EIP-AGRI Focus Group

Robust and resilient dairy production systems

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1. Introduction

The competitive environment of dairy cattle production systems is often linked to increased pressure on animal welfare due to various stressors. It is argued that there is trade-off between production and animal welfare, which includes animal health. However, this is not always the case. Increasing attention is paid to existing and possible synergies between both concepts. This includes the idea that general welfare conditions positively affect animal health, or for example the increased attention for robustness-related traits in breeding resulting in a higher farm income.

Robustness combines both sides of the productivity versus welfare debate. It can be defined as 'the ability to express a high production potential combined with resilience to stressors in a wide variety of environmental conditions'. It is therefore the link between economic competitiveness, resilience and animal welfare, which are all key priorities in dairy cattle production.

In view of the sustained economic pressure on the dairy cattle sector and demand for animal welfare, this Focus Group will investigate the following question.

QUESTION: how to create good conditions for dairy cattle husbandry in different production systems? The group should look for approaches and practices which take into account breeding, nutrition, fertility, health, welfare, monitoring, and overall management in all parts of the life cycle of animals. The impact on profitability and sustainability (in animal welfare terms) should be assessed.

The Focus Group is expected to carry out the following main tasks:

- To identify new or underused approaches and practices which increase robustness in dairy cattle husbandry in different production systems and regions. Practices and strategies increasing robustness at animal, farm, species and/or production system level can be taken into account.
- To analyse the impact of the most promising identified approaches and practices on profitability and animal welfare, their success and fail factors and barriers for implementation.
- Summarise how to address these aspects and explore the role of innovation and knowledge exchange in addressing the challenges identified.
- Propose potential innovative actions and ideas for Operational Groups to stimulate the use and improvement of robustness related practices at farm level.
- Identify needs from practice and possible gaps in knowledge related to robustness which may be solved by further research.

The Focus Group is encouraged to make use of insights created by previous and on-going projects. The group could look into paradigm shifts related to robustness, such as the move from productivity per lactation to productivity per lifetime.

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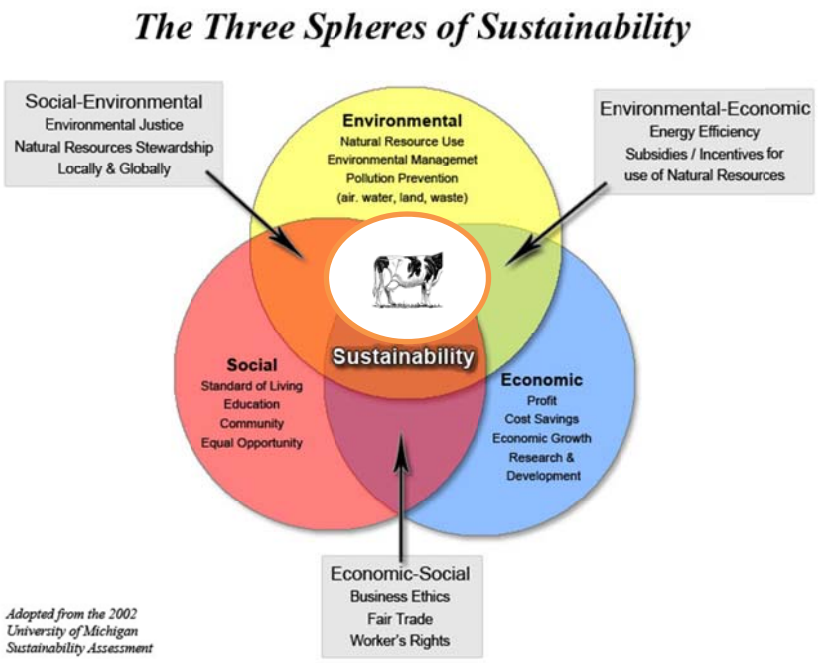
Fig 1 The challenge of multiple objectives. A robust and resilient dairy production system should be in the centered triangle.

Three Spheres of Robust & Resilient Agricultural Production Systems



What is a robust &resilient system in terms of dairy? Brendan Heron and John Roche[1] wrote a paper on this item:

Milk price and input prices will be more variable than they have been historically.

