EIP-AGRI Focus Group 'Robust and resilient dairy production systems'

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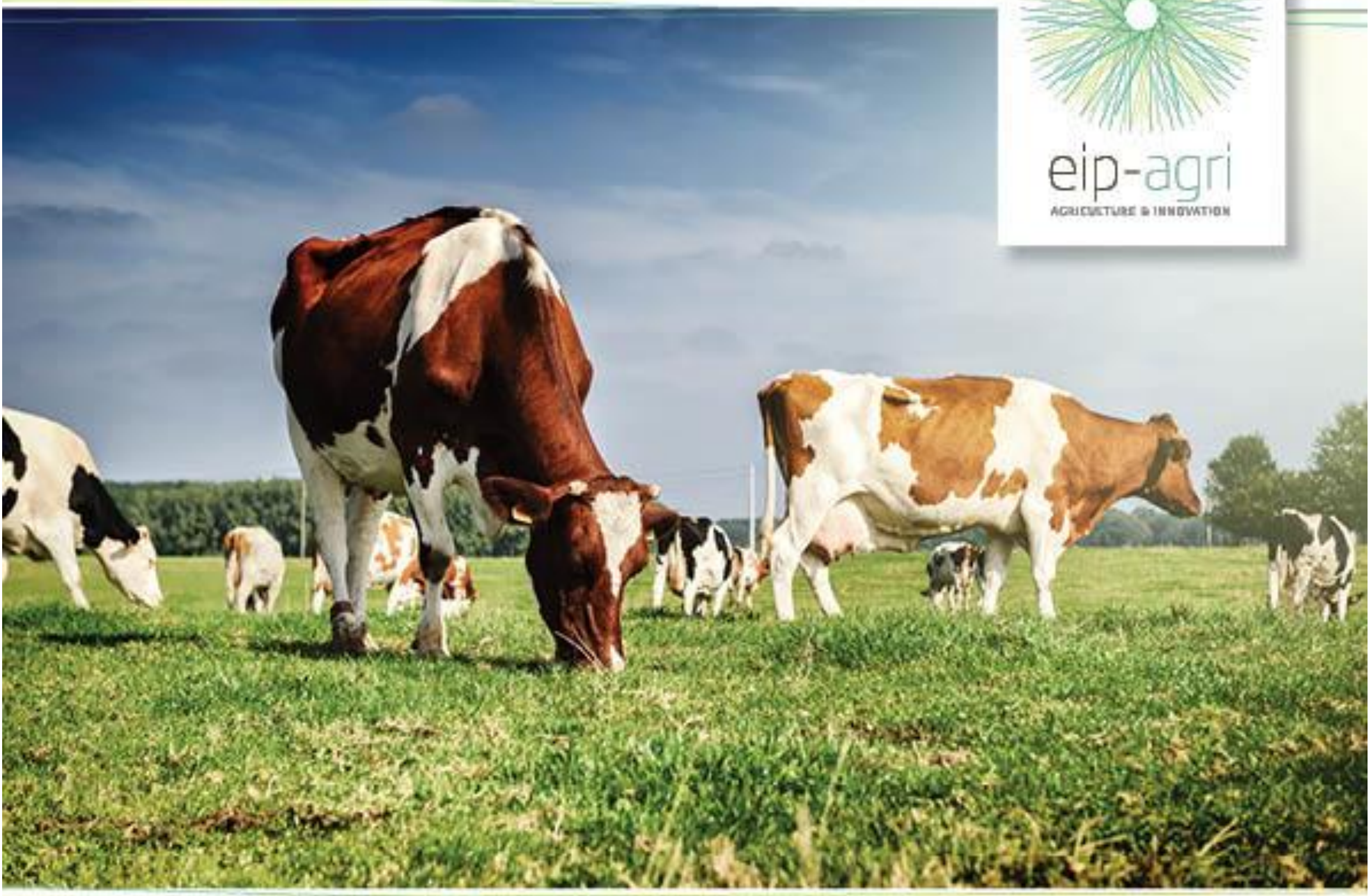

EIP-AGRI Focus Group
Robust & Resilient dairy production systems

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Summary

The competitive environment of dairy cattle production systems is often linked to increased pressure on animal welfare due to various stress factors. It is argued that there is trade-off between production and animal welfare, which includes animal health. However, this is not always the case. The EIP-AGRI Focus Group on 'Robust and resilient dairy production systems' discussed how to combine both of these issues. Robust and resilient dairy farms can cope with these challenges in the context of increasingly volatile economic and environmental circumstances.

Robustness and resilience are considered on three levels: individual dairy cow, farm and sectoral. The Focus Group discussed some of the most promising intervention areas for each of these levels:

- **Individual dairy cow**: new breeding objectives and new precision livestock farming technologies giving accurate information about cow performance.
- **Farm**: a strategic approach is required, benchmarks which are easy to understand need to be developed, including new indicators such as protein or energy self-sufficiency. This may lead to new farming approaches which will require new skills and strategies.
- **Sectoral**: consumers are concerned about issues such as animal welfare, system sustainability and greenhouse gas emissions. When dairy farms can provide ecosystem services, for which they are paid, this helps the dairy industry to become more robust and resilient.

