Programma
KB35 Food Security and Valuing Water

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1 Organisatorische informatie programma

Titel	KB35 Food Security and Valuing Water
Programmaleider(s)	Ivo Demmers

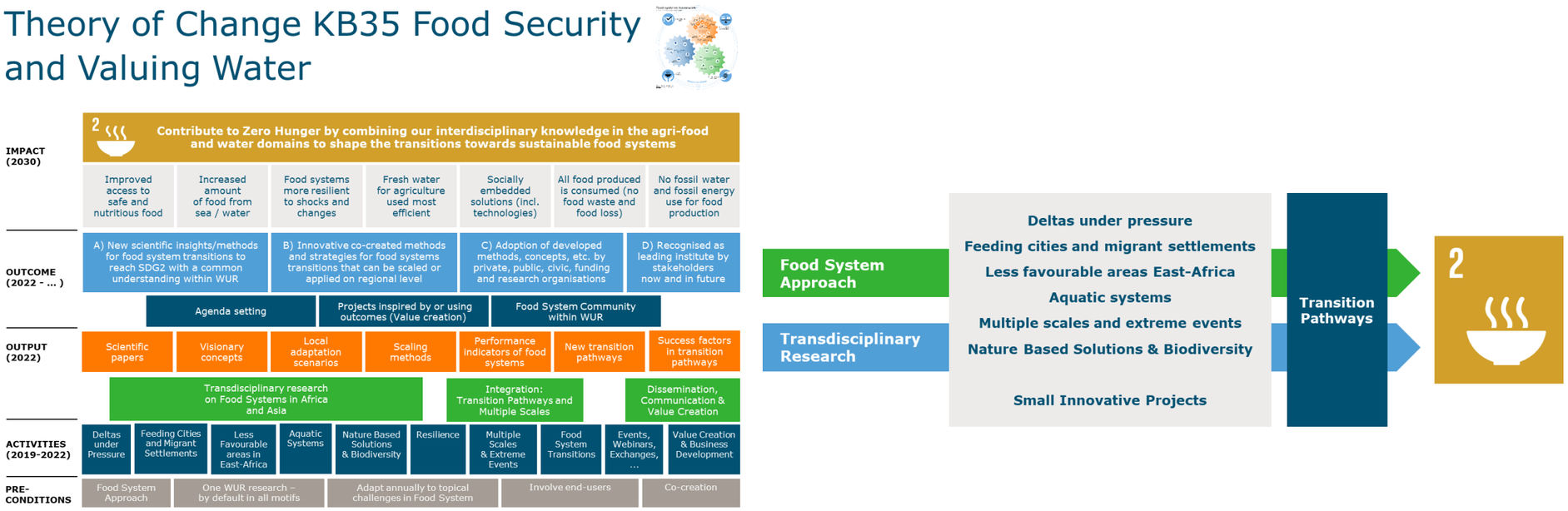
Contactperso(nen) LNV

Naam	Organisatie	E-mail	Telefoonnummer	Akkoord met het definitieve activiteitenverslag:
Vera Musch	SKI	v.a.j.musch@minlnv.nl		
Hans Brand	EIA	j.m.brand@minlnv.nl		

2 Het programma

2.1 Doel van het programma

The mission of the programme is defined as: We will contribute to Zero Hunger by combining our interdisciplinary knowledge in the agri-food and water domains to shape the transitions towards sustainable food systems. This mission, and the activities, outcomes and impact are summarized in a Theory of Change, see the figure on the left below.



2.2 Thema's

The analytical framework we use to address the challenges in achieving SDG2 is the Food System Approach (FSA) (Van Berkum et al., 2018). The research is set up and organized along 6 transdisciplinary motifs focusing on specific areas where urgent transitions in food security meet water stress. Besides the main motifs there are smaller projects that are used for emerging topics and opportunities.

3 Gerealiseerde bijdragen aan doel programma in 2021

3.1 Inhoudelijke voortgang en resultaten 2021:

Below we discuss how a selection of activities in 2021 contribute to the mission of the KB programme. The progress of the motifs and projects are discussed in more detail in Section 5.

Food System Transitions (& Just Transitions)

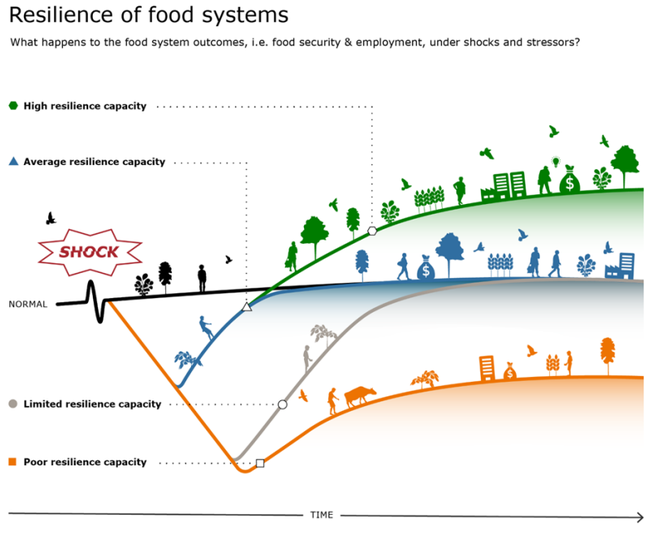
The KB programme contributes to 'transition pathways towards sustainable food systems'. A good example for this is a joint result from the work in the motifs 'Deltas under pressure' and 'Transition Pathways': 'guidelines to facilitate transition pathways'. These guidelines combine the best of several worlds as they build on climate adaptation (Delta plan development and the UN system for National Adaptation Plans) and apply the TransPath approach that was developed in this KB. These guidelines help to increase the impact of (our) research and identify critical points for interventions. These guidelines can be used in the upcoming Agricultural Transitions in Vietnam and Bangladesh. In a separate project that was initiated in 2021, we focus on 'Just Transition'. The topic of just - or also called 'fair' - transitions is often advocated in policies and is widely discussed in science albeit at a very theoretical and abstract level. There is a strong need to further operationalise justice in transitions and much can be learned from ongoing practices that have not yet been studied by scientists. Learning from practice and reviewing scientific literature led to an overview of scientific evidence. In 2022 the framework for action will be developed and tested.

