regret strategy. This strategy focuses on increasing the absolute supply of biomass (more kilograms per hectare), increasing the share of demonstrably sustainably produced biomass, restoring degraded land and farming on marginal land, and finally the production of non-land based biomass, such as sea weed.

The productivity of Dutch agriculture has increased significantly since the 1950s. The industry still sees opportunities for further increasing this productivity sustainably. The Dutch forestry and wood industry indicated in the Forestry and Wood Action Plan that a significant growth of the Dutch wood production is possible both by increasing the wood production and the harvest level from existing forests and by increasing the forest acreage. By designing the public (urban) space differently, there will be opportunities to produce more biomass. Moreover, the Netherlands has acquired a lot of experience with stimulating sustainable biomass production in developing countries, for example, through the Sustainable Global Biomass programme. The Netherlands is also actively making trade chains sustainable via the Sustainable Trade Initiative, for example. Sustainable growing standards have been developed in the global platform called Sustainable Agriculture Initiative.
The Netherlands depends on the import of biomass. On the one hand, because the Netherlands is a major food producer and imports a lot of resources and exports a lot of food products. On the other hand, for the generation of energy in the context of achieving the energy and climate goals. It is vital for the business community to have long-term security in terms of a sustainably produced biomass supply chain.

The Biomass 2030 Vision concludes that focusing on increasing the supply of sustainable biomass is required both within and outside the Netherlands. The Netherlands as a country with limited acreage and a high population density has unique knowledge of and experience with the efficient production and processing of biomass, for example, with crop breeding, seed development, and advanced production methods.
The Netherlands can utilise this position by using innovations regarding circularity to make a contribution to the global challenge. In doing so, the Dutch business community can reinforce its international market position. T is vital in terms of contributions to economic growth and employment.

There is currently no stimulus in the market to focus on a larger supply of sustainable biomass. At a European level, the agricultural industry indicates that there are currently various options for increasing the supply, but that there is no market demand. The result is that investments in the increase of production and efficiency as well as innovation are lacking.

GOALS

- The Dutch agriculture and horticulture industries are developing and implementing plans of action together with national and regional governments, NGOs and buyers for the further increase of sustainably produced biomass for feed and food and other bio-based applications, both nationally and internationally, based on regional risk analyses.
- Increasing the national production of wood through focused forest management (species composition, quality of plant material, soil development, growing systems) and the growing of forests and green areas.
- Stimulating the development of non-land-based biomass production (aquatic biomass).
- Stimulating sustainable biomass growth on marginal land and in the sea and restoring degraded soil.

The following preconditions must be taken into account at all times for the production of biomass[23]:

- Biomass production must not endanger the food supply.
- Biomass must be grown sustainably, with the soil quality staying at the same level. Furthermore, water, artificial fertiliser and pesticides, waste management and limiting greenhouse gas emissions must be handled responsibly.
- Biomass production must not contribute to deforestation, degradation of nature reserves, and land expropriation.
- Biomass from forests must come from sustainably managed forests.
- Social sustainability is guaranteed. This applies both to and around the production location as well as the rest of the chain. Land grabbing and bad working conditions in countries with a delicate governance structure must be prevented.

[22] *RVO, Sustainable biomass production and use – Lessons learned from the Netherlands Programme Sustainable Biomass 2009-2013, 2014.*

[23] *For the production of wood, among other things, the Dutch government uses the Timber Procurement Assessment System (TPAS) that covers the preconditions. For biofuel and bioenergy, the EU has mandatory preconditions for the sustainability of biomass, and the green deal green certificates have developed a sustainability framework for the chemical industry. These initiatives can be built on in the future.*

REQUIRED ACTIONS AND INTERVENTIONS

The Dutch agricultural and horticultural industries take the initiative in developing plans of action for further increasing the amount of sustainably produced biomass. Moreover, they are looking to unlock residual streams of biomass within the context of sustainable soil use (both more supply and a higher share of sustainably produced biomass).
In doing so, they are involving many sectors further on in the chain that process biomass into food, animal feed, materials, and energy. Furthermore, a focus is on the execution of the Forest and Wood Plan of Action through cooperation between land owners, the forestry & wood sector, other businesses, and the different authorities. Finally, the government stimulates the development of non-land based biomass, such as sea weed.
Together with the Ministry of Agriculture, Nature and Food Quality, discussions are held on what the Dutch contribution should be regarding the revision of the European Common Agricultural Policy (CAP) in order to increase the supply of sustainably produced biomass for all applications. There will be a joint focus at NL/EU level on diplomacy in order to create acceptance and harmonisation of biomass sustainability standards.

It is important to create broad support among producers and processors of biomass in order to actually use the existing systems for safeguarding sustainability criteria regarding the production of biomass.
Sustainability criteria are mandatory for energy applications and have been recorded in the Renewable Energy Directory.
The social criteria are difficult to enforce legally. These social criteria, which relate to working and living conditions of farmers in production countries, are often already included in voluntary certification schemes for biomass for food and chemical applications. For wood and wood products, this has been 'anchored' in the so-called Timber Procurement Assessment System (TPAS). The chemical and plastics industries have developed a sustainability framework in the context of the Green Deal Green Certificates in which, apart from ecological criteria, social and economic criteria have been recorded for the use of biomass as a resource. This creates a level playing field and, on top of that, sends an easy message to all stakeholders and interested parties. Such an approach can also be applied to other biomass streams.
Moreover, there is a need for harmonisation of sustainability requirements, although these requirements should actually be set for all resources. If this is not the case, the burden will be placed unilaterally on biomass and not on fossil and critical resources.

There must also be a focus on creating more capacity in order to guarantee sustainability. Furthermore, there needs to be an international institutional governance framework that can be controlled from the basis of a good span-of-control for the responsible parties in the chain.

This capacity creation and a good, reliable governance structure require concrete pilots and business cases that can be realised based on focused research into the opportunities for biomass in a circular economy (better use of production residues and residual streams in a circular way, increasing the supply of sustainable biomass). If possible, existing initiatives such as the Sustainable Agriculture Initiative Platform (SAI), a global platform for sustainable growing standards, can be built on.

A plan of action will be drawn up together with the Ministries of Foreign Affairs and Foreign Trade and Development Cooperation that focuses on the Dutch efforts in order to increase the supply and trade of sustainably produced biomass. There will be specific attention for the Dutch partner countries in the field of development cooperation and the use of global forums, such as the OECD and the UN. Moreover, there will be support for international policy aimed at maintaining biodiversity and restoring degraded ecosystems via CBD, FAO and UNEP, and public-private partnerships that contribute to this will be sought. Correspondingly, there will also be a focus on international policy frameworks, such as UN/UNEP and EU, regarding environmental governance, rule of law, compliance, and spatial planning tools.

Together with UN Environment, Rabobank starts the global climate smart 'Kickstart Food' platform. The first step for this is the financial provision of 1 billion dollar, to be used for providing support to projects focused on sustainable and environmentally-friendly food production. 'Kickstart Food' focuses on global restoration of the current agricultural land (under the name 'Earth'), reducing food waste in the entire food production chain (Waste), creating a more stable and resilient food and agricultural industry (Stability), and the necessary of a balanced healthy diet for everyone (Nutrition). The initiative has been designed as an open platform.

Focusing on increasing the supply outside of the Netherlands also results in export opportunities for the Dutch business community. As a part of the above plan of action, the participation of the business community in Holland Circular Hotspot will also be explored and agreements with the government will be made about active support for companies and knowledge institutes that want to share and market knowledge and innovation internationally. This is achieved, for example, through market studies, economic diplomacy, and incoming/outgoing missions.

3.1.5 THE PROTEIN TRANSITION

Protein is a vital component in our diet and the building blocks of our body. With the growing global population, sustainable protein provision is one of the major sustainability issues for the decades to come. Nitrogen is a crucial component of protein, but out of the total amount of reactive nitrogen added by the agricultural industry only 25% ends up in human food. Scientists indicate that the planetary boundaries for sustainable use of resources in terms of the nitrogen cycle have been exceeded[24]. Apart from the global disruption of the nitrogen cycle, the land use for the animal production chains is problematic as well. The global production of biomass for animal feed in 2011 was 58%[25] of the total production of biomass for food, animal feed, materials, and energy.

From the perspective of land use, greenhouse gas emissions and the severely disrupted nitrogen cycle, we need to depart from past trends for both the production and consumption of protein. Aiming for a higher nitrogen efficiency that will necessarily lead to both the increased sustainability of the animal protein production and a change in consumption are at the heart of this line of action.

CONSUMPTION

More animal protein than vegetable protein is consumed in the Netherlands. The Netherlands Nutrition Centre recently recalculated the five basic food groups for protein and concluded that a ratio of 50% animal protein and 50% vegetable protein fits a healthy diet for most Dutch people[26].
In the 2007- 2010 period, the ratio was 62% animal protein and 38% vegetable protein. In terms of sustainability, it is recommended to reverse this ratio in our diet in the longer term (from 60:40 to 40:60). This implies a reduction of the climate impact of 70%. Consuming less animal protein and more vegetable protein and limiting protein loss in the human food chain lead to a more efficient nitrogen use. Apart from this dietary shift, an average reduction of 10% to 15% of the total protein intake in the Netherlands is desired in order to achieve a sustainable diet.

PRODUCTION

A higher efficiency and circularity can be achieved in the production chain through a combination of 'nature-inclusive agriculture and cattle farming', letting cattle graze on land that is unsuitable for food production, and feeding cattle with protein-rich residual streams that are unsuitable for human nutrition. It can also be achieved through fewer transport movements, technological innovation, and the valorisation of protein-rich residual streams.

In cattle farming there are losses of over 50% in terms of the conversion from vegetable to animal protein[27]. Parties like Nevedi continue to make an effort for a more favourable feed conversion, or in other terms the more efficient production of animal protein.

By using co-products from the food, beverage and bio-ethanol industries (think of potato peels, brewers grains and beet pulp) as animal feed, the animal feed industry reduces loss and waste of high-grade feed and nutrients. Research is also conducted into new resources for animal feed based on algae or insects, for example. However, the application of these resources does require the elimination of legislative obstructions. Reducing protein cycles to increase the efficiency by creating a more regional (EU) protein production means that closing the cycles will need to take place within the EU.
Further research will have to show under which conditions a reduction of the production-protein cycles will offer sustainability benefits.

Proteins are an important component of the by-products of the meat industry. Darling Ingredients makes bio-functional applications, such as collagen peptides that ensure flexible joints and firm bones. They are also used for techno-functional applications to, for example, give meat products an optimum texture, such as a functional chicken protein and a high-function pig protein. The additional effect of the latter is that phosphate is no longer required in the meat products.

[24] *Rockström et al, A safe operating space for humanity, Nature, 461, 472-475, 24 September 2009.*
[25] *Global use of harvested biomass from forestry and agriculture in 2011 (source: Nova institute).*
[26] *Van Dooren, Source document 'Naar Meer Plantaardig Eten', November 2017.*
[27] *https://www.cbs.nl/-/media/_pdf/2017/33/dierlijke-mest-en-mineralen-2016.pdf*

TASTY BITES BASED ON VEGETABLE PROTEINS

GOALS

Extensive sustainability of both the production and consumption of proteins:

- By 2050, the ratio between animal and vegetable protein in our diet compared to now has been reversed from 60% animal protein, 40% vegetable protein to 40% animal protein and 60% vegetable protein. The total protein consumption per person has decreased by 10-15% in 2050.
- No later than by 2050, the footprint (measured in, among other things, land use, greenhouse gas emission and nitrogen loss) of proteins produced in the Netherlands has decreased by 50%, resulting in a total savings potential of 12.5 Mt CO_2-eq emissions (production 4.5 Mt, consumption 8 Mt)[28]. This must not lead to negative side effects, such as an increase in intensive cattle farming, because the ambition is to make the cycles as small as possible (i.e. land-based cattle farming).

REQUIRED ACTIONS AND INTERVENTIONS

The Netherlands can call itself a global frontrunner in the field of protein sustainability. There have been many protein research programmes since 1990. They resulted in a wealth of insights, technologies, and data. The protein sustainability theme is an important point on the Dutch Food Agenda for safe, healthy, and sustainable food. National protein initiatives are, among others: the Green Protein Alliance (shift in protein consumption from less animal to more vegetable), the Green Deal Dutch Soy (local growing of soy), Resource Sustainability of Nevedi, Dutch cuisine, the New Food Challenge (SBIR, product innovation), the STW programme Protein Innovation, and research into meat substitutes in the Agri & Food Top Sector.
The Top Institute Food & Nutrition (TIFN) is closely involved in this theme. Linking up with and joining the SUSFANS EU project that focuses on mapping out the influence of consumer behaviour on dietary patterns and the TIFN project SHARP (Sustainable, Healthy, Affordable, Reliable and Preferable diet) seems to be a logical step.

Globally, 70 million tons of rapeseed a year is processed for the extraction of oil. After pressing, a protein-rich press cake is left that contains a total of 14 million tons of protein that is currently used in the animal feed industry. DSM is developing a 'food-safe' method to extract the protein and has already obtained the approval to use the highly functional fraction in high-grade food applications. Scaling up and marketing are required to make use of the potential of this protein source.

In an international context, initiatives to make protein import more sustainable (among others Round Table Responsible Soy, FEFAC Soy Sourcing Guidelines) and the recently signed IMVO Vegetable Proteins Covenant are relevant. The advisory government bodies pay specific attention to the theme through the Netherlands Enterprise Agency, the Ministry of Agriculture, Nature and Food Quality (Food Transition Participation Table) and the Council for the Environment and Infrastructure (Dutch RLI).

These initiatives each have their own focus in the protein chain, from primary production to consumption. The protein transition line of action focuses on connection through the following actions and interventions:

- Supporting (coalitions focused on) sustainable protein consumption (less protein consumption and a shift to more vegetable protein in the diet).
- Further quantification of and monitoring the footprint of the produced and consumed protein with a focus on the climate, land use, and nitrogen efficiency chain of (1) agricultural production, (2) the range of food products offered to the consumer, and (3) our diet.
- More efficient use of nitrogen in the animal protein production through more favourable feed conversion and the use of more sustainable, 'food-safe' alternative protein sources.
- Natural nitrogen bond through leguminous plants in crop rotation schedules.
- Valorisation of protein-rich vegetable and animal residual streams from the food and feed industry into high-grade applications.
- Developing, scaling up, and marketing circular (vegetable and animal) protein propositions with attention paid to the entire chain, from growing up to and including consuming. This includes, for example, soy, sea weed, algae, field beans, and cultured meat.

The participants in the protein transition work group are prepared to cooperate in the further development of the line of action.

[28] *Blonk Consultants, Protein consumption and production footprint, September 2017, EZ order number 1300025087.*

[29] *www.greenproteinalliance.nl*

[30] *www.greendeals.nl/green-deal-soja-van-eigen-bodem/*

[31] *https://assets.nevedi.nl/p/229376/20170814%20Nevedi-factsheet%20Verduurzaming%20grondstoffen.pdf*

[32] *www.rvo.nl/subsidies-regelingen/sbir/oproep-plantaardige-eiwitten-op-het-bord*

[33] *http://www.tifn.nl/project/sharp/*

[34] *https://mvonederland.nl/sites/default/files/media/IMVO%20Convenant%20Plantaardige%20Eiwitten.pdf*

[35] *RLI expertsessie 5 juli 2017, 'Een voedselsysteem waarin de productie en consumptie van met name dierlijke eiwitten meer in overeenstemming is met de draagkracht van de aarde: hoe komen we daar?'*

3.1.6 FEEDING AND GREENING MEGACITIES AS A DUTCH REVENUE MODEL

Every day, over 180,000 people move to urban areas. Within 30 years, over 80% of the global population will live in such an area. The growth of megacities continues without pause, and close to 15% of people will live in the ten largest cities.
The demand for calories and safe, fresh food will increase by 60%. And it will do so in a climate that is more and more extreme. The demand for conditioned and controlled harvests and a green and healthy living environment to keep the cities liveable is increasing significantly.
All cities are looking for comprehensive and sustainable solutions, while the West is mostly looked at for innovative knowledge and skill. The traditionally innovative Dutch agricultural and horticultural industry can take the lead in coming up with comprehensive solutions to these global challenges. This allows the Netherlands to maintain and further expand its globally recognised unique position in terms of knowledge and innovation in the fields of e.g. agriculture and horticulture, water management, and logistics. After all, the Netherlands is one of the few countries in the world where knowledge, expertise and experience are in ample supply to help feed the five billion people in megacities in a sustainable way. A transition to new ecosystems is required to develop those high-grade, circular, high-tech production, transport, distribution, waste processing, water purification, marketing and consumption patterns in or near megacities.

In horticulture, an exemplary transition was actually implemented a number of years ago. Based on a low-zero impact strategy (closed greenhouse), it is possible to work towards further specification of products (inter alia through fully controlled growing) and towards unique circular concepts (vertical farming, use of residual streams from the greenhouses for packaging the products from those greenhouses). The background document 'circular economy in horticulture' that has been included as an appendix to this agenda describes these developments and was the inspiration for this line of action.

The 'feeding and greening megacities' line of action is aimed at developing an international revenue model that is based on comprehensive systemic solutions for megacities. Resulting from Dutch knowledge and innovation in the field of agriculture and horticulture, logistics, water management, and waste processing. Within these systemic solutions there is close cooperation between the government, entrepreneurs, researchers and education, and a contribution is made in a broad sense to the food, health, and well-being of people in megacities.

THE HARVEST

'Feeding and greening megacities' reinforces and renews the Dutch competitive position in the fields of green technology systems, computerisation, infrastructure, smart distribution, waste processing, water purification, logistics, and closing cycles. Moreover, new knowledge is acquired about metropolitan developments and climate adaptation as well as the way in which Smart Cities concepts can be combined with circular Urban Farming and Feeding concepts. On top of that, it will also reinforce the cooperation between and within chains and will create a strong international position for the Dutch business community.

By acting fast in the 'feeding and greening megacities' line of action, the partly autonomously used circular developments that are already in place in horticulture can be stimulated even more.

GOALS

As the result of the lengthy transition towards circular horticulture, the sector developed alongside the socio-demographic development towards extensive urbanisation and the large-scale population movement from the countryside to the cities. The high-quality innovative developments in horticulture contributed directly and indirectly to meeting the food and greening needs of the new society and to the global approach of complex issues. Unique concepts have already been developed, such as the almost complete recycling of used substrates and the development of self-supporting – and even energy-generating – greenhouses.

The sector's circular economy agenda also focuses on full, high-grade utilisation. Applications like cosmetics, organic pesticides, construction materials, packaging and high-grade speciality chemicals are developed in cross-sector partnerships. Using this to focus on low-impact to zero-impact and circular cultivation, processing and marketing will allow the sector to develop unique knowledge and take the lead in executing and implementing the 'feeding and greening megacities' line of action.
The following goals are at the heart of this:

- Development of comprehensive concepts for circular food provision for megacities. Including attention to the processing of residual streams and waste water, logistics, water management, and climate adaptation.
- Applying these concepts to one or more megacities.

INNOVATIVE HORTICULTURE

John Bijl automated his fern nursery in such a way that it required less manpower and less surface area. This new approach made Vitro Plus in Burgh-Haamstede a global player – with only 50 employees.
He also invented a type of miniature greenhouse in which the plants can grow fast and clean while requiring little water. He nicknamed them 'magic boxes'. They can also be used for other crops, such as lettuce, with which the entrepreneur is now entering a new market.

REQUIRED ACTIONS AND INTERVENTIONS

In order to contribute optimally to the global need of a growing population, that increasingly lives in a strongly urbanised region, to continue to be provided with healthy food produced with a minimum impact on the environment, it is necessary to take the following actions:

- The horticulture industry proactively involves chain partners from other relevant sectors, such as those in the logistics, waste and water treatment sectors, in order to develop innovative, comprehensive circular revenue models that will have to lead to solutions for the megacities and to added value for the Dutch sectors in terms of export and employment.
- Refining the 'feeding and greening megacities' concept for implementation in Europe and globally. Translating technological solutions to other regions within and outside Europe depends strongly on specific regional (climatological and demographical) conditions. Insight into this is vital in order to optimally encourage future research.
- Developing international feeding and greening test projects with a multi-year ambition and international allure in which, together with the business community, research institutes and foreign partners, comprehensive systemic solutions are developed for megacities. The condition is that such a megacity has a clear demand and that important stakeholders in that city are prepared to work with Dutch partners in a pilot project.
- In parallel and linked to the international test projects, 'feeding and greening learning labs' are created in the Netherlands to safeguard the learning process in practice and to speed up the transition towards new business models.
- Setting up partnerships with a maximum of three megacities, with a number of Dutch experts being outsourced as fast as possible to ministries and/or regional governments in order to provide input on planning and mapping out the exact needs. In parallel to this there are diplomatic explorations in the selected megacities in order to make contact, create support among regional stakeholders and participating parties, and test feasibility.
- Linking up with international (EU) work groups regarding circular horticulture to develop and promote the development of new healthy and sustainable food and greening concepts together.
- Further deepening of this line of action in terms of required interventions and consortium formation.
- Willing partners are the Greenports, Meeting more Minds, Holland Horti International, consortia in the field of installation technology, greenhouse construction, production, seed growers, agricultural logistics and packaging, and knowledge centres like World Horti Campus.

3.2 PRECONDITIONAL LINES OF ACTION

3.2.1 REINFORCING THE INVESTMENT CLIMATE FOR BIO-BASED INDUSTRY

Biomass and recyclate are the renewable resources of the circular economy. Over the past years, the Dutch business community has developed new technologies and bio-based products in numerous fields. Many companies are ready to enter the market and increase their scope, but require pre-cyclic investments. The first investments need to be made at an early stage of the development cycle, which comes with bigger risks. Moreover, parties find that the investment climate in the Netherlands is often less favourable than it is abroad. Investments in technological concepts that have often been developed with Dutch support for research, development and demonstration purposes are at risk of ending up abroad.
The risks of investing in new bio-based production capacity are high. The market is not convinced, and the technology has not sufficiently been optimised. Furthermore, the first plants often do not appear to function properly, which leads to stricter investment requirements for the next plants.
A transition period (the start and middle of the S curve) requires the boosting of investments that contribute to the transition itself. This incentive can be phased out in the institutionalisation phase ('the new standard') if the agreements made are respected. In this phase, conditions should be created on the basis of which circular business cases can hold their own.

Transition projects are complex in nature due to the necessity of working with new and unknown partners from different sectors. This is also referred to as social innovation. These social innovation aspects should not be underestimated. Many new forms of contracts are also required. For instance, parties have specific images of other players beforehand that could impede the process. In addition, many companies are not equipped to deal with open innovation, IP, distribution risks, costs, yield, CO_2 credits, etc. Another difficult issue is that there is often a missing link between biomass producers and buyers further up the chain: operators who invest and bear risk. There is also the aspect of time for the forestry and wood sector. After all, investing in biomass will only lead to actual supply after many years. This can make it very difficult for individual producers and buyers to enter into agreements. Chain management is vital for this.
Because of the complex nature of bio-based investments and the fact that a consortium of companies is often required to realise the desired production capacity, there is a need for chain directors who can facilitate transition projects.

WHAT TYPES OF INVESTMENTS ARE REQUIRED?

In the Netherlands, investments in inter alia the following types of production capacity are required:

- Planting of forests and increasing the national wood production in accordance with the Forest and Wood Plan of Action.
- Realising biorefinery complexes in which biomass is used in a cascaded way, based on comprehensive and optimum valorisation concepts (e.g. waste wood refinery for the production of bio-based chemicals and lignin for energy production).
- Bio-based plastics (among others PEF, PLA, PHA, alginates) and bio-composites.
- Bio-based intermediates (among other things fatty acids).
- Cellulose from waste water.
- High-grade fibre applications (nano-cellulose, micro-fibres for applications in, among other things, coatings, surfactants, packaging).
- Fine chemicals from crops and residual streams (applications include plasticisers, flavours and fragrances, medicines).
- Fertilisers based on nutrient reclamation from organic residual streams.
- Food and feed ingredients based on residual streams (including proteins).