The Focus Group identified seven factors which can enhance robustness and resilience, which were further developed in mini-papers:

1. A genetically robust and resilient dairy cow for the future.
2. Farm management strategies to increase the robustness and resilience of dairy farming systems.
3. The impact of precision livestock farming (PLF) on dairy farm robustness.
4. Societal challenges such as re-establishing strong relationships between consumers and producers and looking for synergies with economic factors to make dairy farms robust and resilient.
5. Sustainable (robust and resilient) dairy cow milk production systems
6. Indicators of robust and resilient dairy production systems.
7. Skills for future robust and resilient dairy farming – curriculum for farmers and advisers.

Experts agreed on five main development directions for dairy systems to become more robust and resilient:

1. Precision Livestock Farming: Data integration & interpretation (different devices/systems)
2. Systems: Put in place a programme for dairy farmers to review/reflect/validate their system of production to achieve 'best practices' for R&R (robust and resilient) dairy production systems
3. Indicators: Create an index, integrating a selection of indicators, that provides R&R scores at an individual, group and system level
4. Skills: Define skills and knowledge for robust and resilient dairy farms and include these in the curricula for different types of farmer training, which are adapted to farmers` needs
5. Socio-economics: Develop milk sector programmes: EU framework national and regional adaptation including regulation, contract rules, including instruments to manage overproduction

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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 stress factors, both environmental and economic. It is argued that there is trade-off between production and animal welfare, which includes animal health. For dairy farm businesses to remain viable, these challenges must be managed to create a state of economic stability combined with cattle health and welfare. The terms 'robustness' and 'resilience' are often used to describe this state of relative stability. Research has been carried out to investigate the means by which this stability can be achieved. The EIP-AGRI Focus Group on 'Robust and resilient dairy production systems' discussed how to combine productivity with animal welfare in the dairy sector.

A robust and resilient dairy production system should be able to withstand changes from outside like drought and volatile prices.

This Focus Group tackled different types of challenges with diverse sources: from market demands, i.e. demands for more animal-friendly production systems, to environmental change, i.e. global warming. The competitive atmosphere resulting from price volatility and uncertainty created by some of these new challenges often leads dairy farmers to focus on productivity rather than animal welfare. However, existing and possible synergies between productivity and animal welfare are receiving increasing attention. This was the starting point for the discussion of this Focus Group. Both animal welfare and economic resilience of the farm will need to be considered when responding to challenges like high prices of concentrates or low milk prices, resulting in low farm income.

The Focus Group focussed on animal welfare and productivity, addressing topics that affect the robustness and resilience of dairy production in a very wide scope, from large and intensive farms to small and grass-based farms. Robustness in farm animals was one of the components in the discussion. The definition by Knap as *"the ability to combine a high production potential with resilience to stressors, allowing for unproblematic expression of a high production potential in a wide variety of environmental conditions"* was used to frame this part of the discussion.

A sustainable robust and resilient dairy production system can recover from or adapt to changes in environmental, social or economic conditions.

Resilience applies to individual animals but also to higher organisational levels such as the farm or system. In the latter, resilience is the capacity of the system to cope with disturbances, and at the same time maintain its functions. More resilient systems are able to absorb larger disturbances without changing their foundations. Resilient systems can adapt, renew, self-organise and learn from change and disturbance. When resilience is lost, vulnerability increases, and the system is no longer able to function properly when disturbances occur.

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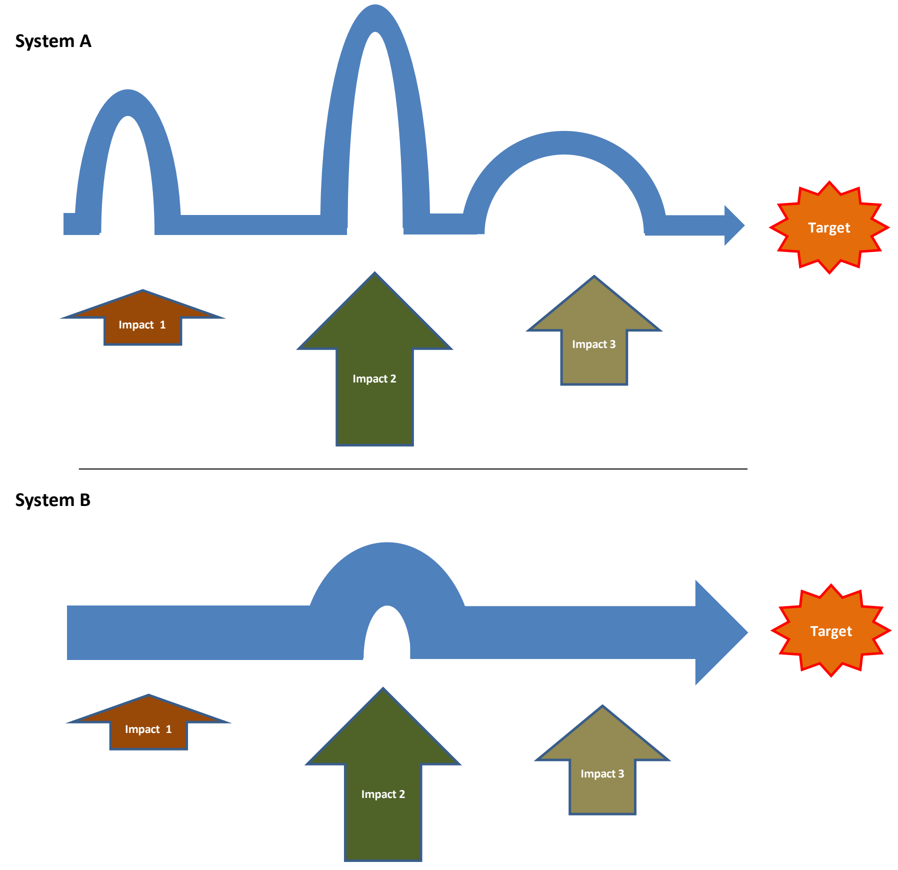