Food and water

Combining knowledge of both the food and water domains increased our understanding of tradeoffs and synergies of a combination of production systems. For instance, cultivating both mangrove and shrimp in one pond showed benefits in improved water quality, providing shelter for shrimp, providing nutrients (mangrove leaves) hence increasing shrimp production. In addition, multiple examples of non-timber products of mangrove forests (fodder, juice, food, tea, honey, medicines ...) and prove of socio-economic benefits to communities can be found in literature and practice. But these are often overlooked in developing mangrove forests. For successful upscaling, these socio-economic benefits need to be considered more in research, implementation and investments. The effects of farming seaweed together with shrimp is studied in 'Aquatic Systems': WUR and partners discovered that combining seaweed with shrimp culture allows shrimp to grow to a much larger and higher-value market-size compared to shrimp culture without seaweed and yields additional income from seaweed. A point of attention here is the safety aspect of seaweed when used for consumption. Data on safety was collected and after additional testing in 2022, results can be presented. Meanwhile, work is ongoing to identify seaweed production potential worldwide by: (a) developing a 12-parameter bio-economic seaweed growth model (video) and (b) identifying potential locations for sustainable seaweed production worldwide.

Resilience

Following the Covid 19 crises, the KB programme initiated work on Resilience in Food Systems. This resulted in an 'ABCD approach' to increase Food System resilience. This approach is presented and taken up by governments and through capacity building activities of WCDI to improve their interventions (a.o. a BO project).

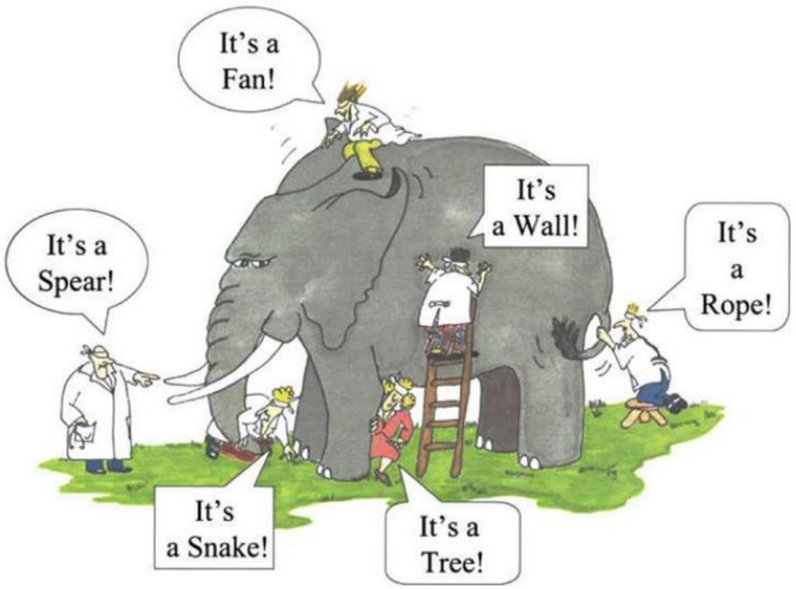


Informal Sector and Midstream development

The combined work in the KB programme led to new insights on the importance of informal sector and midstream developments in food systems. This is particularly visible in successful interventions in the motif on Feeding cities, where 1000 kg of fish is made available and consumed by people in the slum of Kibera, Nairobi, Kenya. The informal sector is also identified in the value chain analyses of the seaweed sector in domestic and international value chains in Indonesia (Aquatic Systems motif). Our work also showed the importance of increasing empowerment and employment by strengthening the midstream sector in food value chains. As midstream developments in Africa and Asia often take place in the informal sector, these topics are interwoven and should be addressed in close conjunction. One of the ways to develop the midstream is by developing postharvest and processing activities, as was elaborated in a co-production of the motifs 'Feeding cities' and 'Less favorable rural Areas in East Africa'. Enhancing post-harvest and food processing will increase healthy diets, decrease food loss and waste and cater for a growing demand of (processed and packaged) food in growing cities. Midstream development and informal sector engagement are taken up in a separate research project (ongoing in 2022). This project will also deliver research questions for the update of the KB food security and valuing water programme in 2023 and 2024.

Lessons learned from Transdisciplinary research and Food System Approach

Key underlying approaches in this KB are transdisciplinary research and the Food System Approach. In 2021 we assessed the lessons learned in applicability, benefits and suggestions for improvement of the Food System Approach in our research. The report consists of interviews with researchers involved in KB and a set of conclusions. The Food System Approach can be considered a valuable element of research. It helps to bind projects and research together in multidisciplinary research projects because it provides a way of organising interactions between them, as well as giving space to both the specialists and the system thinkers. The Food System concept itself is not applicable as an integrated quantitative tool (for example, for carrying out integrated assessments) but it does provide a means to connect outcomes, insights and data from existing concepts, models or tools. For communication purposes it is important that the terminology is continuously translated into what is meant in practical terms.



A final point related to the complexity of Food Systems is that difficulties have been encountered in setting boundaries of the research. To this end, in a specific paper on setting food system boundaries by Van Berkum (2021) , it is suggested to explicitly state choices about boundaries at the design phase of projects in general (so not only research projects). While doing so, this will also provoke discussion among researchers, between researchers and clients, between researchers, practitioners and beneficiaries on the purpose of the project, the boundaries of the food system analysis and the assumptions about inclusion and exclusion. Such a listing also makes clear whether there are 'value conflicts', that is, different opinions on who and/or what should be in the project.

Related to transdisciplinary research, the researchers place great value on transdisciplinary research because they consider it important to be 'open-minded about others' truth' and to integrate different views. However, to gain deep knowledge, disciplinary depth is also needed. Demarcation of the research for each project and dividing the research into clear and smaller (sometimes monodisciplinary) packages is a way to safeguard progress. Transdisciplinary research has the potential to add greatly to common understanding. However, lack of communication, using jargon and not making underlying assumptions explicit can jeopardise the outcomes and should be explicitly dealt with.

