RiSE
RURAL
INVESTMENT
SUPPORT FOR EUROPE

What is the Safe Operating Space for EU livestock?

2018

EXECUTIVE SUMMARY

About the RISE Foundation

The Rural Investment Support for Europe (RISE) Foundation is an independent foundation which strives to support a sustainable and internationally competitive rural economy across Europe, looking for ways to preserve the European countryside, its environment and biodiversity, and its cultural heritage and traditions. It works as a think tank, bringing together experts to address key environmental/ agricultural challenges in Europe and develops high quality accessible research reports with clear recommendations for policy makers. It draws on its extensive network of rural stakeholders to highlight innovative practises developed at the farm level and provides a platform for debate on issues that affect rural communities.

Report Authors

Emeritus Professor Allan **BUCKWELL**, Report director
Dr. Elisabet **NADEU**, RISE Foundation

Report Contributors

Prof. Erik **MATHIJS**, KU Leuven
Annabelle **WILLIAMS**, RISE Foundation
Natalia **BRZEZINA**, KU Leuven

The Report Advisory Committee

Prof. Tim **BENTON**, Strategic Research Dean at the University of Leeds, UK
Dr. Alberto **BERNUÉS**, Centro de Investigación y Tecnología Agroalimentaria de Aragón, Spain
Dr. Krijn **POPPE**, Business Developer, Wageningen Economic Research, WUR, Netherlands
Dr. Henk **WESTHOEK**, Department of Water, Agriculture and Food, PBL, Netherlands

Recommended Citation

Buckwell, A. and Nadeu, E. 2018. *What is the Safe Operating Space for EU Livestock?* RISE Foundation, Brussels.

For Orders and Download

The RISE Foundation, Rue de Trèves 67, Brussels 1040, Belgium
www.risefoundation.eu/publications

The RISE Foundation

What is the Safe Operating Space for EU livestock?

EXECUTIVE SUMMARY

2018

Authors:
Emeritus Professor Allan Buckwell
Dr. Elisabet Nadeu [1]

With contributions from:
Prof. Erik Mathijs[2], Annabelle Williams[1] and Natalia Brzezina[2]

[1] RISE Foundation, [2] KU Leuven

PREFACE
by Janez Potočnik

It was during the RISE Foundation's research for the 2016 report on nutrient recovery and reuse in European Agriculture, that we first began to see how livestock – its production and consumption - is at the heart of so many of the challenges we struggle in agriculture today. The evidence concerning the sector's contribution to greenhouse gas emissions, and the impact of the leakage of nutrients from the sector to air and water, cannot be ignored. And as governments grapple with food security in an increasingly populated world that is already feeling the devastating effects of climate change, the inefficient use of resources by livestock is rightly being questioned.

But we also became aware of the disjointed aspect of the debate. Of a growing chasm between different stakeholder groups defending a cause or calling for change and a lack of crucial connectivity between addressing challenges around production *and* consumption.

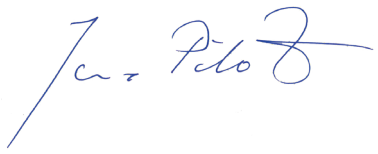
The RISE Foundation is a public utility foundation. We aim to provide unbiased and balanced perspectives concerning areas of European agriculture. We do this by tackling issues that often inspire great debate among those representing a particular sectoral, ideological or interest group, who will often have a silo approach to what are multi-faceted challenges requiring a combination of approaches.

We cannot shy away from the mounting research that is detailing the impacts of livestock production and consumption on our health, environment and climate. Whilst the massive advances in innovation in the livestock sector will certainly form part of the solution, it will not be enough. The shift needed for the sector to contribute to Europe meeting its commitments under the Sustainable Development Goals and the COP21 Paris agreement is just too great. And change is inevitable.

We are going through one of the most disruptive periods of recent decades across multiple sectors – mobility, housing, advertising, banking... and farming. Transition to a more sustainable production and consumption model will not be easy, but it can present enormous opportunities for those who are willing to engage in the process.

With this report we aim to call upon policy makers to use the range of policy tools at their disposal to support the sector through a necessary and inevitable transition. These will be uncomfortable messages to hear for the many who work hard to earn their living in volatile times by producing the livestock products that so many of us love to consume. But unless policy makers face up now to the need of the European livestock sector to adjust, and support the sector through that transition, the sector will pay the price of their inactivity. Protecting the status quo is providing a disservice to the sector.

The livestock industry should recognise the emerging evidence of the impact of their sector and actively engage in the necessary transition. And society should recognise livestock producers as partners for change: the majority of who have acted and invested in the evolution of the sector in good faith. They need and deserve public support for the transition to make it fair and viable. It is time to act so that we have the time to support a well ordered and structural shift to a form of European agriculture that is more sustainable. This is not only necessary, it is also unavoidable.



