Executive Summary

Key messages

- Leakage of reactive nitrogen (N_r) from food systems threatens the environment and human health by causing air, water and soil pollution, while contributing to climate change and biodiversity loss. Nitrogen use efficiency (NUE) of the EU food system was only 18% in 2015. Most of the remaining 82% was wasted by loss to the environment contributing to these environmental and health threats.
- A combination of dietary change and technical measures across the food chain can halve nitrogen waste (as the sum of all nitrogen losses) and contribute to reaching the targets set in UNEP's Colombo Declaration, the EU Farm to Fork Strategy and the Kunming-Montreal Global Biodiversity Framework.
- A transition towards plant-based diets will reduce nitrogen inputs and increase the NUE of the food system, since plant-based foods have higher NUE than animal-based foods. Diets that are predominantly plant-based correlate with lower nitrogen footprints, lower greenhouse gas emissions and positive health outcomes compared with current diets in the EU.
- Among 144 scenarios investigated, a combination of halved meat and dairy consumption (demitarian) with improved farm and food chain management, and reduction of excess energy and protein intake achieves 49% reduction in nitrogen losses with the highest score for net societal benefit.
- Full exclusion of meat and dairy products from human diet combined with ambitious technical measures could reduce the need for virgin nitrogen inputs by 73% and achieve a food system NUE of close to 50%. Taking these factors together, such a change could reduce nitrogen waste by up to 84%. However, this scenario did not offer net societal benefit when the environmental benefits were offset against the stringency of actions needed.
- At farm level, there is scope for significant improvement in NUE using available technologies. Values of farm-level NUE of up to 92% for arable systems, 80% for granivores, 61% for ruminant meat production, and 55% for dairy production can be achieved.
- Only about 55% of the nitrogen in commodities leaving the farm-gate suitable as human food is actually used for human consumption. This leaves considerable scope to improve the NUE of the whole food system by reducing food waste and improving wastewater treatment, with an emphasis on nutrient recovery opportunities.
- Agroecological approaches, urban and high-technology food production systems (e.g., vertical or indoor farms) may support a transition towards plant-based diets and sustainable food systems. Investing in legumes, novel and future foods offer opportunities for consumers to reduce the consumption of animal-based foods, with multiple environmental benefits.
- A range of policies addressing consumer food choices is available for public authorities to support dietary change towards lower nitrogen footprint diets. Policy makers are encouraged to combine policy instruments in coherent policy packages to reduce nitrogen inputs in the food system, increase NUEs and monitor their effectiveness, as well as possible adverse side-effects.
- Bottom-up approaches to sustainable food systems are increasingly emerging at local and regional level and require ambitious strategies to facilitate a transition towards a plant-based food system, including novel foods and new food production technologies.
- The unprecedented rise of energy, fertilizer and food prices since 2021 underlines the need to address the vulnerability of the food system. A transition towards plant-based diets requires less land and mineral fertilizers, thus reducing energy dependency and increasing resilience to food and energy crises.
- This report adds evidence on the need and actions to transform the food system based on a systems approach. Encouraging more plant-based diets can promote human health and a healthier planet.

Reduce use of nitrogen to bring benefits for health, nature and climate

The previous report 'Nitrogen on the Table' prepared by the Expert Panel on Nitrogen and Food (EPNF) highlighted that high levels of reactive nitrogen emissions are linked to intensive livestock production and a high share of animal products in the human diet. Losses of reactive nitrogen to the environment have pushed the global nitrogen cycle out of its planetary safe operating space and has detrimental effects on all life on Earth. The nitrogen use efficiency (NUE) in the EU food system has been estimated to be 18% revealing the urgency in addressing this issue [1; **the number indicates the chapter of this report where evidence is presented**].

In the second half of the last century, investments, innovations, import tariffs and agricultural subsidies incentivized agricultural productivity and food production, which increased the availability of affordable but also energy-dense food. This resulted in important changes in the European diets including an increased consumption of animal-based foods and processed foods high in salt, sugar and saturated fatty acids. Such dietary transition had unintended consequences across the food system and public health in the EU. The prevalence of overweight and obesity has more than doubled in Europe within the last 50 years and diet-related diseases are now a leading cause for premature mortality. In addition, a large share of arable land of the EU (40%) is now used to produce animal feed. Producing animal-based foods relies heavily on imports of crop product for animal feed (oil seeds), and production and import of fertilizers, making the current food system vulnerable to energy and food crises.

Reducing nitrogen (N) use requires policy capacity for governing the food system, recognizing the importance of integrative and interconnected policies that address nitrogen use based more on a systems approach, than on separate measures. This report 'Appetite for Change' extends the scope of nitrogen policy assessment by providing additional tools and policy-making approaches for food system governance. It explores the opportunities for reducing nitrogen losses from food production and consumption from a systems perspective, including the links to nutrition and public health.