REQUIRED ACTIONS AND INTERVENTIONS

There are various options for reinforcing the investment climate for transition initiatives that need to be tested for their effect, feasibility, and support. The proposal is to start a CE Investment Climate Table in which the business community, banks, pension funds, the central government and EU fund managers jointly develop proposals for interventions aimed at structural improvement of the investment climate.
The central authority participates in this table with experts from the intervention teams, financing and smart market incentives, legislation and regulations, and international cooperation. The following organisations from the Biomass and Food Transition Team want to participate in this Table: Sappi, Rabobank, Green Protein Alliance, VNCI, Royal Cosun.

Photo credit: Total Corbion PLA

BIODEGRADABLE FRUIT, VEGETABLE AND GARDEN WASTE BAGS

These bags are used to prevent dirt and nasty odours in the fruit, vegetable and garden waste bins. The bags are made from compostable plastic. They can be disposed of in the fruit, vegetable and garden waste bins together with the appropriate waste.

Promising interventions that can be looked into jointly and developed further are, among other things:

- Financial interventions focused on 'de-risking' the early-cycle investors through providing low-risk capital, such as participation funds and schemes, funds for subordinated loans, the Invest NL for CE tool set, etc.
- Financial interventions aimed at scaling up innovative solutions in order to, in particular, compensate for financial setbacks in the start-up phase through financial guarantees and subsidy schemes.
- The national climate fund mentioned in the Coalition Agreement that will be installed by 'OS'.
- Reinforcing the role of the government in bio-based procurement and as a launching customer.
- Input of needs on behalf of the Netherlands in revised MFF (European multi-annual financial framework).
- Execution of international iconic projects (EU and worldwide).
- Facilitating complex transition processes through chain directors and green deals that provide preconditional support (such as matters regarding legislation and regulations like zoning plans, permits, and facilitating deliberations).
- Research into how cycle closure in chains and clusters can be guaranteed through producer responsibility.

PLAYGROUND

A forest manager is left with 30 m3 of wood chips after pruning trees, 26 m3 of which can be used to harden a forest path on site under an exemption of the waste materials regulations. The remaining 4 m3 can be used as a soft surface underneath play equipment by a nearby playground, but this purpose is not covered by the exemption for these wood chips. Delivery of the chips to the playground needs to meet all the strict conditions and regulations for 'waste materials'.

3.2.2 EMANCIPATION REGULATIONS

BOTTLENECK DESCRIPTION

The current (waste) regulations are based on a linear economy in which we make, use and then discard products (end-of-life). In a circular economy, we try to convert all production residues and residual streams into as high-grade materials and substances as possible during the production phase36. Subsequently, these products (or residual matter) will be upgraded to new resources and products after the use phase. This is achieved, for example, by turning vegetable, fruit and garden waste into compost and energy or by processing biogenic residual streams into an oil that can be mixed in with fossil oil to make plastics or transport fuel. The current legislative system in which substances and materials are classified and qualified either as product, resource or waste material is not properly attuned to the circular economy. Different interpretations on the part of legislators and supervisors may lead to uncertainty and inequality among both private and public stakeholders. The new LAP3 (national waste management plan) does anticipate the circular economy.

The formation of a circular economy requires an adjustment of the waste regulations and product regulations for the following reasons:

- New technological developments made it possible to process ever more substances that are now considered to be waste in a high-grade manner, to (re)use them, and to reclaim valuable resources from waste. Concrete examples are: production residues from conditioned production processes, biomass from the management and maintenance of green areas, and resources from industrial process water and communal waste water. Current legislation does not sufficiently take this into account.
- New cross-overs between fossil and mineral resource chains and innovative biogenic chains (and between the biological and technical cycles) are created that raise questions regarding whether or not the new resource/process combinations can and may be used for specific applications. Think of the production of fish feed based on methane, chemicals based on CO_2, hybrid plastics and composites, for example. Current legislation does not cover this properly either.
- As more high-grade substances are brought into the economy with a reasonable degree of sale security, the question remains whether waste regulations, under strict conditions, should not have a safety net function (following the substances and product regulations and based on a properly implemented producer responsibility through quality control and certification, for example). Currently, the waste regulations are applied almost automatically to all pre-consumer and post-consumer reusable resources.

Moreover, the *execution* of the waste regulations also results in obstructions:

- If a reusable material or substance has the label 'waste', this may constitute an impediment to the use of this substance in a high-grade manner and to its marketing, especially for export purposes. At the same time, the term waste material in the Netherlands also gives the option of aiming towards high-grade reuse through the LAP (minimum processing standard).
- Material with the 'waste' status can have an unattractive image.
- At a (national) policy level there is usually a very clear vision and the will to facilitate circular initiatives inthe market, but a company often gets bogged down elsewhere. This occurs at the national/provincial/municipal level, but also in the following roles: policy/permit provision/supervision and enforcement. When drawing up a national circular policy, it is important to make sure that there is sufficient support among all layers of the government to ensure that they will commit to this policy and act accordingly. This all needs to fit in with the responsibility for other interests that have largely been determined at a European level, such as environmental protection. Moreover, European harmonisation might be desired, but this is not feasible in the short term and not a prerequisite for taking a number of firm circular steps.
- The autonomous position of local governments is likely to increase in the execution of the new Environmental Planning Act. Decentralisation of the decision-making authority regarding substance handling may pose a threat to providing legal certainty and legal equality to entrepreneurs if too much room for interpretation is left to local authorities.
- Policy formulation must reach across sectoral boundaries and policy fields. For instance, all decentralised authorities that want to market or exchange biomass with the business community in the context of management and maintenance end up in a split between cost-effective and innovative business operations and the code of conduct laid down in the Market and Authorities Act. Based on this act and the procurement tool set, (co)authorities are fundamentally prohibited from freely exchanging resources with market parties in the context of local cycles. The market dynamics and the legislation require a more rational, circular approach in this matter.

[36] *Naturally the entire chain needs to be considered from the (planning of the) extraction of resources onwards.*

REQUIRED ACTIONS AND INTERVENTIONS

The transition towards a circular economy is lacking an integrated, referential legal framework within which thinking exclusively in terms of waste and residual streams (based on origin) must drastically be turned into thinking in terms of recycling (resource for a specific application). From an environmental and public health perspective and in terms of economic potential, the government has the explicit task of creating the right preconditions. Preconditions for protecting society against uncontrollable ecological and health risks, but also preconditional incentives that offer the necessary legal certainty and equality to the business community.
The task of producers is to meet these preconditions and provide reliable data that allow for the assessment of the quality and possible risks of the product as well as for safeguarding that quality.

The advancing scientific knowledge regarding risks of substances and products has made us aware of the effects specific substances and organisms have on public health and the environment. This knowledge of the risks and the prevention and control thereof should be a leading factor in designing a risk assessment system (assessment framework) that can support the decision-making process of policy-makers, producers and enforcing authorities in determining whether or not resources and processing methods are suitable for the production of products for specific applications. The composition, nature and properties of the substance in relation to the application as well as a substance's purity are of importance. This equally applies to the application and waste phase, because these determine the actual risks. A referential and proportional assessment and review process offers both government and business community guidance in assessing the risk of substances and products. This makes the step from research and development to market introduction more cost efficient, easier, and smoother. Furthermore, it is important that such an assessment system improves harmonisation. After all, it should not be the case that a resource/application combination is assigned one risk profile in one management area that differs from the risk profile of the same resource/application combination at a different, but equivalent, location.
In due course, this all requires adjustment of legislation and regulations (not just the waste regulations) and a revision of assessment systems (permit provision/supervision/enforcement), which requires additional knowledge and capacity. With respect to the European regulations, this is only possible through the Netherlands' active input in European policy processes, preferably with like-minded member states.

In the light of the scope and complexity of the recalibration issue described above, a Task Force will be formed that can give advice on the way in which thinking in terms of waste and residual streams can be turned into thinking in terms of reuse as a resource for a specific application. And in which the adequate protection of health and the environment are safeguarded and proper enforcement is still feasible. This includes both the execution of existing legislation and regulations as well as proposals for amendments that will take more time, such as European matters. At a European level, cooperation with other member states is preferably sought and proposals can be discussed with the European Commission. Furthermore, the Task Force's advice must contain a responsible balance between providing a framework on the one hand and producer responsibility on the other hand. The Task Force must also consider the current system of issuing permits, enforcement and supervision that is currently not attuned to a circular system. An initial list with concrete issues has already been drawn up. It will be included as input for the work agenda discussion of the proposed Task Force.

Because the implementation of waste and environmental legislation primarily takes place at a decentralised and executive level, the representatives of provinces, municipalities and water boards (IPO, VNG and UVW) intend to take the organisation of this 'Task Force for the Review of Waste Materials' upon themselves in the context of their joint CE Investment Agenda. This Task Force will consist of a balanced group of representatives from the central government, other authorities, inspectorates, NGOs and the organised business community to achieve the changes that are deemed necessary. On the recommendation of the co-authorities, the Task Force will be formally appointed by and report to the Ministers of Economic Affairs & the Climate, Agriculture, Nature and Food Quality, and the state secretary of Infrastructure and Water Management. The idea is to begin preparations for the work agenda as quickly as possible. From the Biomass and Food Transition Team, BVOR, Royal Cosun, MVO and UVW are interested to take an active part in this Task Force.

3.2.3 HONOURING (LONG-TERM) CARBON SEQUESTRATION IN SOIL AND PRODUCTS

In a circular economy, we strive towards closed carbon (C) cycles in which CO_2 from the air is sequestered in crops. The challenge is to keep the sequestered CO_2 out of the atmosphere for as long as possible, preferably for decades. At the same time, the extraction and oxidation of fossil carbon needs to be reduced and the carbon level of soils needs to be maintained.

There is also an important intersection with recycling. By recycling plastics, for example, carbon is also maintained, which means that recycling also results in a reduction of CO_2 emissions.

Bio-based materials in general provide at least as much CO_2 reduction per used amount of biomass as bio-energy applications. The current Dutch energy and climate policy focuses on reducing national CO_2 emissions ('from the chimney'). International agreements are based on this, and countries are held accountable for emissions within the national borders. Producers are not really encouraged to use biomass as a resource for chemicals and materials through, for example, the ETS system that will only reward biogenic CO_2 emission reduction if the products are incinerated. Thus, ETS does not stimulate substituting fossil resources with biomass for the production of chemicals and materials. As a result, solely focusing on CO_2 does not necessarily always lead to closed carbon cycles.

Because the Netherlands exports relatively many materials and products, the replacement of fossil resources with bio-based resources for materials and products hardly contributes to achieving the Dutch climate goals. This is only the case for those products that are incinerated in a waste incineration plant, for example. The benefits of resource sustainability thus do not end up with the business community investing in it. Companies are held accountable for the CO_2 they emit themselves, but they are not rewarded for the CO_2 emissions they prevent elsewhere in the chain.

However, to counter climate change, it does not matter where the CO_2 is emitted. That is why many companies reason based on the effects in the (often cross-border) chain, the global footprint. The transition to a circular economy focuses on making international chains sustainable. This tension shows that a policy that is cost-effective from a national perspective can be suboptimal for global cost reduction and may discourage investments in a circular economy.

From 2021 onwards, carbon sequestration in long cycles will be honoured in the climate policy (LULUCF), but tools need to still be developed for this.

REQUIRED ACTIONS AND INTERVENTIONS

In terms of circularity it would be better to first sequester biomass in the form of materials and products and turn it into energy in a final stage after recycling (multiple times). And to also honour carbon sequestering in the soil. This requires managing carbon preservation instead of CO_2 emissions. This type of management also stimulates the use of renewable sources (apart from bio-based, there is also fossil-based recyclate) to replace non-renewable sources in other sectors, such as the plastics and construction industries.

The proposal is to form a CE Carbon Sequestration Table consisting of representatives from agriculture, industry, relevant intervention teams (in the context of legislation and regulations, financing and smart market incentives, knowledge and innovation, international cooperation) and parties involved in drawing up the climate act and the national Climate and Energy Agreement. From the Biomass and Food Transition Team the following parties have already shown an interest in participating in the CE Carbon Sequestration Table: Dutch Biorefinery Cluster, Royal Cosun, BVOR, UVW, VNP. This CE Table will work on the following issues:

- Generating support to get carbon sequestration incorporated in the future climate act and the Climate and Energy Agreement.
- Developing a tool set for climate policy that honours carbon sequestration in soils and products37.
- Developing tools that honour the efforts to sequester carbon in soil and products in an interim period during which C-sequestration management has not yet been regulated. Other countries have developed multiple tools on the basis of CO_2 credits, for example in Brazil to counter deforestation and in Austria to stimulate increasing the organic matter level in the soil. Various parties in the Netherlands entered into a 'national carbon market Green Deal' in 2017 in which the viability of a national carbon market is tested.

[37] In afstemming met de Green Deal Pilot Nationale Koolstofmarkt.

3.3 SUMMARY OF GOVERNMENT INTERVENTIONS

BEHAVIOUR

To counter food waste, there is a need for measures that increase consumer awareness, stimulate the level of knowledge about desired waste separation, for example, and tempt consumers to change their behaviour (custom purchasing). The protein transition also requires behaviour interventions that lead to an adjusted diet.

KNOWLEDGE AND INNOVATION

This intervention is described in the knowledge agenda chapter. It is about the development of knowledge required for proper monitoring as well as the specific knowledge required for designing interventions in terms of legislation or market incentives, for example. Furthermore, there is a need for applied research focused on the development and upgrading of desired innovations (including pilots, living labs, and demonstration projects).

INTERNATIONAL COOPERATION

The Netherlands depends on the import of resources and will have to cooperate internationally to guarantee an adequate supply of sustainably produced biomass and to close international nutrient cycles. The circular economy also offers the Dutch business community unique opportunities to export circular concepts of which the 'feeding and greening megacities' line of action is an example. Adjustments in policy, legislation and regulations at a European level require cooperation with other member states.

LEGISLATION AND REGULATIONS

Emancipating the waste and product regulations is a prerequisite line of action that is crucial for the formation of a circular economy. Moreover, there is a need for interventions that stimulate the market demand for circular, bio-based products, such as dynamic standardisation focused on incrementally increasing the amount of renewable resources in plastics and fertilisers, for example. Or phasing out products for which there is a clearly better bio-based alternative.

FINANCING AND SMART MARKET INCENTIVES

Improving the investment climate for the bio-based industry in the Netherlands is crucial lest we miss out on important economic opportunities. There is a need for new financial arrangements.
The Social and Economic Council is expected to present a report on this in late 2017. Subsequently, it is important to improve the investment climate with a broad coalition consisting of the government, the financial sector, pension funds, the business community, and European governments. Another important intervention for getting innovations through the 'valley of death' is to have the government play the part of launching customer and circular procurer.
Finally, it is essential that interventions that stimulate low-grade applications are phased out or that interventions are adjusted to such an extent that high-grade valorisation will receive at least the same incentive.

The tables/consortia per line of action will customise the required intervention in close deliberation with the ministries and intervention teams.

4. KNOWLEDGE AGENDA

Research and innovation is an iterative process with companies that spans several decades. The current breakthroughs in the protein transition are the partial result of years of research.
The foundation for the knowledge agenda is securely embedded in the knowledge agendas of the Agri & Food Top Sector and the Bio-based Economy Top consortium for which Wageningen UR and TNO are important suppliers of knowledge. Nutrients, soil fertility and sustainable protein are part of the knowledge agenda of the Agri & Food Top Sector. At the request of the Ministry of Economic Affairs and Climate, the BBE TKI developed the bio-based economy research agenda together with businesses and knowledge institutes. This is the guideline for fundamental and applied research in the bio-based economy. The chairman of the Supervisory Board of the BBE TKI recently emphasised the importance of bio-based economy research in a letter to the Ministry of Economic Affairs and Climate.

In addition, the biomass and food transition agenda requires the following:

- The current financing of research for the new circular economy theme is under pressure because of the reduction in government financing. Moreover, under the current circumstances, smaller entrepreneurs and start-ups are unable to use their own budget to compete in the research calls for tenders of the Top Sectors. Instead of a decrease in budget, an increase in budget is required for research and innovation in the bio-based economy, preventing food waste, closing nutrient cycles, sustainable proteins and soil fertility (Agri & Food), and also in the circular economy for horticulture and the forestry and wood chain development.
- Firmly embedding the circular economy in the research agendas of the Agri & Food, Horticulture & Basic Materials, Chemicals, Energy and Water Top Sectors.
- New sectors and companies need to be connected to the top sectors. These are companies outside of agriculture that are, for example, working on recycling high-phosphate residual streams, such as sewage water and offal, and sectors and companies active in creating value for biomass and residual streams in bio-based products (such as the forestry and wood sector and the paper industry).
- In order to speed up the transition to feeding and greening cities there is a need for extensive internationalisation of knowledge and educational activities, including sharing knowledge and insights with international partners.

Apart from innovation-oriented research, a budget is required for having generic knowledge questions looked into:

- More insight is required into how behaviour in the consumption of proteins can be influenced and be given a more sustainable character. There is too little insight into the effects of potential measures.
- New products made from biomass (bio-based products) must have an application in, e.g. the construction industry or the plastics industry. More knowledge is required regarding specifications and translating the needs of other sectors and consumer wishes to the suppliers of bio-based resources.
- Legislation may be an impediment to the development of business cases. Specific business cases can be supported with the analysis of obstructing regulations.
- We need to make up lost ground to increase the knowledge regarding functional organic matter and soil fertility.
- In general, there is a need for monitoring and analysis of the set goals and lines of action.
- In the start-up phase of the transition, it is important to support the exchange of knowledge between companies in the further set-up of new chains and cycles. On top of that, there needs to be support for companies to develop generic knowledge for new business models.
- The high amount of uncertainties about the biomass supply in quantitative and qualitative terms and the Dutch dependency on the import of biomass require constant monitoring of the availability per type of biomass at a Dutch, European, and global level. At the same time, the development of the demand abroad and requirements set to sustainable production (especially in terms of soil fertility) need to be taken into account.

The 'Bio-economy Strategy' is being revised in Europe in 2018. This will be the basis for new Horizon 2020 research programmes. The Netherlands can introduce the lines of action of the Biomass and Food Transition Agenda and resulting knowledge and research needs in the European Bio-economy Strategy.

5. INVESTMENT AGENDA

The circular economy in terms of biomass and food requires a number of major change processes, as made clear by the lines of action described in this agenda. Even though a circular economy results in considerable social profits in the long term with respect to jobs, innovation, the environment and climate, investments are still required en route to this in order to speed up the transition. Authorities, the business community, trade unions, social organisations and citizens face this challenge together. This investment agenda describes the investments that are required in the years to come (2018-2021) to speed up the transition to a CE. This can involve investments in terms of speed (research/knowledge), scaling up (demonstration, first-of-a-kind plants), specific programme investments per line of action, and means that are required for support/programme management.

Table 1: Investment agenda biomass and food transition agenda [sums in M€, cumulative 2018-2021]

	RESEARCH/ KNOWLEDGE		DEMONSTRATION		SPECIFIC ACTIONS[4])		SUPPORT		TOTAL	
LINE OF ACTION	PUBLIC	PRIVATE	PUBLIC	PRIVATE	PUBLIC	PRIVATE[1])	PUBLIC	PRIVATE[1])	PUBLIC	PRIVATE
1: Creating value for Biomass / Residual streams	16	16	20	50	0.4		0.4	0.4	36.8	66.4
2: Nutrients/Soil quality	4	4	9	21	4	0.5	0.4	0.4	17.4	25.9
3: Less food waste			4.5	11	2	1.5	0.4	0.4	6.9	12.9
4: Supply of sustainable biomass	3	3			3.5	1	0.4	0.4	6.9	4.4
5: Protein transition	1.4	1.4	2	5	2	1.5	0.4	0.4	5.8	8.3
6: Feeding, greening megacities [3])					0.4		0.4	0.4	0.8	0.4
7: Investment climate of industry [2])			50	450			0.4	0.4	50.4	450.4
8: Emancipation regulations							0.4	0.4	0.4	0.4
9: Working towards carbon sequestration							0.4	0.4	0.4	0.4
TOTAL	24.4	24.4	85.5	537	12.3	4.5	3.2	3.2	125.4	569.1

1 *Private contribution in kind.*

2 *Investments in production capacity.*

3 *Programme 'feeding and greening megacities' is still being developed.*

4 *Specific actions per line of action:*
line of action 1: bio-based procurement programme.
line of action 2: monitoring specifically aimed at soil quality and nutrients.
line of action 3: programme focused on behavioural change products/consumers regarding food waste. line of action 4: programme aimed at international exchange of knowledge and pilots focused on productivity increase.
line of action 5: programme aimed at behavioural change of consumers regarding protein consumption.
line of action 6: reserved for development of a 'feeding and greening megacities' programme.

6. SOCIAL AGENDA

The circular economy will make our economy more future-proof. The transition phase will offer us new opportunities and business, but will also require companies and consumers to make major adjustments. We will also have to say goodbye to specific products, specific types of business and habits. The transition can only succeed, however, if we create broad support for the intended changes in society, take the required competencies of employees and employers into account, and anticipate risks and opportunities with respect to shifts in employment.

EFFECTS ON SOCIETY

Humans have always used organic resources to meet the need for food, materials, and energy. In a circular economy there will be a much stronger connection between sectors, such as the agricultural sector, the chemicals industry, and the logistics sector. New products are made from residual streams and new chains will form through the process of biorefinery and multifaceted valorisation of crops and residual streams. This offers opportunities to agriculture, because farmers can get more value out of a hectare and will have more sales channels for their products. Processing biomass will often take place close to the source, considering the costs. Small-scale concepts will be developed, which will offer opportunities to counter depopulation and ageing of the countryside and to create employment outside of the cities. In the Netherlands we will depend on (large-scale) import of biomass. This will provide the ports with new opportunities, which are necessary due to the decreasing importance of the processing of fossil resources in the refineries and the petrochemical industry.

In 2011, the knowledge and innovation agenda for the bio-based economy already described that the bio-based economy will lead to new crops, new trade relations, new definitions of quality for trade and consumer goods, redistribution of the industry (more activities in the countryside and small-scale companies), and new geopolitical power structures. Our strong position in terms of agriculture, chemicals, logistics, waste and residual streams processing and the excellent knowledge position in the field of biomass and food offer the Netherlands new revenue models that we also can export, such as the 'feeding and greening megacities' line of action described in this agenda.

There are risks as well. The Netherlands will set strict sustainability requirements for biomass that is imported, as it is already doing for bioenergy, for example. Producing countries may view these requirements as trade politics or react negatively to the added bureaucracy and additional efforts that will have to be made. And can we make supervision of compliance with these new requirements water-tight? Moreover, there is a risk of land grabbing if the demand for biomass increases significantly around the world.

A lot is also asked of citizens, such as changing their diet. They will consume less proteins and proportionally less animal and more vegetable proteins. Their purchase behaviour also needs to change (products with a long lifespan or products that can be recycled well). They need to change their attitude (having products repaired instead of replacing them and leasing products instead of owning them). And they are expected to handle waste differently (meticulous separation). Smaller cycles means more activities in the region and at a farm level, which can also lead to resistance. Think of protests against windmills and fermentation plants.

[38] *WTC BBE, Towards green chemicals and green materials – Knowledge and Innovation Agenda for the bio-based economy, 2011.*

Photo credit: Lars Folkers, Seamore

SEAWEED TAGLIATELLE

Seamore makes tagliatelle from seaweed – sea thong or Himantalia elongata - that grows in Ireland. Seaweed has many benefits: it grows quickly, contains special nutrients, and there is ample space to grow the vegetable on the sea.

EFFECTS ON THE LABOUR MARKET

The position of sectors and branches that work on the extraction and processing of fossil resources will decrease in importance. Refineries, the petrochemical industry and ports are thinking about this transition, but currently do not have a shared vision for the future. The ideas vary from maintaining the processing of fossil resources by combining it with the capturing and subterranean storage of CO_2, an interim model in which gradually phasing out takes place in tandem with the formation of a new green industry, to an idea of a future in which these sectors are becoming less important in the very short term.