- *Farming businesses will need to be resilient; this requires a solid farm system foundation (strategic plan) with the technical expertise to make appropriate tactical decisions (tactical implementation).*
- *Farm businesses must be business focused; they must be designed with land production capacity, soil class and rainfall in mind; they must be based on elite high performance animals, they must be highly efficient per unit of land, labour and capital, and they must limit their exposure to external forces.*
- *Such businesses should:*
  - ✓ *Provide a reasonable rate of return on equity*
  - ✓ *Be environmentally sustainable and animal welfare compliant*
  - ✓ *Allow for an enjoyable and rewarding lifestyle*
  - ✓ *Allow opportunities for training and personal development*

The "Robust and resilient dairy systems" Focus Group will focus on animal welfare and productivity. Aspects of environmental sustainability have been tackled in two other focus groups (permanent grasslands & reducing emission from cattle production). This document is written to encourage the participants to discuss, to trigger reflections and to create a good and open minded environment for the first meeting in Zagreb.

This document addresses topics affecting the robustness and resilience of dairy production in a very wide scope, from big and intensive farms to small and grass based farms, but for all there are questions which need answers for these systems to become more robust and resilient.

[1] http://www.dairynz.co.nz/media/4106342/resilient-dairy-farming-systems.pdf

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2. Challenges for dairy production systems

A robust & resilient dairy production system should be able to withstand changes from outside its own system. This focus group tackles different types of challenges with diverse sources. From market demands, like demands for more animal friendly production systems to environmental change, like 'warming'. Adaptation to those new circumstances tends to first ensure productivity levels, but the starting point for the discussion of this focus group is how to combine this with the maintenance or even improvement of appropriate animal welfare. Therefore, responses to challenges like high prices of concentrates or low milk prices resulting in low farm income will need to consider animal welfare combined with the economic resilience of the farm.

In this focus group 'robustness' combines both sides of the productivity versus welfare debate. Robustness in farm animals is defined in this Focus Group as *"the ability to express a high production potential combined with resilience to stressors in a wide variety of environmental conditions'* Actions at different levels, including systems level can help achieving this, as they set the broader scene for increasing robustness.

The future is uncertain by definition so we can't make a complete list of factors challenging productivity and animal welfare in dairy systems. Nevertheless, envisioning those challenges is the first and critical exercise to create more robust and resilient production. An initial list of factors from environmental, economic and social domains is proposed below:

- Disease outbreaks
- Reduced effectiveness of conventional treatments (i.e. antibiotic resistance)
- Extreme weather conditions
    - Heat and cold waves
    - High humidity
    - Drought
    - Other extreme weather events
- Temperature stress (heat, cold)
- Feed prices, availability and variability (own produced and imported)
- Availability of skilled labour
- Mild prices volatility
- Grazing days and other prescription of production systems (consumer demand)
- Demand for antibiotic reduction
- Longevity (culling strategies)
- New milk quality demands (components, functional traits, etc.)
- Pollution regulations
- GHG emissions and carbon footprint
- New technology in milking and housing
- More...

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3. The dimensions of robustness and measures to create good conditions

Dairy production has to deal with stressors coming from economic (i.e. changing prices of inputs), social (i.e expressed through new regulations) and environmental (climate change) domains. Therefore, robustness in dairy systems needs to be considered from the three perspectives and not from just one of them. Besides, robustness can be considered at cow, herd and production system (farm) levels since strategies to tackle the different challenges may be envisaged in one or more of those dimensions.
The inter-relation of production and welfare debate has a double perspective. Animal welfare can be considered an important variable for enhanced robustness because it leads to higher productivity under different circumstances and thus improves farm economics or because it's a social requirement framing conditions of dairy production.
Therefore it requires a holistic approach (see figure 2). It goes further than the concept of resource use efficiency, which is often addressed within the dairy practice and research communities.
Obviously, these different dimensions of the robustness *matrix* are completely inter-related and factors affecting robustness may be influencing it simultaneously at different pillars and levels. In many cases it depends on the approach used, the field of expertise, or geographical and cultural background.

The same occurs with the levels of robustness *matrix*: CO2 emissions can be analyzed at cow, herd or production system levels, although importance from robustness perspective and variables involved might be different for the three levels.