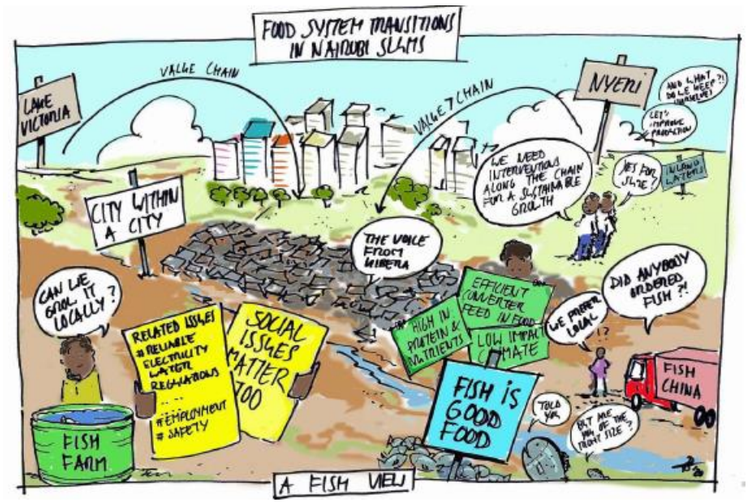
Insights per motif

Deltas Under Pressure

Vietnam and Bangladesh both embarked on developing programmes to transition the agricultural sector in their deltas. In both cases, the Food System approach and the results from the KB motifs 'Deltas under Pressure', 'Multiple Scales & Extreme Events', 'Aquatic Systems' and 'Transition Pathways' are used in providing an evidence base on how to organise, analyse and design the transitions in the deltas (like the Roundtable on Agricultural Transition in Bangladesh) in such a way that they not only contribute to improving agriculture, but also to sustainable and healthy food systems. A key aspect here is dealing with salinity. In this KB several options for water treatment were identified in Vietnam, where in Bangladesh the understanding of changing salinity levels and the possible adaptation interventions are developed in co-creation with local stakeholders. Scientific output is foreseen a.o. in the double session on deltas in the Circular@WUR conference, and the Special Issue on water for food in deltas in the International Journal of Water Governance.

Feeding Cities and Migrant Settlements

The Feeding cities and migration settlement project provides a good example of rejoicing implementation and science hand in hand, ensuring applicability of research towards the SDGs. The Food System Approach is used to identify core bottlenecks and for implementing solutions by providing healthy affordable diets in Kibera, a slum in Nairobi. Action research is carried out in close cooperation with local networks, network leads, game changers, citizens, value-chain stakeholders, fish farmers, vendors, cooperatives, and trusted community leaders. The project team is particularly proud of the new insights of the informal sector cooperation and the achievements of the new Nyeri-Kibera fish value-chain set up. With this fish value-chain, business models are set up on production level, along the value-chain including women traders, reaching the consumers in Kibera, which are highly viable and attracting new investments. Also, in Arua (Uganda) and Dhaka (Bangladesh) local co-creation and stakeholder engagement have contributed to investigating the Multi Stakeholder Platforms, governance, and post-harvest losses, within and across informal settlements. The Value-Analyses-of-Relative Importance (VARI) App is developed in this project to apply pairwise comparison of a set of pre-defined criteria to find relative importance to each criterion. It is a weighing method belonging to the category of multicriteria analyses (MCA) and is inspired by the method Analytic Hierarchy Process (AHP). It is designed to respond to the question: What is relatively more important to whom? This could differ across people, across groups, with a context or across contexts, which is interesting to this method. The software supports a total of 4 steps: 1) a pre-designed value-tree to be plotted into the software, 2) an email operation system to send the questionnaire generated by the software to potential respondents categorized into groups, 3) estimates of the inputs to perform the eigenvalue-methodology, and 4) presentation of priority scores in a series of charts, as well as datasets for further analyses of the data. The App is being used for stakeholder participation purposes and has successfully been proposed in acquisition and proposals for WUR (e.g. XGain). Worthwhile noticing is that the project conducted a household survey in Kibera twice (August 2020 and 2021), thus enabling analyses of a series of food system factors, such as consumption frequencies of nutritious food, food security levels, employment, safety, water access, trust relations, rural-urban connectiveness, and a lot more. Surveys are also conducted with fish traders in Kibera (urban), and small-scale fish producers in Nyeri (rural), hence filling a big void of lacking data in urban-rural food system involving informal settlements. Scientific results are, among others, presented in a Special Issue "Development of Resilient Urban Food Systems—Exploring Synergies and Making Priorities", for which three papers are published already.



Less favourable areas in East Africa

The current subsistence agriculture in the West Nile region of northwestern Uganda (annual population growth 3%) is unable to produce enough food to ensure a healthy diet for the rapidly growing host population and the refugees coming from DRC and South Sudan. The KB research is developing quantitatively underpinned answers to questions like how much land is still available for expanding the current cropping area and increasing food production, what are possible environmental consequences of any production increase? Results indicate that available land resources in the Arua district in the West Nile region are by far not sufficient to feed the population with a healthy diet in 2040. Interventions aimed at increasing current yields with 30%, reducing food loss and waste reduction each with 30%, and vitamin A supplementation are each insufficient interventions, only a combination of all these interventions will be sufficient to produce a healthy diet with the available land resources, but at the expense of large-scale land use conversions resulting in undesired greenhouse gas emissions and biodiversity loss. Any undesirable environmental effect and other consequences and trade-offs of various interventions/options are made explicit to identify truly sustainable development pathways. In the Amhara region of Ethiopia, we focus on quantifying synergies and trade-offs of climate smart agriculture at a farm level. In 2021, we tested models and data sets with local stakeholders using the Multiple Stakeholder Platforms (MSP) and defined four typical mixed farm types for which we will develop different transition pathways.

