NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

NOTAT

Forfattere:
Audun Korsæth, Direktør Matproduksjon og samfunn
Anne Kjersti Bakken, Forskningsleder Matproduksjon og samfunn
Arne Bardalen, Spesialrådgiver NIBIO
Per Stålnacke, Forskningsdirektør NIBIO

Dato: 16.01.2023

Høringsuttalelse til Helsedirektoratet vedrørende nye nordiske ernæringsanbefalinger (NNR) - kommentarer til «paper 2».

I regi av NNR 2022 er det utarbeidet en vitenskapelig rapport, benevnt som paper 2:
Background paper: *Overview of food consumption and environmental sustainability – considerations in the Nordic and Baltic region*

NIBIO har avgitt høringsuttalelse til nevnte rapport, oversendt Helsedirektoratet den 16 januar (lastet opp her). Høringsuttalelsen er skrevet på engelsk, og gjengitt i sin helhet i dette notatet.

Høringsuttalelse på paper 2, (NNR 2022) fra NIBIO

Authors at NIBIO: Audun Korsæth, Anne Kjersti Bakken, Arne Bardalen and Per Stålnacke

I. General comments'

The manuscript (ms.) does not apply with the standard expected for a scientific paper due to lacking structure, inappropriate use of methods, and weak or missing discussions. The conclusions are not justified, since the ms. does not represent a balanced and comprehensive evaluation of environmental impact of food production under Nordic conditions.

We have chosen to first address the main conclusion of the ms. (1.) before we substantiate our claims further (2.).

1. Bold conclusion on unstable ground

The main conclusion of the ms. is that "*reducing the consumption of animal sourced foods (particularly meat, dairy and eggs) is the key approach to reducing adverse environmental impacts at the system, aggregate or absolute level*". The ms. is relying heavily on LCA-methodology to assess the environmental impact of the food groups evaluated.

It is remarkable that the authors find reason to come up with such a bold conclusion, considering the range of limitations relating to the use of food LCAs, as thoroughly discussed in a previous paper (*Assessing the environmental sustainability of diets – an overview of approaches and identification of 5 key considerations for comprehensive assessments*), a paper which was meant to build the methodological framework of the current paper.

1.1 Few LCA-data, and of general origin

The LCA data included appear to be very general and originate from only two sources; Poore and Nemeck (2018), who performed a meta-analysis comparing various types of food production systems globally, and a "*comprehensive database of environmental footprints, differentiated by country, food group, and environmental impact*" taken from the Global Nutrition Report (2021). Looking closer at the origin of these data, they all result from a single modelling exercise performed by Springmann et al. (2018), which rely on data from global datasets on environmental resource use. The study was partly funded by EAT Foundation.

1.2 Large deviation between general and local LCAs

There is partly very large deviation between the resulting score on these LCA-indicators, and data published on the same food groups using data on inputs and management of a more local origin. For example, are the GHG emissions for beef 36.78 kg CO_2eq/kg in the Global Nutrition Report (2021), and 0.23 kg CO_2eq/kg for wheat. In comparison, LCA studies using Norwegian input data, probably with wider system boundaries, report GHG emissions for beef of 19-20 kg CO_2eq/kg (combined productions with milk, which represents the largest share of Norwegian beef production; Bonesmo *et al.* 2013, Bakken *et al.* 2017,) and 0.5-0.9 kg CO_2eq/kg for wheat (Korsaeth *et al.* 2014).

1.3 Missing environmental indicators

The LCA analysis provided data on GHG emissions, cropland and blue water consumption (lines 378-402). Terrestrial acidification, and marine eutrophication are included in some figures (e.g. Fig. 3.1), but these indicators are not specifically mentioned in the section *Environmental data sources and handling* (pp. 10-12). LCA-based analyses yield very limited information on nutrient losses to the environment (e.g. not accounting for recession time and retention in freshwater bodies and denitrification of N before reaching the sea; Grimvall *et al.* 2000), and soil carbon dynamics is handled rather rudimentary. Other environmental aspects, such as erosion risk, or risk for losses of chemical substances related to plant protection were not considered. Biodiversity, was not systematically addressed since "*comprehensive data was lacking*" (p. 10), NIBIO

and biodiversity impacts across food groups was assessed "*partly as an expert elicitation*". These missing or poorly addressed environmental processes are weakening the overall environmental assessment significantly.