1. **Leakage of reactive nitrogen from food systems threatens the environment and human health. Nitrogen use efficiency of the EU food system was only 18% in 2015 [1]**

   Losses of reactive nitrogen (N_r) to the environment have pushed the global nitrogen cycle out of its planetary safe operating space and is considered one of the key global risks to all major environmental threats that humanity is facing today. It is regarded as a main cause for losses of biodiversity and natural resources. It is also causing several forms of air pollution and climate change. Around 2015, the EU agri-food system used 20 Tg of virgin (new) N to deliver less than 2.5 Tg N in food and 1.2 Tg N in non-food products to consumers, yielding a nitrogen use efficiency of the food system (NUE_{FS}) of 18%. Of the N loss, 10.9 Tg N is emitted to the environment as N_r and 3.2 Tg N as N_2 and 3 Tg N is solid waste or lost outside the EU linked to feed imports [1].

2. **Plant-based diets correlate with lower nitrogen footprints and positive health outcomes [2]**

   Increasing sustainability of the livestock sector and reducing consumption of animal-based food products is crucial for improving the sustainability of the EU food systems and public health [1, 2]. Overweight and obesity affect almost 60% of adults and nearly one in three children in the WHO European Region.

   Today, unhealthy diets are a major risk factor for non-communicable diseases (NCDs) in the European Region. Diets with a lower nitrogen footprint, e.g., plant-based diets including vegetarian or the Mediterranean diet, are often healthier and can improve public health and reduce the burden on health care systems (i.e., by prevention and behavioural measures to reduce numbers of hospitalized in-patients). Such dietary patterns are associated with improved body weight, lower blood pressure and chronic disease prevention compared with omnivorous diets high in red and processed meat. In addition, excess nitrates in drinking water and nitrogen air-born pollutants can increase the risk of NCDs, including cancer, thyroid disease, and cardiovascular disease.

   Global excess mortality due to air pollution from $PM_{2.5}$ and tropospheric ozone is 8.8 million per year. In some regions more than 90% of the $PM_{2.5}$ concentrations can be attributed to agricultural sources and about one third to emission of N_r. Moreover, the link between $PM_{2.5}$ exposure and increased mortality risk from COVID-19 further underscores the risk of leaving nitrogen pollution unchecked [2]. The livestock sector is also a major source of emissions of methane and N_2O, which are strong greenhouse gases. The livestock sector might be linked to antimicrobial resistance, as well as the emergence of new zoonotic disease. Dairy farming, meat processing and slaughtering are regarded as high-risk jobs [1,2].

Agreed targets to halve nitrogen waste are possible to reach with a shift in diets towards more plant-based foods

3. **The most feasible strategies to reduce nitrogen losses in agriculture by 50% will combine diet change towards plant-based diets with intermediate ambitions of farm level and food chain measures [10]**

   Scenario analysis of the European food system and environmental impacts shows that relying on technical solutions will clearly not be enough for reaching political nitrogen-targets. Successful strategies will need to address a mix of interventions targeting different food system stages. Diet change towards plant-based diets is a key condition for succeeding with a 50% reduction. Specifically, combinations of interventions are needed, in tandem with policy evaluations of their effectiveness, to improve nitrogen (N) management in agriculture, reduce food waste, explore ways to recover N from organic residues, reduce the share of animal products in diets and enable a shift to a balanced and healthy diet. By combining ambitious changes in diet, food chain and residue management, and farm level practices, an increase of the nitrogen use efficiency (NUE) to almost 50% and a reduction of nitrogen waste by 84% is achievable. Additionally, a rising demand for land to produce energy crops and nature conservation cannot be met without decreased land demand for meat production.

4. **Dietary changes reduces the socio-economic cost of achieving ambitious nitrogen reduction targets [10]**

   The scenario analysis showed that focused action within single stages was not sufficient to meet the 50% reduction target. The maximum reduction in N loss achievable with improved N management at farm level only was 37%. In the case of improved nitrogen management in food processing, retail and sewage treatment, the maximum reduction in wasteful nitrogen losses was 17%.

   By contrast, of a total of 144 scenarios combining changes in different parts of the agri-food system, it is shown that a wide range of outcomes are achievable using a mix of measures, ranging from a reduction in nitrogen loss from 0% to 84% (Figure ES.1). Of these, 12 scenarios were selected that delivered between 49% to 51% reduction (Figure ES.1) for more detailed analysis in Chapter 10.

   Of the 12 selected scenarios, we here illustrate four example scenarios that achieve around 50% reduction in wasteful nitrogen losses and compare these with the baseline scenario and the maximum ambition scenario (Table ES.1). These examples show how contrasting scenarios provide alternative pathways to halve nitrogen waste from EU agriculture and satisfy critical environmental loads and levels of N. The example scenarios reflect contrasting assumptions on improvement of farm N management, waste N management and change of diet. These examples illustrate different strategies to halve nitrogen waste:

   Scenario O41 represents a broad approach with somewhat improved farm and food management, slightly reduced energy and N intake and demitarian diet (i.e., half meat and dairy compared with EU average). This represents a healthy diet approach that fully meets dietary needs. This moderate combination of changes achieves halving of nitrogen waste with the highest overall score for net societal benefit (overall score).