Aquatic Systems

This year a new 12-parameter bio-economic model of seaweed production was developed to determine seaweed seeding size and harvest cycle duration for maximize pond yield. Market chain studies show that seaweed in Indonesia offers an important alternative livelihood for fishermen who's catches have dwindled due to overfishing. Also, notwithstanding the wide array of product possibilities, product innovation has so far been critically lacking. New experiments by WUR and partners discovered that combining seaweed with shrimp culture

(Multiple Species aquaculture) allows shrimp to grow to a much larger and higher-value market-size compared to shrimp culture without seaweed and yields additional income from seaweed. In 2022 the focus will be on how to combine seaweed with shrimp and fish culture for optimal synergistic effects. Finally, the global review paper (in preparation) uncovers a great disbalance in seaweed research that has focused on production biology to the neglect of other critical aspects of the value chain. Hence, for seaweed use indeed to be developed effectively to help address world hunger, the focus must be changed towards product innovation and polyculture with shrimp and fish and include all parts of the value chain. Out of the longlist of interventions to improve the Indonesian seaweed supply chain we, together with the industry, selected the most prosperous interventions. The most impactful transition pathway is to develop quality- and market-driven seaweed supply chains by producing high value products combined with the design of efficient agro-logistic networks.
The feasibility of those interventions is currently assessed. One of the opportunities for outreach was a session titled 'Coastal food innovation and livelihood' during the "WINNER" conference organized by NWO for the promotion of Netherlands-Indonesia academic cooperation.

Multiple Scales, Food System Seismology and Resilience

Assessing tradeoffs and synergies in Food Systems on multiple scales requires models, data and tools to work together. Also, we need to couple models, data and tools across disciplines. We are on track with aligning the models to each other and tailoring them to local situations. At the same time, we see that model development and updating takes time. A lot of the models rely on labour intensive data-preparation and cleansing. In 2021 we already yielded results from work in previous years. Global/ regional biophysical models such as LPJml (also used for our work for/with PBL) were used within plant production studies. The ontology/terminology work resulted in a nice tool for the support of discussions on terminology. Building and adjusting graphs of word-associations allows researchers from different disciplines to quickly understand where differences and similarities in understanding lie. The extreme events work explored a meta-ensemble approach combining different perspectives and quantifications of food systems resilience. Mid 2021 we started the Food systems seismology to see whether shocks in Food systems could be predicted using data science. This project combines data science techniques with a deep understanding of the structure and functioning of food systems to identify potential early warning signals of system change and produce actionable knowledge for managing the vulnerabilities in the system, preparing for shocks and preventing loss of food security. In this research we work closely together with FAO. The Food System Seismology and the work on Food System Resilience will be merged with the work on extreme events within the Multiple Scales and Extreme Event motif in 2022.

Transition Pathways

A methodology was developed to identify and elaborate transition pathways together with stakeholders, besides the 'guidelines to facilitate transition pathways' as a coproduction with the 'Deltas under Pressure' motif. This will result in a practical guide for practitioners in 2022. The interactive booklet 'Tools for Transitions' (clickable PDF) contains an operational framework to support stakeholders working on structural solutions in the 'stagnant' food system and describes approaches, methods and techniques for transitions. The discussion paper 'Transition pathways and transitions to sustainability: A critical exploration of perspectives, typologies and agendas' shows that transition thinking often goes with a focus on technology and innovations. It is concluded that researchers need to carefully consider implications of underlying dynamics and political agendas more than they tend to do.
The developed methodology is being used in an initiative to elaborate pathways for healthy and sustainable diets in Accra. It is an active collaboration and co-creation with the Netherlands Food Partnership, several local organizations (e.g., Ghana Health Service, Agriculture and Climate Empowerment Centre Ghana) and the 'future of the dairy sector' in Ethiopia with SNV and Ethiopian research and private partners engaged with the Ethiopian dairy sector.

Nature Based Solutions for Climate Resilient Food Systems

Nature Based Solutions (NBS) are known for their multifunctionality and interdisciplinary approaches. The transition to a more nature-based food system is influenced by and dependent of many different social-ecological factors like functional ecosystems, beliefs systems and business economics. In this project NBS are categorised in 1) Intrinsic NBS using existing ecosystems 2) Inspired NBS using technologies that copy ecosystems or natural processes. In this motif (which is funded by two KB programmes: Circular and Climate Neutral Society (KB34) and this KB) NBS are examined by case studies: crop diversity, natural pest management, herbal rich grassland, wastewater re-use and rainwater harvesting. The individual case studies in this project experience that they must deal with 'a whole world around us. In the research so far, it was identified that the cases show that NBS do improve climate resilience and circularity. For the coming year we will work on a comprehensive knowledge base for potentials and limitations of nature-based interventions and pathways that aim to contribute to food security, the delivery of a safe and healthy diet, inclusiveness and equity, while sustainably using natural resources and supporting circularity in different socio-economical and biophysical contexts.

NBS are powerful in their multifunctionality. As it comes to policy recommendation, policy should put effort in integral approaches, to prevent frustrations in planning, financing and implementing NBS. Particular strengths of Nature-based solutions are that NBS have potential to contribute to climate adaptation by increasing business opportunities for sustainable development while simultaneously offering benefits to people and ecosystems, maximize resource-use efficiency and reduce climate risks. To mainstream nature-based solutions, better evidence for short- and long-term benefits of nature-based solutions for climate-change adaptation, and their implementations' potential socio-economic and environmental trade-offs and synergies, is urgently needed. Planning, financing, implementing and monitoring nature-based solutions for climate-change adaptation requires a transparent and inclusive decision-making process, where multiple (often conflicting) interests of different stakeholders must be addressed.

Biodiversity & Food System

This motif discusses the current status and trends of crop, livestock and aquatic genetic diversity, in relation to food systems. The impact of decreasing or enhanced use of crop, livestock and aquatic genetic diversity – within and across species and varieties – is discussed in relation to the four different food system dimensions. The work started in mid-2021. The key messages related to biodiversity in safe and healthy diets include:

- *Biodiverse diets can have positive effects on human health, e.g., through lowering the probability of obtaining chronic non-communicable diseases.*
- *Diverse diets are often referred to as diets that include different food groups/categories/types.*
- *Diversity in the diet is positively correlated to the nutritional composition of a diet.*
- *Increased diet diversity contributes to achieving recommended daily intakes.*
- *Regarding food safety, there are both positive and adverse effects of increased biodiversity.*
- *Increased biodiversity leads to increased resilience of production systems, for example in relation to pests and diseases or climate change related risks.*

4 Communicatie, kennisverspreiding en valorisatie

4.1 Beoogde gebruikers/doelgroep(en) en 4.3. wie maakt gebruik van de inhoudelijke resultaten in 2021

- (international) Researchers and institutes; like Egerton University (Kenya), Can Tho University (Vietnam), Negeri and UNHAS universities (Indonesia), University of Energy and Natural Resources (UENR, Ghana) and colleagues at Wageningen University & Research
- Policy makers in several departments like SK&I, EIA (Water & Food policy domain, preparations for UN Oceans Conference 2022, preparation for COP 27, COP 28), programme/ projects officers at ministries, (such as Netherlands International Water Ambition (NIWA)), embassies (including Agricultural counselors and attaches), RVO. Also, foreign ministries like FCDO (UK) and (Norway) are connected.