1.4 Missing nuance in interpretations of LCA: Interestingly, in lines 593-594 it is stated that "*conclusions in this paper shaped by LCA – as discussed in the previous paper in this series – should be interpreted with nuance*"(!) (lines 593-594). We miss this nuance in the conclusion and claim that these limited analyses of environmental aspects using very general input data and only a few selected environmental indicators does not reflect a balanced and comprehensive evaluation of environmental impact of food production under Nordic conditions.

2. The ms. does not apply with the standard expected for a scientific paper

2.1 Lacking structure:

The ms. is structured more like a report, and not like a scientific paper. Acknowledging that the IMRAD-model is not the only way to structure a scientific paper, the current structure is lacking in terms of clarity and readability and suffer particularly from the considerable length of the ms. The parts of the ms. addressing global issues are remarkedly large (up to 50%) considering the title of the ms., in particular for certain chapters (e.g. Cereals: 3 out of 7 pages (3/7) are globally related, Pulses: 3/7; Fish, fish products and seafood: 7/14, Meat and meat products: 6/14 pp., Milk and dairy products: 2/5). Further, a distinct methodology chapter is missing, and a discussion of the findings is either missing or appears to be rather unsystematically included in the text throughout the entire ms.

2.2 Inappropriate use of methods:

It is stated in the ms. that the selected method is a combination of expert elicitation (expert judgement) and the use of existing systematic reviews of the scientific literature (lines 309-311). Both appear to be applied with clear limitations, as elaborated below. Overconfidence in the use of LCA as main tool for the environmental analyses is already addressed above (section 1).

<u>2.2.1 Inappropriate expert elicitation:</u> Expert elicitation was used to assess existing data on environmental impacts of foods and diets by collecting input from 20 regional experts "*through a series of workshops and via reviews of the manuscript*". To our knowledge, there were performed only two digital workshops addressing this study, at Des. 14, 2021 and at May 18, 2022. In the former, two issues were discussed in breakout sessions á 45 min.; meat and dairy + fruits and vegetables. In the latter, fish, pulses, and ultra-processed foods were discussed in three breakout sessions á 20 min. In our opinion, the expert elicitation was applied inappropriately, without any thorough structure (e.g. elicitation protocols missing, no apparent plan for how to handle contrasting views, or how to aggregate information afterwards), with unclear representativeness among the participants, and with very limited time to discuss complex issues – additionally in a digital setting only. Inappropriate and ill-informed methods for elicitation can amplify

contextual biases, and heuristics such as anchoring, groupthink, overconfidence and difficulties associated with communicating knowledge in numbers and probabilities (Hemming et al. 2018).

2.2.2 Limited systematic reviews and lack of novelty: When it comes to the use of existing systematic reviews of the scientific literature, we see a pattern where data from only a few sources have become central for the data presented in the current ms. This is already mentioned above for LCA. Another example is that each food group is presented in a figure showing the environmental impacts in relation to planetary boundaries across the Nordic and Baltic countries. All these figures are based on one source, the Global Nutrition Report 2021. Apart from the fact, that data from only a handful sources originating from very aggregated studies dominate the ms., we question the novelty of the current study. The method of selecting a few reviews from the literature, and then incorporate their findings without any discussion of their origin, or why these studies were selected in the first place, etc., does not show sufficient novelty for a scientific paper. Moreover, every single table and figure presented in the ms. related to environmental issues appears to be taken directly from another source, and we can't see any attempt to provide any novel way of structuring the data or the knowledge presented.

2.2.3 Planetary boundary values are highly disputed and uncertain: We also question the choice of presenting data on environmental impacts as a percentage of planetary boundary values, which is done both in Section 1 and in each of the focal food group chapters in Section 2. The environmental data in the form of five LCA-indicators, are based on a limited approach with a high degree of uncertainty, as discussed above. Moreover, the planetary boundaries are highly disputed (e.g. de Vries *et al.*, 2013), not least the numerical value of each boundary (e.g. Gerten *et al.* 2015; Campell *et al.* 2017). Springmann *et al*. (2020) stated that "*The planetary-boundary framework is not without criticism, particularly because of the heterogeneity of the different boundaries and their underlying scientific bases, including the difficulty of defining global ecosystem thresholds for local environmental impacts".* It is common knowledge that when dividing one uncertain number by another, the potential errors are added, thus increasing the unreliability of the result. Planetary boundaries may represent a concept, which illustrate the risks for irreversible effects on living organisms and on the physical environment at the global scale attributed to some human-driven activities. We find, however, that using the approach to evaluate quantitatively the environmental impact of food production in the Nordic and Baltic countries unsound. If the point was to "*indicate a range of impacts in a comparative way across the Nordic and Baltic countries*" (line 257), this could be done without involving the planetary boundaries.