   Scenario O45 focuses on highly improved farm practices with improved food management, while retaining current energy and nitrogen intake and dietary mix. This extreme combination, putting all the effort on farmers but none on consumers, scored lowest for net societal benefit of the example scenarios.

   Scenario O48 combines medium ambition for improved farming with somewhat improved food management, somewhat reduced energy intake (avoiding excess) and a vegetarian dietary mix. The approach was found to have an intermediate score for net societal benefit.

   Scenario O51 represents a polarized option, where neither farming nor food management are improved, and the reduction in nitrogen waste is achieved entirely by a reduction in energy intake, combined with a vegan diet across Europe. This scored similarly to O48 but significantly better than O45.

   Scenario O144 is the most ambitious of all 144 scenarios considered, achieving an 84% reduction in total nitrogen waste (sum of all nitrogen losses). This offers strong environmental benefits, contributing towards a positive societal score, but this is offset with substantial negatives associated with the ambitious changes. As a net result, the net societal score of this scenario is no better than the current baseline.

Overall, these scenarios show how there are different pathways to reducing nitrogen pollution impacts. The target to 'halve nitrogen waste' can be most acceptably met by a broad range of actions that combine improved farming practice, improved food management (including food processing, retail and sewage treatment), avoiding excess energy and protein intake, and adopting a demitarian approach that halves meat and dairy intake compared with the baseline European situation.

The Nitrogen use efficiencies achieved in these calculations are lower than those reported in the previous report 'Nitrogen on the Table' prepared by the Expert Panel on Nitrogen and Food (EPNF) with NUEs of up to 47% for a demitarian diet. The reason for this difference are the scope and system boundaries which differ between the two studies. While here no assumptions were made on the use of the land not required any more for feed production, the 'Nitrogen on the Table' report assumed that the land was (partly) used for cereal production for export which increases the NUE of EU agriculture.

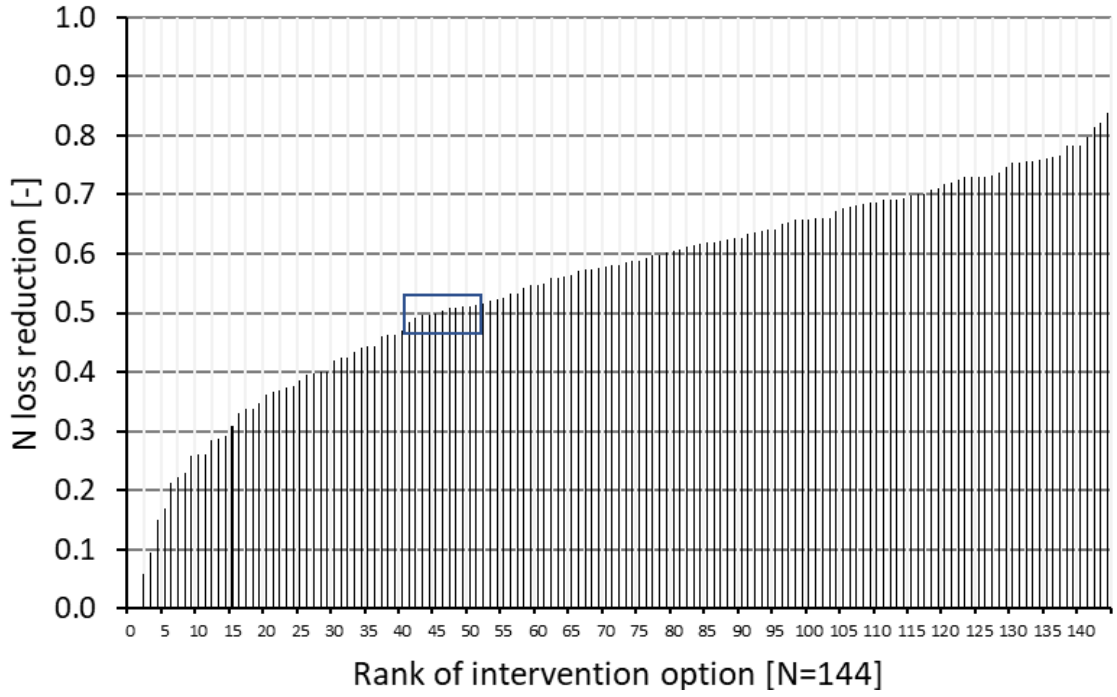

Figure ES.1. *Relative reduction of nitrogen (N) losses in 144 intervention options and selection of 12 intervention options (blue box: O41–O52) with a N loss reduction between 49 and 51%. Source: Leip et al. (2022), reproduced here under CC BY 4.0, https://creativecommons.org/licenses/by/4.0/.*

Table ES.1. *Results of the baseline for 2014-2015 with four example scenarios that deliver around 50% reduction in wasteful nitrogen losses to the environment as compared with the baseline, plus the scenario reaching highest reduction of wasteful nitrogen losses. Source: Leip et al. (2022), under CC BY 4.0, https://creativecommons.org/licenses/by/4.0/.*