Dr Janez Potocnik
Chairman, RISE Foundation

© Shutterstock

Executive summary

Scope and introduction

This report is about farmed livestock in the EU; cattle, sheep, pigs and poultry[1]. It deals with both consumption of livestock products – meat, dairy, eggs and other products – and the associated production of the animals and the feed they consume. These issues have global implications. The EU has high and matured levels of consumption of livestock products and a highly developed agricultural and food system. It is a significant player in global livestock genetics, animal health and technology and in production, consumption and trade in livestock products and animal feeds. Furthermore, some of the issues, particularly greenhouse gas emissions, atmospheric and water pollution and biodiversity loss from land use change, affect the global commons. Therefore, this report considers the EU contribution to livestock consumption and production within a global context.

Back story

Since the turn of this century, evidence has accumulated that livestock have become out of balance. Key publications have been FAO´s Livestock's Long Shadow (2006)[2], and the assessments of nitrogen and phosphorus flows by Sutton et al. (2011)[3] and van Dijk et al. (2015)[4]. Together with the influential report on planetary boundaries by Rockström et al (2009)[5], there is a strong case that livestock are already outside sustainable limits for Greenhouse Gas (GHG) emissions, nutrient flows and genetic biodiversity loss. Given expected population and income growth in transition and developing countries, and the dietary transition involving higher livestock product consumption which will accompany this, the judgement is that this certainly pushes livestock outside feasible and acceptable boundaries. How should the EU react?

The central idea of this report is that there *is* a safe operating space (SOS) for livestock. It lies between the lower boundaries defined by level of livestock production and consumption which offer sufficient health, cultural, environmental, social and psychic benefits of farmed animals, and the upper boundaries defined by the sustainable thresholds for the negative impacts on health and environment and acceptable animal welfare. The practical questions are how to identify this safe operating space, and how to move consumption and production into this space.

1 Fish are not embraced in this report; the substitutability between the fish and livestock products in consumption and production is acknowledged, but the expertise of the analysts was already stretched by considering the wide range of issues for terrestrial livestock.

2 Steinfeld, H., Gerber, P., Wassenaar, T.D., Castel, V., Rosales M., M., Haan, C. de, 2006. Livestock's long shadow: environmental issues and options. Food and Agriculture Organization of the United Nations, Rome.

3 Sutton, M.A., et al. (Eds.), 2011. The European Nitrogen Assessment. Cambridge University Press, Cambridge, pp.612.

4 van Dijk, K.C., Lesschen, J.P., Oenema, O., 2016. Phosphorus flows and balances of the European Union Member States. Science of The Total Environment 542, 1078–1093.

5 Rockström, J. et al., 2009. A safe operating space for humanity. Nature 461, 472–475.

Benefits of Livestock

Farmed animals have an essential place in Europe's culture. Europeans consume livestock products because they enjoy them. Most Europeans consume livestock products because they feel these products contribute to their wellbeing. Meat, dairy products and eggs provide high-quality protein, minerals, vitamins and other essential nutrients. We have an emotional connection to animals in the countryside. Second, ruminant livestock, principally cattle, sheep and goats, consume cellulosic materials such as grasses which humans are unable to digest. This enables large land areas not suitable for crop cultivation to produce food. In the process, many pastoral areas provide a wide range of treasured cultural landscape and ecosystem services. Third, it is claimed that livestock are admirable exponents of the circular economy; they make use of a wide variety of crop by-products and residues and food waste, and they cycle nutrients and organic matter back to crop production. These are true, but there are alternative ways of utilising residues and wastes. Neither can it be overlooked that animals are inefficient and leaky nutrient managers. Whatever livestock society chooses to keep, it is vital that there is careful management of manures and maximum recovery of nutrients, but it cannot be claimed that livestock add nutrients to the system.

Negative impacts of livestock

The first are the GHG emissions, mostly methane and nitrous oxide from animals, their manure, and from the production of their feeds. Second, is the leakage of the nutrients nitrogen and phosphorus and their compounds which cause serious water pollution and eutrophication, and air pollution. Third, there is direct and indirect degradation of biodiversity through land use change and degradation of soils by production of livestock and feed crops. Fourth, negative human health effects from livestock can arise as respiratory disease from air pollutants, especially ammonia, from anti-microbial resistance (AMR) and zoonoses, and risks of certain cancers increase with the consumption of processed and red meat products. Also, a general, over-consumption of livestock products (and sugars) has led to a serious rise in obesity and an associated constellation of chronic and damaging diseases including diabetes and coronary heart disease. Given the innate inefficiency of biological processes involved and the leakiness of livestock production, the over-consumption of animal protein, which is simply burned for energy, represents a grossly wasteful and damaging use of scarce resources.

The evidence on these benefits and negative impacts of livestock is reviewed in Chapter 2 of the report together with summary data on the scale of EU livestock consumption, production and trade.

Defining and quantifying a Safe Operating Space for livestock

This is a developing area of science, which has not been attempted at a sub-global level for a specific economic sector, i.e. EU livestock. Some boundaries e.g. climate protection, are truly global. Others e.g. biodiversity are partly global and party local, and some e.g. freshwater pollution only make sense at river basin or landscape level. Furthermore, there are important interactions between the underlying factors which means that the boundaries are not independent of one another. These considerations complicate the analysis.

Four boundaries of the livestock SOS were examined using data for the EU28 and the individual Member States (MS). They were: lower boundaries for human nutrition and for utilisation of pasture, an upper boundary for GHG emissions, and what was expected to be an upper environmental boundary for nitrogen flows. The analyses are simple and broad brush and offered as preliminary approximations of the order of magnitudes involved.