The importance of land-based cattle farming increases in the agricultural industry. The ambition is to close the cycles as small as possible and as large as is necessary. Recycled nutrients (nitrogen, phosphate) will partially replace the use of artificial fertilisers. There will be an employment shift from the traditional waste processing industry to biomass production and processing. Hubs may form at a regional level where biomass from forestry and agriculture is processed into products.

Processing imported biomass can offer new perspective to the Dutch ports if the investment climate in the Netherlands improves. Recently, innovations developed in the Netherlands in the field of biofuel and bio-synthetics did not always result in additional production capacity in the Netherlands, but did result in them abroad (DSM-POET in the USA, Avantium in Belgium). Investments in the Netherlands lead to an increase in employment. The construction of an average bioplastics plant means an investment of about 250 million euro. Such a project offers jobs to about 2000 constructors in the construction phase and about 250 operators/technicians as soon as the plant is operational.

For employees, the transition to a circular economy will lead to changes; sometimes minor intrinsic changes of tasks, sometimes completely different production processes or significant shifts in work. In the end, the employees are the ones who need to realise the circular economy. They will need to understand the importance of a circular business model and the transition and act accordingly. This means that employees will have to be included in these developments. In order to reach this more sustainable economy, investing in employees and sustainable working relationships is required.

Production and work processes will change, which means different modes of thinking and doing research, regarding protein use, soil use or application development, for instance. Creative solutions will be required and other competences will be expected of employees. This requires attention in the HRM/personnel policy of companies and can be achieved by making circular changes at companies go hand in hand with proper personnel policy so the changes can be anticipated and acted on in time and the personnel can be guided through retraining and reskilling.
Companies need to invest in the education and development of their employees. They can do so by making education possible financially, but also by giving employees the time to get reskilled. Agreements regarding this matter can be made in collective labour agreements, and cooperating with educational institutes is an option. Some companies are already investing in an academy of their own or are in a partnership with an educational institute.
In general, these companies have a positive feeling about this, because this results in a better connection between education and labour market. Employees can be expected to show willingness to get retrained or reskilled. Examples of intensive cooperation between the business community, education and research are visible, for example in Bio-based Delta (Southwest Netherlands) and Brightlands Chemelot, and Greenport Campus (Limburg).

Employees are vital for the development towards a circular economy. They are often the ones with the practical knowledge in a company, who can say what is and is not possible. That is why it helps to have employees and their representatives provide input for the way in which companies will go through the transition. This can be done by involving trade unions in the execution agendas in order to think along about how the transition can best be handled. Apart from technological innovation, social innovation and input from employees is therefore important.

Moreover, there are international consequences that need to be considered. If the Netherlands becomes a frontrunner in terms of the circular economy, this may result in employment options. This also applies to the other transition in the Netherlands: the energy transition. As a frontrunner, there is also the risk that not all enterprises can or want to move at the desired pace. Dutch (production) companies that are part of foreign multinationals with entirely different socially-oriented and environmentally-oriented priorities are perhaps given insufficient room to act in time, which may ultimately lead to a loss of employment in the Netherlands. In the execution of the transition agendas permanent attention will have to be paid to the potential positive or negative employment effects and how the social consequences thereof should be handled.

Doing business in a circular manner also requires sustainability in the (international) chain. This calls for attention for corporate social responsibility. In the past few years, the Netherlands has been the frontrunner in the field of developing sustainability criteria for biomass, especially for bioenergy purposes. The 'biomass sustainability issues committee' has developed an assessment framework for sustainable biomass production that consists of ecological and social sustainability criteria. The ecological criteria in particular have been recorded in the Renewable Energy Directory. The social criteria are difficult to enforce legally. These social criteria, which relate to working and living conditions of farmers in production countries, are often already included in voluntary certification schemes for biomass for food and chemical applications. For wood and wood products, this has been 'anchored' in the so-called Timber Procurement Assessment System (TPAS). The eponymous committee (TPAC) will assess whether a standard meets this.
The chemical and plastics industries have developed a sustainability framework in the context of the Green Deal Green Certificates in which, apart from ecological criteria, social and economic criteria have been recorded for the use of biomass as a resource. This creates a level playing field and, on top of that, an sends an easy message to all stakeholders and interested parties.
Such an approach can also be applied to other biomass streams.

The strong global increasing demand for biomass can lead to distribution issues in chains as well as to issues regarding the position of (small) farmers.

In the next phase, the following themes for the selected transition paths will be expanded in an action agenda:
- monitoring employment effects.
- including employees in the transition, social innovation.
- participation/business culture.
- training and education regarding knowledge and the healthy and safe handling of changed products/resources and production processes.
- CSR in the chain.

EFFECTS ON TRAINING AND EDUCATION

Specifically for biomass and food, employees are needed who can connect knowledge of agriculture with industry. Companies consistently indicate that a bio-based economy requires craftsmen, who are also able to look beyond the scope of their own profession. The Dutch education is already anticipating this. Programmes have been developed for primary and secondary education. MBO (secondary vocational education), HBO (university of applied sciences) and universities already offer bio-based minors and some bio-based majors. Online education (MOOC) is available to both professionals and students. Moreover, a Bio-based Economy Knowledge Network has been developed that contains an up-to-date knowledge base containing information of interest to companies, researchers, education, society, and the government.

In order to continue the development towards a bio-based economy, educational institutes and the business community joined forces in the National Bio-based Economy Knowledge Network (LBKN) to train professionals. The LBKN does this through three pillars:

- Transferring knowledge and developing education.
- Reinforcing practical research.
- Stimulating innovation projects.

Fourteen universities of applied sciences (Hanze University of Applied Sciences, Van Hall Larenstein, Aeres University of Applied Sciences, NHL, Stenden, Windesheim, Saxion, HAS University of Applied Sciences, Inholland, Rotterdam University of Applied Sciences, HAN, Zuyd, Avans University of Applied Sciences, HZ and the four CoEs), a number of MBO schools, Wageningen University and a number of top sectors (BBE TKI, TS Energy, TS Chemicals, VNCI, Innovatielink) work together in the LBKN. The Bio-based Economy Lector Platform (31 lectorates) works on a more accessible and joint programming of practical research. A number of universities of applied sciences work together with universities in Brazil on a student exchange at the Living Lab Brazil.

The cooperation between universities of applied sciences and companies is then mostly visible in the various regions with centres of expertise (HBO level) and centres for innovative craftsmanship (MBO level) as the logical points of contact.

South Holland, Zeeland and West Brabant are working together in the Bio-based Delta. Here, the Bio-based Economy Centre of Expertise (BBE CoE - HZ UAS, Rotterdam University of Applied Sciences and Avans University of Applied Sciences) is responsible for the human capital agenda. For the secondary vocational education there is a Centre for Innovative Craftsmanship BBE. Market research into the demand for education is conducted in collaboration with institutes in Flanders. Innovation for SMEs is centred around a number of clusters, such as construction materials, packaging and pyrolysis. Together with the ROMs and provinces innovation programmes such as 'Ondernemerslift' and 'Bio-booster' (vouchers) are used. Furthermore, there are a number of facilities centres, such as the Biopolymer Application Centre, the Natural Fibre Application Centre, the Green Chemistry Campus, and the Agricultural Innovation Centre Rusthoeve (the Bio-based Network).

The Centre for Bio-based Economy (CBBE) consists of Wageningen University & Research, HAS University of Applied Sciences, Inholland, Aeres University of Applied Sciences, Van Hall Larenstein, Avans, University of Applied Sciences of Arnhem and Nijmegen, HZ. The CBBE and the aforementioned CoEBBE took the initiative in 2017 to form the National Bio-based Knowledge Network (LBKN).

In the Northern Netherlands, NHL, Stenden University of Applied Sciences and the Hanze University of Applied Sciences are working together in BERNN (Bio-economy Region Northern Netherlands). Moreover, there are matching innovation clusters where cooperation between the business community and senior secondary vocational education (MBO), universities of applied sciences (HBO) and universities (WO) in the bio-based chain is put into practice: accessibility, biorefinery, bioprocessing technology and green chemicals in Groningen (ZAP), food technology (FACT) and water research (WAC) in Leeuwarden, and biopolymer applications (GreenPAC) at the Centre of Expertise in Emmen. Together, this will lead to a dynamic ecosystem for research and development with a strong focus on green chemicals (Chemport Europe) and on food & dairy (Dairy Valley). BERNN - in which the University of Groningen is a partner, too - plays an important part in this.

Education, research and production are combined at the Brightlands Chemelot Campus. The focus is on sustainable materials, including bio-based materials. Chemelot Innovation and Learning Labs (CHILL) is a partnership between the business community, MBO, HBO and University in which companies and knowledge institutes work together on developing new materials and products. Two other public-private knowledge institutes are active on the same campus: Chemelot InSciTe and AMIBM. The on-site availability of a wide range of pilot facilities makes the site attractive to starting and developing enterprises. Moreover, there is cooperation with Brightlands Greenport Venlo and the BioTreat Center.

FURTHER DEVELOPMENT

The transition towards a circular economy affects everyone. There is a need for further elaboration and insight into how negative effects regarding the reduction of specific activities, for example, can be dealt with. In the transition agenda's execution phase there will be a dialogue with all relevant stakeholders per line of action to further develop the social agenda.

APPENDIX 1: BIOMASS AND FOOD TRANSITION TEAM

This Transition Agenda was formed in a multi-stakeholder dialogue between experts from the business community, non-governmental organisations (NGOs) and authorities, and also fed by the input of other relevant stakeholders through organised stakeholder meetings and networks. The Biomass and Food transition team was appointed by the signatories of the Raw Materials Agreement. This agenda describes the transition team's recommendation to the signatories of the Raw Materials Agreement.

NAME	ORGANISATION
Emmo Meijer	Chairman (Top sector Chemicals)
Agnes van Ardenne	Vicechair (DBC)
Edith Engelen	Secretary (RVO.nl)
Marian Geluk	FNLI
Thijs Cuijpers	LTO
Wouter van der Weijden	Centre for Agriculture and the Environment
Henk Wanningen	Staatsbosbeheer (National Forest Service in the Netherlands)
Wouter de Buck, Renske Verhulst	Nutrient Platform
Anouk Florentinus, Peter de Jong	Foundation for Nature Conservation and Environmental Protection
Mat Quaedvlieg	Sappi
Ed de Jong	Avantium
Willem Sederel	Bio-based Delta
Henk Westhoek	PBL
Jeroen Willemsen	Green Protein Alliance
Marcel Wubbolts	Corbion
Ruud Tijssens	Agrifirm
Klaas van den Berg	Orgaworld
Richard Piechocki	Rabobank
Nic Grandiek	Province of North Holland
Jaap Petraeus	FrieslandCampina
Saskia Goetgeluk	Brightlands Campus Greenport Venlo
Rein Coster	VNCI
Paul van den Heuvel	VVNH
Coen de Haas	Royal Cosun
Jan IJzerman	Water Board Union
Marc Jansen	CBL
Wouter-Jan Schouten	TIFN
Frans Claassen	MVO
Joke Klap	Nevedi
Peter Besseling	Ministry of Economic Affairs and Climate
Herman Walthaus	Ministry of Infrastructure and Water Management

Thanks to contributions from the following people who participate in the work groups of the biomass and food transition team:

NAME	ORGANISATION
Hilde Engels, Karen Eilers	Foundation for Nature Conservation and Environmental Protection
Frits Mandersloot	LTO
Floor Uitterhoeve, Tim Lohmann	FNLI
Bertram de Crom	Suiker Unie
Frank Bergmans	MVO
Joop Suurmeijer	Orgaworld
Annita Westenbroek	VNP/DBC
Arjen Brinkmann	BVOR
Pieter Brooijmans	Suiker Unie
Harry Kager	ZLTO
Jan Willem Straatsma	FrieslandCampina
Luuk Hagting	Agrifirm
Patrick Lemmens	Greenport Venlo
Jan Smits	Kenniscentrum Plantenstoffen
Paul Monincx	Topsector Tuinbouw en Uitgangsmaterialen
Ernst van den Ende	WUR, Plant Sciences Group

APPENDIX 2: BACKGROUND DOCUMENTS OF THE WORK GROUPS

The formation of the Biomass and Food Transition Agenda was the result of important groundwork performed by a number of work groups. They drew up the background documents that provide the foundation of the overarching transition agenda.

APPENDIX 2A: NUTRIENTS CYCLE AND SOIL FERTILITY WORK GROUP

Wouter-Jan Schouten (theme coordinator, TiFN), Klaas van den Berg (Orgaworld), Arjen Brinkmann (BVOR), Pieter Brooijmans (Royal Cosun), Wouter de Buck/ Renske Verhulst (Nutrient Platform), Rein Coster (Meststoffen Nederland), Luuk Hagting (Agrifirm), Harry Kager (LTO Nederland), Oene Oenema (WUR), Jan Willem Straatsma (Friesland Campina), Herman Walthaus (Ministry of Infrastructure and Water Management), Wouter van der Weijden (Stichting CLM), Henk Westhoek (PBL)

1. SCOPE

An ecologically sustainable food production for the growing world population requires a transition towards sustainable soil use and circular economy for nutrients. For the Netherlands this primarily entails a responsibility for the soil and nutrient use related to the Dutch food and agricultural system. The emphasis lies on soil use and nutrient streams in the Netherlands and, whenever relevant and possible, outside of the Netherlands, too.

Central factors are:
(i) Reusing nutrients and organic matter from animal manure, crop remains, compost, organic residual streams from the agricultural industry, struvite and sewage sludge as fertilisers on agricultural lands within legal frameworks.
(ii) A properly functioning soil as a basis for the production of crops.

A properly functioning and healthy soil as the basis for crop production needs:
1. Prevention of soil degradation (due to compaction, erosion, nutrient exhaustion, flooding, reduction of the organic substance level, reduction of soil biodiversity, pollution, desertification, salinization, and acidification).
2. Availability of nutrients: both macronutrients and micronutrients.
3. Sufficient (supply of) stable and functional organic matter.

1.1 PREVENTING SOIL DEGRADATION

The prevention of land degradation has been recorded in SDG 15.3. Concrete threats for the Netherlands are, among other things, soil compaction, peat soil degradation, and accumulation of heavy metals. Even though these are serious threats, dealing with those threats falls largely outside of the scope of this transition team.

1.2 NUTRIENTS

Macronutrients (phosphorous, nitrogen and potassium) and micronutrients (among other things selenium, boron, zinc, manganese, and molybdenum) are essential and vital for all life on earth. It is necessary to close nutrient cycles, because:
- There is actual and potential scarcity and geopolitical dependency.
- Three planetary boundaries are being exceeded (biochemical streams, especially N and P), climate and biodiversity.
- Local accumulation of some nutrients may have adverse effects on people, animals and plants.

The sustainable and efficient handling of natural resources has also been recorded in SDG 12.2. Using current technology and the current level of use, extractable amounts of phosphorous (ore) could get exhausted within 100 to 300 years. The supplies are concentrated for 70% in Morocco (including the annexed Western Sahara), which is a geopolitical risk to the EU that only has small supplies. The Netherlands only imports little phosphate directly from Morocco, but does so indirectly through the import of raw materials for animal feed. The same applies to many micro-elements (e.g. potassium, copper, zinc, cobalt, and selenium). There is a world-wide shortage of zinc and selenium in large acreages of agricultural soil. This is not a major problem in Europe yet, but the levels of some micronutrients are decreasing. The production of nitrogen and phosphate artificial fertiliser costs a lot of energy and the use thereof around the world, along with the nitrogen and phosphate in manure and domestic and industrial waste(water), is a major cause of the exceeding of planetary boundaries of biochemical streams. However, this problem has been largely solved in the Netherlands and Europe through the reduced use of mineral fertilisers.

The large cattle farming industry and the limited amount of agricultural land per person and per animal means that the national mineral balance of the Netherlands differs from that of other countries; there is large-scale import of minerals in the form of animal feed and food. This means that the use of mineral fertilisers, with the exception of nitrogen, is relatively low.

[39] *UNEP: Food Systems and Natural Resources; Table 6.*

In order to offer a real solution for the aforementioned three bottlenecks, it is important for the Netherlands, too, to aim at far-reaching closing of nutrient cycles. Nutrients must be used as efficiently as possible, reused as much as possible in short cycles or made suitable for useful reuse, both nationally and internationally. Input of primary, virgin nutrients needs to be minimised within the Netherlands and in animal feed exported to the Netherlands.
In the past fifty years, emphasis lay mostly on preventing nutrients from washing away into the environment and less on keeping minerals inside cycles. Examples of solutions opted for at the time are sewage water purification (with low reclaiming of minerals) and incinerating offal and manure.

1.3 STABLE ORGANIC MATTER

The regular supply of stable organic matter is essential for soil fertility. The soil fertility and quality of organic matter in the Dutch soil is worrisome. Reasons for these worries are, among other things, the intensive use of the soil, the use of heavy machinery, dewatering of peat soil, and the sometimes frequently changing responsibility for the soil (especially in case of one-year leases).

To keep the soil healthy and productive in the long term, it is important that, among other things, there is sufficient stable organic matter in the soil. This will enhance eco-systemic services in the soil, such as improving the soil biodiversity, increasing the water storing capacity, reducing emissions and the washing out of nutrients, and increasing resistance against diseases and plagues. Good soil fertility contributes to the efficient use of nutrients by crops. Moreover, the structural increase of organic matter in the soil means that more carbon can be sequestered for a longer period. This makes the soil a vital link in limiting climate change.

2. VISION AND SOLUTIONS

The ambition is to have closed nutrients cycles by 2050[40] and to have Dutch soils with optimum organic matter levels, so eco-systemic services will be utilised maximally. This will all be in service of the circular economy and soils that function in a fully sustainable matter.

The basic principle for closing nutrient cycles and optimising the level of organic matter is:

Make the cycle as small as possible and as large as is necessary. Benefits are: limitation of transport, cost efficiency, governance of the cycle, and transparency in the food chain. This requires:

- Cherishing small cycles that are already/still there, for example within the land-based agricultural and livestock companies and through local and regional circular terrain management[41].
- For non or partially land-based livestock companies: closing cycles, e.g. between farms or agricultural companies in the form of feed or fertiliser contracts. Locally, if possible and regionally, if necessary.
- If possible, closing national cycles between the city and the countryside.
- Countering large-scale geographical nutrient displacement as a result of commercial trade streams (regional exhaustion and accumulation elsewhere) through exporting reclaimed fertilisers to regions with nutrient shortages in addition to the priorities above.
- Preventing contamination at the source to keep the cycle clean. This applies to purchased animal feed and artificial fertilisers, but also to recycled fertilisers and soil enrichers, such as struvite, sewage sludge, and compost[42].
- Acknowledging the value of biomass/organic matter for the soil in the cascading ladder.

To achieve this there are four main solutions:

2.1 MAXIMISING THE UTILISATION EFFICIENCY OF NUTRIENTS AND MINIMISING LOSSES TO SOIL, WATER AND AIR

In agriculture, a large supply of nutrients is currently coming in from abroad through the import of resources for animal feed and artificial fertilisers. By increasing the utilisation efficiency of both streams, fewer nutrients need to be imported. Though a lot has already been done in this respect (see the high efficiency percentages in table 1), a further increase in efficiency is required and possible for nitrogen and a number of micronutrients. This requires innovations and further development of precision agriculture. The reuse percentages are still low, however (table 1). In order to achieve actual closing of cycles, the solutions 2.2 and 2.3 are required.

[40] *Full closing of the cycle is not possible for nitrogen and from the perspective of scarcity it is less of a priority, because it is available in the atmosphere in high quantities.*

[41] *Circular terrain management is defined as: Using grass clippings from roadsides, dykes and embankments in the rural area (immediately or after composting, for example) for soil enrichment or as a bio-based resource for the local industry.*

[42] *Commissioned by the European Commission and in the context of revising the European Fertilisers Regulation, JRC is developing criteria for the safe use of struvite, ashes and biochar as fertilisers ('Strubias project'). Products that meet these criteria lose their waste status and may be added to the Fertilisers Regulation as CE-labelled freely marketable fertilisers and be traded within the EU.*

	NITROGEN	PHOSPHOROUS
Supply kg per Ha	470	59
of which in animal feed	335	56
of which in fertilisers	135	3
Efficiency% (% input sequestered in food or feed)	66%	98%
Reuse% (% input in NL reclaimed in NL)	Appr. 30%	Appr. 40%

Table 1: Key indicators for Nutrient streams by the Dutch food system in 2015[43]

2.2 MINIMISING THE USE OF VIRGIN INPUTS BY USING NATURAL NITROGEN FIXERS, RECYCLING NUTRIENTS, AND MINIMISING DOWNSTREAM NUTRIENT LOSSES.

Agriculture has recycled resources for centuries, among others through manure and natural nitrogen fixers, such as clovers. However, currently there is very little recycling outside of this agricultural system. By reclaiming nutrients from, among other things, waste water, offal and other waste streams, these nutrients can be reused in agriculture (especially farming), the animal feed and food industry, and the chemical industry. Moreover, nutrients from animal manure surpluses can be reused, after refining/processing or otherwise. Concentrated manure-processing products can be transported to locations where the need is greatest.

2.3 COUNTERING STRUCTURAL NUTRIENT DISPLACEMENT

In the current global food system, resources for animal feed are often produced a long way from the location where the animals are bred. This causes nutrient displacement. The production site uses virgin inputs and/or nutrients are extracted from the soil in a structural manner.
On the site of the animal breeding, a surplus of macronutrients (N, P, K) may be generated in the local environment on the one hand and a shortage of specific micronutrients on the other hand. In order to bring the biochemical streams on earth back within the boundaries of one planet it is vital to counter systematic displacement. This means that the remaining import of nutrients after solutions 2.1 and 2.2 needs to be balanced with the export of reclaimed nutrients (in a state that is usable or can be made usable for use in practice) to regions with a nutrient shortage.
Solutions 2.1 to 2.3 are presented schematically in figure 1.

2.4 OPTIMISING THE AMOUNT OF ORGANIC MATTER IN THE SOIL

It is not possible to define one clear optimum level for organic matter. However, we can define ranges (sand soil 1.2-4.7%, sulphurous soil 0.6-2.7%, clay soil 1.0-2.4%). It is important to at least strive for a good balance between supply and extraction (degradation). There is about a 2% (1.6% - 3.2%) degradation of organic matter per year in the Dutch soils that need to be compensated. Increasing the level of organic matter in the soil takes time.
An increase in the amount of organic matter is required for a significant part of the acreage. This requires considerable amounts of good quality organic matter every year. By means of an increased focus on source separation of fruit, vegetable and garden waste and by differently designing the public green space, more resources can be made available for the production of organic soil enrichers, such as compost.

Degradation of organic matter in the soil can be limited through crop rotation, minimal or non-recurring tillage, and not tearing grassland. At a national level, in the context of the Common Agricultural Policy, the share of remaining grassland (placed against the entire agricultural acreage) per member state cannot decline too much. Within Natura 2000, remaining grassland is protected per plot. The tearing of remaining grassland within this is not permitted either.