Scenario option						**Effects on N cycle and implementation**				
Example scenario	**Farm level** **Ambition**	**Food chain** **Ambition**	**Healthier energy intake** ***% reduction***	**Healthier protein intake** ***% reduction***	**Diet**	**Virgin nitrogen** **Tg N yr^{-1}** ***% reduction***	**Nitrogen losses** **Tg N yr^{-1}** ***% reduction***	**NUE food system**	**Implementation costs score**	**Overall score for net societal benefit [$]**
Baseline	Baseline	Baseline	*0%*	*0%*	Default	16.0 *0%*	12.4 *0%*	19%	0	0
O41	Low	Intermediate	*13%*	*20%*	Demitarian	9.4 *41%*	6.4 *49%*	27%	0.1	0.8
O45	High	Improved	*0%*	*0%*	Default	10.0 *37%*	6.2 *50%*	32%	-2.8	-0.6
O48	Medium	Intermediate	*13%*	*0%*	Vegetarian	9.7 *40%*	6.1 *51%*	32%	-1.0	0.4
O51	Baseline	Baseline	*13%*	*0%*	Vegan	9.5 *41%*	6.0 *51%*	32%	0.0	0.5
O144	High	Improved	*25%*	*40%*	Vegan	4.3 *73%*	2.0 *84%*	47%	-2.8	0.0

[$]*The overall score for net societal benefit is calculated from the private and public cost of the implementation of measures to decrease nitrogen (N) losses in agriculture and waste management, the public benefits of improved healthy life expectancy and reduced public health cost due to healthier diets and reduced exposure to pollutants; the public benefits of increased biodiversity and ecosystem services; and the public cost for overcoming socio-cultural barriers for adoption of alternative diets. NUE = nitrogen use efficiency.*

Sustainable food systems could profit from a mix of traditional and novel plant-based foods

5. Increasing the share of legumes in food production and consumption needs to be part of a food system policy [2]

In Europe, protein intake is almost double the recommended amounts. Consumption of processed and red meats are more than three times the quantity recommended by the EAT Lancet Commission in all EU countries. Only 1.5% of the EU arable land area is used to cultivate legumes compared with 14.5% worldwide. Legumes can fix parts of their nitrogen requirements through symbiosis with nitrogen-fixing microorganisms in their root nodules. Consequently, they have substantially higher nitrogen uptake efficiencies. The nitrogen footprint from soy, peas, chickpeas and lentils is estimated to be almost one order of magnitude lower than that of any other food group. In addition, legumes are a sustainable alternative to animal protein sources in line with dietary guidelines. Legumes are rich in protein, complex carbohydrates, dietary fibre and various micronutrients such as phytochemicals, and they are associated with positive health outcomes. Increased consumption of legumes consumption is a key measure that will positively impact on the share of legumes cultivated in the EU [2].

***Figure ES.2**. Illustration of key elements to be considered in future sustainable and healthy diets [3]. © Catharina Latka.*

6. A shift to lower animal-based foods consumption can be achieved in many ways to reach all people [2]

Agroecological approaches aim to reconcile nutrition, ecosystem health and social welfare, combined with dietary change. Agroecology uses traditional practices and maximizes the contribution of ecosystem to food production. It also integrates new knowledge and technologies but minimizes reliance on external inputs. In a visionary food system, advanced technologies and widespread dietary changes can lay the foundation for other paths to a sustainable future food system if acceptance-, technology-, and energy-related obstacles can be overcome [3]. A shift towards urban, high-technology food production systems, for example vertical or indoor farms, promises sustainability improvements with improved nutrient- and water-use-efficiencies and reduced agricultural land requirements, and the supply of urban areas with close-by and seasonally independent produced plant-based food. In addition, novel and future foods such as from cellular agriculture (cultured meat and precision fermentation) will contribute to sustainable visionary food systems. High-energy requirements and the need for further technological breakthroughs remain as continuing challenges [3].

7. Future foods offer opportunities for substituting unsustainable high consumption of animal-based foods [5]

Farmed insects, farmed seafood, microorganisms (e.g., microalgae and fungi) and so-called 'cultured meat' all have a major role to play in the future food system. These have the potential to supply valuable nutrients to human diets including protein and a diverse array of minerals, vitamins and fatty acids using less land resources and lower greenhouse gas emissions compared with conventional animal-based food. While many future foods are already in the market, their major adoption will require overcoming technological, economic, legislative and socio-cultural barriers. As such, recognizing and understanding the potential of future foods in providing environmental and nutritional benefits can encourage opportunities and innovations across the food system to address the overconsumption of conventional animal-based foods in the EU.