Fig 1 Comparing the resilience and robustness of two different systems

A visual example of robustness and resilience of two systems is explained in Figure 1. If we compare both systems, A and B, in terms of robustness, system B is more robust than A because after impact 1, system B can easily adapt, while system A is not prepared for such an impact.

For example, if impact 1 was a drought period, system B can continue production as usual because it had developed a new crop strategy in case of severe drought. As a result of impact 2, both systems were affected, but system B less than system A. Impact 2 could be for example a demand from society for lower Green House Gas (GHG) emissions, and the reasons behind the higher robustness might be the sum of several aspects: farmers with better knowledge, introduction of legumes as crop or many others. Regarding impact 3, which could represent for example low milk prices, system B is again more robust than A. System B could have made a deal allowing them to temporarily not pay their loan repayments for periods when cash flow is limited.

The width of the blue line indicates that system B is more robust, it stays on target for longer, and it is more resilient, since it recovers faster than system A.

There is a large variety of dairy production systems, each with their own advantages and disadvantages. Ideally the system for a specific country, region or farm must provide a good income and return on investment for the farmer, while maximising animal welfare and health, as well as social and environmental sustainability.
The different levels within dairy farming (cow, farm and system) are considered in this report. They are all interrelated, but they are not influenced to the same degree by the different key variables related to robustness and resilience.

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2 The work of the Focus Group

2.1 Aims of the Focus Group

The overall aim of this Focus Group was to identify how to create good conditions for dairy cattle husbandry in different production systems. The Focus Group looked for approaches and practices which take into account breeding, nutrition, fertility, health, welfare, monitoring, and overall management at every period of the life cycle of the animals. They also had to assess the impact on profitability and sustainability (including animal welfare).

The Focus Group was 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.

2.2 The process

The group met twice. The first meeting took place in Zagreb, Croatia, hosted by the Croatian National Rural Network, on 23-24 November 2016.The second was in Edinburgh, Scotland, on 19-20 April 2017, hosted by Scotland's Rural College.

In preparation for the first meeting, a starting paper was prepared by the EIP-AGRI Service Point team, setting the scene for the Focus Group work. A questionnaire was sent to the experts prior to the meeting to make an inventory of topics which, according to them, could contribute the most to improve robustness and resilience in dairy production systems.

The first meeting of the Focus Group was primarily concerned with making an inventory of relevant topics and related measures and strategies to achieve robust and resilient dairy production. Following these discussions, topics for mini-papers were decided on and groups were formed for the seven topics selected. Between the first and the second meeting, the groups produced mini-papers.

At the second meeting, the preliminary mini-papers were presented and discussed by the whole Focus Group. As a result, the Focus Group prioritised and described the five main *directions* towards robustness and resilience:

1. Precision Livestock Farming: Data integration & interpretation (different devices/systems – indicators)
2. Systems: Put in place a programme for dairy farmers to review/reflect/validate their system of production to achieve 'best practices' for R&R dairy production systems
3. Indicators: Integration of a selection of indicators in an index that provides R&R scores at an individual, group and system level
4. Skills: Curriculum development for farmers. To be organised, dynamic and in time, during the career

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5. Socio-economics: Develop milk sector programmes: EU framework national and regional adaptation including regulation, contract rules, including instruments to manage overproduction

These 5 directions were used to guide the discussion on success & fail factors and to identify the gaps in terms of adoption.

This discussion was continued during the second meeting. Finally, the group discussed the gaps for adoption in terms of research needed and innovations to be addressed. The experts worked out potential innovative actions (Operational Group ideas) to stimulate the knowledge and use of management practices and strategies.

The second meeting also included field visits to two Scottish dairy farms. Parkend Farm, Brian Weatherup and Partners, a dairy farm with Holsteins which had installed 2 milking robots. The 2nd farm was A&S Lawrie Cuthill Towers, an Ayeshire dairy farm. These visits helped the experts to keep a practical implementation perspective in mind while formulating their recommendations.

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3 Towards a more robust and resilient dairy production system

This section explores the key directions identified by the Focus Group experts to achieve robust and resilient dairy production. These directions are addressed at three levels: cow, farm and sectoral. Some directions are relevant for the three levels while others are particularly important for one of them (i.e. PLF at cow level).

3.1 Paths towards more robust and resilient dairy cows

At the level of the cow, genetics and precision livestock farming (PLF) are areas with a high potential to enhance robustness and resilience.