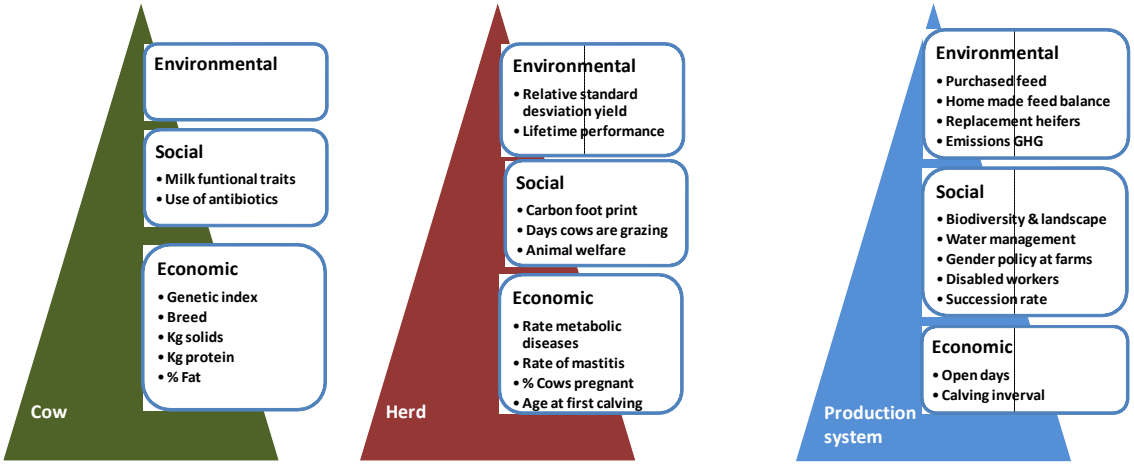

Figure 2 Robustness matrix: 3 pillars and 3 levels of analysis

Robustness is a complex subject and addressing it at farm level poses important challenges. Practitioners in dairy industry and especially farmers need indicators easy to understand and to use which can give an idea of how robust & resilient the farm is, or which are weak aspects to be improved. Nowadays the sector is already quite used to efficiency indicators which evaluate dairy systems with partial ratios referring to kilogram of milk or hectare of farmland. The large number of these indicators sometimes complicates their interpretation and communication to stakeholders. Furthermore, such partial ratios do not account for the whole range of production performance parameters and the holistic insight is frequently missed.[2]
In the next section seven topics are proposed as of major relevance when reflecting on robustness and resilience (R&R) of dairy production from the animal welfare and economics perspective within the robustness matrix. In the subsequent section two topics are discussed which are more related to the environmental issues and, although they are not within the frame of this focus group, they should be borne in mind when discussing measures to increase robustness and resilience.

[2] A.D. Soteriades et al (2015). Agricultural and food science. Vol24: 235-248

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The main aim presenting those topics is to encourage discussion and identify new potentially innovative approaches and gaps in innovation and research. This means that more questions than answers are presented and that some items may be lacking. For every topic some indicators at farm level are proposed (Figure 2).

4. Topics related to robustness and resilience in dairy systems

a. Genetics and breeding

Genetics has greatly contributed to improving dairy cows' yields in the last years. Classical approaches look for animals genetically more efficient in their production environment. In this way selection is closely linked to a particular setting of a given production system and environmental conditions and, at the same time, path dependent. Thus the question arises: if production systems have followed a kind of standardisation pattern at regional level and contextual factors have been quite stable during the previous decades –compared to those foreseen for the future-, is this breeding approach still valid to cope to new changing conditions? i.e cows with increased production potential based on an increased use of concentrates vs. prioritisation of traits conducive to a better valorisation of different types of forage.

Besides, although genetic indexes normally include several traits related to profitability, for many breeders and farmers increasing milk yield has been the main goal. As result many others characteristics were less considered (or even neglected). For instance milk yield records were improved faster and deeper compared to fertility index, strength of immune system or longevity of dairy cows. Nevertheless a higher fertility index leads to an enhanced efficiency in transforming feed to milk and therefore to higher robustness against increased feed prices or growing demands on less GHG emissions.

Dairy cow breeding should also be analysed in terms of adaptation to environmental stressors like heat waves or very humid periods for grazing dairy herds. Breeding strategies are expected to contribute to maintaining dairy cow production under extreme and volatile (i.e seasonal disorders) weather conditions, considering different production systems (i.e indoors vs. outdoors) where relevant variables and stressors may be different.

Genetic indices must have a broader scope than just production. Feed conversion efficiency, longevity, solids, built, immunity are components that could be included in the genetic indices, on several levels; breed, breeding line, animal. Once these indices are available, they should be easy to use for farmers.

b. Animal health and welfare

A low morbidity rate, or rate of disease in farms, is a determining factor for a robust dairy production combined with good animal welfare. Several elements can be considered, starting from the promotion of robust immune systems (i.e through targeted breeding).

Metabolic diseases are a cause of concern in many farms for several reasons. These diseases are often a general problem for the whole herd and they can cause serious economic losses. They are a good indicator when things are not going well in terms of nutrients or balance in ration, and they are generally linked with poor feed economy. New technologies and approaches to reduce these diseases should be developed, especially in the most intensive systems.