Strengthening food systems governance

8. Combining policy instruments can better support a transition towards more plant-based diets [2, 6, 7]

Taxes and subsidies, which alter consumer prices, are powerful market-based instruments. Combining taxes on food with high environmental impact or that is typically overconsumed from a health perspective with subsidies to healthy, low impact food can reduce the regressive effect of these instruments. Behavioural policies support both consumers' active and conscious choice (learning and information approaches about plant-based diets) and 'nudge' people into making healthier and more sustainable food choices more or less consciously (e.g., changing the position of food items on supermarket shelves or reducing food portions). Food reformulation and innovation could increase the availability and access to more sustainable food products. Sustainable public procurement could support an increased offer of healthier and more sustainable food options and meals in public institutions. Food-based dietary guidelines (FBDGs) already support the development of national food and nutrition policies and could integrate sustainability goals to better align food and environmental policies. Effective strategies to food system governance must integrate a combination of such measures and target environmental, social and economic objectives at all food system stages. A coherent combination of different demand-oriented measures, together with supply-oriented is likely to be more effective in increasing demand for lower nitrogen footprint diets.

9. Strengthening governments' coordination and operational capacities can support more integrated solutions [8]

Although most nitrogen emissions occur at the farm level, it does not mean that policies have to first target farmers [1,2]. The shape of the European food environment is asymmetric and largely controlled by food and feed industry and retail, influencing consumers and primary producers. Nitrogen reduction options remain un-tapped if these asymmetries in food supply chains are ignored. There are major obstacles to consumers wishing to make sustainable healthy choices and farmers wishing to shift to less intensive farming. Many problems linked to food systems are not yet addressed in food system action-plans [1]. Coordination between government actors at administrative and jurisdictional levels and sectors is crucial to address trade-offs and set priorities. Critical evaluations (reflexivity) of practices, policies and behaviours must be the basis for policy debates and policy-making, supported by monitoring systems and platforms to drive innovation and critical thinking of system dynamics.

10. Strengthening governments' anticipatory capacity is essential for imagining a future food system that can address trade-offs and anticipate risks and unknowns [8]

National governance structures can help guide a common direction for change by investing in anticipatory capacity. Anticipation includes approaches of organisations and institutions to manage their future goals and govern future surprises. Anticipation requires resources for conducting future-oriented tools, such as scenario planning and foresights, and abilities for integrating different types of knowledge in governance processes. In addition, future vision-building needs to involve participatory processes that empower citizens and helps stakeholders build a shared vision. A broad agreement is of great importance to support an effective food system transformation. Systemic approaches at regional or city level are emerging as a relevant opportunity to address food systems worldwide, as for example the Milan Urban Food Policy Pact engaging more than 200 cities.

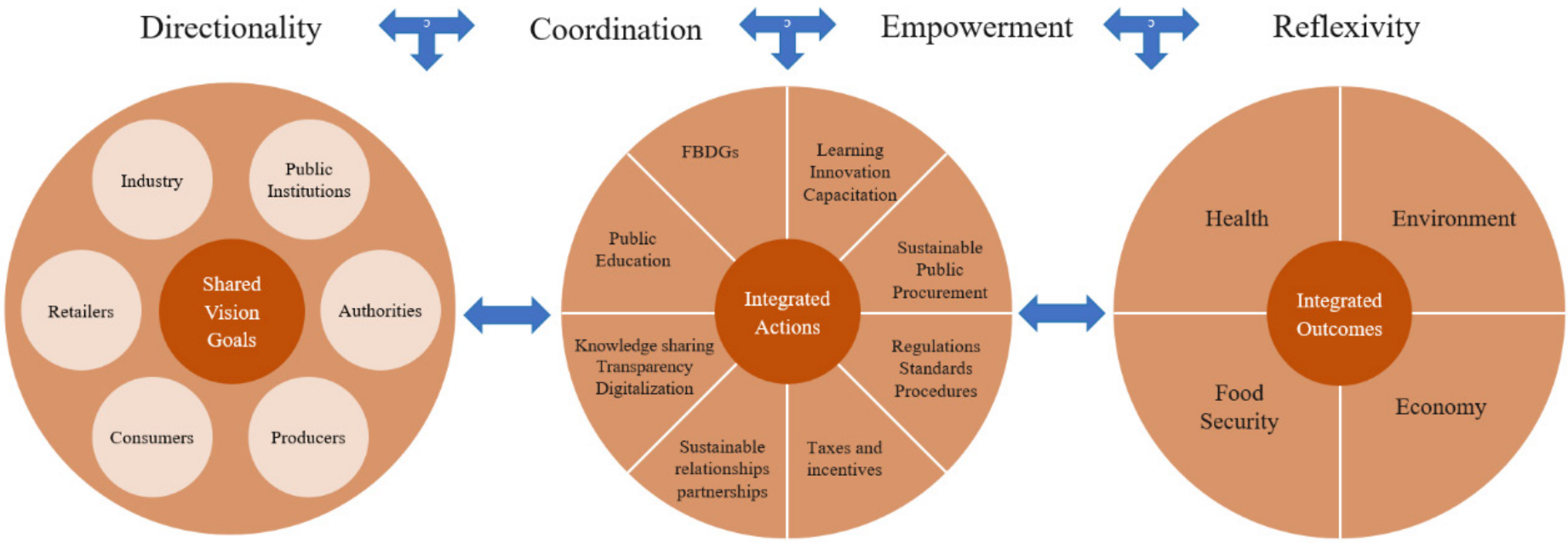

Figure ES.3. *Core principles for planning a food system transformation, resulting in a shared vision, integrated actions and outcomes. FBDGs = Food-based dietary guidelines. Source: created for this report by the authors.*

Set-up a food system monitoring framework along all sustainability dimensions to identify and manage trade-offs

11. Food systems' sustainability can be measured against four societal goals:

1) Adequate, safe, healthy and affordable diets for all;

2) A clean and healthy planet;

3) Economically thriving food systems, supportive of the common good; and

4) Just, ethical and equitable food systems [9].