- International Financing Institutions, like Asian Development Bank (project on salinisation in Vietnam, Round table on Agricultural Transition in Bangladesh), World Bank/ IFC (a.o. post-harvest projects in Vietnam and India)
- UN bodies, like FAO (Dhaka Food System project, Agricultural Transition of Bangladesh Delta), WFP, IFAD
- NGO's like Solidaridad (Bangladesh, Ghana) and SNV (Food System Resilience ABCD and Informal Sector and Midstream Development)
- Private companies (a.o. DSM, Cargill, Lamb Weston Meijer) and Private Investors (like PYMWYMIC)
- Youth, students & young professionals: through challenges (Food System in 10 yrs time (2020), QING Innovation track (2021), Nature Based Solutions Challenge (2022)) and through contacts with Students Organisations like the International Association of students in Agricultural Sciences (IAASWORLD)
- Education: Professional trainings are organized by WCDI on Food System Transformation, the motif Feeding Cities contributed to an MOOC on Food and Nutrition Security in Urbanizing Landscapes - WUR, The programme manager gave a guest lecture on Food System Transitions for 'MBA in AgriFood' (Wageningen/ Tias Business School) and a MSc course on Healthy Food Systems is currently being developed at WUR.

4.2 Hoe zijn deze gebruikers/doelgroepen geïnformeerd?

WUR colleagues are updated on the intermediate research results in this KB Programme through internal exchange events (held before summer 2021). These are comprised of virtual as well as live events. In June, four virtual exchange sessions were held. This led a.o. to a paper on Food System Boundaries. Covid-19 regulations led to postponing of the planned Food System Community day from November 23rd to March 15th 2022 (after movie).

Many researchers from all motifs contributed with one or multiple blogs to the series of blogs on Food System Research blogs that are published on Linked-In, Twitter, the WUR website and most notably, the weekly newsletter to the 'Landbouwraden en -attache-network' published by RVO/ LNV/ Buitenlandse Zaken.

UN Food System Summit

The year 2021 was the year of the UN Food System Summit. Our research contributed to many of the preparatory events, dialogues and publications that were organised and prepared. This KB programme supported WUR researchers to contribute to the preparation of the UN Food System Summit through amongst others:

- Commissioning two papers and editing other papers for the Food Security Special Issue "Food System Transformations for Healthier Diets, Inclusive Livelihoods and Sustainable Environment " (September '21 – December '21)
- Organising Virtual Dialogues on Climate resilient food systems for Africa (January 2021)
- And co-organising the "Independent Food System Summit Dialogues on agricultural innovation and food systems for a climate smart-smart future", (April 2021) and contributing to: 'Independent Food Systems Summit Dialogue on the role of aquatic foods in sustainable food systems, exploring actions, how to connect research and policy, and how to scale up the good solutions'.

The KB Food Security and Valuing Water and the WUR wide cooperation towards UN Food System Summit and the COP 26 on Climate, COP 15 on Biodiversity and the Nutrition for Growth Summit led to the decision to make the WUR theme of 'Feeding the world' a pilot theme in communications and marketing within WUR. Some examples of outreach to specific audiences as well as the more general audience are the Food System animation (explaining the concept of Food Systems), two stories of Food System Approach for Vietnam and Ethiopia. See the Programme website for the entire overview http://www.wur.eu/foodsecurity-valuingwater

5 Inhoudelijke voortgang projecten binnen het programma

Projectnumber	Title		Product 2021, as per Annual Plan for 2021	Results 2021	Comments in case of modifications and deviations
Motif Deltas under Pressure					
KB-35-001-001	Deltas under pressure		Workplan 2019-2022 will be continued. Emphasis for 2021 on - pilot experiments on farm level in Vietnam, selection of crops, livestock including farmers, focus groups - focus on salinity in agriculture - Linking Food Systems approach to climate impact by applying knowledge in Joint Cooperation Programme (models, governance, good practises) - HLPE Valuing Water – support to the Bangladesh project on shadow pricing	Highlights: - The storyline of the Bangladesh part of the KB motif has been presented to the Minister of Agriculture of Bangladesh during his visit to WUR in November 2021. - Further, the 'guidelines for transition of food systems in deltas under pressure' is recommend to read and promote further. - Also, a scientific paper contributed to improving understanding op of contribution of mangroves in our food system The list of deliverables can be found on the KennisOnline site: Deltas under Pressure - WUR	Due to covid we reallocated some work (data collection, stakeholder meetings) to our partners in Bangladesh Solidaridad and Khulna University and in Vietnam (Can Tho university) (budget neutral changes).
Motif Feeding cities & migration					
KB-35-002-001	Feeding cities & migration		Next to main lines of research set out in previous years (Kampala, Nairobi, Dhaka), in 2021 work will focus on fish value chain development in Kibera. Here and also in Dhaka processing and analysing socioeconomic, business, governance, environmental and food quality impacts data will continue. Specific attention will be given to urban-rural relationships and the opportunities of applying spatial analyses in planning, implementing and sustaining food system improvements	We rejoice implementation and science hand in hand (action research) to ensure applicability of research towards the SDGs. The findings are analysed and reported on scientifically. Some highlights: 1) attendance in the preparatory UN Food System Summit in June, where we presented a film: HIGH LEVEL UN Food system summit 2) (preventing) Post harvest losses and their role in Food Systems has been put on the agenda, a.o. @ World Bank. 3) Spatial analyses, the integration of the environemtn into food system thinking by a spatial approach, is providing insights urgently needed. 4) The Multi Stakeholder Platforms (MSP) for dialogue and interaction within and across informal- and formal sectors, are put up front in this project, which has international urgencies and relevance. 5) The Special Issue is a very important highlight in this motif, for which 3 articles are now visible and a series where at least 5 more of the articles will be published coming year. 6) The project team is particularly proud of the new insights of the informal sector cooperation and the achieveints of the new Nyeri-Kibera fish value-chain set up. With this fish value-chain, business models are set up on production level, along the vlaue-chain inlcuding women tradosr, reaching the consumers in Kibera, which are highly viable and attracting new investments. Informal sector investigations are currently being carried out also in Arua, Uganda. 7) Moreover, it was a highlight to be reported on newspapers and in the Blog. 8) Also, in a travel to Kenya in Oct/Nov, the Dutch Embassy informed that a follow-up to the activities carried out is a possibilities, depedning on how this develops. 9) Given the low information of the livelihood and food security existing in Kibera, we are proud to have carried out a hh survey twice, and a vendors survey, as well as teh fish farm survey in Nyeri. These datasets covers a big data gap. 10) We have developed the VARI App which increasingly is being used for stakeholder participation purposes and proposed actively in aquisition and proposals for WUR, far beyond the scope of this project. More results on the KOL: Feeding cities & migration	The budget was slightly revised: Additional budget was spent to hire Laikipia University to take the lead to carry out a total of three surveys: two datasets on the value-chains in Kenya, and one of food security scenarios that was initiated late 2021. We freed up budget by not carrying out all the proposed workshops planned but instead, postponed the case-based ones to 2022. This was because we observed Webinar fatigue within networks, because too many online events took place.