The most common disease in dairy farms is mastitis. The cause is usually multifactorial and/or morphological: the shape of the udder, environment, cow comfort, nutrition, among others, may be involved alone or combined. Persistent lameness is another frequent and serious factor affecting both welfare and production, as well as the lifespan of the cows suffering from this affliction..

Milk quality is also related to this item; somatic cell count and risk of presence of antibiotics have a positive correlation with a high morbidity rate.

Overall herd welfare aspects can affect many of the factors mentioned above and animal welfare is also drawing more and more public attention, increasingly influencing consumer choice. Regional differences are significant though.

As mentioned in other sections below, precision livestock technologies offer much potential for detecting health and welfare problems and they can play a major role supporting farmers and farm advisors.

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Cow longevity, which was already mentioned under the previous heading, also depends on management approaches concerning, for instance, life feeding or health (including culling approach). This is another clear point of attention both in terms of production and welfare. It has indeed a clear economic dimension: in dairy herds replacement heifers' expenses is a key economic factor. This factor is the result of multiplying the unit cost of rearing heifers by numbers of heifers reared. There is a lot of information available about the first element (unit cost), but the second one should be further explored. Many questions about this can be raised which also relate to R&R of the farm: how to measure number of heifers, economics of suckler x holstein cross vs black and white males, how many females should be reared depending on farm situation?
Age at first calving is a factor related with replacement heifer rate too.

c. Feeding strategies

Feed is the most important expense in dairy farms and good nutrition is a core aspect of both production and animal welfare. Any improvement in feeding performance would be very relevant in terms of improving resilience in any dairy system. Feeding strategy in general (including feeding autonomy) and feeding efficiency are two key aspects here.
In general terms, feed efficiency in dairy cows is lower compared to poultry or swine. Flat ration is wide spread in dairy herds but compared to mono-gastric, which are flat rationed too, the coefficient of variation in terms of yield, weight or physiological stages is much higher in the case of dairy cows compared to swine or poultry. This is a very weak point in farms where at the same herd cows peaking 52 liters often share the same ration with those at the end of lactation, yielding 26 and often having a 35 liters designed ration on feeder. Thus, to fit rations to cows' necessities in an all year around calving system is a challenge and the same occurs with seasonal calving herds in terms of adjusting ration to physiological necessities. When seasonal availability of feed also varies complexity increases. Aspects like body condition, metabolic performance, and many others come together here influencing both productivity and welfare.

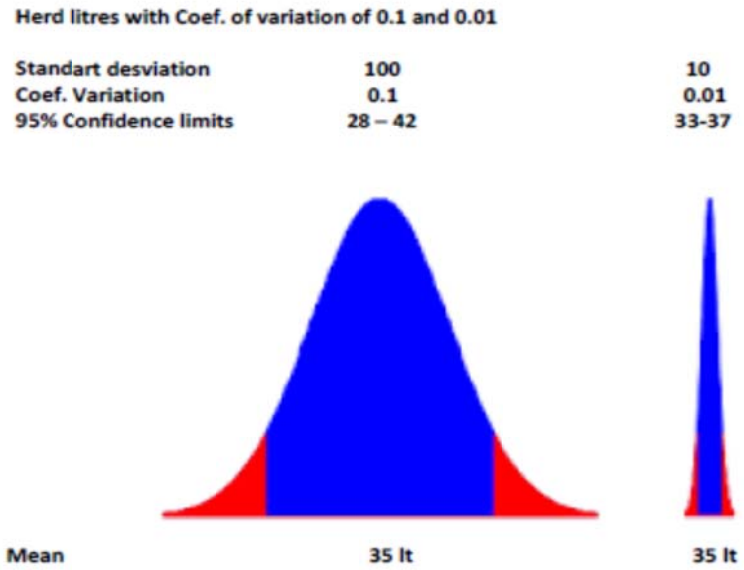

Figure 3. Coefficient of variation

Frequently, farms asses their paddocks coverage in terms of kilograms of dry matter, but how is this ration balanced in terms of cows' necessities regarding energy and protein? For instance, in a grazing system, a 25 liters small dairy cow at peak in late April grazes 17/18 kilograms (DM) of fresh grass with a 22/25% of crude protein content; this makes more than 4 kilograms of protein in daily ration. Nevertheless the National Research Council recommended an average 16% of protein in ration to full fill necessities of those cows (Nutrient Requirements of Dairy Cattle 2001). In this case crude protein in ration is more than 40% in excess. Therefore, precision feeding may become a good tool to improve robustness at production and welfare levels (i.e. concerning metabolic disorders).