A food system monitoring framework must capture all sustainability aspects and consider all people, including those in the future. A growing number of food systems metrics is available to build up capacity for system thinking and reduce policy incoherence between food system challenges. Such metrics can help to find important leverages increasing one or several dimensions of sustainability. Indicators that capture social equity and gender consideration in the food system are lacking, as well as indicators that measure the socio-economic impact of food system policies on other parts of the world.

12. Applying tools to quantify food system sustainability scores is important for identifying trade-offs and co-benefits in policy-making and requires policy targets for all sustainability objectives [9]

Science-based sustainability metrics offer a transparent approach to support decision makers to take better stock of current trade-offs. These include trade-offs between sustainable food production and affordable food prices; the risks of using manure on arable land for recirculation of antibiotics and hormones in the food cycle; or the need to reduce consumption of livestock products and rural development goals. Sustainability metrics must be accompanied by science-based targets to assess policy progress towards endorsed sustainability objectives. By providing a science-based, yet policy-oriented perspective on food system sustainability, sustainability metrics are useful to inform policy dialogues and negotiations, since these provide technical and less value-based judgements to where the trade-offs and positive synergies occur.

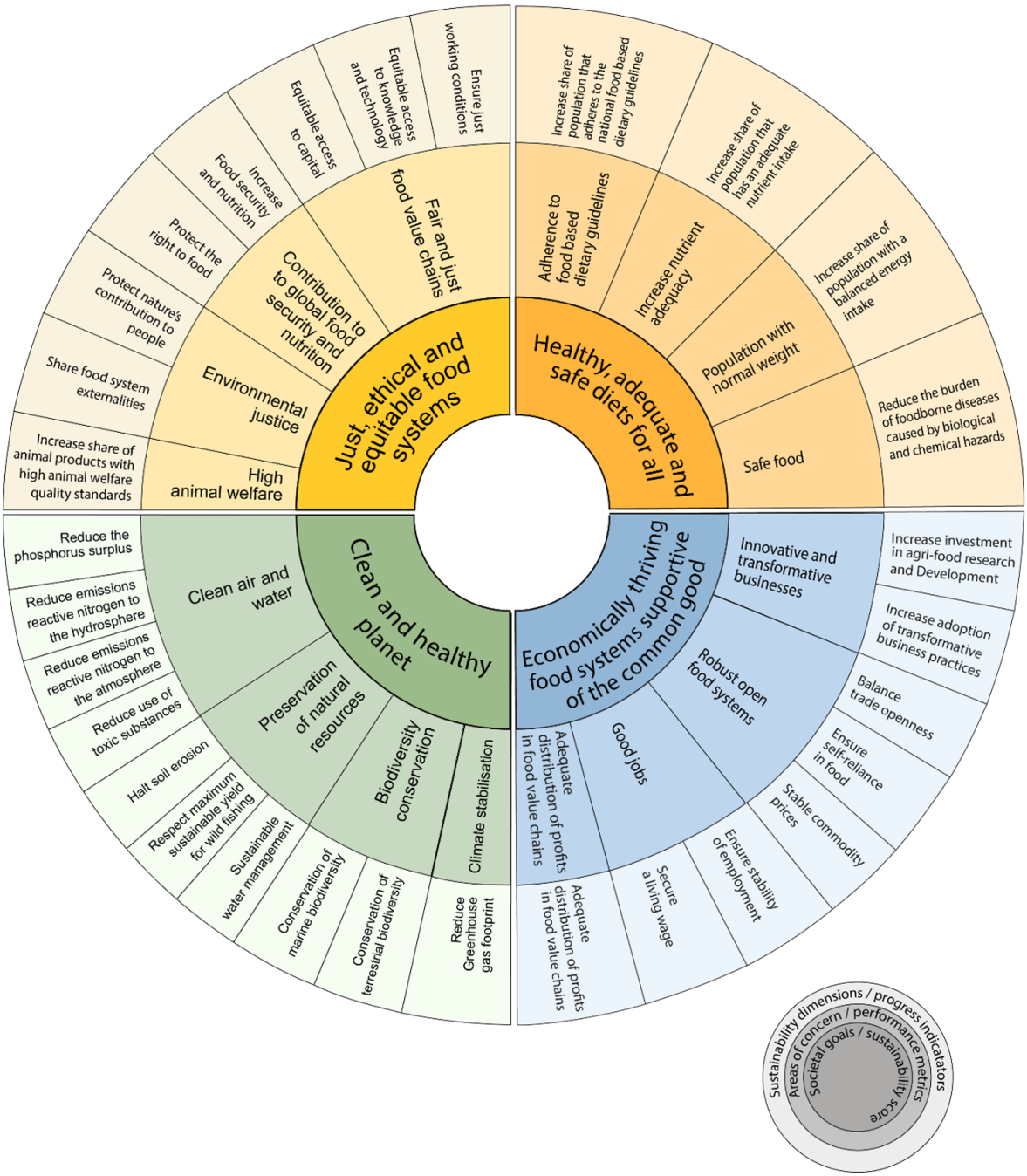

Figure ES.4. *Illustration of how societal goals (centre) link to areas of concern and performance metrics (intermediate ring) and sustainability dimensions, with associated progress indicators (outer ring). Adapted from Hebinck et al. (2021), under CC BY 4.0, https://creativecommons.org/licenses/by/4.0/.*

Increase nitrogen use efficiencies on the farm and in waste/residue management systems

13. **There is scope for significant improvement in the nitrogen use efficiency (NUE) of all production systems with available technologies. Nitrogen use efficiency can be achieved of up to 92% for arable systems, 80% for granivores, 61% for ruminant meat production and 55% for dairy production [4]**