Motif Food Systems in less favoured areas in East Africa					
KB-35-003-001	Improving food systems in less favoured areas in East Africa		Main research lines as set out in multiannual plan: Focus on Uganda and Ethiopia. Uganda's focus: how to make refugees less reliant of food aid in a region that is focused on food self-sufficiency with low food surpluses. Ethiopia's focus: how crop and livestock (dairy) production can reinforce each other, were possible applying principles of circular agriculture. In parallel, integrated models (such as FarmDesign) are improved that support the assessment of effects of new insights through a FS lens.	In this motif we are developing quantitative understanding of the (needed) changes in food systems in Uganda (Arua district) and Ethiopia (two woredas in Amhara). In 2021 we focused on climate change adaptation in addition to the self-sufficiency. We calibrated and developed models and data sets. In several stakeholder workshops (using the Multiple-stakeholder Partnerships approach (MSP)) the outcomes of were tested. The results will be fed into field research to be carried out in 2022, before presenting final results by the end of 2022. Despite Covid-19, we have been able to interact with local stakeholders in physical meetings, hybrid meetings and webinars resulting in better understanding of the food system concept at local level and valuable feedback and validation of data used in models in both case study areas. Covid-19 has limited interaction with partners (also potential partners for future projects), but the Uganda case seems well-embedded in the Refooture project. In Ethiopia, links with the NGO Action Against Hunger will be explored in addition to the WUR-leaded projects the Ethiopia-Netherlands Seed Partnership and Raise FS, both in which food systems are a central theme (see project plan 2022). Read more on KOL: Improving food systems in less favoured areas in East Africa	
Motif Aquatic Systems					
KB-35-004-001	Aquatic systems		The research plan will largely be sustained. Focussing on 1. the Food System seaweed case in Indonesia (technology, value chain development, paper on consumer attitudes in Indonesia and bio-economic seaweed growth model) and 2. the global potential for seaweed culture to address SDG2 Zero Hunger. Additionally: foreseen are: - Paper on multispecies culture of fish and shrimp for increased yield and increased production cooperation with transition pathways motif	This year, various of our motif studies are reaching completion to make a lasting contribution to seaweed food science. WPR presents a new 12-parameter bio-economic model of seaweed production to determine seaweed seeding size and harvest cycle duration for maximize pond yield. Market chain studies by WFBR show that seaweed in Indonesia offers an important alternative livelihood for fishermen who's catches have dwindled due to overfishing. Also, notwithstanding the wide array of product possibilities, product innovation has so far been critically lacking. New experiments by WMR and partners discovered that combining seaweed with shrimp culture allows shrimp to grow to a much larger and higher-value market-size compared to shrimp culture without seaweed and yields additional income from seaweed. In 2022 the focus of WMR will be on how to combine seaweed with shrimp and fish culture for optimal synergistic effects. Finally, the global review led by WEnR uncovers a great disbalance in seaweed research that has focused on production biology to the neglect of other critical aspects of the value chain. Hence, for seaweed use indeed to be developed effectively to help address world hunger, the focus must be changed towards product innovation and polyculture with shrimp and fish, and include all parts of the value chain. This research helps to clarify global research priorities for the seaweed sector. Many of the results were presented during various conference this year. Among these is the "WINNER" conference organized by NWO for the promotion of Netherlands-Indonesia academic cooperation. Out of the longlist of interventions to improve the Indonesian seaweed supply chain WFBR selected together with the industry the most prosperous interventions. Orientation towards quality- and market-driven seaweed supply chains by producing high value products combined with the design of efficient agro-logistic networks were selected as the most impactful transition pathways in order to overcome current challenges. The feasibility of those interventions is currently assessed. More to be found on KOL: Aquatic systems	Deviations from planning: Some delays for deliverables are inevitable due to Covid-constraints (deliverables 2.1, 2.2a, 2.4, 3.2, 3.9 of the detailed workplan). In order to come to deliverable 3.8 one intermediate step (3.7) is needed and therefor added to the planning. One deliverable discontinued (2.3). However, several previously unlisted activities and deliverables have been additionally achieved.
Motif Multiple Scales and extreme events (MSX)					
KB-35-005-001	Multiple scales & extreme events		continuation of plan of 2020. specific attention to be given to resilience and data availability and role of WUR in data in case of extreme events, such as COVID 19.	Highlight for 2021 is that the shared work is starting to come together - as is illustrated by the use of LPJml within WPR, and the documentation on model integration. The idea of the meta-ensemble approach of models which is used in this motif is attractive as it allows for a wide range of alternative perspectives on resilience and food systems (trade-offs and synergies in biophysical, socio-economic and food production aspects). At the same time, we see that model development and	