There are others linking regional environmental impacts on food groups and planetary boundaries. For example, combined Ridoutt *et al.* (2021) environmental impact data (GHG emissions, cropland- and water-scarcity footprints) with planetary boundaries to calculate an environmental impact score (EI) for a large number of processed and unprocessed foods in the Australian food system. In their study, red meat, poultry and pork appeared to have less impact on the environment (here expressed by the EI) than bread and cereal foods, in contrast to the current ms. We mention these contradicting findings to underline the reason for questioning the methodologies used both in Ridoutt *et al.* (2020) and in the current ms., and to be careful to conclude based on such analyses.

2.3 Weak or missing discussion

2.3.1 A discussion of the selected methods is missing: The combination of methods selected for this ms. is rather unusual (i.e. a combination of expert elicitation and the use of existing systematic reviews), and a discussion of this matter is lacking.

2.3.2 Missing references and the use of grey literature: The ms. is characterized by many references to grey literature. Some of this material is not only lacking any scientific quality check, but the content is also highly disputable. Inclusions of contradicting studies, results or views are largely missing, and one may get an impression of “cherry picking” when reading the rather fragmented discussions.

2.3.3. Apparent “cherry picking”: The most obvious example of “cherry picking” is how grassland-based meat and dairy production is handled, where all beneficial factors appear to be systematically neglected. The use of chemical plant protection is problematized for potatoes, but the fact that grassland is far less exposed for chemical plant protection than any of the other crops is not mentioned. Even when correcting for feed concentrates, dairy products and meat produced in parallel compare favourably, particularly since the imported ingredients are only a small share nowadays. Numerous studies have shown that the N- and P-runoff losses along with soil erosion from grassland fields are significantly lower than those from arable fields, particularly in comparison with vegetable fields.

When it comes to the well documented favourable effects of grassland on C-accumulation (for references of relevance for Nordic conditions, see for instance Riley *et al.* 2022), the author states that *“… agricultural land used for grass production (including silage) can have lower CO2 emissions per ha as a result of degradation of soil carbon stock in comparison to agricultural land used for monocultures of annual crops*” (lines 1716-1718). This may be a result of an undesired writing error. The point is that changing the land-use from grassland to monocultures of annual crops, results in large quantities of CO_2 emitted over time, as the soil changes from an equilibrium at a high level of soil organic matter to a new equilibrium at a much lower level (which may take several decades) (e.g. Riley and Bakkegard, 2006). Hence, the *’carbon opportunity cost’* in the following discussion (lines 1719-1723), should logically be related to soil used for annual crops, since this is a possible change in at least some areas. The authors focus, however, on the “*native vegetation cover that would occur if meat production ceased*”, leaving an impression that such a change would be favourable for C-sequestration. This would, however, be in contrast to many reports, concluding that a change from grassland to forest has either very little or negative effects on soil storage (e.g. Conant *et al.* 2001; Gundersen *et al.* 2015).

2.3.4 Discussing international trade and environmental sustainability: The ms. is meant to focus on environmental sustainability, but nevertheless the authors bring in a discussion on self-sufficiency and international trade (lines 1899-1905). Even if these issues relate more to the social and economical pillars of sustainability, and are thus out of context and should be removed from the ms., they cannot be left uncommented. It is well established that food security and safety is a necessity for a sustainable society. For a country to have a food strategy, which do not account for the insecurities, risks, and deficiencies of the international trade, would not only be unsustainable but highly irresponsible. The current geopolitical situation with an ongoing war in Europe and increasing tension in Asia underline this. Even the comparably minor happening in 2007/2008, the financial crisis, had the consequence that more than 20 countries closed their border for food export for food security reasons (Demekem et al. 2009; Miller and Rivera, 2011). Each country should thus aim at producing food according to the demand and with a minimum of environmental footprint, within it's given natural conditions.

