Theme 1: Biosphere: Rethinking our food and bio-based systems

session 1-10

1s1

Healthy Foods produced in circular food systems

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Today’s global food system is responsible for about a quarter of all human-induced greenhouse gases, one third of global terrestrial acidification, the majority of global eutrophication, and covers 40% of the world’s ice and desert-free land. Simultaneously, people still lack sufficient food, consume low-quality diets, or eat too much food (triple burden of malnutrition). Consequently, these unhealthy diets result in serious health risks such as diet-related obesity and diet-related non-communicable diseases including coronary heart disease, stroke, and diabetes. Humanity, therefore, now faces the grand challenge making healthy diets accessible to all people while safeguarding the planet’s health.

An increasing body of literature suggests that a transition towards circularity in the food system might be an important solution to reduce the environmental impact. However, to what extent can a circular food system secure nutritious healthy foods for a growing population? Or, in other words, can dietary recommendations be met in circular food systems while respecting our planetary boundaries?

Within the current literature numerous healthy and environmentally friendly dietary guidelines have been proposed. Such dietary guidelines aim to reduce environmental impacts (e.g., GHG emissions, deforestation, soil degradation, eutrophication and biodiversity loss) while simultaneously reducing the risk of non-communicable diseases (e.g., cardiovascular disease, colorectal cancer and type-2 diabetes). One prominent example of a healthy and environmentally sustainable dietary guidelines is the one of the EAT-LANCET commission. Within the proposed dietary guidelines circular agriculture is however not considered. In a circular food system arable land should be primarily used to produce nutritious healthy foods from plant biomass that fulfil the majority of the nutritional requirements of humans. During the production and consumption of foods from plant sources several by-products are produced, such as crop residues, co-products from industrial food processing and food waste. Such residual streams should be recycled in the food system in order to maintain or improve the soil and fertilize crops, or to feed animals. The availability of those residual streams depend on the plant-based-foods that are consumed and on the way how the raw materials are processed into foods.

The question we, therefore, aim to address in this session is how can we secure healthy nutritious diets while at the same time stimulate a transition towards more circular food systems that reduce the environmental impact. We aim to answers questions like: ‘which crops should be grow and which animals should we keep to provide healthy nutritious diets produced in circular food systems?', 'what are the consequences of circular agricultural practices on ecosystems?' and 'what is the impact of food processing on food quality and how does this affect circularity (e.g. refine versus whole grains)?'. With this session we aim to develop a better understanding of how circular food systems can contribute to improving human and planetary health.

1s2

Nature-based solutions for circular food systems under climate change

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Food systems are currently not delivering what is expected or needed to ensure their desired outcomes in terms of food security, an affordable, safe and healthy diet for all people, ecological sustainability and resilience. Climate change will add further stresses on food systems at multiple scales that need to respond to future trends of increasing population, changes in diet and urbanisation.

At the same time, actors in the food systems are also asked to reduce greenhouse gas emissions and to shift towards circularity in production, processing and consumption. Circular food systems better optimize the use of scarce resources and reduce food losses. Circularity in food systems focusses on efficient use of land and closing the water, nutrient and carbon cycles to minimize resource loss and environmental degradation. Nature-based solutions that are inspired by (inspired NBS) or make use of natural processes (intrinsic NBS) are considered to have potentials for increasing circularity in food systems operating under climate change conditions. For instance it is expected that reuse of treated waste water combined with NBS innovations makes food production less dependent on conventional water resources and offers opportunities to make both nature and food production more climate resilient.

Aim:

This scientific session aims to share knowledge and build an international network on the potentials and limitations of nature-based interventions and pathways to ensure food security, to deliver a safe and healthy diet, to produce equal and equitable benefits, and to sustainability maintain the environment, while using minimal natural resources.