Genetic selection has historically focused mainly on production traits rather than on reducing costs or welfare traits such as fertility and health. Traditionally, breeding values were predicted based on pedigree information. Since 2000 the price of genotyping[1] has dropped dramatically. This has made it possible to introduce genomic selection in many countries and to make progress for other traits rather than those linked only to productivity (i.e. welfare, cost-reduction). Recently gene editing has been proposed as a method to incorporate and fixate genes into animal species. Nevertheless, it is hard to believe that this method will have a significant impact on progress for traits such as resilience and efficiency because these generally quantitative traits are controlled by multiple genes. An alternative to index selection is to find alternative and more robust breeds and increase the genes related to robustness in commercial breeds.

A balanced breeding goal is important to achieve genetic progress for resilience and efficiency. Most countries in Western Europe have either implemented a breeding index or have it under development. An index is an overall score of genetic merit combining the relative economic values of several traits. Resilience is not currently included as a specific trait in any country, but traits like health, longevity, reproduction are included in some way in many countries. Moreover, currently genetic evaluations are done assuming that all environments are equal even though there may be huge differences in terms of weather, herd production, health status, management system (grazing, indoor, etc.). Models need to be developed to handle these differences.

Precision Livestock Farming (PLF) can be defined as the management of livestock farming by continuous automated real-time monitoring or control of production, reproduction, health and welfare of livestock and environmental impact. PLF[2] can be used in several fields related with dairy husbandry, including animal welfare and cow fertility, health, and performance. It can also support the genetic improvement described above by generating valuable data for the development of new selection models.

3.1.1 Animal Welfare

Effects of heat stress on farm animals are one of the greatest challenges for livestock adaptation to climate change. **Heat stress** is a physiological condition when the core body temperature of an animal exceeds its range for normal activity. There is evidence of genetic differences within ruminants with respect to heat tolerance, which may provide an opportunity to include thermotolerance into breeding programs. In consequence, numerous authors advocate the inclusion of this operational genetic trait in animal selection. Besides, heat stress might be a trait of interest for gene editing since Indicus cattle (*Bos indicus*, zebu) seems to be more heat tolerant. Possibly genes could be located and introduced in Taurus cattle (*Bos taurus*, cow) using gene editing.

In daily operations, physiological parameters such as heart rate, body temperature, and **respiration rate** have been demonstrated as adequate and timely **indicators of heat stress** in dairy cows. Therefore respiration rate is considered as a suitable cow parameter for heat stress monitoring, as it is applicable in different weather conditions and because it is easy to monitor without costly equipment. But on the other hand, to date, it is not possible to measure the respiration rate automatically.

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The body surface temperature of animals reflects the blood flow and metabolic rate of the underlying tissues. **Infrared thermography (IRT)** can be used to detect blood flow differentials due to infections and inflammation. IRT has been used in several contexts **to assess disease**. For instance, it has been used to detect hoof conditions associated with lameness in cattle and horses and changes in udder temperature associated with mastitis in dairy cows. However, ambient temperatures will affect the read-out, so careful use is required.

There is also increasing evidence that the emotional state of the animal can be assessed using thermal imaging. This is important, as emotional reactions to stressors is a component of robustness. The degree to which an animal is comfortable to be close to its group-mates is described as **sociability**. Cows housed indoors will have closer individual distances than grazing cattle. This may have implications for stress. Methods have been established to assess sociability and studies have shown that animals show consistency in their social motivation. **Aggression** between animals typically occurs in response to competition for resources such as feed, water or preferred resting areas. Aggression can be genetically assessed and shows consistency. Studies of heritability show low levels, but sample sizes are small. Besides, acceptance that animals do experience emotions has been slow to develop and opinions differ on the nature of emotions and the ultimate functions they serve. Although some work has been done to evaluate emotions, it is still difficult to infer quantitative values of emotions that can be added to breeding models[3].

At management level animals show movement or locomotion in characteristic daily patterns, organised by the **light/dark cycle**, but for dairy cows also by events such as feeding and milking. When considering activity as the ultimate external expression of the internal rhythms in the motivation to feed, rest, drink etc., then activity can be used as an overall indicator of the internal state. Some studies have shown that a lack of synchronisation is shown in animals that are disturbed or unhealthy. This level of synchronisation can only be assessed when activity can be measured over a number of days. These data can be collected using technology such as pedometers or GPS devices.
Research has shown that changes in resting and **activity patterns** can be used to detect health and welfare issues. Lame cows spend longer lying down than healthy cows; these behavioural patterns were shown by cows with mastitis too.
Changes in **locomotion or gait characteristics** are often the first detectable signs of foot disease. Visual gait scoring methods have been developed to assess lameness. Locomotion scoring is a skill that can be taught to researchers and farmers, and it has been widely used. Locomotion or gait scoring has been incorporated into welfare assessment tools such as Welfare Quality® because of its ease of use.

The **stress status** of animals can be assessed by analysing cortisol metabolites in milk. Currently the cortisol level cannot be measured automatically, but in the future systems may be able to measure cortisol concentrations in milk samples, which will make it possible to detect increased stress levels in dairy cows. New PLF technologies to reduce animal stress could be developed when cortisol measurements can be integrated into regular automated milk sampling.