A lower boundary for human nutrition

To capture the idea that livestock products provide high quality nutrition for human development and life this lower boundary was expressed as the proportion of current consumption which would satisfy the National Dietary Recommendations (NDR) published by the health authorities of the MS. The results for meat showed, on average the populations of all MS are consuming more than the recommended amounts. 19 of the MS, and the EU28 on average, are consuming more than twice the recommended level. The excess consumption of dairy products is less pronounced. The average EU28 consumption level is just 5% over the recommended level, with 11 MS consuming less than the recommended levels. 17 MS are consuming above the NDR for dairy products, six of which are more than 20% above. Egg consumption follows a similar pattern as dairy products, with 17 MS consuming above the NDR, several with excess of more than 30%. With such wide variation between MS, average boundaries for the EU28 are not helpful. Broadly, the human nutritional lower bound for meat is in the region of 40% of current consumption for the countries over-consuming most and 60% of current consumption for most others. The dietary lower bound of livestock for egg and milk consumption in the two-thirds of MS which are over-consuming is about 80% of current consumption for eggs and 80% to 90% for milk.

A lower boundary for pasture utilisation

This was defined as the minimum number of ruminant livestock units needed to ensure the conservation of permanent pastures in the EU and the associated habitats,

biodiversity, landscape and communities to avoid their conversion into arable land, scrub, forest or even urbanisation. It was calculated by dividing the areas of permanent and rough grazing by stocking rates chosen to reflect sustainable management of these pastures. Stocking densities, 0.5 and 1.0 LSU/ha, were used to bracket this sustainable rate.

The results show all MS except five (Romania, Lithuania, Bulgaria, Latvia and Estonia) would require fewer ruminant livestock than now to utilise all permanent pasture. Under the low stocking rate assumption, the proportion of current animals justified to maintain pastures is small, less than 30% for 11 MS including the three MS with the largest grazing livestock populations (France, Germany and Italy). Another 14 MS could justify from 30% - 60% of current livestock units. Only Bulgaria and Romania could justify two-thirds or more of their current grazing animals if the lowest stocking density correctly defines the sustainable intensity. These minimum numbers are correspondingly higher under the higher stocking rate. These are coarse estimates and do not take into account grass quality or availability, nor the economic viability of grazing enterprises at low stocking rates. Additional livestock could be supported if rotational grass and crop by-products and residues were included in the analysis.

Upper boundaries for climate protection

The position of the climate boundary in relation to current livestock activity is initially indicated by calculating the percentage reductions from 2013 in direct livestock emissions necessary to achieve the EU's GHG target cuts set following the Paris Climate Agreement of 40%, 60% and 80% by 2030, 2040 and 2050, respectively. Agriculture is not formally included in these targets and the commitments. The calculations show the adjustments needed in livestock emissions if this sector is not gradually to become a growing share of remaining emissions as energy supplies are decarbonised.

The results show the average EU28 reductions required are 21%, 47% and 74% respectively for the three dates. Because emissions in the ten central and eastern MS have fallen so much since 1990 these countries have space to expand their livestock emissions and remain within national targets at 2030. The range in reductions required by 2030 for the other MS is from 18% for Germany to 47% for Cyprus. With respect to the 2040 target, only Bulgaria, Slovakia, Lithuania and Latvia have any further scope to expand livestock emissions, the reductions for the other 24 MS range from 12% for the Czech Republic to 65% for Cyprus. To reach the 2050 target of 80% reduction, all MS must reduce emissions by between 37% (Bulgaria) and 82% (Cyprus). Taking the Paris emission reduction targets as indicators of the upper boundary of the SOS indicates that current production levels are way outside this safe space.

Boundaries for nutrient flows

The planetary boundaries related to biogeochemical flows, specifically nitrogen (N) and phosphorus (P) refer to the excess amounts of reactive N and P that are released into the environment causing eutrophication. For N, the four main sources are: industrial fixation of N_2 into ammonia, biological fixation via agricultural leguminous crops, the combustion of fossil fuels and the burning of biomass. The global N boundary was defined and initially set by Rockström et al. (2009)[6] at 35 Mt N yr^{-1}. Following criticisms by de Vries et al. (2013)[7] that this boundary does not take human needs into account—it was revised to 62 Mt N yr^{-1} (Steffen et al., 2015)[8]. This calculation was based on the levels of protein necessary to provide adequate nutrition for the human population. The global figure was then downscaled to the country level by expressing the limit per head of population using the factor suggested by Kahiluto et al. (2015)[9] of 8.6 kg cap^{-1} yr^{-1}. This was multiplied by the population of each MS bringing the boundary to a more spatially relevant national level.

The national boundaries for nitrogen fixation were then compared to EU data on annual nitrogen fixation which were calculated as the sum of manufactured fertiliser consumption and biological fixation by leguminous agricultural crops. Of course, part of this N fixation is not related to livestock production, but to crop production.