Themes:

Topics that can be addressed include:

- Potentials and limitations of NbS to close water, nutrient and carbon cycles

- Potentials and limitations of NbS to minimize resources losses / reduce waste and environmental degradation
- Governance of NbS that aim to increase the climate resilience of food systems
- Lock-inns and enablers of a nature-based driven transition towards circular food systems under climate change

1s3

The contribution of biodiversity to productivity in circular agriculture

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Widespread "linear" agricultural systems are increasingly dependent on artificial inputs and ignore the essential contribution of biodiversity and natural processes to food production. Biodiversity in this context is generally considered a nuisance, for example biodiversity may compete with primary crops and livestock, reduce quality of the crop, and is considered a burden or at least redundant. While these "linear" systems tend to have higher yields at the short term, they are also associated with major global challenges such as pollution and biodiversity loss. Circular agriculture has recently emerged as a concept to reshape agriculture and is gaining ground. Circular agriculture does not aim to maximize singular yields, but to optimize the system as a whole. That includes preventing wastes, re-utilization of waste streams for food production or using these streams efficiently. Diversity can play a central role in circular agriculture if we consider its contribution to soil quality, nutrient cycling and nutrient- and water use efficiency. Moreover, (associated) biodiversity can enhance productivity, for example through pollination or natural pest control. In fact, in natural ecosystems, productivity and robustness are often higher when biodiversity increases, because nutrients and water are used more efficiently and nutrients are being more recycled within a (bio)diverse systems. Practices aiming for diversity of crops and welcoming on-farm biodiversity, might mimic these biodiverse systems. The concept of circular agriculture is just emerging. Hence, there is not much knowledge about the role of biodiversity in circular agricultural systems, for example whether circular agriculture actually benefits biodiversity; how(bio)diversity can contribute to circularity; what could be the role of circular agriculture in avoiding further biodiversity loss? Increasing our knowledge on these questions gives scope for circular agricultural systems that benefit from and contribute to biodiversity

Session topic

We ask for contributions that show recent research on the link between biodiversity and food production or that shed light on how biodiversity can contribute to circular agricultural systems. Research may include theoretical, observational, experimental and model studies.

These contributions address questions like:

- How to use diversity to maintain or improve productivity within circular agricultural systems? For example: what is the impact of diversity within crops or breeds, crop diversity, on-farm wild biodiversity, or landscape diversity on production and circularity
- How can biodiversity contribute to circular food production?
- What can agriculture learn from circular natural processes, that are key for maintaining biodiversity?
- To what extent can circular agriculture help restore biodiversity?

1s4

Conversion of agri-food residues into foods/feed by (marine) microorganisms: opportunities and challenges

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Currently, about 35% - 50% of the world agri-food production is not consumed and wasted in the form of organic residual streams. In nature, this organic food waste is ultimately recycled to usable small molecules/nutrients/elements by combined activity a broad range of microorganisms. In this session we will focus on this microbial potential to avoid this massive loss of valuable food by delaying or avoiding the spoilage of the food materials and/or by converting the food waste into valuable and usable components for human consumption.

Food stabilisation/food storage:

The importance of microorganisms in extending shelf-life of (fresh) food and feed has been known for millennia and is currently widely used to produce safe (fermented) food and feed products around the world. The most successful cultures, now used for production of, for example, pickles, sauerkraut and silage, are currently also tested/customized for stabilizing a wide range of agri-food primary crops and side streams (in particular relevant during peak production), including tropical produce. The use of these processes will provide the local producer/farmer with higher harvest/income, will provide more food for areas with malnutrition, will lead to large reductions of food waste and will make the food industry more sustainable.

Re-use of Food waste/residual streams:

Even when optimal food stabilisation/storage is achieved, some food waste and residual streams from primary harvest will remain. Using nature as example/inspiration, microbial activity offers the possibility to re-use this natural source of carbohydrates and protein into valuable components for both the food, feed and chemical industry. In this "Microbial Conversion" session, examples will be presented in which agri-food biomass is converted into nutritious and good-tasting meat- and dairy-replacers, into flavour ingredients, into palm/vegetable oil-free mayonnaise and other spreads. Also examples will be given where non-food grade residual streams are converted, through fermentation, into bioplastics, into surfactants/antimicrobials for use in Home & Personal Care-products and even into biofuels.