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3.1.2 Animal Health

Systems for early detection of problems such as lameness have a very large social acceptability because they are tools to support better health and welfare of the cows while reducing the use of antibiotics and reducing mortality due to leg issues. Throughout the past 20 years of research on dairy cow **lameness**, scientists have claimed that early detection of lameness is beneficial because affected animals can be treated before the problem becomes too severe. By doing so, long-lasting and costly treatments, production loss and long-term reduced welfare can be avoided. As several types of hoof lesions take time to develop, it may also be difficult for hoof trimmers or veterinarians to identify the lesion causing the lameness and give accurate treatment at such early stages. Identification of problems in hoof shape, on the other hand, may provide information for the optimal timing to apply preventive hoof trimming. Development of detection methods is needed.

Reticulo-rumen boluses are measuring instruments shaped so that they can easily be swallowed by cows. They are equipped with specific sensors for parameters (temperature, pH, pressure) that can be easily related to **rumen function**. Neck collars that monitor animal head movements are also used to estimate the average time cows spend eating and ruminating. The system can send pre-customised alerts when an individual animal seems to be eating or ruminating less than usual. The use of boluses together with neck collars can be a suitable alternative to accurately and reliably alert farmers to the **signs of illness.**

PLF can also be used to detect the **onset of the calving**, which contributes to healthy and safe calf delivery. Information from rumination sensors (neck collars) is usually combined with data from activity sensors to enhance the precision of the predictions.
Calving sensors help to reduce the need for farmer observation. They are useful tools to improve calf survival as well as cow and calf health, which reduce the number of unforeseen events (in other words stressors) and which will have a positive impact on farm profitability. In extensive or grazing systems, where visual control remains difficult, this will make a difference.

3.1.3 Animal Nutrition

Currently, most dairy cows have been bred to produce a lot of milk from good quality forages[4]. Ideally, dairy cows should easily switch from producing a lot of milk to producing less milk, or vice versa, depending on the feed they are given. When breeding and economic conditions are favourable to increasing dairy production, animals should be able to efficiently respond to an increase in nutritional inputs through concentrate deliveries. This flexibility will help dairy farms to become more robust and resilient, as they can more easily adapt to changing market conditions.
Concerning daily ration adjustments, providing concentrates according to milk yield and composition is the best way to meet cows' nutritional requirements and consequently improve lactation performance and **feed efficiency**. The number of available commercial devices to achieve such control is growing. Automatic and controlled feed and water delivery, integrated with other monitoring systems may help to detect concentrate overload or reduced feed and water intake early. Automatic weighing and body condition scoring in passing zones can also be useful, together with milk records, to adjust rations and prevent extreme weight changes.

Systems focused on assessing **feed quality** will ensure that daily rations are prepared based on the real chemical composition of on-farm feeds. There are portable NIR (Near Infra Red) analysers which can be used to determine the main chemical components. Real time composition of TMR (Total Mixed Ration) gives information about rations that can be combined with faeces analyses to determine ration **digestibility**.

Pasture and grazing management are a factor in dairy cattle production systems. The use of PLF tools for this topic was addressed by the **Focus Group on Permanent Grassland**.

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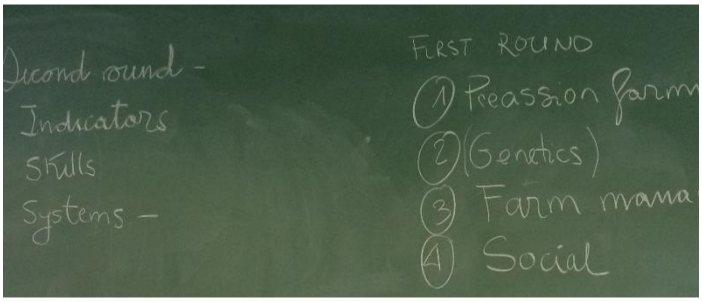
The ability to coordinate lactation, intensity of body fat mobilisation, intake and metabolic health during early lactation, and replenishment of body reserves in late lactation, are major determinants of dairy cattle robustness and functional longevity. Continuous monitoring of variations of **body weight** and **body condition score** (BCS) have been proposed to assess profiles of energy balance and body reserve utilisation, and to phenotype robustness in large field studies. Therefore, collection of daily information about the BCS and the weight of dairy cows is a promising approach.

3.1.4 Milk quality

Better milk quality can help farmers to receive a better price for their milk, which in turn can help improve the robustness and resilience of dairy farms. One element of milk quality is milk composition, and this needs to be considered in relation to the dairy processing chain requirements.

Monitoring milk composition is common practice (Fourier transform infrared (FT-IR) spectroscopy) at commercial milk recording agencies and dairies for routine quantification of major milk components, i.e. fat, protein and lactose content. Several techniques are available.

Moreover, the industry should not be forgotten when defining the breeding purposes. Traits related to milk quality are therefore relevant.



3.1.5 Reproduction

Successful and uncomplicated reproduction contributes to longevity. It is linked to the robustness of the animals, and it contributes to the resilience of the production system by reducing costs. The selection on functional traits as currently implemented will have to be reinforced, especially regarding fertility.

Successful **oestrus detection** is a crucial factor for good fertility in dairy herds. Activity meters (pedometers or neck collars) measure locomotive activity and use peaks in such activity as an indicator of oestrus. These systems have become widespread in recent years.