[43] *Based on the balance of phosphorous and the balance of nitrogen in agriculture in Compendium for the Living Environment.*

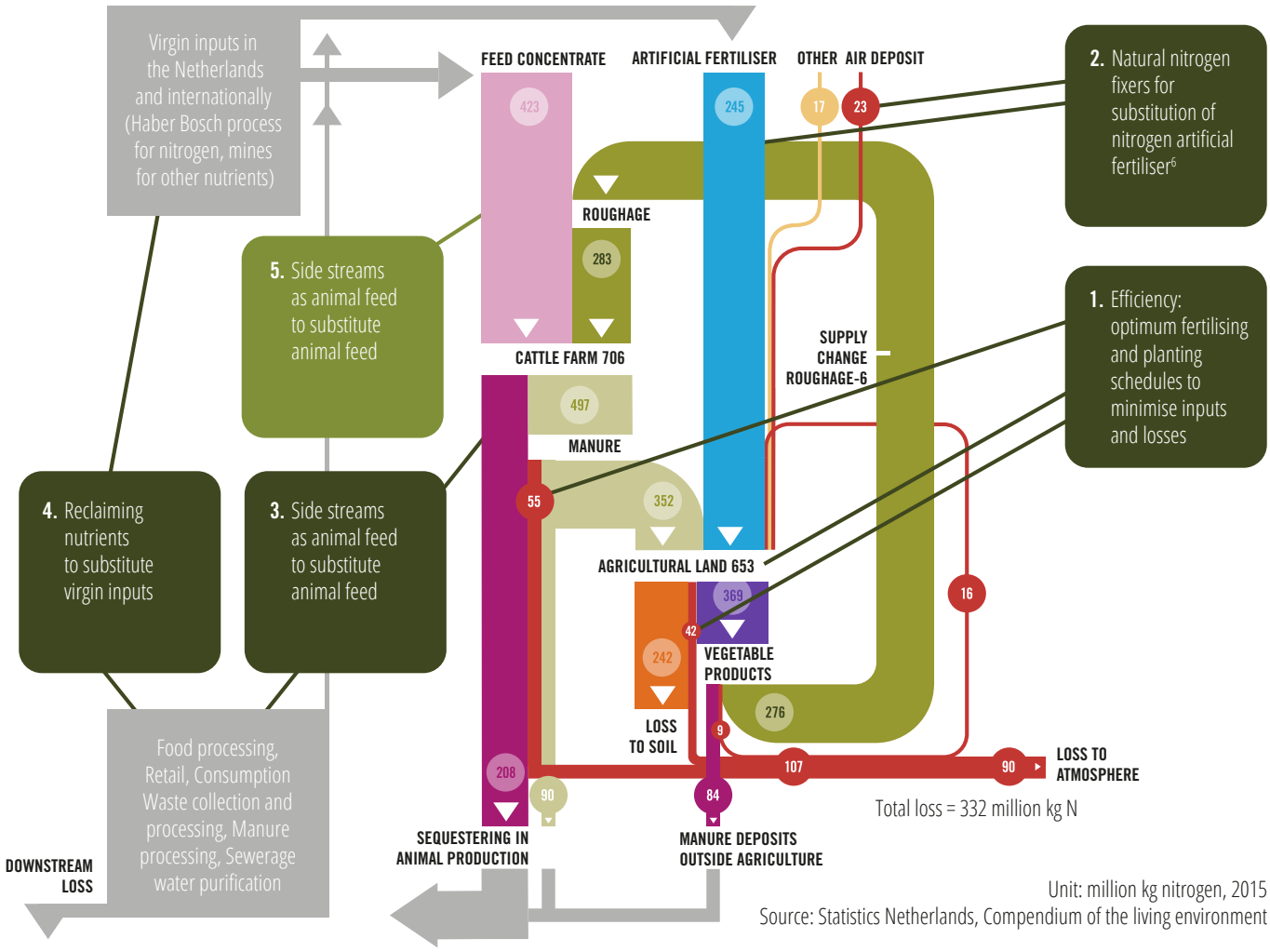


Figure 1: Leverage to close nutrient cycles of the Dutch food system, e.g. nitrogen[44]

[44] *Natural nitrogen fixers are not a form of closing nutrient cycles, but a way to supply new nitrogen to the agricultural system without using fossil fuel. Moreover, there are indications, which need to be looked into further, that natural nitrogen fixers have a positive effect on soil structure and fertility thanks to the slow release.*

3. CURRENT DEVELOPMENTS

There are many developments in terms of closing nutrient cycles and optimising organic matter management. However, the transition has only just started and there is a long way to go to actually close cycles. Some examples:

3.1 FERTILSER AND AMMONIA POLICY

Thanks to the fertiliser and ammonia policy, the nutrient use efficiency in agriculture has already strongly increased since 1990 and the losses of nitrogen to the atmosphere, soil water and surface water have strongly decreased. The phosphate soil excesses have also strongly decreased and, in some cases, the crops even extract more phosphate than is released. To achieve this, among other things, one quarter of all produced animal manure is exported. However, this proves to be increasingly more difficult in the future. The support in surrounding countries is decreasing. In part due to this development, farmers receive support in optimising fertilisation. See, for instance, the following case of the Agrifirm fertilisation plan.

However, the environmental goals for nitrogen and phosphate in groundwater and surface water in particular have not yet been realised everywhere. That is why additional/refined measures are required to reduce the loss of nitrogen and ensure that locally available large phosphate deposits in the soil are used (mining). Precision agriculture offers options for achieving this in due course, but this still requires further technological development.

ILLUSTRATIVE CASE: THE AGRIFIRM FERTILISING PLAN

The Agrifirm experts make a plot-specific fertilising plan for the agricultural company based on sound research and experience. To this end, Agrifirm developed the AgriMineral advice module. In this advice module, the building plan is shared with RVO. Using this application, a complete fertilising plan is made for the entire company. The crop's nutrient need is the starting point for this. This need is based on the most up-to-date knowledge and insights regarding crop growth, yield potential, and the quality desired by the consumers. When drawing up the fertilising plan, the advice module naturally takes the specific plot characteristics, soil type, soil analysis data, additional supply from previous crops, green fertilisers, and the mineralisation of organic matter into account. When determining the need for fertilisers, the balance between supply and discharge of the main nutrients and organic matter is also considered. Not only crop needs, but also especially maintaining the soil fertility eventually determine the results in AgriMineral. As a result, the agricultural entrepreneur will receive a full fertilising plan that includes as many organic fertilising agents as possible. To further meet the crop's needs, inorganic fertilising agents will also be used.

3.2 MANURE VALORISATION

In terms of valorisation for manure surpluses there have been a lot of investments in the past years. For instance, there has been a statutory obligation for cattle farms to have a part of the company surplus (region-dependent) processed since 2014. Recently, the business community presented an initiative (Task Force Manure and Mineral Valorisation) to join forces and shift the focus to a demand-oriented approach: what is the demand (primarily foreign) for products and how can we meet this demand? At research and government level, processes have also been started to achieve a more strategic use and approach. A professional manure processing sector has developed over the past few years.

Further development of the processing processes towards multifaceted valorisation is required. There are multiple initiatives to this end, such as the European research and demonstration project called 'Systemic' in which several Dutch parties are involved. One of the other initiatives is described in the case below 'Also reusing the nutrients in biogas production'. This project is in the initial phase and is very promising in terms of goals. It is necessary to use the coming period to evaluate to what extent the goals are being achieved in order to learn a lot from this project. And to see what the (unforeseen) additional effects of this kind of large-scale manure processing are. In doing so it is possible to continue development and create increasingly sustainable solutions from an ecological, economic, and social perspective.

ILLUSTRATIVE CASE: ALSO REUSING NUTRIENTS FOR BIOGAS PRODUCTION

OCI Nitrogen wants to make its production process more sustainable through the large-scale production of biogas. At the same time, this can make a major contribution to the solution of the manure problem of cattle farmers. By using Chemelot's residual heat, OCI Nitrogen is able to turn all digestate into clean water and exportable and marketable products. All nutrients will then be available in a concentrated form and be used in agriculture wherever necessary.

The biogas plant will use an equivalent of one million tons of slurry. This will be fermented at Chemelot, and the digestate will be fully reprocessed. This results in the creation of 4.5 million kilos of phosphate, exportable as dry fertiliser agent. Furthermore, about 2 million kilos of nitrogen are captured and reprocessed into concentrated liquid fertiliser.

The biogas can be processed directly in the OCI Nitrogen plants, for which residual heat of the site is used to dry the digestate. The fertiliser agents can also be processed or sold via OCI Nitrogen.

OCI Nitrogen has a technology partner with whom this plant is developed. A construction location has been picked at Chemelot and a permit has been granted. The project is technically and economically feasible, but currently only through the support of an SDE+ subsidy. In time, the project is expected to be profitable without subsidies as well. With this plant, OCI Nitrogen would reduce its CO_2 footprint by an amount comparable to that of 25,000 households. The effect in the agricultural sector due to avoided CH4 emissions is twice as large.
All minerals from the fertiliser will be collected and concentrated for reuse.

3.3 MINIMISING VIRGIN INPUTS BY RECYCLING NUTRIENTS

There are several locations and initiatives in the Netherlands where nutrients are reclaimed for the purpose of reintroducing them in the cycle. Below you can find a number of examples of frontrunners in the field.
The water boards already have seven reclaiming locations for phosphate from sewerage water and will commission three more. Sludge processors SNB and HVC entered into a contract with the Belgian company Ecophos, under which Ecophos phosphate is reclaimed from the ashes of incinerated purification sludge.
Royal Cosun uses digestate from sugar factories as a fertiliser for agriculture. Fertiliser producer ICL Fertilizers performed various tests with the collection of phosphate from waste water, bone meal, and ashes from incinerated purification sludge and wood. Currently, ICL purchases struvite from the water boards. This struvite serves as input for the production of artificial fertiliser. Moreover, they are continuing development of the RecoPhos technology with which they can reclaim phosphorus from various sources, such as purification sludge and bone meal.
Multiple companies, such as Nijhuis AECO-NAR, focus on reusing nitrogen. GMB BioEnergy reuses nitrogen through the production of ammonium sulphate when composting purification sludge. Together with the Dutch and French government and French partners GMB currently works on enabling the use of composted sludge as a soil enricher in France.
A number of the technologies mentioned under 3.2 and 3.3 must prove themselves further in practice. Furthermore, proper supervision and enforcement is necessary in light of the significant interests involved, while room for experimentation must simultaneously be offered.

3.4 SUSTAINABLE SOIL MANAGEMENT

Dairy farmers implemented the 'Kringloopwijzer' (cycle guide), a management tool intended to map out the minerals efficiency of a dairy farm. Currently, the upstream mineral losses have not yet been included in the chain. There are plans to add this to the tool and to expand it to soil aspects other than nutrients. From 1 January 2017, the Kringloopwijzer has been mandatory for all cattle farmers. Moreover, a 'Kringlooptoets' (cycle test) is being developed. This is an assessment method for the sustainability aspects of closing cycles based on expert assessments. Various pilot projects ('Klimaatboeren' (climate farmers) and 'Koolstofboeren' (Carbon farmers)) have started to value carbon sequestration in agricultural soil by trading CO_2 credits on the private carbon market. Finally, various pilot and demonstration projects have started that focus on increasing the organic matter levels in Dutch agricultural soils, such as Fertile Cycles in the Achterhoek region and the Northern Netherlands.

4. GOALS FOR 2021, 2030, AND 2050

The vision and ambition can be quantified in the following goals:

2021

- The exact **goals for 2021, 2030 and 2050 were specified and quantified in 2018** in accordance with science-based data. Furthermore, it was determined how these goals can be achieved.
- The term **'land-based cattle farm'** has been defined, and the percentage of land-based companies has at least stabilised.
- **Phosphate, potassium, nitrogen and micronutrients** in animal feed, fertilisers, food and other biomass products are utilised in a better way thanks to 1) further increase of the utilisation efficiency, 2) corresponding reduction of use, and 3) recycling based on further specification (no later than 2018).
- The supply of **organic matter** to Dutch soils has increased and the degradation of organic matter has decreased in line with the ambition of the 4‰ initiative agreed upon by the Netherlands among others during the Climate Conference in Paris.[45]
- More than three **'Living Labs'** are operational. These are labs where solutions are developed for closing cycles and optimum organic matter management on different soil types (see chapter 5 for further explanation).

2030

- **>X% utilisation** (based on specifications drawn up in 2018) of **phosphate, potassium, nitrogen and micronutrients** across the entire cycle in animal feed, fertilisers, food, and other nutrient products by 1) maximising utilisation efficiency, and 2) recycling.
- **Net import of virgin nutrients reduced by …%** with respect to 2015 (% to be determined in 2018).
- **The stable organic matter level** in Dutch soils has increased by an average of ...% compared to 2015 (% to be determined in 2018).
- Where necessary, the **phosphate level** in Dutch soils has been reduced to acceptable levels (based on specifications drawn up in 2018).

2050

- **>95% utilisation of phosphate, potassium and micronutrients** across the entire cycle in animal feed, fertilisers, food, and other nutrient products by 1) maximising the utilisation efficiency, 2) corresponding decreased use, and 3) recycling from non-locally used manure and sewerage sludge.
- **60-70%** utilisation of **nitrogen** from artificial and animal manure by 1) maximising the utilisation efficiency, and 2) corresponding reduction of the use, and 3) recycling from residual waste.
- **Remaining input** of **nitrogen** in the agricultural system from natural methods (nitrogen-fixing crop/bacteria combinations) as much as possible (% to be determined).
- Remaining import (through animal feed and artificial fertiliser) of nutrients balanced with export of reclaimed nutrients; maximum closing of the nitrogen cycle and full closing of all other nutrient cycles.
- **Optimum levels of stable organic matter, minerals and micronutrients** in the soil for sustainable soil management.

[45] *The purpose of this initiative is to increase the amount of organic matter in the soil by 4 per mille every year, on the one hand to improve the soil quality, on the other hand to sequester carbon / CO_2 in the soil. For the Netherlands, this could mean that the annual supply of effective organic matter needs to increase by 25%, which seems very ambitious. Furthermore, the degradation of organic matter should need to be limited through soil management measures. http://edepot.wur.nl/408442.*

5. DESIRED TRANSITION PROGRAMME

As described in chapter three, there are many good developments with respect to closing nutrient cycles. In order to realise our ambitious goals for 2030 and 2050, it is primarily necessary to speed up developments and bring them together in a comprehensive 'circular and regenerative use of soil and nutrients' transition programme. This programme is intended to create a systemic change. From the current linear system to a system in which carbon and nutrient cycles are as small as possible and as large as is required, in which agriculture has a neutral or, if possible, positive impact on climate, soil, water, biodiversity and society, and in which one or more of these elements are no longer exhausted.

Proper governance must be in place for the programme in the next six months. Two basic principles are essential for this:
1. Full and uniform chain responsibility.
2. Inclusivity: cooperation between established chain parties and new innovative parties.

At least, the following parties should be included: producers of fertiliser agents, animal feed producers, the agricultural industry, especially farming and cattle farming cooperatives, food processors, including slaughterhouses and rendering plants, retail, waste collectors and processors, water boards, local, provincial, and national governments. This group of chain parties will need to translate the vision and goals above into measurable goals for every link in the chain. Together, lines of action and interventions can be selected and developed to have unified chain management for closing cycles and increasing soil fertility. Furthermore, one or more exemplary projects can be selected for which breakthroughs are likely in the short term.

The proposed transition programme concerns six lines of action. These lines of action have been described below with an indication of the actions for the next four years. For now, the focus lies mostly on experimenting with and testing a broad set of possibilities for the 2050 vision. The various lines of action will be refined every two to four years and adjusted where necessary.

5.1 DEVELOPING A COMPLETE TOOL SET THAT IS ACCEPTED AS THE DEFAULT AS WELL AS DEVELOPING A FACT BASE FOR MEASURING NUTRIENT CYCLES AND SOIL FERTILITY

In order to achieve the intended transition SMART goals and accountabilities must be formulated. To do so, a standard tool set and fact base will need to be developed at the start of the transition. The following actions are required between now and 2019:
- Map out the current phosphate, nitrogen and potassium streams and cycles to determine what kind of recycling and reduction of virgin materials in the Netherlands and beyond are actually feasible.
- Map out micronutrient streams along with the contribution of better organic matter management to increasing the availability for crops and in the soil.
- Determine which package of measures can lead to proper management of organic matter and micronutrients in the soil. Distinguish between different types/qualities of organic matter. Based on the current level of knowledge, the EOM (effective organic matter level) and C/Norg (carbon/organic matter ratio) parameters are mainly of importance. In terms of nutrient supply (N and P) the following is of importance: the EOM/phosphate (P205) and EOM/Nac (active nitrogen) ratios.
- Improve and turn existing tools, such as the Kringloopwijzer (cycle guide), Kringlooptoets (cycle test) and the biodiversity monitor, into a standard toolbox to monitor circularity of nutrients and the soil quality, including the upstream effects in the chain.
- Design a system for registering sustainable CO_2 sequestration in agricultural soils. This will make it possible to prove and claim CO_2 sequestration.
- Include soil fertility in this toolbox and develop a 'soil passport' to register the soil quality.
- Map out the consequences of closing cycles for growing plans and the size of the cattle population at a macro level.

5.2 TECHNOLOGICAL INNOVATIONS FOR A CONTINUED CLOSING OF NUTRIENT AND ORGANIC MATTER CYCLES

Closing cycles will require a lot of innovation of technology and business models, with major opportunities for economic valorisation. Of course it is not possible to have insight into all possibilities, but the focus will, in any case, lie on experimenting, testing, and increasing the scale for the following directions of innovation:

- Minimising virgin materials in animal feed and fertilisers.
- Natural nitrogen fixation through leguminous plants in crop rotation schedules.
- Further development of precision agriculture to achieve further reduction of nitrogen loss and to limit the exhaustion of phosphate deposits.
- Optimising the classic short cycles at land-based grazing animal companies, both during the stable and the field periods.
- Developing stable systems focused on closing nutrient cycles. This not only concerns preventing nutrient losses from stables, but also concerns developing stable systems where manure and urine, in their most suitable form for reuse, can be collected and stored (e.g. separation of manure and urine at the source).
- Valorisation for nutrients, organic matter, and other elements from manure.
- Demonstration and pilot plants for reclaiming nutrients from waste streams, such as offal and sewerage water (or in a broader sense: urban waste streams).

5.3 DEVELOPING BUSINESS MODELS FOR A CONTINUED CLOSING OF NUTRIENT AND ORGANIC MATTER CYCLES

In order to achieve a far-reaching closing of cycles, it is essential that circular business models become more attractive in an economic sense than existing linear models. This requires the following lines of action:

- Research for which energy and resource costs specific, more circular systems form automatically within the current economic system.
- Developing revenue models for ecosystem services, such as a healthy soil, clean subsurface water, carbon sequestration, and biodiversity, for example, by creating a system for soil-carbon credits (e.g. analogous to the system used in Austria and for which BVOR is looking into applicability in the Netherlands[46]).
- Developing mechanisms to translate fertility and robustness of the soil into financial value of the land, so financiers and owners of the land will also have a clear business case for realising the 2050 vision.
- Developing other system concepts for urban and rural green in such a way that the production of biomass also plays a part (increasing the supply of biomass for, among other things, the production of soil enrichers).

5.4 CREATING LIVING LABS IN WHICH SCALEABLE SOLUTIONS ARE DEVELOPED AND TESTED TO CONTINUE CLOSING NUTRIENT CYCLES.

It is important for a comprehensive transition to create living labs in which the technological and business model innovations described above can be brought together. All relevant local stakeholders can thus work together to actually close cycles that are as small as possible and as big as is necessary. The tool sets mentioned above, such as the Kringloopwijzer (cycle guide), will also be used. Link up with current exemplary projects and initiatives, such as 'Proeflocatie Vredepeel', 'Mest als kans' Lelystad, 'Kunstmestvrije Achterhoek', Bioalliance 'Biomassa als motor voor beheer', and various international projects.
The following test environments will be required:

- At exemplary farms in animal breeding, arable farming, and horticulture.
- In exemplary agricultural areas on various soil types (sand, clay, and peatlands).
- Circular terrain management in rural areas[47].
- In the urban environment, involve consumers in countering food waste, city agriculture, and recycling of residual streams.
- Nationally, between city and countryside (recycling of residual streams).
- Internationally, ending nutrient displacement caused by the import of food, feed, and biomass.

[46] *Source: https://www.oekoregion-kaindorf.at/humusaufbau.95.html*

[47] *Bioalliance: Plan of action for a Circular Terrain Management programme. 2017.*

5.5 EDUCATION AND DISSEMINATION OF KNOWLEDGE

The transition from a linear system to circular and regenerative soil use requires innovation at a significant number of parties. This requires major investments in education, dissemination of knowledge, and social innovation. The focus for this will, in any case, lie on:

- Additional training for teachers and advisers.
- Lectorates focused on soil management and closing nutrient cycles.
- Renewing the curriculum of the green course programmes based on learnings from the above-mentioned three lines of action.
- Creation of a platform where learning from the above three lines of action is made easily accessible to agricultural entrepreneurs, parties in the value chain, scientists, and policy-makers.

5.6 COMPREHENSIVE TRANSITION APPROACH AS AN EXPORT MODEL

Based on the above-mentioned lines of action, the Netherlands can build up an international leading position in closing the carbon and nutrient cycles. The knowledge and technology developed with this may become an important export product for the Dutch Agricultural and Food sector.

6. REQUIRED INTERVENTIONS.

A cohesive package of government interventions will be required to support the above-mentioned transition programme. This package needs to ensure that the rules of the game change to such an extent that circular and regenerative use of soil and nutrients becomes economically more attractive than the use of virgin nutrients and production methods that could affect soil quality.

The parties participating in the transition programme will design such a package together with the government's intervention teams. Possible components of the interventions package currently include the following potential game changers:

- Regulations to keep land-based cattle farming land-based.
- Blending obligation of reclaimed nutrients for fertiliser and animal feed suppliers.
- A ban on removing nutrients from the cycle for waste processors.
- A soil passport as the foundation for valorisation of good soil quality in land transactions and redirecting the CAP subsidy streams based on this. Make it (partly) conditional, aimed at sustainable soil management, extensive closing of cycles and ecosystem services (for example, reward farmers for increasing stable organic matter in the soil via LULUCF/CO_2 credits). A distinction will be made between possibilities within the current CAP and the negotiation efforts for amending the CAP.
- Producer responsibility for suppliers of animal feed and fertilisers, in the context of which a recycling contribution is charged for the supply of virgin nutrients.
- A collective collection system for surplus manure.
- Adjusting regulations, so owners and lessees of agricultural land are stimulated to practice long-term sustainable soil management in which the value of the land reflects the production value in the long term.
- Adjusting fertiliser regulations, so the supply of organic matter and sustainable soil management are stimulated. Customisation at individual and regional level needs to be possible.
- Discourage the tearing of grassland.
- Give credits in the trade of emission rights for the accumulation of organic matter.
- Develop financial market incentives, such as a subsidy scheme for the production or use of Green Fertilisers (non-virgin fertilisers) analogous to the SDE scheme.
- Include goals for nutrient recycling in the Climate Act announced in the Coalition Agreement.

Many other smaller interventions are possible besides these potential game changers. A first elaboration of the interventions above, as well as a number of smaller interventions, is described later in this chapter.

6.1 SMART MARKET INCENTIVES AND FINANCING

Provide financial incentives that allow for the business models described under 5.3. For example:

- Stimulate valorisation/refining of surplus manure in pig farms, poultry farms, and cattle farms. This concerns comprehensive multifaceted valorisation of the nutrients, so it is not solely focused on energy. And it will only be temporary, with intended solutions that can be economically viable without subsidy.
- If necessary (it is too soon to determine): tax nutrient losses and/or the use of virgin nutrients.
- Develop a fund for initiatives that support the circular economy (inter alia for nutrients and organic matter).
- Consider developing an ambitious programme with compensations for the sustainable sequestering of CO_2 in agricultural soil, following Australian and Austrian examples.
- Stimulate cooperation in the chain to organise the provision of information and market incentives towards farmers and horticulturists.

JOINT KNOWLEDGE AND INNOVATION PROGRAMME OF THE WATER, AGRICULTURE, FOOD, AND HORTICULTURE TOP SECTORS

- Stimulating and co-financing lines of action 5.1 up to and including 5.4 (measuring, living labs, technical/business model innovations) in an integrated and multidisciplinary programme (natural sciences, economy, sociology) aimed at systemic transition in support of line of action 5.5 (Education and dissemination of knowledge).
- Develop a science-based vision on the mix and amount of animal and vegetable production that is possible in the Netherlands. Such a system will have closed cycles that are as small as possible and as large as is necessary and will also be economically viable. Translate this vision into implications for the fertiliser and environmental policy, licensing and zoning plans to keep cycles as small as possible.