Comparing the calculated boundaries for N fixation with the annual fixation taking place the results show large adjustments are necessary to respect the national boundaries. For the EU28 a 65% reduction of the fixation would be required to get the system inside the boundary. The range in reductions for individual member states is from 35% for the Netherlands to 90% for Ireland. The reduction required is greater than 50% for 20 MS and over 75% in eight MS.

These highly aggregated results must be interpreted with care. They do signal a serious imbalance. However, they tell us nothing about the regional concentration of nitrogen which varies widely within countries. This spatial variation does however offer an additional strategy to move towards the SOS by de-concentrating and relocating some livestock activity and re-integrating it with crop production. Conceptually this boundary is not as soundly

6 Rockström, J., et al., 2009. Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Ecology and Society 14:32.
7 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. Current Opinion in Environmental Sustainability 5, 392–402.
8 Steffen, W., et al., 2015. Planetary boundaries: Guiding human development on a changing planet. Science 347, 1259855.
9 Kahiluoto, H., Kuisma, M., Kuokkanen, A., Mikkilä, M., Linnanen, L., 2015. Local and social facets of planetary boundaries: right to nutrients. Environmental Research Letters 10, 104013.

based as that for GHG. The practical adaptations to Rockström's approach have, in effect, turned it from an upper bound of environmental capacity to minimise eutrophication to a human dietary lower bound. This demands further work and to complete the picture on the nutrient boundary of the livestock SOS, phosphorus must be included.

Boundaries for other benefits and negative impacts

There is no scientific way to determine a lower bound of livestock production and consumption based on cultural preferences. Similarly, whilst the provision of livelihoods from the livestock sector is of immense economic, social and political importance, there is no objective way to define minimal levels of employment and economic activity. These are outcomes of markets, technology and policy. No progress has been made on quantifying the boundaries for the other variables on which livestock production has significant negative impacts, biodiversity and land degradation, anti-microbial resistance and zoonoses and animal welfare. For all these variables, there is no doubt that they raise critical concerns about livestock product consumption and production. Indicators of the scale of the, mostly negative, impacts that livestock production has on these variables are available. However, there is no obvious objectively measurable criterion which defines an upper boundary of acceptable impacts.

Conclusions on defining SOS boundaries

This field of inquiry is promising but is in its infancy. The nutrient boundary demands more research and further work is needed on the other impacts of livestock. Preliminary indications to this point are:

1. EU livestock production and consumption are not in their safe operating space.
2. Current EU livestock production is associated with greenhouse gas emissions and nutrient flows which are currently far higher than the upper boundaries of the SOS and is therefore unsustainable. Reductions in these leakages of the order of 60% or more are indicated.
3. Current livestock consumption and production are considerably greater than the lower boundaries of the SOS based on national dietary recommendations and on pasture utilisation. Also, the boundaries established for these two variables imply production levels greater than those required to respect the upper boundary for GHG emissions.
4. These findings imply uncomfortable choices for society. However, it is clear that respecting the upper environmental limits should take precedence over the cultural lower boundaries.

Options to bring livestock into a Safe Operating Space

Whatever level of EU livestock production, now and in the future, it is essential that continued progress is made on four fronts: improving resource efficiency, reducing leakages into the environment, increasing the health status and welfare of farmed animals, and minimising the use of antibiotics. A key question is whether sufficient improvement in these four areas can be made to get the sector into a SOS. If this is not possible then active steps to modify consumption behaviour are unavoidable.

Adjusting livestock production

None of the four actions listed above are new ambitions. They are all receiving considerable attention some have been pursued for decades. These have focussed on optimising breeding, feeding, housing and maintaining healthy animals to increase production per unit of livestock, and per unit of inputs into the system. Explicitly embracing environmental standards and reducing reliance on anti-microbials is newer but it is now an overt and active part of the resource efficiency drive, with particular emphasis on reducing GHG emissions.

Europe has produced a great many research and advisory reports offering actions to reduce GHG emissions, nutrient leakage, loss of biodiversity and land degradation. Reducing GHG emissions and nutrient leakage can be approached by changes in feed and changes in manure management. Four strategies on feed are to improve feed conversion ratios, introduce novel feeds, reduce emissions from the feeds themselves, and by manipulating microbial action in the rumen perhaps with feed additives to reduce methane production. Manure management options include covering storage, aerating or composting manure, and processing it in a variety of ways, including anaerobic digestion, to recover nutrients and energy. Nutrient leakage can also be tackled by de-concentrating livestock production and re-integrating it with cropping systems, including more rotations and making greater use of legumes.

There is considerable scope for further innovation in livestock production, four areas are discussed. Digital technologies and precision livestock farming could substantially improve the monitoring of animals their health, nutritional, reproductive and welfare status enabling more timely and precise management to improve health, welfare and thus productivity. Second, new breeding, genetic and genomic techniques offer much potential: to improve disease resistance and feed efficiency of farm animals themselves and also in the speed and effectiveness of development of vaccines. While promising, access to some of these technological advances may not be accessible to all farmers, especially those in marginal are-

as with low incomes. A third area of innovation is in the development of new sources of animal feed which may reduce environmental impacts and demands on land and water. Two such possibilities are insects and alga culture. A fourth area for innovation is in the processing of animal and other wastes to recover and reuse nutrients.