Commercial systems for monitoring rumination have become available at farm level. Currently, the most successful use of these systems is in combination with activity meters to detect oestrus. In fact, changes in rumination as well as feeding times around oestrus have been demonstrated to be a useful aid for early oestrus detection.

Biological models based on time-series of milk progesterone measurement using automatically collected milk samples during milking have recently been developed and improved. These automated in-line systems can measure milk progesterone and allow **detection of ovulation, pregnancy and infertility**.

It seems that **reproductive performance** is negatively correlated with weight loss (expressed in the body condition score (BCS) during early lactation and may be independent of genetic merit for milk yield. Perceptible changes in BCS are delayed relative to the metabolic imbalance This time lag highlights the need for easily measurable biomarkers of metabolic status/imbalance during early lactation, under different husbandry conditions such as strong variability in feed quality, feed scarcity or thermal stress. Individual real-time approaches, via inline measurement of milk **biomarkers of ketosis, mastitis and ovarian cyclicity** are available commercially. Individual **thresholds of specific indicators (plasma Ca, BHBA** and **NEFA)** have been proposed to determine acceptable **prevalence rates** in farm troubleshooting.

3.1.6 Cow and farming system

The fluctuations in farm environments (input costs, dairy products demand, climate, etc.) reinforce the need for permanent adaptation of the production systems. The animal and its management constitute one of the possible tools to adapt the systems, thanks to its capacity to cope with those changing conditions. The first step is choosing **the right type of cow for the right system.**

For many production systems, **crossbreeding** is a profitable and technically feasible option. As the global economic context for dairy operations is quite volatile, crossbreeding may help to improve the profitability of Holstein farms. Crossbreeding is done to improve: 1) health and fertility in the following generation; 2) slaughter quality; and 3) resilience.

In the future there may be a need for more genetic diversity because cows will no longer be bred for only the dairy volume that they can produce. It is important that **local or regional breeds** are maintained because they represent a genetic, a financial and a cultural resource. It is also expected that many of these dual-purpose breeds will be superior in terms of robustness compared to many of the large single purpose breeds.

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3.2 Robust and resilient dairy farms: from strategy to operation

Robustness and resilience can be considered at farm level too. A robust and resilient farm is able to absorb impacts caused by changes in environmental, social or economic conditions. Farms can either do this by adapting the way they manage available resources while maintaining overall production and performance, or by changing their type of production – in terms of output quantity and/or quality- or by creating added value through processing for instance.

3.2.1 Farm strategies

A robust and resilient farm needs a strategic orientation which can be formalised in a business plan which is consistently monitored and adapted, especially through benchmarking. Strategic orientation is particularly important since

dairy farming requires long term investments, but on the other hand, milk, the main product, needs to be processed or consumed rapidly. A **business plan** and a financial overview of the farm are essential, especially when loans are needed for investments. Costs and income analysis and comparison of own results with colleagues and other dairy enterprises leads to a detailed knowledge of the economic situation and farm perspective.

Permanent observation of circumstances and surroundings, knowledge-based decisions, guided by a strategic plan should allow farms to manage price 'valleys' and to recover in times of stable and prospering income.

Professional economic advice and working groups where farmers exchange their knowledge have been proven as efficient tools to develop the single enterprise and to improve performance and sustainability.

Recent studies[5] showed that it is challenging for farmers to have a clear and continuous target for their business with priorities over long time periods, while taking into account new trends and knowledge. Three strategies appeared as solutions for enhanced resilience:

- **Volume**: labour productivity, well-calculated investments, while preserving the financing capacity. The risks in this strategy are: a high dependence on inputs, the amount of labour, and a risk of excessive investment.
- **Low input system**: mastering the production costs, self-sufficiency, well-measured extension of the farm. The risks in this strategy are: achieving a sufficient level of labour productivity, and mastering a complex production system.
- **Added value**: high prices, a greater self-sufficiency, production under specifications (PDO, organic milk, etc.), and increase grazing in the system. Again the risks in this strategy are: achieving a sufficient level of labour productivity, mastering a relatively complex production system, and finding the market.

3.2.2 Efficient feeding

The three strategies mentioned above imply different feeding strategies. Feeding accounts for around 50% of operating costs of dairy farms[6], and almost three quarters of it derives from purchased feed. A robust and resilient farm is able to cope with scarcity and/or high prices of the main types of feed. These types of farm can adapt their feeding strategies, in addition to having cows able to maintain production with varying feedstuff. At farm level the goal should be to ensure a steady supply of nutrients to maintain the overall output, although eventually adjusting the nutritional balance within the flock.

Three possible avenues for agricultural systems to meet the challenges of adapting to global change and to increase and secure food production could be: 1) designing farming systems based on biological regulation and interactions between the components of the farm; 2) increasing local feed resources and input self-sufficiency; 3) working with local actors.