6.3 LEGISLATION AND REGULATIONS AND GOVERNMENT POLICIES

- Keep land-based animal farming land-based and encourage this. This can be achieved through the Responsible Growth Dairy Sector Act or through private sector regulations. These regulations should offer sufficient room for feed/fertiliser contracts at a local scale.
- Include sustainable soil management and good organic matter management in lease contracts (including short-term lease) and land transactions as a mandatory condition, for example by using a soil passport.
- From institutional frameworks, end the current form of deregulated leases that obstruct long-term sustainable soil management. After all, a land user will not be prepared to invest in the soil if he is not certain of long-term use. Determine, in joint consultation with the public and private sector, on new ways of leasing that can stimulate sustainable soil management in the long term.
- Counter speculation with agricultural land. Aim at a closer relationship between the price of land and the actual production value of the land. An example can be the Swiss land politics, in which agricultural land can basically only be the property of farmers. In the last decade, this relationship has become completely unhinged, resulting in an enormous pressure on soil fertility.
- Facilitate composting on one's own land with the option of regional (green) biomass supply made of, for example, nature reserves and roadside clippings (see circular terrain management), if more room is offered for this. Taking sufficient quality control into account, increased application of organic matter becomes possible. Moreover, regional cycles are reinforced in this way.
- Improve the possibilities for the supply of organic matter by adjusting the fertiliser regulations in accordance with the environmental frameworks.
- Include multiannual (e.g. 3-year) positive organic matter balance as a basic principle in fertiliser regulations.
- Improve the possibilities for the supply of organic matter to the soil by adjusting the fertiliser regulations in accordance with the environmental frameworks, for example by increasing the options for using soil enrichers that contain a relatively high amount of organic matter and a relatively low amount of macronutrients (P, N, K).
- Allow more individual and regional customisation in the fertiliser policy in such a way that soil and crops can be fed properly within the applicable environmental frameworks. More attention to the soil in the growing plan of companies and using the learning points of organic agricultural methods is part of this.
- Identify other elements in the current regulations that inhibit good soil management and closing nutrient cycles and eliminate them where possible.
- In policies, apart from food & feed, bio-based and bio-energy, identify 'the soil' as an important user of biomass (organic soil enricher/organic matter) and quantify it. Ensure that the financial incentives (as described in 6.2) have a stimulating effect instead of an disruptive one.
- Give 'credits' in the trade of emission rights for the accumulation of organic matter.
- Discourage the tearing of grassland to prevent the degradation of organic matter.
- Stimulate growing with a broad crop rotation, growing with green fertilisers, and leaving behind or burying crop remains and additional products on the land.
- Make the importer of nutrients responsible for avoiding international nutrient displacement, either with a producer responsibility as described at the start of this chapter, or through other means.

INTERNATIONAL GREEN DEALS

- Include closing nutrient cycles in future IMVOs as part of sustainable biomass and a sustainable animal feed and food industry.
- Initiate international Green Deals with which Dutch knowledge and skill (in the field of closing nutrient and organic matter cycles) is used to close cycles in countries with a high urgency. For instance, a Green Deal between the Netherlands and Kenya regarding a sustainable nutrient chain, with fertilisers tailored to the Kenyan food production system, is being developed.

6.5 AWARENESS AND BEHAVIOUR

This needs to be further elaborated. There have been talks with intervention teams regarding providing farmers with independent practical information, exchanging good practices, and researching the effectiveness of other interventions in terms of behaviour that can be used.

7. EFFECT ON CROSS CUTTING THEMES

Biomass imported for bio-based applications and energy production will also need to have a closed cycle that is as small as possible and as big as is necessary. It is important to set a number of cross cutting principles for this. For example:

- Production of biomass should always be sustainable, i.e. biomass is produced with a neutral or positive impact on the soil, the water, ecosystems and societies, and with a minimum input of virgin ingredients.
- Within these preconditions we strive towards as much biomass production as possible on the existing acreage of agricultural land in the world and, where possible, on recovered degraded lands. There will be no more deforestation and land use change.
- Application of the biomass in the order of social interest (cascading):
    1. Sufficient food for 10 billion people.
    2. Sufficient biomass back to the soil for regenerative production.
    3. Sufficient animal feed for the minimum required animal protein production for 10 billion people.
    4. Bio-based materials with a long lifespan for 10 billion people.
    5. Use biomass that is not required, or not or no longer suitable for the above three applications, for energy.
    6. All of the above will be achieved with an economic model that needs to be sustainable, without any structural subsidies and with a minimum of required transport kilometres.

Bio-based products are reusable and compostable as much as possible, so they remain part of the cycle. It is important that the bio-based materials do not disappear in the conventional waste system, resulting in a loss of nutrients.

8. SOCIAL ASPECTS

The transition will lead to a shift of employment:

- This requires a change in business model for suppliers of animal feed and fertilisers, because import volumes will decline. On the other hand, these parties may become suppliers of knowledge and technology.
- There may be overcapacity in the animal production sector and some vegetable sectors with respect to what is possible with closed cycles. If the overcapacity is too high, winding down will take some time. That is why it is important to set a long-term goal (2050) and start working towards that goal in time.
- Due to the growth of cities there is more attention to megacities and the associated challenges. When setting up new ecosystems in the city together with the agriculture and horticulture sectors, it is necessary to keep an eye on the possibilities for nutrient cycles at a smaller scale. New concepts, in which for example compost is collected at a neighbourhood level for the neighbourhood vegetable garden, may contribute to the reuse of nutrients and, at the same time, provide social cohesion and education about the ecosystem.

APPENDIX 2B: PROTEIN PRODUCTION AND CONSUMPTION WORK GROUP

Jeroen Willemsen (theme coordinator, Green Protein Alliance), Peter Besseling (Ministry of Economic Affairs and the Climate), Frans Claassen/ Frank Bergmans (MVO - the chain organisation for oils and fats), Rein Coster (VNCI), Hilde Engels (Foundation for Nature Conservation and Environmental Protection), Frits Mandersloot (LTO Nederland), Jaap Petraeus (VNO-NCW Platform Resources), Richard Piechocki (Rabobank), Ruud Tijssens (Agrifirm), Floor Uitterhoeve (Federation Dutch Foodstuff Industry), Henk Westhoek (Netherlands Environmental Assessment Agency).

Consultancy provided by Roline Broekema/Hans Blonk (Blonk Consultants), Corné van Dooren (The Netherlands Nutrition Centre), Prof. Jan-Willem Erisman (VU Amsterdam), Stephan Peters (Netherlands Dairy Organisation).

1. BACKGROUND

The National Circular Economy Programme's ambition is: a 50% reduction of use of primary resources in 2030 and a circular economy in 205048. Transition teams have been appointed to this end for five priority fields, including Biomass & Food. Four main themes have been put on the agenda in this field. This memo elaborates on and defines the main theme **#1 Sustainable production and consumption of proteins**.

Proposed lines of action serve to design and determine the government agenda, supporting policy, required interventions, and the deployment of relevant stakeholders (triple helix) by the end of 2017. The agendas are presented to signatories of the Raw Materials Agreement. The central government presents the agendas to the Second Chamber. Signatories and parties involved in drawing up this agenda are subsequently offered the opportunity to indicate separately or collectively if, and if so, how, they will participate in the implementation of the agenda.
Note: refining and further substantiation of the goals and lines of action presented in this document is required.

NITROGEN EFFICIENCY
ratio of nitrogen in our food and the total added nitrogen in agriculture. Wageningen-UR

2. SCOPE: VERHOGING EFFICIËNTIE NEDERLANDSE EIWITPRODUCTIE ÉN -CONSUMPTIE

A sustainable protein provision for everyone, i.e. sufficient protein of a good quality, is a global challenge. Production of vegetable protein and, to a more significant extent, animal protein relies on natural resources[49]. Nitrogen is a crucial building block for proteins. In a circular economy, agricultural land, nutrients like nitrogen, and water are used as efficiently as possible for the protein production and consumption. The work group views the importance of proteins in the context of the **global disruption of the nitrogen cycle**[50]. In the Netherlands, only 7% to 20% of the (reactive) nitrogen ends up in human consumption products via vegetable or animal proteins[51] [52]. This is about 22% at a European level[53]. In the past three decades, agriculture has already progressed significantly in the utilisation of nitrogen (from 25% to 51%[54]). The work group's focus lies on further increasing the nitrogen efficiency through consumable proteins throughout the chain with the following basic principle:

A smart combination of vegetable and animal proteins is the road towards a more circular protein system: for the health of humans, animals, living environment and company, as well as for realising maximum circular profit.

[48] *A Circular Economy in the Netherlands in 2050, Ministries of Infrastructure and the Environment, Economic Affairs, the Interior and Kingdom Affairs, and Foreign Affairs, September 2016.*

[49] *Environmental effects of Dutch consumption of protein-rich products, Blonk Milieu Advies, 2008.*

[50] *The Nine Planetary Boundaries, Stockholmresilience, 2009.*

[51] *Erisman, J.W., Leach, A., Bleeker, A., Atwell,B., Cattaneo, L. & Galloway, J.N. (2017, in press) A proposal for an integrated approach to a nitrogen use efficiency (NUE) indicator for the food production-consumption chain.*

[52] *Findings and lessons from a first European Nitrogen Analysis, Environmental Dossier 2011, Jan Willem Erisman, Henk Westhoek et al.*

[53] *Nitrogen on the table.*

[54] *Minerals in Agriculture 1970 - 2012, Statistics Netherlands, 2013.*

The work team distinguishes between consumption and production. Human consumption of more vegetable proteins instead of animal proteins and the valorisation of protein-rich residual streams for consumption by humans and animals contribute to a more circular economy to an important extent[55]. Production and export of animal protein (meat, dairy and eggs) are important drivers for the Dutch economy and the international protein provision.

Increasing the efficiency of protein use in the Netherlands. Achieving this via the production and consumption of vegetable and animal protein while taking into account protein quality and the quality of other essential nutrients for an adequate health.

3. VISION: TWO COMPONENTS: PROTEIN PRODUCTION AND CONSUMPTION

The work group's vision encompasses two mutually connected components: one focused on the Dutch protein consumption and one focused on the protein production.

PROTEIN CONSUMPTION

Proteins are of an animal or vegetable nature and form an important part of a sustainable diet. The footprint of protein consumption in the Netherlands measured in land use, greenhouse gas emissions and nitrogen losses needs to decrease significantly. The amount of consumed animal proteins in the Netherlands is higher than the amount of consumed vegetable proteins. In the 2007 - 2010 period, Dutch people between 7 and 68 years of age consumed about 62% animal proteins and 38% vegetable proteins. The total average protein consumption was about 75 grammes of protein per person per day[56]. A diet consisting of 50% vegetable and 50% animal proteins offers a healthy balance for most Dutch people[57]. An estimated 60% of the proteins we consume comes from outside the EU. Consuming less animal proteins and more vegetable proteins as well as limiting protein loss in the human food chain lead to a more efficient nitrogen use. Any undesired consequences need to be made clear. The Kringloop Toets (cycle test) can be an aid in this. Apart from a shift in the protein diet, a reduction of 10% to 15% in the total protein intake is desired for a sustainable diet[58]. It needs to be noted that this does not apply to specific target groups: the elderly and athletes, for example. They benefit greatly from a protein-rich diet. The team emphasises the observation that 'the knowledge of consumption behaviour (diet, waste), education and culture is just as important as technological innovation' [59].

PROTEIN PRODUCTION

Higher efficiency can be achieved in the production chain by means of a combination of a higher feed conversion, use of alternative protein sources, nature-inclusive agriculture and cattle farming, less transport movements, technological innovation, and valorisation for protein-rich residual streams. In cattle farming there are losses of over 50% in terms of the conversion from vegetable to animal protein[60]. These losses cannot be prevented, but can definitely be reduced, for example by means of a higher feed conversion and smarter valorisation, including for animal feed. For the production of dairy, 60% to 70% of the dairy produced in the Netherlands goes to other countries; 80% stays within the EU, 20% is transported to countries outside the EU. Meat production (pork, chicken, beef) have comparable figures. Reducing protein cycles to increase the efficiency, for example by means of more regional (EU) protein production, means that tackling the sustainability cycle will need to take place within the EU. It is noted, however, that regional production is not more sustainable by definition.

Natuurinclusieve landbouw: een economisch rendabel landbouwsysteem, dat optimaal beheer van natuurlijke hulpbronnen duurzaam integreert in bedrijfsvoering, inclusief zorg voor ecologische functies en de biodiversiteit op en om het bedrijf. Natuurinclusieve Landbouw, Wageningen-UR

In the light of these challenges and opportunities in the Dutch production and consumption of protein, the work group emphasises that interventions need to focus primarily on one of the two challenges. A comprehensive chain approach of the vegetable and animal protein chains is still a requirement. Finally, the group feels that the business case must be taken into account at all times, which is in line with other reports regarding this theme and with successful long-term transition strategies[61] [62].

[55] *Food for the Circular Economy, PBL, The Hague, 2017 PBL publication number: 2878.*

[56] *Dutch National Food Consumption Survey, 2007 – 2010, Ministry of Health, Welfare and Sport.*

[57] *Corné van Dooren, The Netherlands Nutrition Centre, Towards More Vegetable Food, November 2017.*

[58] *Menu of Tomorrow, N&E/Blonk MilieuAdvies/Optimeal.*

[59] *A Circular Economy in the Netherlands in 2050, Ministries of Infrastructure and the Environment, Economic Affairs, the Interior and Kingdom Affairs, and Foreign Affairs, September 2016.*

[60] *https://www.cbs.nl/-/media/_pdf/2017/33/dierlijke-mest-en-mineralen-2016.pdf*

[61] *Vision Document Valorisation of Protein-rich Side Streams, Dutch Biorefinery Cluster, October 2013.*

[62] *Changing the Food Game; Market Transformation Strategies for Sustainable Agriculture, Lucas Simons, 2014.*

4. CURRENT DEVELOPMENTS: THE NETHERLANDS AS A FRONTRUNNER FOR PROTEIN SUSTAINABILITY

The Netherlands is the **global frontrunner** in the field of protein sustainability. Many protein research programmes have been launched since 1990. They led to a wealth of insights, technologies, and data. The protein sustainability theme is an important point on the **Dutch Food Agenda for safe, healthy and sustainable food**.
National protein initiatives are, among others, the 'Green Deal Dutch Soy' [63] (local soy growth), the 'Green Protein Alliance' [64] (shift of consumption from animal to more vegetable protein), 'Sustainable Resources of Nevedi' [65], the 'New Food Challenge' [66] (SBIR, product innovation), the 'STW Protein Innovation programme' and research into meat substitutes in the Agriculture and Food Top Sector. The Top Institute Food & Nutrition (TIFN) is closely involved in this theme. Linking up with and joining the SUSFANS EU project that focuses on mapping out the influence of consumer behaviour on dietary patterns and the TIFN project SHARP [67] (Sustainable, Healthy, Affordable, Reliable and Preferable diet) seems to be a logical step.

In an **international context**, initiatives to make protein import more sustainable (among others Round Table Responsible Soy, FEFAC Soy Sourcing Guidelines) and the recently signed IMVO Vegetable Proteins Covenant[68] are relevant. The advisory **government bodies** pay specific attention to the theme through the Netherlands Enterprise Agency/the Ministry of Economic Affairs (Participation Table Food Transition) and the Council for the Environment and Infrastructure (RLI)[69].

These initiatives each have their own focus in the protein chain, from primary production to consumption. The work group sees an opportunity and necessity to connect these initiatives. This makes optimum use of enhanced insights, prevents duplication, and makes connections. Monitoring a joint agenda and mutual coordination is a precondition.

5. AMBITIONS

The work group has two clear ambitions. No later than by 2050,
1. the **animal : vegetable protein ratio in our diet has shifted from 60% animal : 40% vegetable to 40% animal : 60% vegetable.**
   The total protein consumption per person has decreased by 10-15% in 2050.
2. the **footprint measured in inter alia land use, greenhouse gas emissions and nitrogen losses of protein produced in the Netherlands has decreased by 50%**.

Blonk Consultants estimates that the **total savings potential** in the realisation of the mentioned ambitions is **12.5 Mt CO_2 (equivalents) emission** (production 4.5 Mt; consumption 8 Mt)[70]. This estimate needs to be looked into further (line of action). The scope of the savings confirms the impact of the set ambitions, in the light of the climate goals set by our country, too.

By indicating a division between vegetable protein and animal protein, the required comprehensive is emphasised. **Translation** of relative profit to absolute profit is desired, especially on the consumption side. With respect to the production chain, it is imaginable that the same absolute footprint produces more and/or better useful protein in the Netherlands, which means that the footprint per unit of protein decreases. The desire is to limit the losses in the production chain and not necessarily to produce less (implication: shift to other countries), but only if the total production stays within the environmental space. In a broader context, aspects such as animal rights, ethics, health, and the living environment need to be included.

[63] *www.greendeals.nl/green-deal-soja-van-eigen-bodem/*
[64] *www.greenproteinalliance.nl*
[65] *https://assets.nevedi.nl/p/229376/20170814%20Nevedi-factsheet%20Verduurzaming%20grondstoffen.pdf*
[66] *www.rvo.nl/subsidies-regelingen/sbir/oproep-plantaardige-eiwitten-op-het-bord*
[67] *http://www.tifn.nl/project/sharp/*
[68] *https://mvonederland.nl/sites/default/files/media/IMVO%20Convenant%20Plantaardige%20Eiwitten.pdf*
[69] *RLI experts session 5 July 2017, 'A food system in which the production and consumption of especially animal proteins correspond more with the earth's capacity: how can we achieve this?'*
[70] *Blonk Consultants, Footprint of protein production and consumption 24/9/2017, Gouda.*

6. LINES OF ACTION

The work group emphasises the necessity of a comprehensive, innovative systems approach and measurability of the effects. Aspects such as soil and biodiversity, animal welfare, local production, nutritional value, and sustainable diet will be included. Broad social support and implementation of innovative business and revenue models are deemed necessary by the team. This requires successful business cases as well as cooperation between SMEs and multinationals. The work group advises to focus on four lines of action. External experts have been proposed for each line of action, and the business community must participate actively in each of these four lines.

LINE OF ACTION 1: ACHIEVING A BEHAVIOURAL CHANGE IN PROTEIN CONSUMPTION IN THE NETHERLANDS

Supporting sustainable protein consumption (less protein consumption and a shift to more vegetable protein in the diet) and coalitions focused on this. There is a lack of substantiated insights into change in (protein) diet. The effect of tax measures ('meat tax') and other interventions are unclear, there are no consumer insights. These are required for effective awareness and information actions and campaigns. There will need to be a link with the (food) education ('Jong Leren Eten', 'Smaaklessen'). Linking up with existing initiatives from the business community, such as the Green Protein Alliance, is encouraged.

- Proposed external partners/experts: WUR-Wageningen Economic Research, Ministries of Agriculture, Nature and Food Quality, Economic Affairs and Climate, Health, Welfare and Sport, Infrastructure and the Environment, Foundation for Nature Conservation and Environmental Protection, the Netherlands Nutrition Centre.

LINE OF ACTION 2: QUANTIFY AND MONITOR THE FOOTPRINT OF PROTEIN PRODUCED AND CONSUMED IN THE NETHERLANDS

Objectifying is a key to success. Clear and consistent information is required to fall back on. Constantly being aware of the long-term goals determines the credibility of the initiative. Apart from a concrete goal, this requires indisputable parameters and models.
Further quantification and monitoring of the footprint of produced and consumed protein is required following the above-mentioned study by Blonk Consultants. There should be a focus on the climate, land use, and nitrogen efficiency chain of (1) agricultural production, (2) the range of food products offered to the consumer, and (3) our diet. The team proposes to use, for example, LCA and Optimeal® analyses that include sustainability, animal welfare, 'balanced soil', and health as a whole. Another part of this is the analysis of opportunities, results, and lines of improvement for production systems.

- Proposed external partners/experts: Blonk Consultants, Wageningen-UR, Louis Bolk institute, Netherlands Nutrition Centre, MilieuCentraal. We also recommending coordination with other transition teams.

LINE OF ACTION 3: INCREASE THE PROTEIN EFFICIENCY IN AGRICULTURE AND MAKE IT MORE SUSTAINABLE

We must make the production of vegetable and animal proteins more sustainable by increasing efficiency in agriculture. Working actively on sustainable agriculture and cattle farming reduces the protein consumption footprint. More efficient use of nitrogen in the animal protein production by more favourable feed conversion and the use of more sustainable food-safe alternative protein sources are key in this. The precondition is the efficient use of land, water and nutrients and maintaining soil fertility. This line of action is a continuation of current improvements and explores new ones. For instance, the use of regional protein-rich (residual) streams for animal feed are looked into as well.

- Proposed external partners/experts: LTO and NAV.

LINE OF ACTION 4: STIMULATE VALORISATION OF PROTEIN-RICH RESIDUAL STREAMS AND THE USE OF NEW PROTEIN SOURCES

The valorisation of protein-rich vegetable and animal residual streams from the food and feed industry into human food purposes and, if this is not possible, into animal feed must be stimulated. Valorisation is limited by legal frameworks. Schemes for sustainable energy provision can unintentionally encourage the use of protein for energy applications. One issue is whether the SDE+ scheme can be adjusted to stimulate the use of vegetable protein directly for animal and human consumption. The "novel food legislation' and the waste legislation also have a limiting effect (e.g. rapeseed protein from press cake for human consumption, the use of insects for converting residual streams for animal feed[71]). The work group considers removing these thresholds via pilots to be a task of the government at a local, regional, national and EU level and as a condition for an accelerated transition. This also increases the chances of a successful scaling up and marketing (line of action 4).

- Proposed external partners/experts: Ministries of Agriculture, Nature and Food Quality and Health, Welfare and Sport, RVO, NVWA, IL&T, IPO, VNG.

LINE OF ACTION 5: IMPROVE SCALING UP AND MARKETING OF CIRCULAR PROTEIN PROPOSITIONS

A familiar transition limitation is that of scaling up, financing, and commercial implementation. The work group strongly supports the use of means and expertise to generate best practices and new revenue models. Monitoring the business case is necessary. The number of successes in the protein-circular sector is too limited. Stimulation requires a more market-driven approach with the support of experts, entrepreneurs, and financiers. Protein scarcity is an important driver and needs to be used as such. This line of action focuses on the development, scale increase and marketing of circular vegetable and animal protein propositions with attention to the entire chain, from growth to consumption. In the short term this concerns, for example, soy, seaweed, field beans, and algae. In the long term this concerns, for example, developments regarding cultured meat.

- Proposed external partners/experts: Rabobank Innovation Food Fund, Green Protein Fund, Future Food Fund, Triodos bank, RVO.

[71] *www.allaboutfeed.net/New-Proteins/Articles/2016/4/Best-practices-in-the-insect-protein-sector-2786856W/*

GENERAL RECOMMENDATIONS

Strategic cooperation contributes to the chances of success. Section 3 shows that there are many initiatives that focus on either animal or vegetable proteins. Combining initiatives through a joint agenda as well as coordination with other work groups (e.g. nutrients) is required.
Furthermore, the work group foresees that the desired changes does have its risks. Social, economic and ecological risks. An overview and monitoring of these risks is necessary. Risk in the Netherlands that concern, e.g. the health of people and animals and the possible effects outside of the Netherlands, for example, with respect to biodiversity. What do the actions we perform here mean for the regions we export to and import from? What socio-economic impact does regional protein production have elsewhere? What does this mean for the Netherlands' competitive position? (Level playing field). The guidelines for the IMVO covenants are a guiding principle in this and are used by the government, social partners, and social stakeholders.
Thirdly, the work group concludes that an impartial entity with experience in transition processes is required for general coordination and organisation. This guarantees a comprehensive approach. All 5 major parties need to be involved at an early stage: entrepreneurs, education, research, government, citizen's organisations. Frontrunners that contribute to the quick realisation of set goals and experts like New Foresight and Drift who can support this.

7. REQUIRED INTERVENTIONS

Interventions result from these lines of actions. In accordance with the recommendations of the Scientific Council for Government Policy (WRR)[72], a sustainable (human) consumption is the starting point. From there, action will be taken in the chain where necessary. Further coordination with stakeholders is required to achieve more explicit and further differentiation of interventions. Not just by the government, because the business community and financiers also play an important part. Some interventions relate to production, others relate more to consumption.