				updating takes time. A lot of the models rely on labour intensive data-preparation and cleansing. Therefore, different approaches were taken and are reported in the deliverables (D2.1, D2.2 and D2.3). The archetypical food systems illustrated with the DARTS approach do provide an interesting framework, as does the Fault Tree Analysis. Technical hiccups that only showed up in final result inspection hampered the finalisation of deliverable 2.2- which is still in draft form. The ontology/terminology work resulted in a nice tool for the support of discussions on terminology that allows researchers from different disciplines to quickly understand where differences and similarities in understanding lie. See more on KOL: Multiple scales & extreme events	
Motif Transition Pathways					
KB-35-006-001	Transition pathways		Continued development of the transition pathways concept, combining Food System Approach and Multi Level Perspectives. Scientific underpinning and practical guidelines for Food Systems related research and implementation projects. 2021 focus on researching practical guidelines and connecting to other KB programmes to contribute to WUR transition research and leadership. Outreach through conference papers, linked to communication plan and event calendar.	Highlights - Despite corona, we managed to hold workshops with local partners in Accra and develop an inspiring vision for the future. Three paths were identified that could contribute to this. This shows that thinking in terms of transition pathways has added value. A breakthrough insight is f.e. local food pride. - The methodology to define transition pathways has been further elaborated, as in shown in the Bangladesh and Vietnam case of the motif Deltas Under Pressure (DUP). - Interactive pdf 'tools for transition' provides guidance for practitioners on approaches, methods and tools - The article 'Transition pathways and transitions to sustainability: A critical exploration of perspectives, typologies and agendas' shows that transition thinking often goes with a focus on technology and innovations. It is concluded that researchers need to carefully consider implications of underlying dynamics and political agendas more than they tend to do. - The active collaboration with the Netherlands Food Partnership, several local organisations (e.g., Ghana Health Service, Agriculture and Climate Empowerment Centre Ghana) and with the SNV and local partners for Ethiopia.	The COVID crisis has slowed down the interactions with WUR colleagues and especially with external stakeholders, because meetings and workshops with partners and stakeholders were delayed for several months. The cooperation with the WR institutes has also caused delays due to staff changes (finding the right people and training them). By the end of '21 the right staff members to replace the ones who left WUR were identified and lined up to participate in this research. Hence, a part of the budget of 2021 will to be shifted to 2022 to complete deliverable 1 on the description of transition pathways.
KB-35-006-005	Integral Findings and Value creation.		Integrating KB insights, knowledge exchange, long term agenda setting Execution of the communication plan (internal WUR and external) Present research results focusing on Food Systems/ Resilience/ Climate/ Water Quality Events: see calendar in main text. Climate Adaptation Summit Pre events UN Food System Summit	- Results such as the lessons learned on applying the Food System approach in research and the lessons learned on executing Transdisciplinary research were captured in a cahier of interviews (to be published in 2022, leading up to the WIFI event on 13 and 14 June. - Communication & events are included in this project (such as: o Food System animation (explaining the concept of Food Systems) o Two stories of Food System Approach for Vietnam and Ethiopia o An active role to link 'Four Summits in 2021' (UN Food System Summit, COP26, COP15 Biodiversity, and the Nutrition 4 Growth) across WUR. We initiated a One WUR Four Summits working group in Q1 2021. (a.o. Independent Food System dialogues (April 2021) and Virtual dialogues on Food and Climate (January 2021) o A series of blogs on Food System Research (Food System Research blogs) o Several other communication items were developed. See the Programme website: http://www.wur.eu/foodsecurity-valuingwater - Events: this included in Integral Findings and Value creation	The Food System Community Day was postponed because of Covid regulations. That was held on March 15th, 2022. Other events were more budget-friendly, because they were organised virtually. So, some budget is transferred to the budge to 2022.
KB-35-006-011	Writing EU Partnership		This project contributes to the development of the Horizon Europe partnership "Safe and Sustainable Food Systems for People, Planet & Climate" and the strategic positioning of Wageningen University and Research in the knowledge and	- Input in research agenda delivered in close cooperation with LNV	

			innovation network that supports the transition towards sustainable food systems in the EU.		
Motif Nature Based Solutions & Biodiversity					
KB-35-007-001	Biodiversity and Food Systems		Focus will be on further developing the framework with stakeholders and (potentially) test it in actual case situations	Progress 2021. - Insight in how food system dimensions relate to decreasing or enhanced crop, livestock and aquatic genetic diversity - Indications, examples and convincing evidence of the value of enhanced crop, livestock, aquatic genetic diversity for the sustainability and resilience of food systems - Clear examples of knowledge gaps on the relationship between crop, livestock, aquatic genetic diversity and the food system pillars - Commitment of food companies to contribute to sustainable food systems, but their role in enhancing crop, livestock and aquatic genetic diversity at farming system level is also limited.	Teamwork was a bit hampered by the covid-19 situation and it also influenced the planning of expert and stakeholder interviews.
KB-35-007-002+003	Nature-based Solutions for Climate Resilient and Circular Food Systems		In 2021, the project will focus more on nature-based solutions as a transition pathway towards climate resilient and circular food systems. More attention will be paid to transition management, lock inns, thresholds, leverage points, push and pull factors. This will accumulate in a paper on transition management-based framework for the implementation and scaling of nature-based solutions. In Ghana, focus will be on East-Bono, there the scope is widened from rainwater harvesting, towards landscape level (ref transition pathways motif). Also, the economic framework (from2020) will be tested, contributing to input on increasing resilience of the most vulnerable.	- Due to the often-unexplored research methods several case studies had to be very innovative to collect data. For example, the case 'Natural pest management' developed a design in the laboratory to test the attractiveness of different crops for insects. And it worked. - With Covid 19 travelling to Vietnam and Ghana was not possible. The case 'Natural pest management' decided to skip the field experiments in Vietnam. The case 'Rainwater harvesting' kept cooperating with colleagues in Ghana. For that they changed their normal way of working to a remote method workable for the researchers in Ghana. And the Quick scan did get an upgrade, so now it can be used online and that is a valuable improvement for the future. - Via our project website and social media (LinkedIn and Twitter) we can reach out to an international and diverse audience. Every project member was able to enlarge the network by publishing research results. As a result we are asked more often to present about NBS in food systems. For instance during the ECCA where we presented a statement about NBS and climate resilient food systems.	
Motif on Small and innovative projects					
KB-35-008-008	Food System challenge		depending on results of the 2020 Food System challenge. Currently ca. 45 student participate. First pitch Oct 16, final presentations on Dec 7th at World Food Centre	Budget not used: Participated in challenge without funding	The programme manager participated in organising committee and as a the chair of the jury chair for the QING Innovation Track - Competition for Climate Adaptation in Food Systems - WUR. No KB budget was used.
KB35-008-010	How can water management improve food security: the role of water valuation		Opportunities for Valuing Water when using the Food System Perspective. Products: presentation and scientific paper.	Added, to investigate research agenda and UN water 2023 - Products delivered. Additional research questions were added on water quality.	Part of the additional research on water quality didn't materialise because of staff not being available.
KB-35-008-013	Food System papers publication		Editing, detailing and finalising WUR papers as input for the Food System Summit.	Added, to collect, deepen and combine WUR contribution to UN FSS - Papers collected in special issue of Food Security Journal.	
KB-35-008-011	Resilience in food systems.		to be elaborated in early 2021, see main text for specifics	- The publication on Food System Resilience was finalised Food system resilience - Towards a joint understanding and implications for policy (wur.nl)	