In summary, this scientific session (or workshop) will

1) present and discuss fermentation as natural storage process;

2) present and discuss examples of re-use of food waste in food/feed products;

3) discuss which actions we can perform to solve bottlenecks in order to contribute to SDG 2 (end hunger and malnutrition and ensure access to safe, nutritious and sufficient food), SDG 3 (Establish Good Health and Well-Being) and SDG9 (Industry, Innovation and Infrastructure).

1s5

Models and tools for estimating circularity of alternative food and agricultural systems

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The purpose of this session is to explore models and other data analytic tools for estimating tradeoffs and outcomes of alternative options for transforming food and agricultural systems (FAS) into circular systems. The session will be organized to attract both modelers and non-modelers while clearly having a focus on models.

Food and agricultural systems are complex, varying considerably over space and time depending on physical, cultural, economic, political, and environmental conditions. Our existing mostly linear FAS lose considerable quantities of natural resources, degrade the environment, and discard large amounts of products as wastes. Having system performance dependent on multiple decision makers contribute to these outcomes. Continued incremental changes to existing FAS will not lead to systems that can meet future global demands for more food and changing diets, demands for reducing environmental degradation and losses of natural resources, and the critical need to address the climate change crisis.

Transforming FAS into more circular economies has the potential to simultaneously meet increasing food demands, regenerate natural systems, reduce GHG emissions and degradation of water resources, and increase resource use efficiency.

Systems modeling and analytical methods are powerful tools to understand and compare performance and tradeoffs (productivity, economic and environmental benefits, and resource use efficiencies) of envisioned alternative circular FAS. These tools will be necessary for monitoring and evaluating system performance to enable consumer confidence and ensure accountability of outcomes to justify payments for environmental services.

Although there are existing models, data protocols, and analysis tools for some components, most are not designed to study holistic food and agricultural systems, that is, the entire value chain from production through consumption and loss of resources in wastes and discarded products.

Presentations in this session may review existing models, data, and analysis tools or describe new progress in developing and deploying integrated tools for advancing circularity in food and agricultural systems. Examples may include dynamic biophysical, industrial ecology, economic, and behavioral models; life cycle analyses; and performance measures for assessing food systems.

Other topics may include integrated system model analyses for different types of FAS; studies at different scales of analysis; data requirements for verification of system performance; data standards; tradeoff analyses at local and broader scales; feed/food competition; agent-based models that address interactions among decision makers across FAS value chains; and others. These presentations may address any one or multiple themes of the conferences. Presentations focusing on technical modeling aspects should also aim at communicating the context and core messages in a non-technical form for non-modelers.

1s6

Towards circular marine food production; Sustainable mariculture

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Global agricultural production has been increasing steadily during the last two centuries. Growing awareness of the drawbacks of modern agriculture, such as deteriorating soils, decreasing biodiversity and nutrient imbalance, has stimulated to look at alternative and more sustainable approaches, as for example nature-inclusive or circular agriculture.

Circular agriculture not just emphasizes the need for nutrient security by keeping nutrients as much as possible in the human consumption-agro- ecosystem, but also advocates a much more efficient production system.

The question is whether the practice of circular agriculture will enable feeding the still rapidly increasing world population, which is expected to reach the 10 billion around 2050, particularly when the expected negative impacts of climate change on important issues like fresh water supply and soil quality are considered. Attention has therefore turned towards the seas and oceans as well. At present only a meager 1.4% of human food comes from the seas, whereas our planet is for more than 70% covered with water.