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Feed autonomy measures how self-sufficient farms are in terms of forage and concentrates and different metrics can be considered to assess it.
Concentrates are included to balance nutrients in dairy rations, mainly protein and energy, and to concentrate them in terms of energy. Milk /concentrate price ratio was almost constant till 2007 (Figure 4), is this a good indicator to relate the amount of concentrate per liter? According to price volatility we are facing (and most probably will face in the future), a zero concentrate strategy is wise or is not?
The overall feed balance will ultimately depend on feasibility and prices to make [good] own feed and/or possibilities and prices to buy [good] external feed. In terms of resilience, how wise is it to rely on imported feed and how far we should go? This also relates to the importance of obtaining a high quality forage and a good preservation, as well as the presence of the necessary farming skills to meet the requirements of cows with the available forage (in farm or purchased).

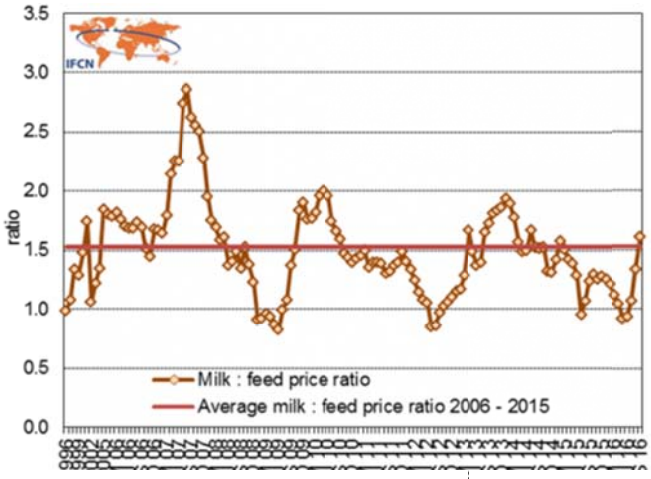

Figure 4. Milk feed price ratio

Forage quality should be considered too, not just in terms of preservation. Try to keep a balance between food requirement for dairy and crops grown is a good task to look at. Farms relying upon maize, for instance, are short in protein resources and those relying on grazing need more energy to balance their dairy cows' ration. This balance between energy and protein produced on farm relates to different aspects of robustness matrix, from just economic perspective to be considered too in terms of animal welfare.
Lifetime cow performance or lifetime daily performance are indicators that gather milk yield, number of lactations and age to first calving in a single measurement. This combination of factors gives a lot of information about herd performance and may also be very relevant as indicator for R&R of a dairy farm.

d. Fertility

Fertility in dairy herds is one of the big challenges farms must face. It seems there is no strong correlation between fertility and milk yield; for many high performance dairy cow herds, poor fertility rates are a concern. These low fertility rates lead to lactations lasting over one year or even longer. Cows' efficiency feed to milk diminishes when the duration of the lactation becomes longer. Besides, in terms of efficiency, feed transformed into fat to be transformed in milk has a lower efficiency than feed to milk directly. Fertility is easy to monitor by e.g. *% Cows pregnant, open days and calving interval*

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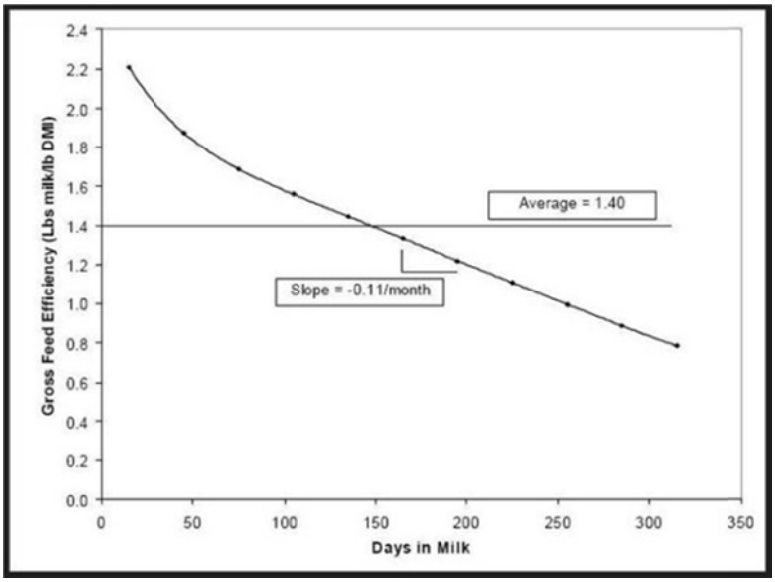

e. Overall production planning

This refers to how the different operational aspects of the farm are organised in view of biophysical resources and conditions, availability of labour, housing and facilities, institutional framework and market demands and prices. For each combination of variables a broad array of production systems may be envisaged with different balance of production and welfare. Skills and training of farmers are fundamental, as well as the knowledge support services around, to find the proper balance in both internal and external contexts of the farm.