2.3.5 Many smaller and larger errors: The ms. suffer from many smaller and larger errors and misunderstandings, revealing that the authors and their local experts possess a rather limited understanding of agronomic issues generally, and in particular for the Nordic production systems. Below are only a few examples evaluated in a Norwegian context (II A-D). We have chosen not to comment on all the unverified comments of the regional experts, which to a large degree appears to be incorrect or at least unprecise.

II. Specific comments

A. Comparing outdoor production with greenhouse production / "vertical agriculture" (lines 858-870): This sequence appears to be very strange. It appears as if greenhouse production of vegetables may be a realistic alternative to outdoor farming, and that the energy requirements for heating and lighting may somehow be balanced by a reduced need for chemical plant protection indoor. For certain minor crops, green house production represents a supplement to prolong the cropping season, or it may provide an opportunity to produce crops with higher temperature demand (e.g. there were 39 ha of tomatoes in Norway in 2021). Considering the large volumes of the major crops produced outdoor today (e.g. 1690 ha of carrots, Norway, 2021), however, such an alternative is practically non-existing. The required greenhouse area and corresponding energy demand both for producing the green house and heating and lightening for only a small share of these volumes would certainly not be very sustainable. Moreover, the need for labour would increase dramatically, when reducing the possibility for utilizing tractor-based equipment designed for high efficiency but requiring large working space. The environmental savings in terms of reduced use of chemical plant protection would be small in comparison.

These issues are even enhanced if we talk about "vertical agriculture", understood as some kinds of vertically stacked layers often incorporated in a controlled-environment agriculture, commonly placed in structures as buildings or shipping containers. Here the energy demand for transporting growth media, nutrients, water and products is often underestimated. The main point, however, is that in terms of forming a significant contribution to the total food requirement of a population (in terms of energy and proteins), greenhouse production / "vertical agriculture" plays and will play an insignificant role, not least considering the increasing demand for building materials expected worldwide in order to replace fossil fuels with renewable alternatives.

B. The main limitations for root vegetables and brassicas are availability of arable land, a short growing season and the need for a long storage period (lines 918-923). There are several reports showing that arable land is not a limitation in Norway, and that we could theoretically increase the production of vegetables several times. Potatoes and vegetables cover only 6% of the total arable land in Norway today, and a large share of the arable area have a temperature range which enable production of potatoes and a range of vegetables. The real limitations are, however, field size and shape, topography, stone content and sufficient carrying capacity of the soil (e.g. not too moist in spring and autumn) suited for modern machinery in order to obtain an efficient production and thereby economical sustainability for the farmer. Moreover, the distance from the field to the further product chain (e.g. storage, packing facilities, wholesaler) poses also an important limitation for the economic viability of such productions.

C. A shift in potato consumption to other root vegetables and sweet potatoes to reduce the requirement for potato blight treatment and related loss of crops (lines 1116-1118). This is also s strange sequence. Firstly, the potato crop is treated for potato blight treatment to avoid crop losses and skipping this treatment may cause severe losses. Secondly, the rational for suggesting a shift from one of the major current sources for carbohydrates is to reduce the use of chemical plant protection, an environmental factor which is otherwise hardly considered in the ms. Beef and dairy production require for example much less plant protection than that of cereals and particularly less than that of fruits and vegetables, but this is not mentioned. Thirdly, a suggested alternative to potatoes was sweet potatoes. This is a plant belonging in another plant family than potatoes, and which requires much higher temperatures. Field trials performed in Norway, have shown that producing sweet potatoes so far north is possible but risky, particularly outside the southernmost region with the longest growing season. The yield potential is much lower than for ordinary potatoes, and it needs more labour. Moreover, the sweet potatoes require a heat treatment prior to storage. We do not believe that sweet potatoes is a sustainable alternative. It should also be emphasized, that although other root vegetables are not suffering from potato blight, they are exposed for several other biological threats (e.g. *Chamaepsila rosae* in carrots), which also require the use of chemical plant protection to avoid severe yield losses.

D. Ceasing grazing, regenerating boreal forest and biodiversity (lines 2002-2006): Claiming that biodiversity is larger in a boreal forest than in a landscape dominated by grazing is not only incorrect, but highly remarkable. There exist several reports documenting that it is a threat to biodiversity when former grazing areas are getting overgrown and gradually becomes a forest.