The fact that these approaches to improve efficiency are familiar is reassuring, but it also implies that without a step change in technology, or in motivation and stimulus, it is unlikely that the future rates of efficiency gain and leakage reduction will be higher than those achieved in the past.

This specifically applies to GHG emission reduction. The core of the methodology for estimating GHG emissions from livestock in national GHG inventories is to take the product of an emission factor for each animal type and the number of such animals. Measured emissions can therefore be reduced by a fall in the emission factors and/or by reducing the numbers of animals. Reducing emissions per animal requires efficiency improvement by changes in breeding, feeding and managing animals and their manure. This is proving difficult and slow. Progress might improve as the challenge is better understood and as more public and private research resources and policies are deployed specifically to reduce methane production in cattle and to better manage manure. However, to achieve the targets for GHG reductions this would imply sustained annual reduction in emission rates per animal in the order of 3.5% per annum. Such rates of productivity improvement have not been seen in EU agriculture for a long time, and never sustained over a period of decades. **The conclusion is** that whilst the flagged areas for innovation are highly promising, they do not offer the step change required. If GHG emissions from livestock are to be reduced in line with the internationally agreed targets then this will necessitate a mixture of efficiency gain ***and*** for most EU MS, reduction in livestock numbers too. It is most likely that the same is true for nutrient leakage. Continuing to improve livestock production efficiency is essential, but options will also have to be pursued to change consumption of livestock products.

Adjusting livestock consumption

Three categories of consumption change are considered, starting with the least radical.

Change species and systems mix. There are large differences in efficiency and environmental impact per kg of product between the species, and between production systems within species, e.g. grass fed versus concentrates-fed beef and dairy. Changing species mix, and production systems mix of livestock consumed could therefore bring about significant reduction in some negative impacts. However, the impacts on *all* the variables of interest - climate, water, air, biodiversity, landscape, health, AMR and welfare – must be considered and these will sometimes go in opposite directions. The result, especially given the multitude of different production systems, is that there are few switches which offer unambiguous gains in all variables. Furthermore, trade-offs between reduced emissions and leakage versus welfare impacts are not easily assessed objectively. Environmental impacts could be far better controlled if animals were completely contained, but this involves a trade-off with the welfare of the animals. Society must decide its priorities.

Choose alternative 'animal' protein. Two potential sources of alternative protein which humans could substitute for farmed meat, eggs and dairy products are ***insects*** and ***cultured meat***. Both substitutes are a response to societal concerns about the impacts of livestock on the environment, human health and animal welfare. Insects as food are regulated under the EU Regulation on Novel Foods[10]. Their presence in EU markets is limited to date. The potential environmental benefits of insects in comparison to livestock are reducing GHG emissions, and water use, freeing up land, and reducing bones and offal, and food waste. Consumer acceptability of insect-based foods or ingredients is a major issue. Regulatory hurdles include the safe containment of insects, the availability of consistent supplies of feedstock for the insects, risks arising from disease spread or allergic reactions. It is likely that the marketing effort required for insects will be much higher for human consumption than for animal feed so the initial major initial developments with insects to prove the concept are likely to be for the latter.

Cultured meat is animal tissue produced in laboratories from animal cells. There are many efforts in the EU and elsewhere to develop this commercially. The promised environmental benefits are similar to those claimed for insects and could be substantial. Other advantages are the reduction in antibiotic use and an ability to control the amount of fat, nutritional value and taste. However, the production of cultured meat is also an energy intense process and considerably more development and assessment is necessary before these claims can be confirmed at scale and the impacts on human health and the environment measured. There are also controversial issues concerning the use of serum from animal blood in some culture techniques.

In short, whilst insects and cultured meat will undoubtedly be further developed, these two substitutes are a long way from making a significant contribution.

Reducing total livestock protein, substituting plant protein. The above two options of finding the

10 Regulation (EU) 2015/2283 of the European Parliament and of the Council of 25 November 2015 on novel foods

least damaging mix of livestock products or finding new substitutes are helpful but they have limitations. The unavoidable conclusion is that total livestock product consumption must contract.

Quantitative analyses of the environmental and health benefits of reducing livestock product consumption are gaining attention. They implicitly or explicitly assume that production is reduced equally across the species, and that all products are reduced proportionally. Several studies conclude a 50% reduction in current consumption of these products in the EU would make a significant contribution to climate change mitigation and align current intake of animal protein and fats with WHO recommended dietary guidelines. Such a reduction could result in 40% less reactive nitrogen emissions from agriculture, reducing eutrophication and acidification in aquatic environments. These studies estimate 23% less cropland area would be needed if livestock were reduced by half. Following national dietary recommendations would result in significant reductions in GHG emissions, eutrophication and land use globally. The effect of a large change in livestock product consumption for animal health and welfare is not analysed. Neither have the economic and social impacts been analysed. These dimensions should not be assumed but investigated.