LINE OF ACTION	EXAMPLES OF INTERVENTION
1. Behavioural change with regard to protein consumption in the Netherlands	Central awareness/information campaigns for Dutch consumers with respect to the impact of protein consumption. Collecting (international) studies into consumer behaviour + incentives/insights, effects of government action. If not available: Initiate new research. Link up with existing initiatives, such as Green Protein Alliance.
2. Monitoring Protein consumption/production footprint	Determining measurable indicator(s) of protein consumption and production footprint + model (e.g. exergy, LCA, land/water use, emission of greenhouse gases). Periodical monitoring (e.g. once every two years) by independent third parties.
3. Sustainability of protein production	Higher sustainability and increased efficiency in agriculture. Linking up with existing initiatives: sustainable dairy chain, vital pig farming, poultry farming vision. Research and tests focused on increasing the feed conversion.
4. Valorisation of protein-rich residual streams	Pilots focused on increasing the scale of valorisation for animal and vegetable protein-rich residual streams. EU Novel Food lobby and Waste legislation (incl. national/local enforcement) with an emphasis on: - Use of (regional) protein-rich residual streams - New sources of animal feed (e.g. bone meal, swill, insects). - Better use by cattle (inter alia improvement of intestinal flora). Clarifying unintended effects of existing schemes + where necessary(e.g. SDE+), adjusting international cooperation with stakeholders in the protein chain.
5. Scaling up & marketing	Realisation of successful business cases by involving banks, investors and multinationals with start-ups. Increasing the availability of venture capital for these types of investments. Initiating pilots with an emphasis on scaling up(production/technological) and behavioural change (consumption/social).

[72] *Towards a Food Policy, Scientific Council for Government Policy, October 2014.*

8. EFFECT ON CROSS CUTTING THEMES

The stated goals and lines of action link up with the sustainability frameworks in the **Food agenda for safe, healthy and sustainable food of the Netherlands**[73]. They answer the call as stated in the overarching 'A Circular Economy in the Netherlands in 2050' plan. As stated, the ultimate goal is to achieve more efficient use of (reactive) nitrogen. Coordination with other themes is required; **Moerman's Ladder** appears to be a useful framework.
The work group feels that higher efficiency should not lead to high point loads, for example, and should not be at the expense of natural capital and sustainable use of resources. There is no explicit focus on increasing the biomass supply. There is a focus on more efficient protein use from/of existing biomass: the protein efficiency can be increased through agricultural improvements. Using protein sources that are made available through biorefinery and, e.g. aquatic sources, can contribute to this.
Production of sustainable protein must be viewed in the broader scope of the supply security of biomass. Crops consist of protein and other functional components, such as sugars, starch, and oil. Components that can be used after biorefinery for food, feed, fragrances, pharma, fine chemicals, fuel, fertiliser, etc. A focus on sustainable and efficient land use must guarantee the supply with a minimum impact on the environment.

9. SOCIAL ASPECTS

Realising these lines of action will greatly rely on the protein production and consumption behaviour in the Netherlands, particularly on the primary sector, the processors, producers, retailers and consumers. **Social support for a complex and controversial topic as protein sustainability might be the biggest challenge we face.** Underlying socio-emotional factors can disrupt the process. The work group is convinced that this is also where we can find the biggest chance of success. If the social sensitivity is acknowledged and integrated, there is a higher chance of success. However, this requires the use of experts. A new balance between focusing on technological and cultural, social innovation needs to be found. We need pioneers: 'people who take a different look at the world around them(...).'[74]

[73] *Progress Food Agenda for Safe, Healthy and Sustainable Food, 21 November 2016, Ministry of Economic Affairs.*

[74] *Prof. Derk Loorbach, DRIFT, Entrepreneurship in Transition, 2014.*

APPENDIX 2C: RESIDUAL STREAM VALORISATION, BIOREFINING & INVESTMENT CLIMATE WORK GROUP

Willem Sederel (theme coordinator, Bio-based Delta), Rein Coster (VNCI), Coen de Haas/Bertram de Crom (Cosun), Annita Westenbroek (DBC/VNP), Frans Claassen, Frank Bergmans (MVO), Ruud Tijssens (Agrifirm), Mat Quaedvlieg (Sappi), Ed de Jong (Avantium), Marcel Wubbolts (Corbion), Peter de Jong (Foundation for Nature Conservation and Environmental Protection), Joop Suurmeijer (Orgaworld), Marian Geluk, Tim Lohmann (FNLI), Jan IJzerman (UVW), Arjen Brinkmann (BVOR), Nic Grandiek (Province of North Holland), Paul van den Heuvel (VVNH), Henk Wanningen (Staatsbosbeheer), Joke Klap (Nevedi), Edith Engelen (RVO)

1. DEMARCATION/SCOPE

The term biomass refers to the biological fraction of products, waste and residual substances and remains of agriculture, including vegetable and animal substances, forestry, the fishery and aqua-culture sector and related business fields as well as the biological fraction of industrial and domestic waste. This work group's focus lies on valorisation for crops and residual streams formed in the production and processing in the chain. This concerns partly biogenic streams that become available in the production, processing, storage, transport, consumption, and waste processing.

The starting point in realising the transition towards a circular economy is a comprehensive approach that looks at the entire chain of growing and extraction of resources to the use of materials in finished products and keeping the constituent resources in the cycle or returning them to it. A high-grade, possible multiple and/or frequent, use of substances and materials is a priority.

2. VISION

The basic principles are the visions as described in the 'Biomass 2030 Vision', the 'Food Vision', and the 'National Circular Economy Programme'. These visions were also the foundation for the Raw Materials Agreement. Recently, the Foundation for Nature Conservation and Environmental Protection's Biomass Vision was published. However, this has not been included in this update.

BIOMASS 2030 GOVERNMENT'S VIEW

- There is a potential availability of sufficient biomass (through production and import) to meet the needs in the Netherlands in terms of food, feed, materials, transport and energy, but only if there is a focus on increasing the supply of sustainable biomass and optimum use of biomass.
- In the short term, the use of biomass remains important for achieving the goals in the Energy Agreement and climate policy.
- In the long term, biomass will only be used for non-food/feed purposes if there are few other renewable alternatives[75].
  - chemicals and materials.
  - aviation and shipping.
  - long-distance heavy road transport.
  - high-temperature heat for the industry sector.

The work group endorses the 'Biomass 2030 Vision'. They also assume that a significant effort is required in the Netherlands and abroad to make sufficient amounts of sustainable biomass available, so the biomass need of the Dutch industry and production sector can be met.

A PEER review performed by WUR in 2017 concludes that the need for biomass for food and feed in the future will stay about the same. The strong increase lies in applications for chemicals/materials and energy. There do not seem to be any major bottlenecks in biomass availability until 2030. However, there does seem to be tension between supply and demand after 2050.

FOOD VISION

In response to the WRR report 'Towards a food policy' the government presented their vision on the food policy to the Second Chamber on 30 October 2015 and sent the progress agenda to the Chamber on 21 November 2016. In it, the government indicates that they strive towards an ecologically viable food system that handles

[75] *If new sustainable and renewable alternatives become available for these applications, these will be preferred over biomass due to possible tension that can arise in the long term between supply and demand of biomass at a global level.*

resources, energy, water and nutrients sparingly and efficiently and takes maintaining the natural capital into account and uses natural capital sustainably. This means that the quality of soil, water and air is protected, biodiversity is maintained, and that greenhouse gases are simultaneously reduced.

National Circular Economy 2050 Programme / Raw Materials Agreement.
- Closing cycles is key.
- All resources and residual streams will stay in the cycle for as long as possible in an as high-grade fashion as possible.
- Cascading and multifaceted valorisation is the aim.
- Reducing the use and replacement of non-renewable, critical resources with biomass.
- Identifying new ways of producing and consuming that lead to departures from past trends.
- Production/consumption must stay within the boundaries of what the earth can handle. The basic principle for biomass and food is: a balanced soil. Maintaining/reinforcing a healthy soil as a sustainable production factor is vital.
- Social sustainability.

The transition to a circular economy requires a shift in thought, action, and organisation. Whereas agriculture and the agricultural industry are now primarily viewed as suppliers of food, they are in fact chains in a network in which many chains are linked to each other. Together with forestry, public green spaces, aquaculture and nature conservation they are sources of biomass for food, animal feed, medication, chemicals, fibres, materials, and fuel.
Through biorefinery, biomass can also be fractioned into components that are applied directly or are converted, through (bio)chemistry, into new molecules which serve as a resource or semi-finished product for other applications. The traditional distinction between primary, secondary, residual and even waste streams is deeply embedded in the social mindset, but is arbitrary in a strict sense and does not reflect the fact that all components from biomass already have a function for a specific application.

Biomass streams that become available in the treatment and processing of biomass, the maintenance on urban and rural green areas or the purification of by-products are used for other applications. Innovation allows a more high-grade use of streams than is currently possible. An important factor is that nutrients such as phosphate and essential minerals are reclaimed and used for the production of new biomass.

Cascading is an important goal in a circular economy, but cannot be approached rigidly. When high-grade applications are (temporarily) not feasible, because market demand is limited or the conversion routes cannot compete with the standard routes, for example, less high-grade applications, e.g. in transport or energy, can be a good alternative to bridge the gap.

Important for first-of-a-kind biomass transitions is the fact that the market is entered, and not primarily at what level in the value pyramid this market introduction takes place. Once the market has been entered, more high-grade applications can gradually be aspired for from the lower regions of the pyramid as a result of market acceptance. This a more or less autonomous process influenced by price incentives at the top of the value pyramid. However, we need to take care that there will not be a lock-in of less high-grade applications, so temporary incentives will eventually have an adverse effect.

Thanks to innovation, new chains appear every day and old chains disappear. New chains can only form if they add functionality or are cheaper than existing chains. Or if government policy stimulates these new applications through interventions in the market (such as renewable energy, biofuel). If new chains contribute to social goals in the field of resource efficiency, environment and/or public health, these will also have to receive the credits for it in a structural way, so entrepreneurs and investors will be prepared to invest in a multi-year business case.

3. CURRENT DEVELOPMENTS THAT CAN BE BUILT ON

The Netherlands already handles biomass efficiently. Most biomass streams have an application. The new possibilities are mostly linked to further optimisation of the applications (based on economic added value, sustainability). Innovations regularly lead to more high-grade applications. The past years have also seen an intensive development of a broad bio-based network in a large number of sectors in the business community, social organisations, authorities, and knowledge institutes. The knowledge level is high and the favourable combination of globally competitive agricultural food, paper and chemical sectors is unique, as is the presence of ports in Rotterdam/Moerdijk, Amsterdam, Vlissingen/Terneuzen and Delfzijl and the connected logistics networks that extend to hinterlands with 160 million consumers within a 500-kilometre radius.

In terms of valorisation for production residues and reclaimed resources, the time has come to realise first-of-a-kind bio-based plants. The required technology development has reached the higher TRL levels[76], but the revenue model for actual investments is lagging behind. This is mostly due to the fact that major risks need to be taken in transition projects, there are insufficient market incentives that facilitate a circular economy, and that there are bottlenecks in terms of legislation and regulations (waste, spatial planning).

[76] *TRL = Technology Readiness Levels. A TRL indicates the phase of a development project. In total, nine phases have been defined that represent the entire development process from first idea to commercial market introduction.*

A small selection of initiatives on which can be built:
- Task Force Circular Economy of Food
- Kringlooptoets (cycle test)[77]
- Forest and Wood Plan of Action and Improving Sustainable Forest Management Covenant
- Green Deals, such as the Business Green Deal with biomass and bio-based gas, the Resources Green Deal and the Circular Terrain Management Green Deal
- Task Force Fertiliser and Mineral Valorisation
- Foundation for Nature Conservation and Environmental Protection: Biomass Vision
- CE Investment Agenda by VNG, IP, and UvW

4. GOALS

The challenge in the transition process lies in discovering which actions and interventions will have the biggest impact on the transition towards the circular economy. Progress can be monitored at a number of levels:
a. Actions and interventions: are the announced steps actually made, are the intended results achieved?
b. Do these actions and interventions indeed lead to progression on the X-curve[78] of the transition?
c. Parameters that measure realistic effects in the Netherlands at a macro level, such as a reduction of the use of resources, reduction of CO_2 emissions, etc.

For 2021, it primarily seems useful to formulate goals at the level of forming a vision, substantiated decision models, and actions and interventions. Up to 2030, optimisation in the current chains will also require considerable attention. In this period, the actions and interventions will need to provide tangible results on the x-curve. In the 2030-2050 period, the real macro effects need to be properly visible.

The overall goals in the CE programme to achieve a 50% savings of primary resources by 2030 does not apply to biomass. What is more, this ambition will almost certainly lead to an increase in the use of biomass. In the light of the significantly increasing demand for biomass in the world, it is important that the supply of sustainably produced biomass is increased, that all biomass fractions are used in an as high-grade manner as possible, and that the cycles of bio-based products are closed as much as possible. This will lead to the following goals:

I. INCREASING THE SUPPLY OF SUSTAINABLY PRODUCED BIOMASS IN THE NETHERLANDS
- The Dutch agriculture and horticulture industries are developing and implementing plans of action together with national and regional governments, NGOs and buyers for the further increase of sustainably produced biomass for feed and food and other bio-based applications, both nationally and internationally, based on regional risk analyses.
- Increasing the national production of wood through focused forest management (species composition, quality of plant material, soil development, growing systems) and the growing of forests and green areas.
- Stimulating the development of non-land based biomass production (aquatic biomass).
- Stimulating sustainable biomass growing on marginal land and in the sea. And the recovery of degraded land.

II. OPTIMUM VALORISATION OF BIOMASS. THE SHARE OF BIOGENIC FRACTIONS RELEASED IN THE GROWING, PROCESSING, CONSUMPTION, STORAGE, TRANSPORT AND END PROCESSING THAT IS USED IN A HIGH-GRADE MANNER (FOR MATERIAL APPLICATIONS) IS MAXIMISED IN 2050
- Halving food loss in the chain in 2030 (SDG 12.3) by preventing waste (also see action line 3.1.3) and more high-grade valorisation of residual streams.
- Governments and companies enter into chain agreements in which they undertake to replace increasing percentages of fossil resources in 2030 and 2050 with bio-based resources for plastics and construction materials. For plastics for the Dutch market, the goal is to replace 15% of fossil resources with bio-based resources in 2030 and to replace 30% in 2050 (this also applied for imported plastics). For the construction materials industry, the goal is that the use of bio-based construction materials has increased by 100% in 2030 and by 200% in 2050.
- Guaranteeing a level playing field for all applications. Policy interventions that favour more low-grade applications over high-grade applications have been reduced in 2020, or the more high-grade applications are stimulated in a comparable way.
- Specific policy interventions will be used for cases in which the desired high-grade applications are not economically feasible because the environmental costs have not been included in the prices of the non-circular alternatives. For example, for keeping the soil quality at a good level.

[77] *WUR, 2016, KringloopToets*

[78] *DRIFT, 2017, State of Transition: patterns of construction and dismantling in five domains*

[79] *The Plastics Transition Agenda's goal is that in 2050 , all plastics are produced on the basis of renewable resources. This means that 70% recyclate and 30% bio-based resources are used in 2050.*

5. DESIRED INNOVATIVE LINES OF ACTION AND REQUIRED INTERVENTIONS

GUARANTEEING THE SUPPLY CHAIN FOR SUSTAINABLE BIOMASS

The Netherlands depends on the import of biomass both for achieving energy and climate goals and due to the fact that the Netherlands is an import and export country. It is vital for the business community to have long-term security about the sustainably produced biomass supply chain. The Biomass 2030 Vision concludes that focusing on increasing the supply of sustainable biomass is required both within and outside of the Netherlands. As a country with limited acreage and a high population density, the Netherlands has unique knowledge and experience with the efficient production and processing of biomass and can utilise this position to help the world and, subsequently, ourselves.

The following preconditions must at all times be met for the production of biomass[80]:

- Biomass production must not endanger the food supply.
- Biomass must be grown sustainably, with the soil quality staying at the same level. Water, artificial fertiliser and pesticides, waste management and limiting greenhouse gas emissions must be handled responsibly.
- Biomass production must not contribute to deforestation, degradation of nature reserves and land expropriation.
- Biomass from forests must come from sustainably managed forests.
- Social sustainability is guaranteed. This applies both to and around the production location as well as the rest of the chain. Land grabbing and bad working conditions in countries with a delicate governance structure must be prevented.

The market shows that stakeholders are focusing on increasing the biomass supply in the Netherlands. In the 'Forest and Wood Plan of Action' a broad coalition strives towards doubling the Dutch wood production in 2050 by expanding the forest acreage by 25% and increasing productivity by more productive and sustainable forest management by 50%. Moreover, better use of the biomass-producing capacity of the public space (urban and rural) is aimed for. Cosun focuses on increasing the Dutch sugar production, which has already commenced and will continue to increase up to 2020. This is achieved by an expansion of the acreage up to about 85,000 hectares and a productivity increase up to 18% sugar (in the beet) and 90 tons of beet per hectare, resulting in 16.2 tons of sugar and 6 tons of beet pulp.

> The wood consumption in the Netherlands is expected to have doubled by 2030. Internationally, the global demand for wood is expected to triple. The Netherlands depends on European wood for 80%. In the light of the fact that the national consumption increases faster than the growth potential of the European wood production and that there are only a few regions in the world where the harvest can be increased in a sustainable manner, the sector aims at doubling the national wood production.
> *Forest and Wood Plan of Action, 2016*

Apart from initiatives focused on increasing the Dutch supply of biomass and recycling of bio-based materials, the possibilities for increasing the supply of sustainable biomass (inter alia aquatic biomass and biomass of animal origin) at an international level (primarily European) will need to be investigated , while sustainability aspects like soil quality, biodiversity and closed cycles are also taken into account.

There is a need for interventions that stimulate the productivity increase of agriculture and forestry and aquatic biomass in EU and developing countries, including its water efficiency and maintaining the ecological foundation.
Moreover, there must also be a focus on creating more capacity in order to guarantee sustainability. Furthermore, there needs to be an international institutional governance framework that can be controlled from the basis of a good span-of-control for the responsible parties in the chain. This capacity creation and a good, reliable governance structure require concrete pilots and business cases that can be realised based on focused research into the opportunities for biomass in a circular economy (better use of production residues and residual streams in a circular way, increasing the supply of sustainable biomass).
If possible, existing initiatives can be built upon, such as the Sustainable Agriculture Initiative Platform (SAI), a global platform for sustainable growing standards.
Harmonisation of sustainability frameworks for biomass is a necessity. To achieve the goals, the same sustainability and CO_2 criteria that are used and are to be used for biomass intended for energy and material applications must also apply to biomass to be used for food and animal feed applications. Tools such as the KringloopToets (cycle test) can offer an initial framework, but need to be refined and embedded in a national policy.

[80] *For the production of wood, among other things, the Dutch government uses the Timber Procurement Assessment System (TPAS) that covers the preconditions. For biofuel and bioenergy, the EU has mandatory preconditions for the sustainability of biomass, and the green deal green certificates have developed a sustainability framework for the chemical industry. These initiatives can be built on in the future.*

OPTIMUM VALORISATION OF BIOMASS INTO CIRCULAR, BIOBASED PRODUCTS

The use of biomass as a resource for the production of, for example, construction materials to replace the currently used traditional fossil and non-recyclable resources can make an important contribution to the reduction of the use of fossil and critical resources. This also applies to processing residual streams in as high-grade a manner as possible. Wherever possible, residual food streams are used for food applications again. If this is not possible, using it and/or upgrading it to animal feed (preferably) and bio-based products is the logical choice.

Producers of sustainable bio-based products indicate that the market demand is still missing or is very limited. Reasons for this are, among other things, the market's unfamiliarity with new products and a higher cost price. After all, primary resources are still relatively cheap. Moreover, the new production processes still need to go through a learning curve. Another factor that is slowing down the development of bio-based products is the fact that due to the sustainable energy policy the government does stimulate biomass for energy applications, but does not do the same for applications in products. Current promotion of biomass as a source of renewable energy is an important step in the right direction and remains necessary.
The lack of such promotion for material applications of biomass is inhibiting the transition. From a CO_2 emissions perspective this does not make sense, because bio-based products use renewable carbon and sequester it for a longer period of time. This occurs either directly via products with a long lifespan or through the recycling of bio-based products, so the renewable carbon is retained. The very slow increase of market demand also inhibits the development of bio-based products, which means market supply remains low.

Transition projects are complex in nature, because they require cooperation with new and unknown partners from different sectors, also referred to as social innovation. These social innovation aspects should not be underestimated. Many new forms of contracts are also required. For instance, parties have specific ideas about other players beforehand that might impede the process. In addition, many companies are not equipped to deal with open innovation, IP, distribution risks, costs, yield, CO_2 credits, etc. Another difficult issue is that there is often a missing link between biomass producers and buyers further up in the chain; operators who invest and bear risk. Then there is also the aspect of time for the forestry and wood sector. After all, investing in biomass supply will only lead to actual supply after many years. This can make it very difficult for individual producers and buyers to enter into agreements. This is only possible at a chain level.

Avantium and AkzoNovel are building a pilot biorefinery at Chemiepark Delfzijl. Staatsbosbeheer (National Forest Service in the Netherlands) supplies residual streams from Dutch forests that will be processed into resources through the Avantium-developed Zambezi process for materials, chemicals, vitamins, enzymes, and transport fuels. Energy company RWE is also a partner in this project.

Communication between links in the chain can also be an issue. It is important to realise that the governance structures of agriculture and the connected links are 'linear' in structure. The product with the biggest economic impact and/or added value in the chain dominates the chain development. This means there is a lack of assessment frameworks for assessing and/or optimising the (economic) secondary effects. There is a need for vision development regarding new chains and for leadership in these new chains.
It is important to also develop other assessment frameworks and to experiment with new, more complex, circular governance structures.

New cross-sector alliances will form in the circular economy. The company Groot Zevert Vergisting processes manure from FrieslandCampina dairy farmers into, among other things, biogas that is supplied to FrieslandCampina in Borculo through 5 kilometre-long transport mains. Here, the biogas is made to generate energy for the production of milk powder and ingredients for baby food. A Green Minerals Plant at the fermenter ensures nutrients and low-phosphate organic matter are reclaimed and supplied to farmers regionally.

The government can help the market get over this slump by making circular, bio-based products economically more attractive or by making the less sustainable alternative less attractive. For instance, by acting as a launching customer for new bio-based applications for which there is only little supply at the moment, or as a circular procurer e.g. product groups that are already widely available on the market. Finally, the government can also boost the market through obligations or prohibitions.

The business community will take the initiative to establish a Renewable Plastics CE Table and a Renewable Construction Materials CE Table. In the execution phase, there will be alignment with the Plastics and Construction Transition Agendas. Every Table has its own representatives from the entire chain from suppliers of resources to buyers of the bio-based products. Moreover, the government will participate by providing expertise in terms of procurement (Pianoo), but also through smart market incentives and financing, behaviour and international cooperation. The participants of the Tables identify promising product groups, make voluntary chain agreements, and record them in a covenant or plan of action. Every Table then makes the required interventions more concrete. These may include the following types of interventions, for example:

INTERVENTIONS IN TERMS OF LEGISLATION AND REGULATIONS:

- Dynamic standardisation: increasing percentage of renewable resources (bio-based/recycled materials) in product groups to be determined.
- The conditional exception of demonstrably safe use of residual streams in food and in animal feed in particular.
- Adjustment of the product policy, at EU level wherever necessary:
  - Phasing out hazardous substances if a good bio-based alternative is available, such as peat, oxodegradable plastics.
  - Stimulating biodegradable products in applications in which products leak into nature. Think of lubricants, agricultural plastics, drilling fluids, microplastic and nanoplastic particles in, among other things, scrubs, sun screen and toothpaste, dolly rope, trimmer wire for brush cutters, golf balls and synthetic granulate on football fields81.
  - Stimulating bio-based products that score better in terms of sustainability and health than their current alternatives. For example, PLA foam instead of EPS, plasticisers, ingredients for cosmetics and construction materials, packaging, and the automotive industry.

THE CE TABLES WILL PROVIDE INPUT WITH RESPECT TO WHICH PRODUCTS ARE ELIGIBLE

Interventions in terms of knowledge and innovation:

- Stimulating the development of knowledge and applied research in terms of the high-grade valorisation of biomass, including pilots and demonstration projects.