    A modelling exercise showed that nitrogen use efficiency (NUE) at the farm level was similar to or higher in Southern than Northern Europe. The NUE of arable production systems is higher than that of livestock production systems and this is likely to also be true in the future, even with the development of new feeds, foods and technologies. Modelling high ambition implementation of current available technologies, arable systems reached the maximum technical NUEs (82% and 92%) followed by granivores (i.e., pig and poultry, 71% and 80%), ruminant meat production on constrained land (beef, sheep, extensive, 45% and 61%), dairy production on unconstrained land (intensive, 53% and 55%) and ruminant meat production on unconstrained land (50% and 36%). However, these values ignore possible impact on other policy areas such as animal welfare. Unconstrained granivore systems offer the greatest possibilities to increase in NUE, while the optimization potential for NUE is lowest in ruminant meat systems with less productive land, as their NUE is already quite high.

14. **There is considerable scope to improve food system NUE by reducing food waste and improving wastewater treatment [1]**

    Of the food sold by EU farmers only about 55% is consumed by humans. If the EU met the objective of SDG 12.3 to halve food waste generation by 2030, emissions of reactive nitrogen after the farm gate would decrease by about 50%, while the amount of valorized nitrogen would increase by 9%. Achieving such targets would greatly improve the NUE in the food system. There is potential for reducing post-farm gate reactive nitrogen emissions by more than 45% when fully implementing current EU legislation on food-waste and improving wastewater treatment, which are together currently responsible for more than 60% of emissions.

    This improvement would require: 1) an increase of the share of tertiary wastewater treatment to remove chemical pollutants such as drugs, 2) a reduction of food waste generation, and 3) a decrease of the quantity of incinerated and landfilled food waste (combined with an increase in compost production and use). More homogenous food waste makes their valorization easier in the food processing stage as compared to the consumption stage and would reduce the risks of introducing chemical components in the food system (such as microplastics).