High expectations were recently raised about the possibilities to increase marine yields. The fast growth of marine aquaculture over the last decades is seen as a promising signal. A blue paper by the High Level Panel for a Sustainable Ocean Economy predicts a six-fold increase. The Food and Land Use coalition even claimed that the step from fishing, basically primitive hunting, to other forms of harvesting can increase marine yields by orders of magnitude. However, these optimistic views have recently been challenged, and the future role of finfish marine aquaculture in global food production is seriously questioned. van der Meer (2020) also warns that large-scale low-trophic aqua- culture of, for example, multi-cellular seaweed may result in serious nutrient shortages, competition with natural phytoplankton and negative impacts on the marine ecosystem.

In this scientific session and workshop we will explore the transferability of the ideas developed in circular agriculture towards the seas and oceans: nutrient security, food above feed, the use of waste streams and the role of an- imals, to ensure high efficiency, but at low costs for the natural environment and avoiding the same mistakes as have been made on land. Mariculture, and particularly low-trophic culture, often consists of open cultures depending on nutrient supply from the environment and we expect that the associated differences in temporal and spatial scales of the marine environment compared to for example the scale of a single farm on land, ask for a rather different approach of the ideas developed for the situation on land about, for example, nutrient security and the treatment of waste products. We will pay attention to various forms of mariculture: seaweed, shellfish, and other invertebrates. In the exploration major knowledge gaps should be defined and steps should be taken towards a road map for a research program.

The following topics could be included:

- Nutrient cycles in coastal marine systems
- Nutrient security in future low-trophic mariculture
- Processing for food system inclusion
- Marine by-product utilisation
- Food production and natural value trade-offs
- Land-sea interactions
- Knowledge valorization and business opportunities

1s7

The environmental and economic consequences of adopting circularity at different spatial scales

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The concept of a bio-based circular society resonates well in society. Spatial scale of circularity will affect the actual consequences of circular use of biomass and nutrients. For example, materials and substances (biomass, nitrogen, phosphorus) can be targeted at regional, country or European Union level. Targeting of materials and substances at these different scales may affect environmental (e.g. pollution, greenhouse gas emissions and land and water use) and socio-economic performance (markets, in- and export, food and nutrition security, economic growth) of the food system. The scale at which we may adopt circularity is determined by the interaction of various factors. Differences in agro-ecological and socio-economic circumstances make some areas more suitable for producing specific types of crops than others. Localized environmental or socio-economic advantages of certain imported crops may outweigh the emission impact of transport. The choice of our future crops, their rotations and location depend on their main and by-products. Hence, not only their food value for humans will be taken into account, but also their non-food value for soil fertility, feeding of farm animals, production of bio-based materials and possibly of biofuels and/or bioenergy, and general economic contributions like employment and value-added creation. For example, soybean oil for human consumption and for biofuel production originates from soy cultivation and generates soybean meal (SBM) as a by-product. Compared with other by-products from oil processing for human consumption, such as sunflower meal, SBM has a high nutritional value for animal feeding but may induce extensive global trade flows and deforestation, given current production locations. Combining all such aspects – e.g. quantity and nutritional quality of main product and by-product, food versus non-food drivers of the main product, transportation and environmental impacts and associated economic costs– ultimately determines the optimal scale at which nutrient loops are to be closed. The optimal scale of circularity is thus context specific and requires an integrated analysis. In this session results and insights from studies based on such integrated analysis of spatial scale effects on potential circular use of biomass and on environmental and economic impacts of circularity will be presented.

1s9

Water efficiency and water recycling: what are the options?

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Fresh water is a crucial resource all over the world. Water is needed for food production, for human consumption, health and hygiene, for industries and energy production etc. However, there is a growing mismatch between water supply and demand. How can we reduce the pressure on (ground)water resources? How can we improve the efficiency of water use? How can we make sure that fresh water is not unnecessarily drained to rivers and oceans? How can we improve responsible water reuse and cooperation between different users like industry and agriculture? In this scientific session we welcome contributions on technical innovations or scenario studies as well as on behavioral changes or new collaboration schemes. Interesting themes are also the governance of water use and economic aspects. Would it help to make water more expensive? It is also important to regard water quantity and quality: how do we deal with water quality issues in relation to water reuse? How do measures propagate through the water cycle; what are the benefits and risks? Can we optimize water management in relation to circularity of other resources like nutrients and carbon? How can we address weather extremes with increasing drought, heat as well as flooding due to climate change in the context of circularity?