f. Housing, facilities and equipment

These are related to different aspects of production and welfare. For instance, resting and thermal comfort or ease of movements are key elements for animal welfare.
New technologies such as sensors and IT allow continuous monitoring and analysis of environmental, physiological, productive and behavioural aspects (i.e. activity monitoring, oestrus detection, milking parameters, etc.). Identified health or welfare problems can be responded to immediately and new knowledge on cause-effect relationship can be quickly generated.

Robotics is another new domain of development within dairy production. Automatic milking is well established in several dairy regions. Challenges remain for combining this and other automation components within certain production systems (i.e. grazing herds) and with some welfare elements (i.e. SCC).

Indoors and grazing systems have different performance concerning welfare aspects and several inter-relations among feeding, health and comfort appear (i.e. thermal comfort vs. access to pasture). Finding the right balance in different production systems poses a challenge.

g. Milk quality

Quality and quantity of milk collected at farms give us a first "customer insight" about farm scale and what measures could be implemented attending to size. Although this is quite likely an old fashioned way to present a farm (number of liters/kg of milk produced per day or year), it still works nowadays. Nevertheless new deliverables are increasingly being considered, following consumer demands and industry innovations: we talk

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about milk quality in terms of fatty acids profile, protein profile, lactose, etc., which can be seen in terms of robustness both from economic or social perspectives (obviously interrelated).
It seems that those elements will be more or less relevant depending on milk factory destination of milk collected. Therefore, coordination aspects of production level with industry level may be also important for enhanced R&R of the dairy farm.
There is a clear relationship between milk components and nutrition, breed and other aspects. In some regions milk components are mostly the same all year round, due to the same feed all year long, but in many others depending on seasonal feed milk components may change with the seasons.

h. Economics

This topic cuts across the seven previous topics. Resilience means the ability to cope with volatile conditions. These volatile conditions could be environmental, climatic, social, economic or others.
A strategic vision, operational efficiency and financial management are the keys but these are probably not widely practiced everywhere in the dairy industry.
It is hard to understand the basic economics of the changing dairy industry or, to have a plan to cope with it. Many farmers focus on production efficiency, which is important, most of topics related before are related with production efficiency, but many farmers seem too often ignore profitability as a general management goal and in decision making. Some production practices may be efficient, but not profitable.
Other than working hard and producing as much milk as you could, not a lot was needed to be strategic on dairy farms in the past. This has changed, and is something many producers are struggling with.
Consistency: It is better to be consistently wrong than inconsistently right. If I have a dairy doing something consistently wrong, it's much easier to identify and correct than if am doing it inconsistently right. Then it's both tough to find the problem and difficult to correct. To be resilient or agile in time of volatility, dairy managers need an evaluation process or system to deal with change, this means to have a proactive plan to cope with changing conditions and not a reactive response. Stay the course once you make a decision to change, and don't try to constantly tweak the plan at every turn[3].

5. Impact of robustness and resilience in dairy systems toward environment

The topics mentioned in the previous chapter are directly related to dairy production itself. However the production system has an impact on its environment, being part of the sustainability. A dairy production system has impact on the quality of air and water. Also the perception of society is part of this environment. Both issues are not to be put in the spot light within this focus group. However when discussing the seven topics (or more in case more are proposed during the work of the FG) mentioned before these issues below have to be borne in mind.

i. Efficiency and pollution

There is a very positive and strong correlation between efficiency and robustness and resilience. In terms of pollution, efficiency is quite important too. Farms increasing nitrogen efficiency a couple of points would raise protein in their outputs and these practices led this farm to recycle less nitrogen as manure, for instance. Furthermore protein worth in milk or meat is much higher than its value as fertiliser in slurry. Concerning this aspect, further reflection on nutrient recycling of livestock manure is conducted by another EIP-AGRI Focus group[4].