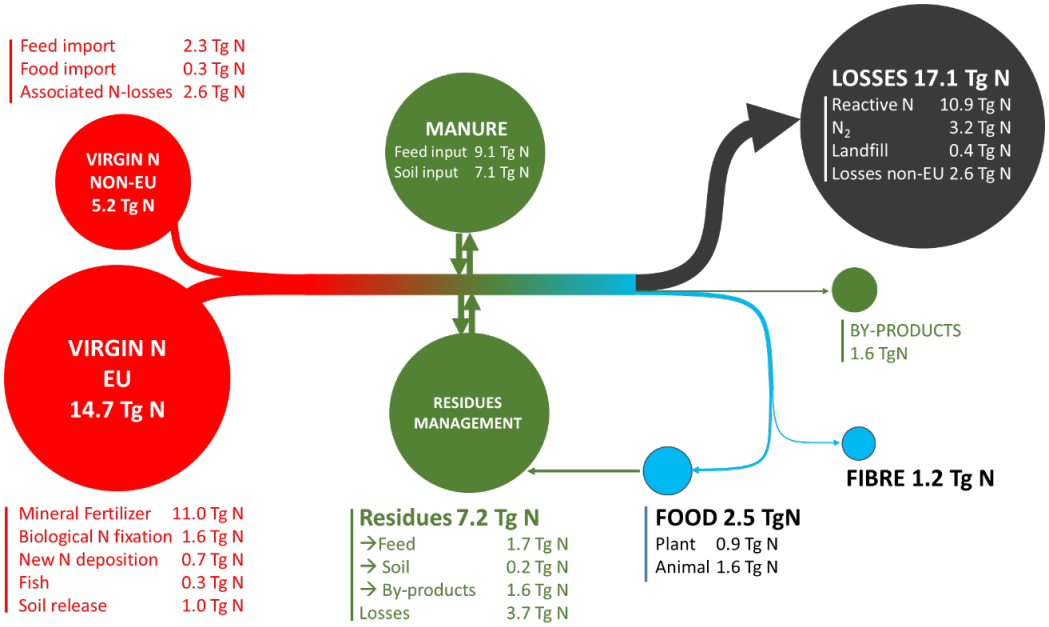

Figure ES.5. *Summary of nitrogen flows in the EU food system around 2015. Around 85% of virgin (newly fixed) nitrogen associated with the EU food system is wasted as losses to the environment [1]. Source: adapted from Leip et al. (2022), under CC BY 4.0, https://creativecommons.org/licenses/by/4.0/.*

Time for action towards sustainable food systems

15. A transition towards plant-based diets leads to a reduction in edible biomass fed to animals, and can promote more resilient and energy efficient food systems

The present geopolitical situation has revealed the vulnerability of the global food system to energy conflicts. It also demonstrates how future crises will keep threatening food security and the progress on climate change mitigation if society does not act systemically. A transition towards more plant-based diets not only helps achieving environmental and health targets. It is also an essential solution to reduce the food production dependency on energy inputs, promoting food systems that are more resilient to future conflicts and shocks. Energy and food connect three threats that need to be tackled at the same time with highest urgency in the current global crisis:

(1) The threat to democracy and security.
(2) The threat to global food security.
(3) The threat to our living environment by climate change, biodiversity loss, and environmental degradation.

A range of policies addressing consumer food choices are available for public authorities to provide incentives for dietary change towards lower nitrogen footprint diets [6, 7]. In addition, energy savings in food systems need to be pursued, among others, by increasing nitrogen use efficiency and substituting mineral fertilizers with organic fertilizers. For instance, producing more energy-efficient animal feed and animal-based food is possible through the integration of agroecological or agroforestry principles, especially when the development of novel foods with lower nitrogen footprint is promoted.

To support dietary changes towards healthy, environmentally friendly produced food, consumer-oriented instruments are available for public authorities, civil society or private actors. Two examples include policies that encourage the food industry to reformulate processed food products reducing the contents of unhealthy ingredients and public food procurement to increase availability of more sustainable options for the public.

So far there has been little implementation of taxes and subsidies that address the environmental impact of foods. A combination of coherent policies can promote healthier and more sustainable food environments empowering consumers towards sustainable food choices.

A priority is to update and implement effectively national food-based dietary guidelines (FBDGs) that include sustainability aspects to help consumers make healthier and sustainable food choices. These are promising instruments that can guide coherent national policies, institutions, and the public towards healthy diets from sustainable food systems.

This report adds evidence for the need and the benefit of food system transformation to a sustainable agri-food system providing healthy diets for people while caring for the planet.

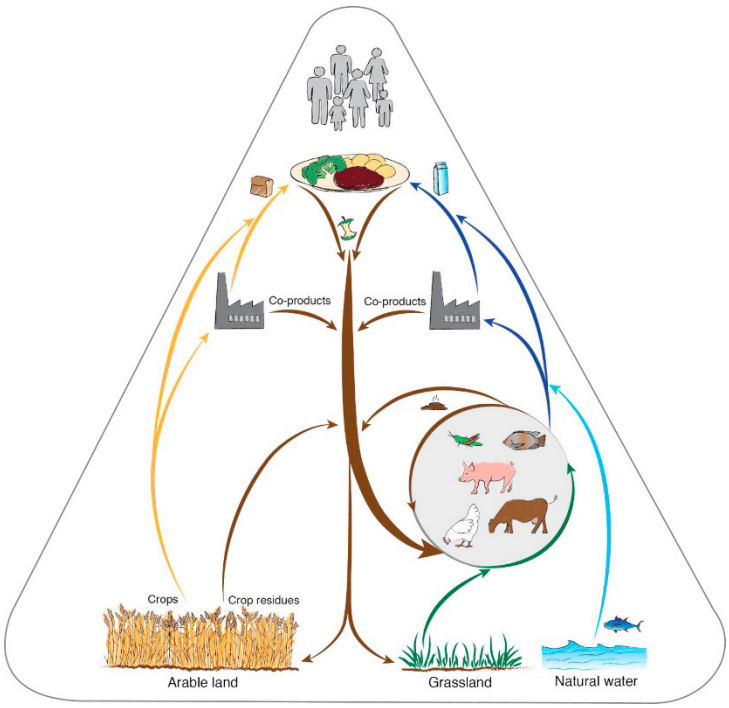

Figure ES.6. *Illustration of a sustainable agri-food system providing healthy diets for people while caring for the planet. A reduced share of meat and dairy in Europe is envisaged as allowing livestock to be primarily fed from food-waste and residues/co-products that are not directly edible for humans. Source: Van Zanten et al. (2019), reproduced here under CC BY-NC-ND 4.0, https://creativecommons.org/licenses/by-nc-nd/4.0/.*