Literature:

Bakken, A.K., Daugstad, K., Johansen, A., Hjelkrem, A.G.R., Fystro, G. Strømman, A.H., Korsaeth, A. 2017. Environmental impacts along intensity gradients in Norwegian dairy production as evaluated by life cycle assessments. Agric. Syst., 158, pp. 50-60, 10.1016/j.agsy.2017.09.001

Bonesmo, H. Beauchemin, K.A., Harstad, O.M., Skjelvåg, A.O. 2013. Greenhouse gas emission intensities of grass silage based dairy and beef production: A systems analysis of Norwegian farms, Livestock Science, Volume 152, Issues 2–3, Pages 239-252, ISSN 1871-1413, https://doi.org/10.1016/j.livsci.2012.12.016.

Campbell, B. M., Beare, D. J., Bennett, E. M., Hall-Spencer, J. M., Ingram, J. S. I., Jaramillo, F., Ortiz, R., Ramankutty, N., Sayer, J.A., Shindell, D. 2017. Agriculture production as a major driver of the Earth system exceeding planetary boundaries. Ecology and Society, 22(4), doi.org/10.5751/ES-09595-220408.

Conant, R.T., Paustin, K. and Elliot, E.T. 2001. Grassland Management and Conversion into Grassland: Effects on Soil Carbon. Ecological Applications, 11, 343-355. http://dx.doi.org/10.1890/1051-0761(2001)011[0343:GMACIG]2.0.CO;2

Demekem, M., Pangrazio, G. and Maetz, M. 2009. Initiative on Soaring Food Prices Country Responses to the Food Security Crisis: Nature and Preliminary Implications of the Policies Pursued. EasyPOL module 062, http://www.fao.org/3/a-ap239e.pdf.

Gerten, D., Rockström, J., Heinke, J., Steffen, W., Richardson, K., Cornell, S. 2015. Response to comment on "Planetary boundaries: guiding human development on a changing planet." Science 348(6240):1217, http://dx.doi.org/10.1126/science.aab0031.

Gundersen, P., Ginzburg Ozeri, S., Vesterdal, L., Bárcena, T. G., Sigurdsson, B. D., Stefansdottir, H. M., Lazdina, D. 2015. Forest soil carbon sink in the Nordic region. Frederiksberg: Institut for Geovidenskab og Naturforvaltning, Københavns Universitet, pp. 39.

Grimvall, A., Stålnacke, P., Tonderski, A. 2000. Time scales of nutrient losses from land to sea — a European perspective. Ecological Engineering 14:4, 363-371.

Hemming, V, Burgman, MA, Hanea, AM, McBride, MF, Wintle, BC. 2018. A practical guide to structured expert elicitation using the IDEA protocol. Methods Ecol Evol. 9: 169– 180. https://doi.org/10.1111/2041-210X.12857.

Korsaeth, A., Henriksen, T.M., Hjelkrem, A.G.R., Strømman, A.H. 2014. Effects of regional variation in climate and SOC decay on global warming potential and eutrophication attributable to cereal production in Norway, Agricultural Systems, Volume 127, Pages 9-18, ISSN 0308-521X, https://doi.org/10.1016/j.agsy.2013.12.007.

Miller, DeMond S., Rivera, J.D. 2011. Comparative emergency management, CRC press, p. 161-163.

Riley, H., Bakkegard, M. 2006. Declines of soil organic matter content under arable cropping in southeast Norway. Acta Agric. Scand. Sec. B – Soil Plant Sci. 56, 217–223.

Riley, H., Henriksen, T. M., Torp, T., Korsaeth, A. 2022. Soil carbon under arable and mixed dairy cropping in a long-term trial in SE Norway. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science, 72:1, 648-659, DOI: 10.1080/09064710.2022.2047770.

Springmann, M., Spajic, L., Clark, M.A. 2020. The healthiness and sustainability of national and global food based dietary guidelines: modelling study, BMJ, 370 (2020), m2322. http://dx.doi.org/10.1136 bmj.m2322.

de Vries, W. Kros, J., Kroeze, C., Seitzinger, S.P. 2013. Assessing planetary and regional nitrogen boundaries related to food security and adverse environmental impacts. Curr. Opinion Environ. Sust. 5, 392–402. doi: 10.1016/j.cosust.2013.07.004.