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Feed self-sufficiency is defined as the balance between the herd requirements and all the resources than can be harvested or grown on-farm. It helps the farm to tackle input cost volatility and climatic hazards, and to improve feed traceability. The main challenge for dairy farms is improving home-grown feedstuff and protein production[7]. In some countries the relatively high availability of land at a moderate price is an opportunity to meet animal feed requirements with home-grown fodder and crops.
When forages are managed to reach high nutritive value, they can be an important protein and energy source to sustain high milk yield and to assure dairy product quality, in both intensive and extensive dairy farming systems. Farming systems with different levels of milk yield, different agricultural setting and different levels of intensification can all increase their self-sufficiency in high-quality forage. This also requires the ability to adapt forage and crop cultivation to farm needs, taking into account climate change. The **use of non-human-edible feedstuffs**, exploring potential feed sources around the farm –i.e. sub and by products of other industries-, may bring adaptive alternatives for some farms when facing scarcity or high prices of regular feed supplies. Another approach is to keep the **link between dairy production, forage and territor**y, contributing to the specificity and the image of dairy products for consumers.

Whichever strategy they choose, farmers should be able to prepare an equilibrated ration for the cows independently of feed composition, and to properly manage the transition when feedstuffs change.
Dry matter (DM), energy and protein self-sufficiency evaluation on-farm can be introduced as indicator of farm robustness and resilience. This is calculated as the ratio between the amount of feed DM, energy or protein produced on farm and the total amount of feed DM, energy or protein fed daily to lactating cows.

3.2.3 Herd management

There are different indicators that can show, combined or alone, the status of critical management aspects at herd level and so partially represent the robustness of the farm. Management is one of the most influential factors on milk yield. For instance, feed quantity and quality, but also milking technique can cause fluctuations in the milk yield.

In order to evaluate the production performance of a cow or herd, and the influence that management factors have on it, it is necessary that animal-related factors are excluded like age, calving season, etc. This is the reason to use the 'Farm Standard Cow' (FSC) indicator. Research at the University of Minnesota has shown that statistical process control analysis of daily milk yield alone detected the onset of disease up to 8 to 10 days prior to the clinical disease.

The higher the **average age of dairy cows**, the higher the resistance of the animals. It shows therefore that the animals are properly adapting to their husbandry system and farm environment. However, we should not look at average age only. Average age, combined with a high lifetime daily yield, low antibiotic daily dosages and low feed costs per kilogram of milk produced, give us a more accurate idea of the robustness of a farm.

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Involuntary culling is when a cow has to be taken out of the herd for reasons that are not of the farmer's choice. The major reported reasons for culling in dairy herds include poor fertility, lameness and udder health. Thus, the **rate of involuntary culling** can provide information on how cows from a certain herd or group are dealing with the environment or the production system. For instance, a high rate of involuntary culling due to fertility failure may suggest that cows are pushed beyond their production capacity.

The **Farm Accountancy Data Network (FADN)** is a European system of sample surveys that take place every year to collect structural and accountancy data relating to farms. These FADN data can be used as basis for benchmarking of resource use efficiency and so provide valuable information on robustness and resilience at farm level. For this purpose, new variables concerning management of the dairy farms should be included (for instance replacement rate, rate first calving age, culling rate or PLF data).

3.2.4 Attitude, skills and support

The skills that are required for modern farm entrepreneurs are evolving. Farmers face the challenge of coping and adapting to a more complex and volatile context. A more robust and resilient farm will strongly rely on farmer capacity to manage farm components in a flexible and efficient way –by herself or with external support-.

For larger farms, with larger herds and a larger workforce, it may be less important for the farm managers to have "hard skills", i.e. Expert knowledge, professional (cow/technical) management, etc. So-called "**soft skills**" such as attitude and behaviour towards employees and co-workers, social competencies, and human resources management, will be more important to balance and to consolidate a large dairy farm enterprise.

Future farmers should meet most of the following requirements: creative, innovative and self-reflecting; able to try something new and to persevere; flexible and adaptable to change; communicative and open to colleagues and society.

Family farms are no longer working only with family members. Working with hired labour makes a difference in **organisational and personal requirements** for the farm entrepreneur. Having employees also provides farmers opportunities to enhance their social life and to participate in society like "regular citizens", not being bound to the farm enterprise 24/7.

The interaction of a dairy farm with its local context may offer opportunities for win-win situations at different levels leading to improvement of efficiency (shared machinery, labour cooperation, alternative feedstuff sources, residues management, etc.). The ability to identify and deploy cooperation options adds value to the development paths of the farm.

A dairy farmer needs to be a multi-disciplinary expert. In fact, most farmers could make better use of innovative practices by using external support to 'translate' the knowledge to their own farm situation. An adviser is a specialist that gives customised advice, taking into account the demands of the farmer, his/her personality and leads him/her to the best solutions for his/her farm. The availability of specific **independent advisers** differs substantially between the member states in the EU. Dairy advisers should have an open mind and willingness to deepen their knowledge and seek further education, which is necessary in order to stimulate and support dairy farmers towards robust and resilient production systems.

A dairy farm adviser should meet the following requirements: being independent from commercial brands; creative, innovative and self-reflecting; have expertise on farm management and economics; be able to perceive strategic decisions and to do business planning; able to coach the farmer under volatile conditions; skilled to organise labour force and automatisation; open minded and open attitude towards innovation and; constantly increase his/her knowledge and education.