INTERVENTIONS IN TERMS OF BEHAVIOUR:

- Increasing familiarity with and the importance of bio-based concepts among producers, buyers, and consumers.
- Exploring influencing behaviour through other mechanisms, such as nudging.

INTERVENTIONS IN TERMS OF FINANCING AND MARKET STIMULI:

- Greening the tax system through a tax shift from labour to resources, materials, and waste. This fits in with the PBL report regarding greening the tax system82.
- A bonus/malus system, public or private, for renewable products (bio-based and recyclate): levy on, for instance, non-renewable plastics, the proceeds of which can be redistributed to renewable plastics.
- Reduction of the waste management contribution rate in the Packaging Waste Fund for bio-based plastics. Currently, there is a lower tax rate for biodegradable plastics, but not for bio-based plastics in the broader sense.
- The government as a launching customer for innovative bio-based concepts (innovative procurement).

6. REQUIRED PRECONDITIONAL LINES OF ACTION

The business community and (decentralised) authorities jointly and together with knowledge institutes develop new circular innovations and introduce them to the market via demonstration projects and by scaling up in the market Appropriate incentives are required, depending on the phase of the development process. The way in which society is currently organised – through tax levies, subsidies and other legislation and regulations – fits in with the current business models. A lot of circular and bio-based business models cannot compete with these conventional linear business models in the current market situation. On the one hand this is due to the fact that, contrary to innovative concepts, such concepts have been optimised over decades, on the other hand this is due to the fact that the legislator needs to create the preconditions for creating the new situation of a circular economy that can also be maintained in the future. Hence, there is a need for a number of preconditional lines of action focused on reinforcing the investment climate, emancipating regulations, honouring carbon sequestration in the soil and products, and involving consumers in the transition.

REINFORCING INVESTMENT CLIMATE FOR BIO-BASED INDUSTRY

An inventory by VNCI shows that many companies are preparing investments in bio-based pilot plants and demo plants. In the paper industry, developments for nano-cellulose are now in the pilot and demo phase. Moreover, dozens of SMEs are working actively on developing and producing bio-based construction materials. An overview can be found on http://www.biobasedbouwen.nl/.
Processors of (organic) residual streams and water boards are also developing high-grade products. For instance, a lot of communal water purification plants are converted into energy and/or resource plants. Think of the production of, among other things, cellulose, phosphate, alginate, and resources for bioplastics. In many cases, these energy and resource plants form in co-creation with the business community to facilitate ground-breaking technologies for the valorisation of all sorts of reclaimable resources from residual streams. A similar development is going on in the transition towards high-grade biomass production of animal origin.

[81] *An important condition is that the biologically degradable plastics meet the degradation requirements of the environment in which they need to degrade (e.g. ISO 17556 for biological degradation in the soil).*

[82] *PBL, Tax greening: tax shift from labour to resources, materials and waste, November 2017.*

The risks of investing in new bio-based production capacity are high. The market is not yet convinced, and the technology has not yet been optimised enough. Furthermore, the first plants often do not yet function properly, which results in stricter investment requirements for the next plants.
A transition period (the start and middle of the S curve) requires the boosting of investments that contribute to the transition itself. This incentive can be phased out in the institutionalisation phase ('the new standard') if the agreements made are respected. Conditions should be created in this phase on the basis of which circular business cases can hold their own.

The transition can only take place through sufficient smart market incentives. There are various options for reinforcing the investment climate for transition initiatives that need to be tested for their effect, feasibility, and support.

Examples include the risk-bearing participation funds, guarantee tools and constructions for which environmental tax dispensation is granted if it is used for a sustainable investment. But also think of managing the sequestering of carbon (C) or CO_2, adjusting ETS, and adjusting import duties. Also think of stimulating the use of circular products through financial and/or market incentives (inter alia through purchase conditions) and measures to improve the reuse and recycling of bio-based materials.

EMANCIPATION OF REGULATIONS

Initiatives focused on the high-grade use of production residues and residual streams regularly face limitations in terms of waste legislation and regulations, licensing, and supervision & enforcement. Sometimes, it is a matter of perception and it turns out that more is possible in practice than was previously thought by companies and authorities, was seen at the 'Room in Regulations' counter. At other times, there are legitimate barriers that have been created to guarantee food safety and environmental protection, for example. However, on the whole there are structural limitations, for which a number of factors ensure that they are not removed, or will only be removed after a long time.

- There is not just one government. At a (national) policy level there is usually a clear vision and the will to facilitate circular initiatives, but things often get bogged down elsewhere. This occurs at the national/provincial/municipal level, but also in the following roles: policy/permit provision/supervision/enforcement. The autonomous position of local governments is likely to increase in the execution of the new Environmental Planning Act. When designing circular policies (vision), all layers of the government must commit to these policies and act accordingly. Moreover, European harmonisation is desired to make circular steps, but this is not a requirement in the short term.
- There are conflicting regulations from the perspective of food safety and environmental safety. An integrated legal framework is required in which thinking in terms of waste and residual streams (i.e. origin) needs to be shifted to thinking in terms of reutilisation (i.e. resource for a specific application). If there are risks regarding the use of a specific resource/application combination, this is usually adequately regulated in product and/or substances regulations, for example in animal feed/food regulations. The business community needs a clear and uniform legal framework for the use of biomass that offers legal certainty and leaves no room for legal inequality. This requires a transition in legislation and regulations for which additional knowledge and capacity is also required.
- Policies need to be flexible across sector and policy borders. For instance, decentralised authorities that want to market or exchange biomass with companies end up in a split between cost-effective and innovative business operations and the code of conduct laid down in the Public Enterprises (Market Activities) Act.
- Finally, abolishing the waste status may be helpful. As soon as something is labelled 'waste', the possibilities for reuse are limited. This can be blamed on the criteria for waste in the national waste management plan. As soon as something has been marked as waste, you cannot do anything with it without a waste processor's license. The government needs to offer companies room for experimentation. For instance, if company waste is temporarily placed under the residual stream, the company can come up with solutions for this residual stream itself[83].

The answer to a legal knowledge question[84] in this respect showed that the European Waste Substances Framework Directive in our country is regularly interpreted and applied incorrectly. The result is that production residues and reusable waste substances are often unjustly subjected to the waste substances regime. This unintentionally discriminates secondary and tertiary resources and materials compared to primary virgin resources and materials. In practice, this leads to the fact that it is not always possible to (re)use production residues and other (re)usable residual streams in a circular way while maintaining their functional and economic value. The result is that these residues and residual streams leak out of the cycle. The proper specification of inbound and outbound streams by the business community linked to a transparent quality control can quite easily be the foundation of an effective circular system.

[83] *Infrastructure and Environment Consultation body (OIM), Circular economy: from local innovation to transition, September 2017.*

[84] *Lobry, Emancipation of waste regulations – handling waste substances in a circular economy, September 2017.*

Based on waste emancipation plan that had already been drawn up, a Task Force to be formed for this purpose could advise on the legal room the Netherlands has in the context of the European Waste Substances Framework Directive to free production residues and waste substances from the waste regime. This can boost a wide availability of biomass that is currently not permitted as a product or resource on the regular trade market.

HONOURING (LONG-TERM) CARBON SEQUESTRATION IN SOIL AND PRODUCTS

Bio-based materials in general provide at least as much CO_2 reduction per used amount of biomass as energy applications. The current Dutch energy and climate policy is focused on reducing national CO_2 emissions ('from the chimney'). International agreements are based on this, and countries are held accountable for emissions within the national borders. Producers are not really stimulated to use biomass as a resource for chemicals and materials through the ETS system for example, that will only reward biogenic CO_2 emission reduction if the products are incinerated. As a result, ETS does not stimulate substituting fossil resources with biomass for the production of chemicals and materials. Steering solely based on CO_2 does therefore not necessarily always lead to closed carbon cycles.
The current CO_2 management is not an incentive for resource replacement and recycling of bio-based products, because on the one hand many products are exported and on the other hand the 'incentive' benefits the final processor (through SDE, ETC, etc.). Moreover, organic carbon sequestration in the soil by farmers and other terrain managers is not stimulated yet. Second to oceans, soil is the largest carbon buffer. Effective climate policy means that more extensive use of this potential is required. Moreover, organic carbon sequestration contributes to improving the soil fertility, which in turn improves the biomass-producing capacity of the soil in the long term.

The circular economy requires custom solutions. Steering one or more parameters can lead to a shift in environmental effects. Legislation should generate a framework to prevent the undesired effects, such as resource scarcity, environmental damage, and social impact in countries of origin.

INVOLVING CONSUMERS IN THE TRANSITION

The way in which consumers handle their food, in terms of both buying it and using it, impacts the use of agricultural land and resources. Moreover, the consumer is largely unfamiliar with bio-based products. Research has shown that the willingness to pay an added price for sustainable or bio-based products is only limited. Only 10% to 15% of the consumers, for example, is willing to pay a little more for sustainably produced wood. The consumer also often does not know in which waste bin bio-based products will have to be deposited after use. Knowledge of (consumption) behaviour, education and culture is an important factor. The retail sector, brand owners and social organisations can play an important part in stimulating the demand for and acceptance of sustainable products. Apart from that, other measures will need to be identified. This includes, for example, phasing out non-sustainable products or stimulating circular resources, such as circular phosphate through the procurement conditions for food.

APPENDIX 2D: CIRCULAR ECONOMY IN THE DUTCH HORTICULTURE WORK GROUP

Saskia Goetgeluk/Patrick Lemmens (theme coordinators, Campus: Brightlands, Campus Greenport Venlo), Agnes van Ardenne (DBC), Jan Smits (Plant Substances Knowledge Centre), Paul Monincx (Horticulture and Basic Materials Top Sector), Annita Westenbroek (DBC)

1. DEMARCATION/SCOPE

The Netherlands has a highly diverse primary sector. In this sector, horticulture is often a trendsetter in the translation of social and economic challenges into sustainable innovations. A distinction is made between closed (covered) growing and full-soil growing. Both (sub)sectors fall within the scope of this memo in which it must be stated that the nature of closed growing (controlled and manageable) means that this is often the breeding ground for new concepts. The horticulture sector has been working successfully on limiting the environmental impact to a minimum for a long time. Moreover, they are regularly developing new growing concepts based on trends and developments on the market.
Apart from striving towards low/zero impact on its environment, the sector also strives towards a positive impact situation and structural added value for the sector. More extensive chain cooperation and comprehensive concepts will be the foundation for the circular economy with a lasting value for horticulture. The starting points for this memo were the comprehensive goals in the National Circular Economy Programme / Raw Materials Agreement:

NATIONAL CIRCULAR ECONOMY 2050 PROGRAMME / RESOURCES AGREEMENT

- Closing cycles is the focus.
- All resources and residual streams will stay in the cycle for as long as possible in an as high-grade fashion as possible.
- Cascading and multifaceted valorisation.
- Reducing the use and replacement of non-renewable, critical resources with biomass.
- New ways of producing and consuming that lead to departures from past trends.
- Production/consumption must stay within the boundaries of what the earth can handle.
- Social sustainability.

2. VISION FOR 2050

IN 2050 WE…

Horticulture plays a pivotal role in the circular economy in the Netherlands. The basic principle of this situation is to have a zero-impact status for the horticultural sector. At business level, the relevant chains of resources and additional materials are fully closed and there is no net contribution to the CO_2 output. Based on this situation, horticulture has developed a large diversity of comprehensive (chain) concepts that also contribute to the circular economy in the Netherlands.
Together with their suppliers and buyers (in existing and entirely new markets), the material needs of the horticultural sector have been minimised and made more sustainable. Think of the increase in the use of biodegradable additional materials and packaging, sustainable growing systems, etc. And horticulture also contributes to a reduction of the material needs of its market partners. Horticultural products will be used fully, in a high-grade and cascaded (starting with food and pharma) manner. For applications such as cosmetics, biological crop protection agents, construction materials, packaging and high-grade speciality chemicals, the possibilities horticulture offers and the Power of Plants are familiar and are being used. A situation has been created in which horticulture contributes directly to the greening of a large number of related sectors. As such they optimally fulfil this pivotal role. This situation will be achieved if horticulture takes a proactive part in the development, introduction and implementation of comprehensive circular concepts, such as feeding and greening megacities, High Tech Urban Farming, etc. with food safety as the natural precondition.

FROM NOW…

In order to achieve the dream vision of 2050 in which creation of added value for the sector is combined with extensive integration with urbanised regions, horticulture will:

- Continue the current move towards zero/low impact with maximum effort.
- Introduce and implement alternative growing/food concepts that contribute to comprehensive circularity and reduction of the CO_2 footprint.
- Take up a proactive role towards chain partners and other relevant sectors (logistics, waste processing, water purification) to create innovative circular revenue models that should lead to added value for the sector.
- Operate together with chain partners in three new lines of action:
  - Circular growing.
  - Circular logistics, processing, and packaging.
  - Circular marketing.
- In doing so, we want to directly and clearly contribute to the joint efforts of the Biomass and Food Transition Team to achieve structural change in cycles of nutrients, proteins, and organic matter.

On the way to 2050, a triple helix approach will be used as much as possible, with a major part to be played by educational and knowledge institutes and with support from public financiers.
Crucial for the success of the transition and the role of horticulture in this are:

- Chain partners' willingness to develop comprehensive partnership concepts: with suppliers, buyers and the environment.
- Innovative entrepreneurship, possibility (financial and organisational) of innovative frontrunner initiatives, awareness of product and chain responsibility.
- Large extent of data collection and distribution (including semi-open innovation).
- Regional embedding with international scope.
- Expansion of cooperation with knowledge and educational institutes.
- A facilitating innovation and research policy, including budget.

3. CURRENT DEVELOPMENTS THAT CAN BE BUILT ON

Over the past years, there has been a focus on a large number of innovative programmes to make the sector more sustainable. At the same time, new growing concepts are introduced and demonstrated. In the subdivision into circular revenue models, a division is used as proposed in the book: Waste to Wealth: Creating Advantage in a Circular Economy.
Examples of this are:

TO LOW/ZERO IMPACT

- Programmes focused on CO_2 reduction, water savings, etc. (inter alia 'Greenhouse as Energy Source, Waterproof Greenhouse Horticulture) that led to significant turnarounds in horticulture with respect to the use of land and additional materials.

CIRCULAR ECONOMY IN HORTICULTURE

Circular input/physical concepts

- Central role in CO_2 networks (as a buyer).
- Role in other physical circular concepts (valorisation parks, heat networks, etc.).
- New growing concepts contributing to or based on circular systems.
  - Vertical Farming / High Tech Urban farming (More compact growing systems, Limiting land use – Feeding & Flowering the city).
  - Growing on water (Limiting land use and nutrients).
  - Growing without daylight (efficient with water, energy, and nutrition sources).
  - Growing on bio-substrate.
  - Growing with exclusively biological nutrients and crop protection agents of a natural origin.
  - Replacing production methods with sustainable alternatives, such as continuous development of used plastic clips >> degradable alternatives.
  - Using low-P and low-N 'champost' to enrich organic matter level on sandy soils.

LIFESPAN EXTENSION

- A focus on plant health and resilience (inter alia breeding, increased and controllable growing (integrated crop protection)), such as 'Het nieuwe doen in Plantgezondheid'.

VALUE RECLAMING/VALORISATION

- New markets, applications and revenue models.
  Examples: realisation of the Extracts Library, the introduction of vanilla growing in the Netherlands and the 'Green and well-being' programme.
- Innovative valorisation of residual streams in a circular concepts (packaging, additional materials).
  Examples: Valorisation of mushroom-feet to a new food concept (components from) 'champost' as a mineral fertiliser, etc. Horticulture's initiative to produce paper/packaging materials based on tomato stalk fibres also received a lot of attention. An initiative with enormous PR value, but complex to implement.
- Experience and knowledge position in high-grade markets:
  - Application of plant components for sustainable crop protection.
  - Use of plant substances for the treatment of chronic afflictions, such as rheumatism, and diseases, such as obesity and type-2 diabetes.
  - Replacement of chemical synthetic flavours with plant substances and the use of plant fibres in food.
  - Personalised Food.
  - Feeding & Flowering Megacities.

Concepts in which horticulture wants to expand its position at the base of the chain and use the acquired knowledge, but for which cross-sector cooperation, flexibility of legislation and policy as well as reinforced facilitation of frontrunners are required.

4. GOALS FOR 2021, 2030, AND 2050

The goals in the National Circular Economy Programme are directly and indirectly leading for the more concrete subgoals in this theme:
The shift or further development towards a system with new economic opportunities for the sector and as little use of new resources as possible.

Material savings and CO_2 reduction.

- Efficiency improvement in substance and material chains.
- Energy and water savings.
- Replacement of fossil resources with bio-based resources.

Safe and healthy.

- Replacement of substances that affect health or the functions of ecosystems with safe functional plant substances.
- Creation of certified products together with the retail sector (by means of 'Miliekeur', other sustainability quality marks or equivalents) for both the national and export markets.

2021

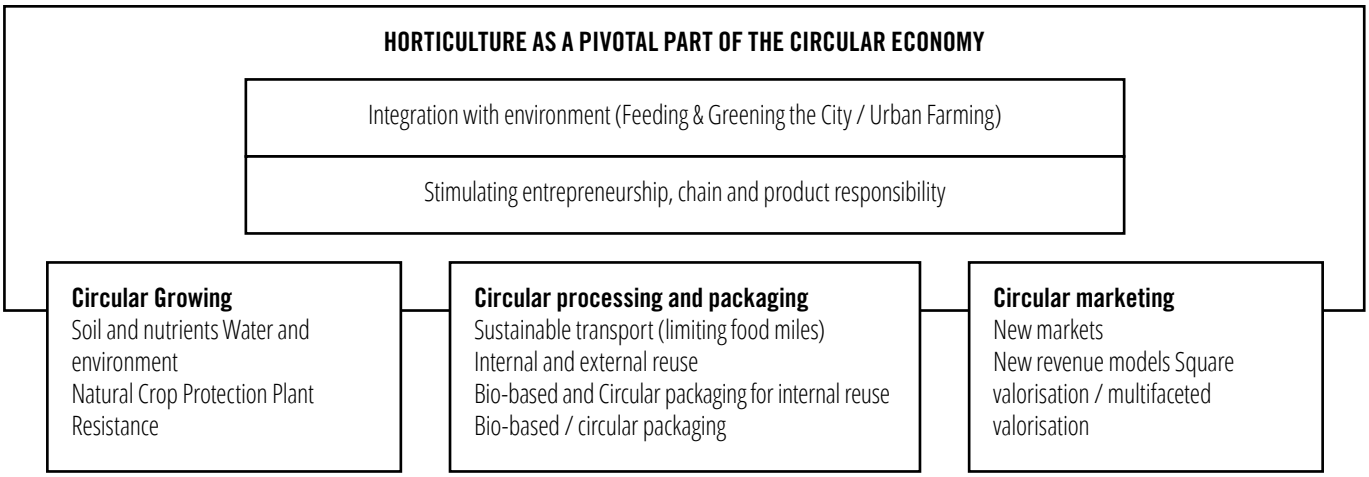
The goal is: The first clear steps have been made. Pilots are executed together with frontrunners and chain partners in the following subareas:

- Nutrients applied in horticulture have been 'recycled'.
- Vegetable residual streams from horticulture are used with a positive value in new products together with the chain partners/end customers in question.
- Resources are reclaimed by collecting the products after use.
- The packaging used in the horticultural chain is bio-based and/or reusable.
- Materials and products are procured in a circular, sustainable manner by the horticultural sector.
- Additional materials in the horticultural chain are biodegradable (strings, clips, elastic bands).
- Plant substances are extracted and valorised.
- All horticultural products in the Dutch supermarkets meet the state-of-the-art sustainability requirements and at least have a sustainability quality mark.

2030
- Producer responsibility has resulted in a system in which rejection and loss in the chain is collected and used in a useful and coordinated way.
- The same applies to crop remains at the end of the growing cycle and which are generated during the growing cycle through, for example, clipping.
- Green crop protection agents based on plant substances produced by the sector itself take up a substantial share of operational plant health programmes at an operational level.

2050
- Growing concepts, valorisation concepts and techniques have been developed with which circular production is possible in an economically viable manner.

5. DESIRED INNOVATIVE LINES OF ACTION (PROGRAMMES, PROJECTS) – WHO/WHAT/HOW



1) CIRCULAR GROWING
Health of the soil/growth substrate is crucial for the future of the global food provision. Balance and circularity in nutrient use, organic substance and soil quality combined with (effectiveness of) soil use is the first priority for agriculture and horticulture. Innovation in and introduction of new, accommodating growing systems is of great value to the sector for this reason. Another point of attention is knowledge of the effects and application methods for green crop protection agents.
Cross-over is necessary between: T&U, HTSM, Water, Logistics, Energy, VNCI Top Sectors.

2) 'CIRCULAR LOGISTICS, PROCESSING AND PACKAGING'
Innovation and increased sustainability of logistics as well as the processing and presentation of the product can to a large extent contribute to the comprehensive CO_2 footprint of the sector. This additional step must also contribute to the sustainability positioning of the sector with the consumer. Translating this perception into concrete added value (and thus additional room for innovation) is a big challenge.
Together with technology partners and chain partners (especially the demand market), the horticultural sector wants to translate the acquired knowledge into a more mainstream application within the sector of circular processing and packaging concepts.

CHALLENGE
Translation from experimental projects into mainstream. Translation from sustainability into concrete product added value.
Cross-overs are necessary between: A&F, T&U, HTSM, Energy Top Sectors, LSH Logistics, and the creative industry.

3) CIRCULAR MARKETING

New concepts do not necessarily result in extra added value for the sector. The challenge is to develop new market concepts together with the buyers and to translate them into innovative forms of cooperation and revenue models. Introduction of square valorisation of resources and/or cascaded marketing of products are an important part of this.

CHALLENGE

Translating the aforementioned knowledge of components and market possibilities into actual market penetration of new products in new markets with a focus on as high-grade a sale as possible. Think of food and pharma in this case.

Cross-overs are necessary between: T&U, LS&H, Chemicals Top Sectors and especially the retail and manufacturing industry.

TRANSLATION INTO LINE OF ACTION: 'FEEDING AND GREENING MEGACITIES'

In a broader perspective, the relevant developments in this context contribute to the knowledge, concept and technology development that can meet the ever-growing urbanisation in the future, along with the search for sustainable, highly efficient production systems with added value for the sector. This mainly concerns more compact systems that can better be fitted in with future situations. This line of action in particular can also contribute to further stimulation of circular concepts with horticulture as a pivotal part and a multitude of other sectors as enablers.

6. REQUIRED INTERVENTIONS SUCH AS LEGISLATION AND REGULATIONS, KNOWLEDGE & INNOVATION, SMART MARKET INCENTIVES, FINANCING, INTERNATIONAL COOPERATION, AND BEHAVIOUR

REINFORCING FUNDAMENTAL KNOWLEDGE DEVELOPMENT

The following lines of research at least require a lot of attention:

1. Seed and species breeding and multiplication. Breeding needs to further enhance plant health and resilience as well as enforce sustainability and climate resistance. Dutch high-end breeding companies will have to make a difference around the world.
2. Speeding up and simplifying degradability of materials in horticulture (in line with the growing season).
3. Knowledge of plant substances, their functionality, genetic and physiological background for the production of plant substances, extraction and biorefinery methods.
4. Knowledge about soil life and the production methods to be realised.

FLEXIBILITY AND INNOVATION IN LEGISLATION AND REGULATIONS, FINANCING, AND INNOVATION AND RESEARCH POLICY

- A primary scaling up (proof of principle <> proof of concept) leads to major complications in legislation and regulations. Legislation in the field of waste, new food concepts, etc. that is strict and not very flexible by nature usually limits a first scaling up. Making such specific, impeding regulations flexible (e.g. by using test grounds) is strictly required to achieve actual change.
- Legal procedures regarding 'an end to waste' and the use of residual streams in new products need to be sped up and made easier. Moreover, room for experiments is required to process vegetable components and residual streams in new products.
- An initial scaling up of innovations usually comes with a cost-price limitation. The standard, less circular, benchmark can be offered at a lower cost. There should be a tax on 'non-circular'.
- Developing new legislation in order to admit so-called green crop protection agents with a low environmental impact to the market faster.
- Circular revenue models need to be encouraged to clarify responsibility and liability in new circular chains.
- Whether rules regarding producer responsibility as are now common for household appliances can be expanded to horticultural chains and related packaging chains needs to be checked. Legislation should improve resource efficiency and high-grade valorisation. This means that undesired incentives regarding incineration and fermentation of valuable biomass need to be stopped.
- Frontrunners in sustainable / circular innovation have a lot of knowledge questions and take a lot of risks. Support in this field, especially as a cross-sector, circular innovation and research programme and network, is essential.