What replaces the livestock product? If consumption of livestock products is reduced people may not eat less, they will eat differently, with different responses for each demographic group. The products which replace livestock will determine the effective impact of reducing livestock consumption on human health and the environment. Environmental benefits may also not automatically appear from reduced livestock product consumption. Some vegan and vegetarian diets with high consumption of proteins and fats could have a larger carbon footprint than omnivore diets, although in general the contribution to GHG emissions is larger for the latter. Examples of possible replacements are: the replacement of milk by vegetable-based drinks from cereals, legumes, nuts or seeds, and vegetable material sold in the shape of sausages and hamburgers, some of which are made to taste like meat but have a reduced environmental impact. Other alternatives to animal-based protein are pulses, nuts, algae and soya. A widely consumed and well-studied meat substitute launched in the mid-1980s is a mycoprotein-based product Quorn, derived in a continuous fermentation process using the fungus Fusarium venenatum. Its story provides an interesting insight into the many years it takes, and the technical, regulatory and marketing hurdles which must be overcome, to develop novel foods at scale.

Concluding remarks on options to get to the SOS. A wide range of practicable actions is already known which could help adjust the sector. The actions on livestock production and on consumption are not mutually exclusive, they all have a contribution to help the sector back to a SOS.

The scale of change indicated may seem high and unattainable. But the livestock sector has experienced significant change in many countries and sub-sectors. For example, the 20% reduction in GHG emissions from agriculture experienced between 1990 and 2015 was driven largely by a reduction in livestock numbers (cattle and sheep) and a reduction in the use of nitrogenous fertilizers according to Eurostat. There have been periods of quite large cuts in pig numbers in the Netherlands and UK, and in sheep numbers in the UK. Red meat consumption is already on a downward trend. Change is occurring and can be managed.

Conclusions, policies and recommendations to move livestock into a Safe Operating Space

Although the 'livestock challenge genie' is well out of the bottle, it has not yet been seized by European governments as an identified strategic policy issue. The extent and dangers of the principal negative impacts of livestock are well analysed in scientific literature. Environmental NGOs have long campaigned on the issue. However, livestock have not yet enjoyed a 'Blue Planet' moment[11] as occurred for plastics when public and governments seize this as a strategic issue demanding real action. To date neither EU policy, nor that in any Member States, has yet chosen to focus public attention on 'the livestock problem' as such. It is now time to do this.

Part of the problem is that policy is compartmentalised, yet the livestock challenge spans health, food and agriculture, the environment including climate change and economy. Also, the EU does not have prime competence in health matters. Nonetheless a more strategic EU food system approach is required. Because the issues involve traded goods this must be grasped at EU level, although as consumption patterns and production systems vary around the Member States, the concrete actions will inevitably be devolved to that level.

The adjustments suggested are very large so discussion of these issues is deeply uncomfortable to the very substantial economic interests of producers in the whole livestock chain, who are very aware of the challenges. Their response, not unnaturally, is to suggest that the positive impacts of livestock are insufficiently noted and the neg-

11 This refers to the 2017 BBC Programme series with this title presented by Sir David Attenborough which graphically filmed the far-reaching impacts of plastics on ocean life, and which has spurred a step change in public awareness and, it is hoped, government action.

ative impacts are exaggerated. There is a reluctance to accept that livestock is outside the SOS. Whilst there is acceptance that action to reduce negative impacts is needed, the hope is that technical progress on the production side will be sufficient.

These observations prompt the primary conclusions and recommendations of this report:

R1 The EU should set up a formal inquiry to investigate the following questions.
- ***Where is the safe operating space for EU livestock?***
- ***What adjustments in production and consumption are necessary to get into it?***
- ***What policy measures would be required to propel these adjustments?***
- ***What would be the impacts on health, environment and the economy of these changes?***

The challenge is immense and complex because the scale of change in livestock production and consumption necessary to get the EU sector into its safe operating space is large, and it will require action from all participants in the livestock food chain and a large proportion of consumers. The task is most definitely not the elimination of livestock, but a substantial contraction of its harmful environmental and health effects by whatever actions can be agreed to achieve this.

R2 It is suggested that the change must be a citizen-led, consumer-led, enterprise. Although it requires action by both consumers and producers the transition required will only occur if driven by consumers. This will not happen spontaneously but only if Government takes strong action to spur the necessary changes.

Change will not be brought about by a frontal assault on the livestock production sector. Rather the predominant driver for change should be citizens' pressure for the amelioration of environmental and health damage from the production of livestock products they buy and consume.

Yet constructive change will go better and faster once producer interests are persuaded that the changes are unavoidable as the present trajectory of livestock is simply unsustainable. The changes are challenging: new livestock production modes will require new science and technology, which, in turn, demands research and investment. This will be hard to secure for a sector which, overall, may have to contract. This is why public assistance will be necessary to manage the transition. It should be made clear that resources will be available to help businesses with stranded assets to adjust.

Encouraging sustainable consumption of livestock products in the EU

Given the wide range of influences on what people eat, an equally wide range of tools will be necessary to help them change what they eat. The approach required may be different depending on the prime reasons for changing consumption, whether it is to do with environment, climate and animal welfare concerns, or consumers' own health and that of their family.

The actors to bring about change in consumer behaviour must include businesses in the food chain, civil society, governments and collaborations of all these. Wellesley et al. (2015)[12] classified actions into three groups: first, to inform and empower for example through labelling and information campaigns, second to guide and influence, e.g. by nudging, and third to incentivize, discourage or even restrict with taxes, subsidies, bans or standards. Each actor has potential actions under each of these headings. Such interventions will have a range of effectiveness with different demographic groups.