1S10

A healthy soil as a basic enabling condition for the transition towards circular land management and land use

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To complete the transition in agriculture towards a circular bio-economy we see benefits from taking a holistic approach. We propose to look beyond traditional disciplinary boundaries such as soil science, agronomy, biology, social science, economy, and beyond boundaries in land use systems (agriculture, nature and urban areas). In this session we examine how healthy soils play a decisive role in designing such holistic land management and land use approaches.

In a circular bio-economy a range of cycles relate to and utilize soils:

- Carbon cycle; biomass and organic matter in re-use and returns
- Nutrient cycle; relying on internal ecosystem sources
- Water cycle; providing and returning clean water

In contributions we invite abstracts that from a systems perspective study the processes in our soils, e.g. on soil carbon sequestration and/or retention of water or safe returns of wasted biomass . Besides, we are inviting studies in applied research addressing to what extent specific soil management strategies are impacting the different cycles as mentioned above and how they will contribute towards the transition towards a circular bio-economy. We aim to bring together scientists and practitioners working on different types of solutions that together enable and enhance a successful transition. In other words, we seek paradigm shifts in which healthy soils and healthy landscapes are key in successful climate smart and circular land management and land use.

In this session we invite all stakeholders working with soils to show their work and experiences when working on the transition towards circular land management. The role of soils should be highlighted.

Theme 1: Biosphere: Rethinking our food and bio-based systems

masterclass 1

1m1

The butterfly model, an integrated conceptual framework for the circular and climate neutral society

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In this masterclass the participants learn how to set up interdisciplinary projects that contribute to a circular climate neutral society. This interactive masterclass pays attention to: i) the different perspectives to look at the transition to a circular climate neutral society; ii) the ways to bring these perspectives together. The masterclass offers a tool to do so by applying the butterfly model, an integrated conceptual framework. Depending on the questions and wishes of the participants, we will work on the application of this model as tool for e.g.: setting up a interdisciplinary project, developing a product, assessing Circular and/or Climate neutral initiatives, assessing a policy.

Theme 1: Biosphere: Rethinking our food and bio-based systems

workshop 1-3

1w1

Cross-overs: Closing loops together

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This workshop will be limited to 20-25 participants.

One of the pathways to close resource loops within the transition towards a circular economy could very well be an intensification of cross-sector collaboration. Cascaded use and exchange of (waste)material flows between industries was mentioned in the groundbreaking report by the Ellen MacArthur Foundation (2013) as a crucial building block of a circular economy. Not only did this encourage companies and governments to reevaluate their perception of 'waste', but also a number of platforms (e.g. Circular Goodz, BioBoost, Seenons, Werflink) arose that aim to connect companies by centralizing information on supply- and demand of residual materials.

In this context, participants of the workshop "Cross-overs: Closing loops together" will explore how their respective sectors could become more connected by exchanging resource flows such as (waste)water, nutrients, biomass, minerals and metals. The workshop consists of presentations by the organizers and a co-creation session in collaboration with illustrators from JAM Visual Thinking. The presentations will be used to introduce the concept of 'Cross-overs', based on cases that have been developed within the KB project on Circular Greenhouse Horticulture (KB 34 1-2C-5) and the Flagship project Circularity by Design (KB-40-004-001). The first example case focuses on aquaponics: a cross-over between the horticulture and aquaculture sectors. The second example case focuses on how to develop a circular approach, utilizing organic sources within a high-rise setting and combining it with food, feed and energy production, educational and community functions within the living, working & recreational environment.