REINFORCING CROSS-SECTOR COOPERATION

Building on the various cross-industry dialogues and programmes (e.g. Bio-based Circular Business platform), the intentions need to be concretised into actual cooperation at an operational level. This step is usually quite complex. A switch from sector-oriented support to theme-oriented support (full-chain) needs to be made at multiple levels.

- Developing innovative cooperation concepts (new cooperative formats).
- Introducing theme-oriented/cross-sector subsidy programmes.
- Facilitating (sector) independent chain directors.

SMART MARKET INCENTIVES

- The market inclusion of new circular and bio-based products need to be stimulated.
- Socially responsible and innovation-oriented procurement.
- A system that includes the social costs in the cost price to further reinforce the market inclusion of sustainable circular products.

7. EFFECT ON CROSS CUTTING THEMES: SUSTAINABILITY FRAMEWORKS, INCREASING BIOMASS OFFER

This priority is an example for the integration and implementation of circular concepts from other components of the National Circular Economy Programme:

- Plastics - stimulating the reuse of plastic packaging + biodegradability of plastic additional materials in the horticultural sector (e.g. elastic bands for flowers, thread and clips in the greenhouses).
- Consumption goods - reducing rejected and lost food products in the chain + producer responsibility in respect of waste collection and reuse + better use of products that are currently rejected because of their looks. Scaling up initiatives like 'Kromkommer'.
- Construction - applying horticultural residual streams in sustainable construction materials.
- Biomass and Food - priority of nutrient cycle: essential for sustainable growth
- Biomass and Food - valorisation of residual streams/biorefinery/investment climate - technological and financial models that contribute to economic concepts for complete valorisation of horticultural products.

8. SOCIAL ASPECTS

Horticulture is changing. The buyer will need to change along with the entire chain.
Various current developments, especially regarding growing concepts, lead to frowns among consumers. 'Lettuce belongs in the field, not in an enclosed space.'
The communication of developments in horticulture to the buyer, including the end consumer, will need to be enhanced in order to influence the 'citizen' and the consumer perception. Awareness of the necessity of new concepts for a healthy future for the sector and for society (from a sustainability perspective) is vital. Apart from this 'social' understanding of technological innovation and the resulting demand, the sector also faces a major challenge in translating increased sustainability and quality into concrete added value. Chain cooperation is required, but an open mind for the end consumer's needs is definitely necessary, too. That is the only way in which we can contribute to a sustainable future for the horticultural sector and thus for the Netherlands as a whole.
Involving young entrepreneurs in the process is crucial. Through technology to be developed and applied, young people can be made enthusiastic about involvement in the process. Realising an 'Education for circular horticulture in 2050' Master Plan for young and old, with involvement of the circular horticultural companies, appears to be essential for this.

APPENDIX 2E: FOOD WASTE REDUCTION WORK GROUP

Editor: Toine Timmermans (chair of Task Force Circular Economy in Food), administrative office (Ministry of Agriculture, Nature and Food Quality, Food Sustainability Alliance, Wageningen University & Research), input (through interviews and work sessions) from CE in Food Task Force members (see paragraph 6 for an overview of the members)

1. SCOPE

In May 2017, a closing balance was drawn up of the ambition of the Dutch government to reduce the amount of food wasted by 20% between 2009 and 2015. This ambition was not achieved despite the many initiatives and the efforts of a range of different parties. The amount of food waste in 2015 for the entire food chain including the consumer lies between 1.7 and 2.5 million tons[85]. This means there is a significant decline in waste. A light at the end of the tunnel is that there appears to be a slight decrease in the amount of avoidable food waste by consumers of about 15%, from an average of 48 kg per person in 2013 to 41 kg per person in 2015. Because this difference falls within the reliability margin, the decrease is not significant. The amount of food wasted by consumers in 2015 totals 700 kg per year.

It concerns **food waste** if food intended for human consumption is not used for this goal. Residual streams used for food, animal feed, bio-based materials and chemicals are not covered by the term food waste. A final proposal for a European Framework is part of the Circular Economy package that will be published before the end of 2017.

The food waste in 2015 in the Netherlands lies between 1.77 and 2.55 million tons. Converted, this is between 105 and 153 kg per capita.

The impact of unconsumed food on climate change in the Netherlands is 16%-22% of the total impact caused by food (FUSIONS, 2016)[86]. The contribution of 'food' in the total amount of climate gas emission due to human activities is about 30%. The biggest impact by far is caused during the primary production phase; for the Netherlands, the impact of food waste is indicated to be between 5 and 8 Mt CO_2-eq/year. This calculated estimate is based on the combination of the LCA analysis and calculations for EU-28, combined with the data from the Food Waste Monitor. In terms of total emission in the Netherlands in 2014, this amounts to 204 Mt CO_2-eq, which is a significant contribution. The FAO estimates a global food waste-linked emission at 3.3 Gigatons CO_2-eq/year, which is 7% to 8% of the total global emission.
FUSIONS estimates the emission in EU-28 at 304 Mt CO_2-eq/year, which is 6% of the total emission. Apart from the negative effect on climate change, negative effects of food waste are directly related to food security (loss of nutritional value) and ecological impact (water, land use, biodiversity, etc.). These impact factors are described in a qualitative manner, and quantitative where possible, at European level in the FUSIONS report.

There is an increase in momentum at all scale levels (global, national, regional, sectoral, local) to depart from past trends and achieve actual reduction of food waste. This required a more widely supported mindset for change and reinforcement of the connection between all actors at the various levels, from decision-makers to operational execution with a combined top-down and bottom-up approach. In order to realise this situation, companies from the entire food chain and related industries joined forces to form the Task Force Circular Economy in Food (TCEF) to increase the circularity in the food chain and drastically reduce waste. An important ambition of the Task Force that was formed in 2017 is the necessity for speeding up the initiated actions, identifying and breaking down barriers, and achieving an economic and social impact. Connecting actors and solutions with an impact for change and realising an effective ecosystem is key. Companies will take the lead and the other actors will take up a catalysing, supporting, and facilitating role.

[85] *Wageningen Food & Bio-based Research, Food Waste Monitor, update 2009-2015, report number 1747, 2017.*

[86] *FUSIONS, Criteria for and baseline assessment of environmental and socio-economic impacts of food waste, 2016.*

2. VISION AND SOLUTIONS

The Netherlands committed itself to SDG 12.3: halving the food waste by 2030. An increasing group of organisations and stakeholders are now convinced that there is enough momentum to act and make a change. There are sufficient solutions to scale up and create mass and impact. The Combating Food Waste[87] report of the European Court of Auditors, published in early 2017, conveyed a clear message: The EU's current policy is not sufficient; only a more comprehensive, holistic policy will have sufficient effect. This means that the link with the future European Common Agricultural Policy is essential. Topics such as fishery policy, regional agriculture, honest trade practices between chain parties, and Europe's social agenda need to be included in the formation of an effective strategy.

The Task Force Circular Economy in Food has set the following goals:
We will prevent and reduce food loss and food waste in the chain and at the consumer to a minimum (SDG 12.3) and will become the international frontrunner in maintaining (unavoidable) by-products within the food chain. This will make a major contribution to countering climate change and guaranteeing food security.

Halving food waste at the consumer and food loss in the chain by 2030 (SDG12.3) are goals for the long term. The intermediate goals for 2020 and 2025 were specified in 2018. Companies affiliated with the Task Force are committed to their own ambitions and the joint goals. From 2018 onwards, the affiliated companies will report on their own actions and progress annually.

An estimated 88 million tons of food is wasted in EU-28 every year (FUSIONS, 2016)[88]. Achieving SDG12.3 means that we need to prevent about 44 million tons of food from being wasted and maintain it within the food chain (or give it a high-grade use) through innovations and behavioural change among consumers and the business community. And we need to do so within a period of 13 years. This offers explicit opportunities for new business concepts for Dutch companies. Prevention, reduction and maintaining by-products in the food chain will allow the Netherlands to reduce food waste in the chain up to and including the consumer to between 450 and 900 million kg. This will result in a reduction of at least 2-3 Mt CO_2 eq/year and cost benefits of at least 1 billion euro. It will also lead to a significant net positive contribution to the profit and competitive position of the Dutch business community and create new activity and profit through innovation. However, not everyone can be a winner in such a transition process. In the end it is about the joint realisation of such opportunities in an open dialogue, with a focus on social interests and challenges.

The Task Force's focus lies on reducing food waste. We distinguish between three different forms of action to maintain resources intended for human consumption in the food chain. In order of priority:
1. Preventing food waste (design issue).
2. Reducing food waste (innovation and chain issue).
3. Better valorisation of (unavoidable) residual streams within the food chain (human consumption, or upcycling of low-grade resources into high-grade nutrients through livestock farming).

The Task Force's mission is to be a catalyst in the transition towards a food chain and food system in which unnecessary waste does not exist and in which resources are efficiently and effectively maintained in the food chain. This is achieved by inspiring entrepreneurs and companies to reduce food waste and the amount of waste in the entire food chain and at the Dutch consumers. We will show the possibilities (give direction, dot on the horizon) and the yields (business case and impact). We will make it easy to get to work yourself step by step. We put matters on the agenda, act as pioneers, and experiment in the context of the major challenges regarding SDG 12: A responsible food system for which there are no (good) solutions yet.

To achieve this, four main strategies have been defined:
- Setting the agenda: creating awareness, increasing willingness for action, increasing transparency, setting new standards, and offering structure to get to work.
- Learning and innovating: focused on actions, implementation, and monitoring progress and impact.
- Making mass: from start-up to scale-up, speeding up and increasing the scale of innovations by major companies.
- Changing the rules: looking into systemic challenges, developing proposals for adjustments (legislation, transparency, reporting), developing scenarios, multi-stakeholder processes.

[87] *European Court of Auditors, 2016, Combating Food Waste: an opportunity for the EU to improve the resource-efficiency of the food supply chain, report no 34.*

[88] *FUSIONS, Estimates of European food waste levels, 2016.*

2.1 SETTING THE AGENDA

The following themes have a priority in putting actions on the agenda and stimulating these:

- At a national level, formulating a leading goal (biannual) based on an analysis of hotspots, progression, and sector analyses. Companies and sectors are challenged to share the transparency of the utilisation of the resources.
- Active coordination and collaboration (and deduplication) with parallel initiatives to reinforce and connect.
- The Task Force members have a leading role and act as ambassadors in their own chain(s) and sectors. This includes providing access to knowledge, skills, means, and tools (open source).

Individual companies (signatories and supports) will be supported in the positioning of the opportunities within their organisation, inter alia through:

- Development of annual reporting and dialogue strategy, ambition and actions.
- Baseline measurement and benchmark based on their goals.
- Mapping out relevant initiatives, possible partnerships, strengths, and focus areas.
- Chain tables, opportunity maps with ideas and possibilities for speeding up and realising the goals.
- Developing a roadmap draft for impact for each specific company and chain.

2.2 LEARNING AND INNOVATING

- Improving current streams and challenges and looking for solutions for prioritised ones. (Help) setting up pilots and filling in the underlying business cases.
- Learning from Global Champions. 12.3 and other international initiatives (EU REFRESH, Consumer Goods Forum, etc.).
- Starting pilots and breakthrough projects (at least 4 each year) for evidence in hotspot approach, e.g.:
  - Preventing waste through better prognoses and replenishment (including the utilisation of new technology platforms, such as smart sensoring and blockchain networks).
  - Mobilising large companies, municipalities, provinces and governments, for instance, to include a mandatory 5% 'residual stream products' in tenders (link with Circular Procurement Green Deal).
  - Increasing the scale of the conversion of fruit, vegetable and horticultural residual streams (in the food chain).
  - Start-up Booster (cooperation with NL Circular and other start-up and accelerator programmes).
  - Physical experiment capacity (SME living lab) and Field Lab (consumer interaction).

2.3 MAKING MASS

Changing the mindset and setting new norms and standards are the primary goals in the Creating Mass strategy:

- En route to a tipping point: it would be mad to leave any value behind. It is not done to waste food.
- Connecting companies, initiatives and authorities with (partially) overlapping ambitions for reach and clout.
- Collecting available and proven solutions and making them easily accessible and attractive.

2.4 CHANGING THE RULES

Identifying and looking deeper into systemic challenges, developing proposals for adjustments (legislation, transparency, reporting), developing scenarios and analysing the impact thereof (exergy, environmental impacts, economic, social), in accordance with multi-stakeholder processes.

The goal is to structurally remove the underlying systemic limitations; Systematic breakthroughs (where does it go wrong and what do we go for?) based on impact projects / chain tables. The promising ideas will be substantiated in line of action (2) learning and innovating.
In 2018, the following will be started:

- Making an inventory of the top-10 barriers in impeding legislation and regulations and removing them.
- Developing an awareness and action campaign regarding the value of what we are throwing away.

3. CURRENT DEVELOPMENTS

There are many developments in the field of reducing food waste. The challenge lies in focusing on solutions based on a more holistic and systemic perspective, with major positive effects (economic, ecological and social). Some examples of such cases:

CASE: REDUCING WASTE AT CONSUMERS, THE BUSINESS CASE

Consumers in the Netherlands waste an average of 41 kg per person, which makes a total of 700 million kg per year. This represents a purchase value of about 2.6 million euro, about 350-400 euro per household. Experience gained in the UK shows that the revenue model of the reduction of food waste among consumers is interesting. Every invested euro resulted in a reduction of 100 euro worth of food (at city level) and a factor 250 nationally (Love Food, Hate Waste model). This result is primarily related to fewer purchases of food by consumers. Furthermore, the evaluation showed that a part of the money saved due to buying less food was used to buy higher quality and more sustainable food.

The reality is that, broadly speaking, the food sector does not have a direct economic interest in reducing food waste at consumers. And, because food has always been cheap, saving 1 euro per day is not a strong incentive for the consumers themselves. This clearly is a social challenge that requires a lot of effort from the central government and local authorities. A possible hypothesis can be: a 20% reduction of food waste in 5 years will result in social savings of about 1 billion euro/year, whereas the investment is estimated at 20 million euro (divided over multiple years). Apart from lower social costs, a strategically designed action programme also has other benefits, such as an increase of social inclusivity, lower environmental pressure (reduction of at least 1-2 Mt CO_2-eq/year if combined with an approach aimed at making the diet more sustainable, a healthy diet (with lower health costs), etc.

The outlines of such an approach can already be drawn. A national structural action-oriented approach (countering food waste together) with an action perspective and a direct reward for desired behaviour. Inspiration from, for example, the successful LoveFoodHateWaste campaign in the UK, designed from a modern perspective together with the business community and the main drivers for consumers as the starting point; (1) ethical aspects, (2) saving money, and (3) sustainability/climate. Financing, at least 2M Euro/year from the national government for a period of at least 5 years, doubled through equal participation of the business community. And similar efforts at a local/regional level through local partnerships and regional programmes (municipal/neighbourhood level). What is the yield? 20% reduction of food waste, about 140 million kg per year (value of food is 500 million euro, savings largely used to stimulate better food) and a reduction of at least 1-2 Mt CO_2-eq/year.

CASE: VALORISATION OF (UNAVOIDABLE) RESIDUAL STREAMS TO ANIMAL FEED

Matters that could not and were not permitted to be discussed a number of years ago are now tentatively put on the agenda in both the Netherlands and Europe. There are open discussions about the future new possibilities and dilemmas regarding the use of former foodstuff and other residual streams, such as animal feed, instead of more low-grade fermentation or composting. Matters such as food safety, animal welfare, nutritional value, ecological impact, positioning and marketing are all discussed. In the current plans in place in Europe, the processing of the volume of former foodstuff into animal feed can be expanded from about 3 million to 7 million tons with a significant reduction of food waste as a result. If other by-products in the future can also be used safely and responsibly for animal feed, such as swill and bone meal, this may have an even larger (economic and ecological) impact.

Researcher Hannah van Zanten obtained her doctorate in 2016 with her research into the perspectives and benefits of a sustainable livestock farming industry that is primarily based on the use of waste and by-products and marginal grassland that are not directly suitable for our food production. The importance of safely using residual streams that are not permitted under current European legislation and regulations has been described in Zu Ermgassen et al. (2016) and Salemdeeb (2017). The conclusion was that 'food waste' processed into pig feed via heat treatment will reduce land use by 20% (about 1.8 billion hectares of agricultural land). Such processes are extensively applied in Japan and South Korea, for example. Recently, an international expert committee determined that technically, there are no real reasons for not (re)introducing such a system in Europe with fully transparent and safe use and while maintaining low-grade food streams in the food chain.

Additional work is required in the field of traceability and guaranteeing the health of humans and animals, social acceptance, positioning products as premium and sustainable, and sound environmental and LifeCycleCosting assessment.

4. DESIRED TRANSITION PROGRAMME

The proposed transition programme consists of seven lines of action. These lines of action have been described below with an indication of the actions for the next four years. The lines of action are linked to the four strategies in the transition process: (1) Setting the agenda, (2) Learning & innovating, (3) Making mass, and (4) Changing the rules. The various lines of action will be refined every two to four years and adjusted where necessary. A diverse set of harmonised and coordinated actions is required to achieve these goals. The approach focuses on the following required and linked actions:

1. **Monitoring & assessment** of food waste and resource efficiency The EU will oblige the Netherlands to report bi-annually on the development of the amount of food waste from 2020 onwards (Circular Economy Package). Over the past five years, experience has been accrued, a basic framework has been developed, and various reporting tools have been made available (Food Waste Monitor, FUSIONS). In order to create a more reliable overview including insight per chain segment, this monitoring tool will need to be expanded through a methodology of self-reporting (by companies in the entire chain) and smart expansion of existing data collection methods. By order of Economic Affairs, two exploratory studies have been conducted into the feasibility of such an approach. Moreover, WUR gained experience with self-monitoring pilots.

2. **A change in awareness and mindset** of actors (waste is a resource that still needs to find its way to its final destination). Transparency about their goals and the progress of their actions is a proven way of positively changing the attitude and willingness for action. According to the principle: Target, measure, act. Various companies – early adopters and early followers in particular – require supporting tool sets, such as vouchers, opportunity cards, process support, opportunity analysis tools, and expertise to create a business case in broad outlines.

3. **Action 'Countering Food Waste Together'** Consistent and structural approach to consumer behaviour via a coordinated and harmonised action, both publicly and privately (co-design and co-creation). To be launched in March 2018 during the National Month against Food Waste.

4. **Innovation and pilots** especially regarding chain cooperation, breakthroughs and scaling up, start-up support (SBIR), accelerator and coaching programmes (combination of start-up and business community).

5. **Living labs** (regional and national ecosystems, such as ThreeSixty/FoodWasteXperts, Bluecity, World Food Center) and field labs (supermarkets, restaurants and catering, waste collection/municipalities, kids' education, farmers markets/gentleman farmers).

6. **Portal with best practices** to stimulate interaction between stakeholders as well as continued development of existing digital platforms (www. refreshcoe.eu, www.nowastenetwork.nl and food.waste.community).

7. **Sharing knowledge and experience at an international level.** Taking responsibility for international chains, implementing solutions locally. Moreover, positioning the Netherlands as a frontrunner in Europe and the rest of the world (EU Platform on Food Losses and Food Waste, Holland Circular Hotspot, Champions 12.3 coalition).

5. REQUIRED INTERVENTIONS

A cohesive package of government interventions will be required to support the above transition programme. This package needs to ensure that the rules of the game change in such a way that food waste is reduced by at least 50% in 2030. An overview of the interventions that are a part of the action agenda against food waste has been included in the table below.

TYPE OF INTERVENTION	BOTTLENECK	DESIRED MEASURES	SCALE
Smart market incentives and financing	Incentives for better valorisation (food, feed)	Remove unintended negative effects (SDE+), reward good behaviour, the polluter pays, break lock-ins.	NL
	Stimulate sustainable investments and innovations.	Monitoring (SDGs), private-public investments True pricing/externalities Government and business community as launching customer, sustainable procurement criteria.	NL
	Offer a platform for positioning innovations and best practices.	Support good initiatives and companies (through independent assessments).	NL, EU, global (via Champions 12.3)
Knowledge and innovation	Insight into microbiological safety and assessment frameworks for residual stream use in animal feed.	Research (food safety, risk assessment), deep-dive best practices (Japan, Korea), impact assessments (cost-benefit), consumer acceptance.	NL, EU, global
	Consumer willingness to pay and starting points for behavioural change.	Relatively little knowledge about drivers and motivators for behavioural change.	NL, EU
	Knowledge circulation is still difficult (especially towards SMEs and regarding scaling up).	Support Field Labs for co-creation and open innovation, Living Labs/ testing grounds for social reality check.	NL
Legislation and regulations	Bottlenecks in waste legislation with respect to high-grade reuse.	Conditional exception of demonstrably safe use of residual streams in food and in animal feed in particular.	NL, EU
	Bottlenecks in Novel food legislation.	High-grade and safe use of vegetable residual streams for upcycling via insects, for example.	NL, EU
Behaviour	Counter food waste: joint action: samentegenvoedselverspilling (Countering food waste together).	Stimulate awareness, field labs (various target groups), education. Date labelling (link to Best-before Date Green Deal).	NL
International cooperation	Coherence and consistency of policy.	Position of NL as a frontrunner (EU FLW platform, Holland Circular Hotspot, Champions 12.3 coalition).	NL, EU, global
	Innovations that contribute to Zero Hunger and Climate Change challenges.	Take responsibility for international chains, implement solutions locally (food security).	NL, global

6. COMMITMENT FROM COMPANIES AND STAKEHOLDERS

The Core Team of the CE in Food Task Force supports this strategy and agenda. It is made up of representatives from the business community and supplemented with public and social organisations. Below, you can find a list of the committed core team members. The Task Force is supported by ambassadors with a focus towards a responsible global food system. These will form the link to the Global Champions 12.3 coalition. In the coming years, more individual companies will join the Task Force voluntarily, either as a Signatory or as a Supporter (goal of 200 companies in 2019). Signatories support the ambitions of the Task Force, report transparently about their progress and actions in the field of reducing their food waste, and act as ambassadors within their sectors. If so desired, supporters are supported to develop themselves to become frontrunners in the field of the Circular Economy in Food (through a broad tool set in line with the company). All partners in the Task Force make a visible contribution to the realisation of SDG 12.3.

Ahold (Tony Vendrig), Alliantie Verduurzaming Voedsel (Marc Jansen), Brightlands Campus Greenport Venlo (Saskia Goetgeluk), Food Tech Brainport/Proverka (Jan van Rijsingen), Google (Michiel Bakker), Hutten / ThreeSixty (Bob Hutten), Lamb Weston / Meijer (Jolanda Soons-Dings), LTO (Elies Lemkes), McDonald's (Manu Steijaart), Milgro (Laurens Groen), Moonen Packaging (Gé Moonen) , MVO Nederland (Gerard Teuling), Protix (Roel Boersma), Rabobank (Ruud Huirne), RijkZwaan (Anneke van de Kamp), Scelta Mushrooms/Kids University for Food (Jan Klerken), Sligro Food Group (Gerrit Buitenhuis), Unilever Food Solutions (Eveline Nederlof), Ministry of Agriculture, Nature and Food Quality (Martijn Weijtens), Kenniscentrum Duurzaam Verpakken/KIDV (Hester Klein Lankhorst), Natuur & Milieu (Hilde Engels), NVRD (Olaf Prinsen), the Netherlands Nutrition Centre (Margret Ploum), Youth Food Movement (Jorrit Kiewik), Wageningen University & Research (Toine Timmermans).