The sheer immensity and complexity of the livestock challenge, and the needed response, is such that public authorities must be prepared to take bold initial steps to overcome the inevitable inertia. Without such a jolt or shock there will be insufficient action.

R3 A mandated output of the proposed inquiry should therefore be a suggested set of policy proposals which include measures to discourage consumption of livestock products harmful to health and environment, and to encourage consumption and production beneficial to health and environment.

To be meaningful these must include interventions which include, but go beyond, informing, empowering, guiding and influencing, i.e. taxes and subsidies. Considerable further thought and analysis is required to determine at what level and in what way to impose such taxation. Because the subject of the tax is basic foodstuff such proposals must include consideration of necessary accompanying welfare provisions. The imposition of over-consumption taxes and implementation of changes in social welfare are of course matters for Member States but to avoid distortions in the EU single market they must be coordinated at EU level.

12 Wellesley, L., Happer, C., Froggatt, A., 2015. Changing Climate, Changing Diets Pathways to Lower Meat Consumption. Chatham House Report 64, London, UK.

Encouraging sustainable production of livestock products in the EU

Proposals for EU-wide taxes on livestock product consumption harmful to health and environment will take considerable time to debate and implement. Meanwhile further policy action can and should be taken to help livestock production move towards the SOS. This should work on three fronts.

R4 Policies must encourage: structural change in farming, to bring about a better balance, structure, location and de-concentration of livestock and better integration of crop and animal production, as well as resource efficiency improvements and reduction of leakage and waste.

There is extensive literature on policies which could assist resource efficiency and leakage reduction, but there is a research deficiency on structural change. Policies which can help achieve these objectives include but must go much wider than agricultural policy. They must also cover policy for: the environment, animal health and welfare, research, development and technology, and food chain engagement. Most of this is well-trodden ground, the missing ingredients are the conviction that it is necessary to act by the relevant authorities, and willingness to change on the part of the food chain. Two policy sectors merit particular attention.

For environmental policy, the key recommendations are:

R5 Implement existing environmental regulations and directives.

More specifically,

R6 Help farmers better manage the environment on their farms by assisting establishment of better farm-level environmental performance indicators, benchmarks and plans for GHG emissions, nutrients and biodiversity.

EU agricultural policy enshrined in the CAP has continuously, but rather slowly, evolved to adapt to emerging challenges. It is suggested that with one exception the CAP already contains most of the main kinds of measures which are required to steer agriculture, especially livestock, into its SOS. The major exceptions are the diagnosis of the scale of the transformation required and consequently the recognition that this will require significant structural change in farming and active measures to foster transition to sustainable businesses. The proposed high-level inquiry will help make this case.

The CAP has tended to inhibit rather than encourage and enable structural change. Sustainable farm businesses should not be undermining the soils, biodiversity, clean water and climate on which they depend, they should be commercially viable without annual handouts, and embedded in lively, diversified rural communities. The CAP is the correct and obvious policy framework to provide the assistance that is needed to bring this about. Only when it is openly recognised and explicitly acknowledged by the agricultural policy community in the EU that the balance of the agricultural sector must radically change to reduce the scale of the negative impacts of its livestock component will it be possible then to plan for the adjustment assistance required. The most important change required in the CAP is to its direct payments, including the coupled, payments. As proposed in the previous RISE Foundation report[13] the principal recommendation for Europe's agricultural policy is to:

R7 Better target the Pillar 1 resources currently provided as direct payments, by deploying them to stimulate and enable structural changes required to help the livestock sector make the transition to a SOS.

The aim should be to emphasise the positive reasons for the change, to improve health and the environment simultaneously whilst developing new technologies and new markets. These expanded markets will be for plant based protein, fruit and vegetables, nuts and pulses, for cultured protein and for novel sources of protein such as insects and algae. New technologies will also have an important role in changing the character of continuing conventional livestock production. A realistic period for the change is measured in two or three decades to give time for changes in technology, institutions and social attitudes and consumer behaviour.

Research policy. The proposed inquiry will discover that there are gaps in our understanding of many issues and data gaps, one of its tasks must therefore be to identify the research agenda and data collection necessary to guide action. Two issues are singled out for specific attention.

R8 An important task for the proposed inquiry is to develop a better conceptualisation and measurement of the ceilings or upper boundaries of the safe operating space especially with respect to nutrient flows and biodiversity.

13 Buckwell, A., et al., 2017. CAP: Thinking Out of the Box. Further modernisation of the CAP - why, what and how? RISE Foundation, Brussels.

It is important that as farmers adopt more efficient practices which improve their resource efficiency and reduce the emissions per unit of output that the official inventories measuring emission properly account for the changes taking place on the ground. Therefore,

R9 It is essential that GHG emission factors for livestock are regularly updated to reflect the expected, and necessary systematic improvements in resource efficiency.