[3] Adapted from http://dairybusiness.com/archive/?p=4843 by Dave Natzke
[4] See the starting paper here: https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-agri_focus_group_nutrient_recycling_starting_paper_2016_en.pdf

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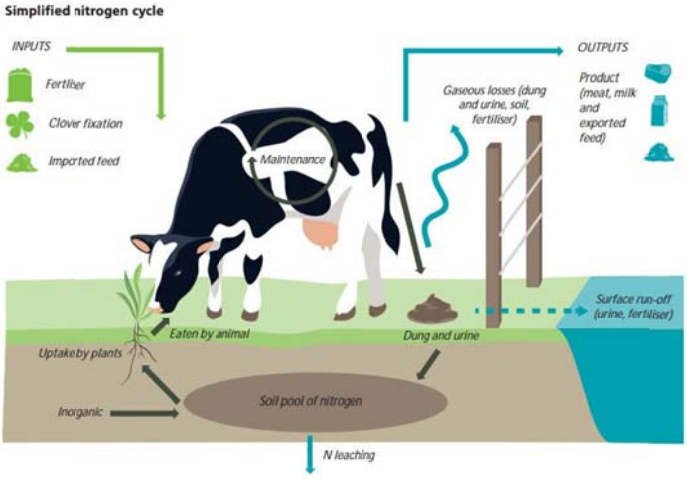

Energy consumption, water use and other inputs, nowadays less relevant in economic terms, should be also considered in the frame of R&R. Availability of water (quantity and quality), energy prices (or even availability of fossil fuels in the long term), or soil depletion are critical elements for R&R. In most of farms there are no consumption indicators and even having them, most farmers would probably find it difficult to rank their farms as good, medium or bad (i.e. in terms of water, electricity, fuel or gas expenses). How resilient is the farm in a water scarcity context or with high volatility of oil prices (which affects not only direct cost of fuel at farm but also other key inputs as N fertilizers)?

A bigger challenge is to address the performance of the farm up and downstream. For instance, calculation of GHG emissions or water consumption and pollution becomes even more complicated when considering processes in the farm input supply chain, but requests for that are increasing as environmental concerns grow. Another **EIP-AGRI Focus Group** is discussing in depth how to reduce cattle livestock emissions in ways that are cost effective for farmers. In the long term environmental, economic and social perspectives come together in this topic.

A good challenge in this realm is to find simple indicators to be measured and which are very easy to understand.

j. Social perception of dairy industry

Social perception of production methods is increasingly influencing production itself, either through the market (i.e. demand for products coming from concrete, sometimes certified or labelled, production systems) or through dedicated policies (i.e. regulations on animal welfare). Especially in the most intensive production areas citizens' concerns about environmental impact of cattle livestock systems, including dairy, is growing. The idea of ruminants as relatively important GHG source is increasingly debated. Nevertheless, most livestock production in the developed world contribute to global warming, but ruminants are able to produce high quality food from cellulose and this is an exclusive characteristic. How to create a friendly atmosphere about these points or at least to put all aspects in the balance should also be a goal for enhancing robustness of dairy systems.

Perceived reduction of animal welfare in dairy systems, especially those more intensive, is increasingly rejected by society in some European regions, where animal welfare-sensitive consumers claim for monitoring and certification systems proving the farm performance in that realm. What's understood by animal welfare can be controversial and public view may not always correspond to science- based knowledge (i.e. demand for more grazing days/pure grazing systems vs. thermal comfort). Different approaches can be considered, from those oriented to biological functioning (towards productivity aspects as health or growth) to those giving to behaviour and feelings the same importance. Nevertheless, animal welfare may be profiled as a strong point of dairy industry. There are no huge dairy factories with thousands of cows, compared to pig or poultry factories. Dairy farms are, in general, based on small and family farms that may be considered much more friendly in social terms.