				- And presented on September 9th to the Interdepartmental Food Security Cluster In 2022 Food System resilience will be integrated in the motif of Multiple scales and extreme events (MSX	
KB-35-008-0XX	co-financing		EU research projects	Not used, no co-funding request	No co-funding was used in 2021
KB35-008-014	Food System Seismology		Exploring opportunities for early warning signals of changes in Food System. The project will outline the current situation, identify realistic medium term ambitions and plan the realization for these 3 aspects: a. Data engineering: the technical side of sharing data: which possibilities can or need to be created. b. Data science: the combination of domain knowledge and data analysis techniques: which signals are to be extracted from the data, and what do they tell us. c. Data economy: the added value of data exchange: how to organise the sharing of data and how to ensure that the generated insights arrive there where they can make the difference.	Added, following Covid shock: exploration of how to engage early warning for food system shocks Results delivered in a PowerPoint presentation and WUR report. In 2022 Food System Seismology will be integrated in the motif of Multiple scales and extreme events (MSX).	
KB35-008-015	Food Loss and Waste		Creating Food Loss and Waste research agenda and present new insights in FLW by using a food System lens. To be finalised half 2022.	Added, following knowledge and exchange sessions early 2021: Food System approach led to new insights of looking towards FLW Highlight: the great cross-disciplinary topics being brought forward, creating novel and diverse views on the topic of FLW. In addition, we see new connection being built between researchers of different institutes. - Papers are underway.	
KB35-008-016	Paper on Food System boundaries		The limits, or 'boundaries' of a Food System or that of a specific Food System related project was one of the three topics that were selected to be discussed in the 'exchange sessions' on Food Systems. Those session were held in June 2021. Following the particular session on 'boundaries' it was decided to collect the topical insights in a paper.	Added: following knowledge and exchange sessions early 2021, the issue of what are the food system boundaries for policy, research and implementation arose. - Paper finalised and presented during Food System Community Day on March 15th 2022	
KB35-008-017	Build Food Literacy Through Education		Develop innovative solutions to Build Food Literacy Through Education as part of the Game Changers lab organized by EAT, IDEO, Thought For Food, The Rockefeller Foundation and Forum For the Future. Our focus is on creating and ceasing the opportunities and power that (young) consumers exert when making healthy, sustainable choices.	Added following Food System Challenge in the preparation of UN Food System Summit - The team was introduced to different scaling partners: (Jersey City and UNESCO proposal) while other partners joined other possibilities (Simfoni Capital and Kitchen Connection). A detailed proposal was developed in PowerPoint format. Only follow-up funding available for US parties	
KB35-008-018	Role of informal SMEs in food system transformations		Develop actional approach to the questions of how informal SMEs can be supported to enhance their role in delivering desired food system outcomes? Project starts in 2021, will deliver in 2022	Added following insights from several motifs and IFAD preparatory work for UN FSSS, this topic needed a research agenda to be developed. - Execution is on track; results were planned for 2022	
Additional (general) KB funding, reported under KB35 Food Security and Valuing Water					
KB-35-009-001	Understanding vulnerability		continued workplan from 2020	A small remainder of the work of 2020 was finalised in February 2021	

KB-35-009-002	Just Transition		This project helps policymakers to operationalise just transition by collecting scientific evidence. - Literature review - Develop approach/ framework - Discuss with stakeholders Project started in 2021, final results delivered in 2022	Highlights to share: - Just Transition is a topic that brings together WUR experts that are involved in different types of transitions. It has potential for building dialogue community within WUR and to develop a positioning of WUR on this topic. Just transition was considered to also reflect on our own role in the different transition processes - The topic of Just Transition is widely discussed in science but at a very theoretical and abstract level. There is a strong need to further operationalise justice in transitions and much can be learned from ongoing practices that have not yet been studied by scientists. There is a large potential for knowledge development and the pending knowledge gaps are significant. Justice is interpreted in many ways and is therefore in itself also a basis for conflict, confusion and frustration within transition processes. The operational framework aims to help making these differences explicit and guide stakeholders in the transition process to find a way to integrate justice in transition processes and solutions.	

6 Planning en eventuele knelpunten

2022 is the final year for the first phase of the research programme on Food Security and Valuing Water. An updated programme will be developed for 2023 and 2024. On 13 and 14 June 2022, a joint event will be organized with the Wageningen University Programme 'INREF'. Not all KB results will be presented here, but it is an opportunity to reach out to policy makers and research colleagues. The individual motifs will organize events to reach out to their stakeholders as well. And several 'special issues' of scientific journals will be developed to help capture the scientific results of the KB Programme. Not all the budgets were used over 2021: these totals 3% of the budget. This 'underspent/partly NAPRO' budget will be added to the budget of 2022. A part of the budget was not spent because of unavailability of staff, as some staff members started a job outside WUR, others had over-allocated time with no colleagues who could take over. Another reason was the organization of online meetings, which is less costly than live meetings. Also, the Food System Community Day was postponed from November 2021 to March 2022. More details for underspent budget can be found in the last column of the table under 5.