International impacts of the EU moving to its SOS

The EU is a significant participant in international trade in livestock products, importing animal feed and exporting: animal technologies, genetics and health products, high value processed meat and dairy products, and some lower value meat and products. Despite the protection the livestock sector enjoys behind the EU common external tariff and the generous support of the CAP, a fear of producer interests when higher environmental or animal welfare standards are discussed is that this will impose additional costs and render domestic production less competitive with suppliers abroad. They claim raising standards will therefore hurt domestic producers and may displace local production in favour of imported goods produced to lower standards. This is often described as displacing and increasing pollution. Given the complexity of tackling the livestock challenge and the difficulties of coordinating the quite different measures applied to consumers and producers, it is quite likely that there will indeed be different rates of progress on reducing consumption and reducing production especially for individual products amongst the wide array of livestock goods. For some products, domestic consumption may contract more quickly than production, and the EU or a Member State may find its livestock product exports growing. This will invite criticism that the EU is suffering the pollution of other people's unsustainable consumption habits.

Three responses are offered to these concerns.

The first, and the most important is that if it is the case that current livestock consumption/production levels are demonstrably unsustainable in the sense that they are approaching, at, or beyond boundaries which mean indefinite continuation of the activity is not possible, then corrective action is unavoidable. This *is* thought to be the current situation for livestock production.

Second, is the need for debate on these issues to be based on sound data assembled by trusted institutions under internationally agreed methodology. To make judgements on whether certain trade flows increase or diminish environmental damage globally requires scientific studies on impacts on each environmental medium of marginal future changes in production, and for this to be available on a comparable basis for the main trading countries across the world. This requires coordinated international research which the EU can lead.

Third, for two of the most important environmental challenges, climate and biodiversity protection, there are already in place international agreements (Paris 2015, and Nagoya 2010) in which signatories, which include most of the largest trading countries, have agreed to actions, respectively, to limit GHG emissions substantially, and to halt degradation and encourage restoration of biodiversity. Therefore, if the EU takes actions which limit its own livestock output more than it reduces consumption, and if this results in expanded production and increased exports to the EU from some other part of the world then the exporting countries will be obliged to accommodate this within their own commitments under international agreements. Such countries will most probably also discover that they too are obliged to address GHG from livestock if they wish to meet their Paris agreement targets. Dissatisfaction and distrust of this response is distrust of international agreements.

Final words. Technical and economic change in the last seven decades have dramatically reduced the real cost of food and enabled an expansion of consumption of all foods to the extent that populations are eating themselves into ill health by consuming way beyond dietary advice. The livestock component of this over-consumption demands priority attention because of the intrinsic inefficient and leaky nature of animal production which results in serious environmental damage. The concerns expressed should not be viewed as an attack on livestock, but an attack on the negative health and environmental impacts of over-consumption of their products.

A more positive and more confident observation is that as a highly developed bloc, with a strictly regulated and well-supported farm and food sector, the EU and its standards are internationally trusted. Chinese dairy and meat imports from the EU are partly motivated by the greater trust endowed in high quality EU products. EU regulations are emulated and matched by many other countries. ***Europe should be confident that if it takes the lead in defining and moving to a safe operating space for livestock this can help set the standards and procedures which others will follow.*** Such first mover advantage will itself provide opportunities as Europe develops the information, motivation, messages, technologies, and policies for more sustainable, balanced livestock consumption and production.

NOTES

THANK YOU

In addition to the invaluable comments and advice given to RISE on this report by the Report Advisory Group, named below, we would also like to thank the following people for their commentary during the projects evolution, and presentations and engagement in the RISE workshop on livestock in March 2018 which helped shape the development of this piece of work.

1. RISE Foundation's Board with special thanks to Corrado **PIRZIO-BIROLI** and Mella **FREWEN** and Koen **VAN KEER**

2. Report Advisory Group
    - Professor Tim **BENTON**, Strategic Research Dean at the University of Leeds, United Kingdom
    - Dr. Alberto **BERNUÉS**, Centro de Investigación y Tecnología Agroalimentaria de Aragón, Spain
    - Dr. Krijn **POPPE**, Business Developer, Wageningen Economic Research, WUR, Netherlands
    - Dr. Henk **WESTHOEK**, Department of Water, Agriculture and Food, PBL, Netherlands

3. Tom **TYNAN**, Special Advisor to Commissioner Hogan

4. Duncan **WILLIAMSON**, Food Policy Manager at WWF UK

5. Hans **HUIJBERS**, Farmer and Member of the Board of the LTO Nederland

6. Animal Task Force

7. Dr. Jean-Louis **PEYRAUD**, French National Institute for Agricultural Research

8. Franz **FISCHLER**, former Chairman of the RISE Foundation and European Union Commissioner for Agriculture, Rural Development and Fisheries (1995-2004)

9. Donal **MURPHY-BOKERN**, independent researcher at Murphy-Bokern Konzepte

10. Stephen **MEREDITH**, Institute for European Environmental Policy (IEEP)

11. Imogen **LAMBERT**, former RISE trainee

12. European Landowners Organisation

CONTACT:
The RISE Foundation
Rue de Trèves 67 – BE – 1040 Brussels
Tel: +32 (0) 2 234 30 00
Fax: +32 (0) 2 234 30 09
Email: rise@risefoundation.eu
Website: www.risefoundation.eu
Twitter: @RISE_Fnd