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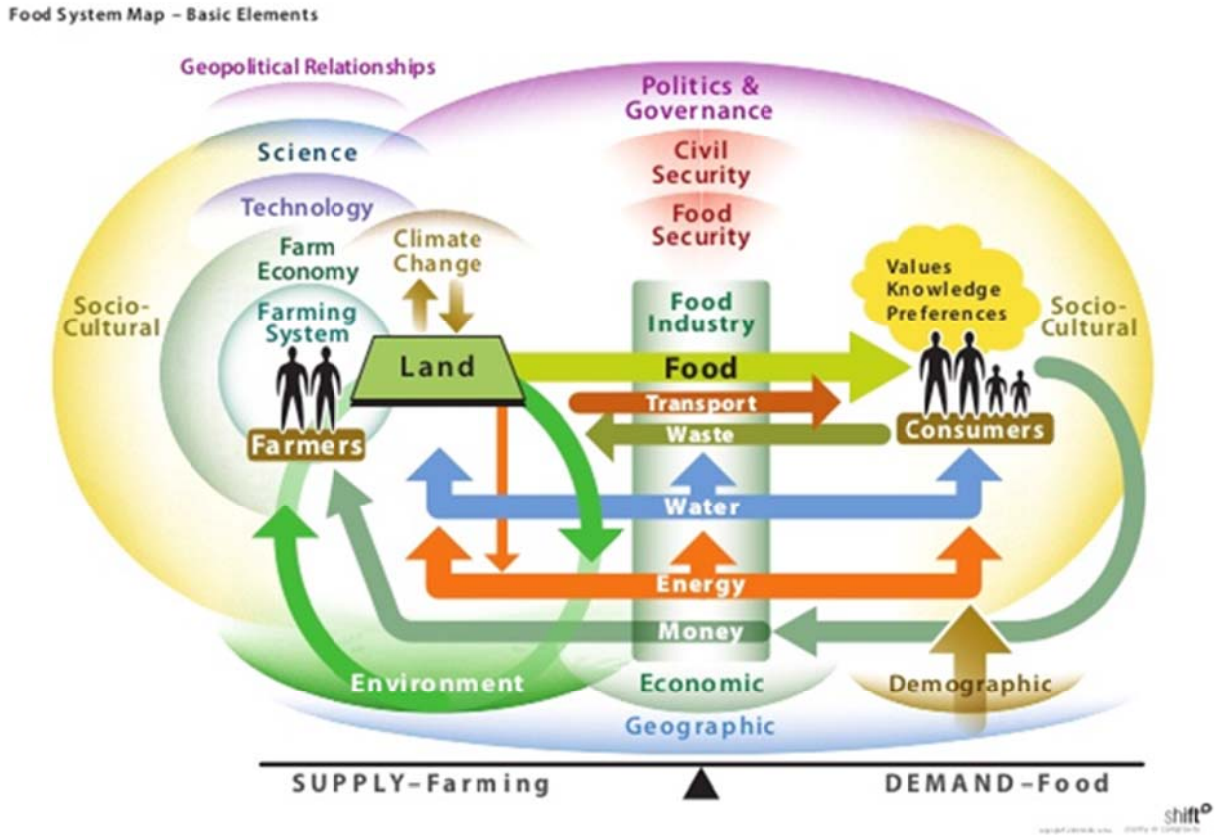
Europe´s landscape is forest, paddocks, meadows, crops, etc., and it has been in this way for centuries. Dairy cattle activity definitively contributes to preserving this landscape in many European regions, and maintaining this landscape would be difficult without cattle farming.

6. Reflections

This is not intended to be a comprehensive list, but reflects some views on the priority areas for improving the R&R of dairy systems in view of productivity and animal welfare.



The task of the FG is not easy, dairy systems are very complex and often there is no 100% solution and compromises between technical, social and economic solutions must be adopted.
Appropriateness to audience must be another issue for this focus group. Metrics are most useful when they provide information to which the receiver of that information can respond. Target audiences vary in their ability to make informed responses to different metrics. For example; consumers are best able to relate to greenhouse gases associated with the production of the product they are consuming, no matter where in the supply chain those emissions arose. However farmers can respond best to the emissions generated within their farm boundary. Some potential indicators were mentioned to strongly link the discussion to field level. Further work is needed to elaborate guidance on the selection of appropriate metrics that could be used.

To rank farms in terms of robustness combining productivity and animal welfare in a very simple and objective way might be a good way to communicate with society. Transparency and easy understanding about what is going on at dairy farms should be another goal for this FG. Dairy products are mass consumer products so to inform customers about dairy product quality in terms of animal welfare, environment, energy efficiency and others items related with sustainability and R&R will add a plus of robustness and resilience to dairy systems.

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The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- ✓ the EU Research and Innovation framework, Horizon 2020,
- ✓ the EU Rural Development Policy.

An EIP AGRI Focus Group* is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, Focus Groups temporarily bring together around 20 experts (such as farmers, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

The concrete objectives of a Focus Group are:

- ✓ to take stock of the state of art of practice and research in its field, listing problems and opportunities;
- ✓ to identify needs from practice and propose directions for further research;
- ✓ to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

Results are normally published in a report within 12-18 months of the launch of a given Focus Group.

Experts are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

*More details on EIP-AGRI Focus Group aims and process are given in its charter on:
http://ec.europa.eu/agriculture/eip/focus-groups/charter_en.pdf

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