To assess the potential of cross-overs a clearly outlined approach has been developed that can be summarized as a set of questions:

1. Which waste material flows do your companies/sectors produce?
2. Which of these flows are potential resources for other companies/sectors?
3. What are the foreseen benefits of exchanging/reusing a waste material flow?
4. Which challenges are perceived before the potential benefits are achieved?

   (e.g. scale, logistics, quality requirements and legislation)

5. What are potential solutions for these challenges?

(e.g. technology, infrastructure, governance aspects, new business models)

1w2

Transformation opportunities for linear to circular marine resource inclusive food systems; bivalve mollusk perspectives

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What is the role of marine organisms in the food system? How can we transform from linear marine food chains to a circular marine inclusive food system? Low trophic marine organisms such as seaweed and shellfish can be produced much more efficiently, and with other carbon footprints than high trophic organisms such as pelagic fish. What is the role of low trophic organisms in the "new" food system? How can industrial partners, science and producers partner up to overcome the first challenges of this transformation? Circular approaches as envisioned for terrestrial production are not directly transferable to the marine food system, what is needed as a first step in a marine inclusive system? Together we'll explore the transformation opportunities from linear systems with high carbon footprint to circular marine resource inclusive food systems.

There is growing awareness of the need to incorporate marine or aquatic resources in the food system, in particular via the production of low trophic organisms. This will potentially lower pressure on agricultural land for food production. It potentially also positively affects resource scarcity as well as environmental pressure. However, there is still debate on the extent to which marine resources can be produced and on the energetic efficiency of the production systems involved.

Alternative routes, such as conversion of current aquatic based feed production to human food, increasing the efficiency of the food system, are explored. Processing and refining the currently underused low trophic marine resources and marine by-products to food ingredients, to plant and animal production applications, and to non-food applications, is a field that is gaining interest and of high importance for the circular economy. Besides there is also the path of resource efficiency, in which great challenges lay in the use of other trophic levels/species, and the use of stocks, which are currently underexploited or of invasive character. How may these help in the process of by product valorization and utilization.

In this workshop we will discuss the opportunities to incorporate marine bivalve resources in a circular food system and explore the potential to valorize the (international) knowledge and business opportunities. WUR will introduce the ecosystem services related to bivalve production as a unique selling point for food system implementation. This will be followed up by an introduction on the health aspects of bivalve mollusks (to be determined). This will provide the basis to continue an (interactive) creative session to explore potential routes to incorporate bivalve mollusks in a circular food system (market idea generation). The second part of the workshop will focus on the discussion on what is needed to evolve to the next phase of opportunities (knowledge gaps and business development).

This workshop is particular of interest to food and feed protein sectors seeking for added value and health promotion in their food business.

1w3

Re-rooting Wageningen Campus

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'Re-rooting the Dutch Food System: from more to better' is a vision for a regenerative and nourishing food system in 2050. This inclusive food vision is based on healthy agroecosystems and the resources they provide, and is rooted in socio-economic conditions. By 2050, we have replaced the wasteful, linear model of our current food system with a circular one. A circular food system safeguards natural resources, prioritises plant biomass for human consumption, prevents losses and wastes, and recycles unavoidable losses and waste into the food system.

Moving the food system towards this future requires action by all actors and stakeholders in the food system. By connecting to our roots – our healthy agroecosystems, and our capacity to collaborate – we can collectively realise a healthy and regenerative food system in the Netherlands.

Together with students (e.g. Circular Farming Platform Wageningen) and other Campus actors (e.g. Green Office Wageningen; the rector), we will envision how we can make the WUR campus more circular, and define concrete steps for action. Through brainstorm sessions and futurecasting we will work towards a shared goal, and short and medium term actions. Then we will identify which stakeholders and people at WUR are needed to take steps towards this future. What can each of these people/organisations do to make a meaningful contribution? Which potential collaborations and synergies do we see? And which steps can be taken today or tomorrow? In this way, we come up with a joint vision for the future as well as with concrete steps that can be taken to make the campus more circular.