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Young dairy farmers need a well-adapted **education and to carry out traineeships** at well-managed farms. This will result in well-skilled young dairy farmers who are ready to start work at their own farm or elsewhere. A good variety of farms with different production systems will enable the young farmer to make the right decisions for his/her own farm and situation. A well-educated dairy farmer will be self-confident, with the skill to be critical. Ensuring that farmers have a high level of education is probably the best guarantee for robust and resilient dairy farms.

3.3 Robustness and resilience of the dairy industry to address social demands

3.3.1 Societal concerns and dialogue on dairy production

Farmers are requested to fulfil contradictory societal demands. Producing quality but cheap raw material for the processing industry in a more resilient way[8]. The dairy industry reacted to society's changing requirements not only by producing new products but also by establishing new standards on the milk production process for consumers (DMK Milkmaster, Arla Arlagarden, Friesland Campina Focus Planet). Without a strong relationship between farmers and consumers and an adequate knowledge of dairy farmers' activities and services to society, consumer demands might ultimately result in dairy farmers going out of business. New requirements and standards often generate additional costs for producers, and the value added by farmers to such products does not always result in an adequate economic return. This could result in solutions which are not feasible on-farm and not economically sustainable, with a consequent further deterioration of the relationship between farmers and consumers.

A widening information gap between farmers and consumers may lead to market failures in the medium and long run, weakening the dairy chain and making dairy farms more vulnerable. Public opinion is increasingly sensitive to health scares linked to food scandals, and these can lead to abrupt drops in demand[9]. Only a strong consciousness of consumers of the overall role played by dairy farms (i.e. ecosystem services, animal welfare, product quality, authentication of products, food security, etc.), and farmer awareness of consumers' needs and demands will ensure that consumer requests can be responded to through applicable and sustainable solutions.

Information and communication are becoming very important to cope with both long term and short term social developments. Such solutions have to involve both the dairy and agro-food industries, with special attention to marketing and communication, transparency for consumers and farmers and a fair share of the value-added by farmers to the dairy products throughout the chain. Policy and regulation, intended as an extension of society as a whole, can also contribute significantly.

Four main challenges can be identified in terms of increasing **social demands**[10]**:** environmental impact (GHG emissions, water pollution, land-use intensification, nuisance), animal welfare (life conditions, human interventions), health (use of antibiotics, disease outbreaks) and breeding management issues (OGM).

Reducing the information gaps between consumers and producers requires better knowledge and understanding of dairy production, and better ways to benchmark it. Furthermore, this knowledge needs to be translated and communicated in a way that the final consumer can understand and appreciate.
For instance, a **better standardisation and comprehensiveness of life cycle calculation for dairy farming systems** must be addressed in future research (for instance, related to **$C0_2$ emission per kg of milk**[11]**)**, including the valuation of ecosystem services of dairy farming. Besides, concerns related to animal welfare, expressed by several parts of society, should be addressed. In this sense, several international dairy companies have run advertising campaigns and labels to demonstrate their respect of animal welfare standards (Arla; 2017, Origin Green; Ireland). Similarly, paying attention to the product's nutritional quality and authentication has become increasingly important.

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In summary, consumer and industry requests and requirements can change quickly, but actual **changes on the farm can take years**. This leads to **the need for a constant dialogue between farmers and consumers**, ensuring that consumers are aware of the time required to change a farm and of the costs that the changes imply. This discussion must also involve dairy industry and policy. In this way market shocks could be mitigated and resilience at farm level would come from improving communication and awareness of the different chain actors.

To start and incite changes in production and production processes, economic incentives may be required. This support can be addressed through subsidies which facilitate modernisation or by a direct remuneration of milk, on the condition that subsidies and milk payments have to be targeted to actions increasing robustness and resilience of dairy farms and/or meeting consumer demand.

3.3.2 New parameters for milk quality

The information need mentioned in the previous section could be addressed via new milk parameters translated into simple and easy indicators (i.e. nutritional quality, environmental impact, animal welfare, etc.) to be placed on the labels of dairy products. Milk processing companies can inform consumers about the different health, environmental or other values of the milk products through labelling or marketing messages.

Current milk payment systems in the EU are mainly based on a base price with some extra prime or penalties, related to milk composition. The parameters on which the extra prime is paid can vary, as well as the threshold, but these are mainly related to industry requirements (i.e. fat, protein, casein contents, butyric spore) and milk safety (Somatic Cells Count and Total Bacterial Count).

Nevertheless, scientific evidence shows that several milk components can be indicators of farming practices and can show which farms are implementing measures to increase farm robustness and resilience and responding to general or local consumer requirements. For instance, concentration of some fatty acids has been associated to feeding systems and farming practices which are related to high environmental sustainability (i.e. use of fresh grass as feed; ruminal metabolic diseases; GHG emissions).

To be effective, these parameters have to be rapidly, easily and inexpensively measured in the milk, as it is now the case for milk fat, protein, casein contents, etc. New, inexpensive and efficient technology has been recently developed for the analysis of these compounds (i.e. based on infrared spectroscopy, the same used for the routine milk analyses of the current parameters for milk payment).

The implementation of more accurate and cost-effective indicators on product labels will enhance information and allow for better matching between supply and demand. Therefore the consumer's request and the farmer's needs should be looked at under a win-win approach, identifying strategies which can be applied on the farm with the lowest possible increase, or reduction of production costs, thus increasing farm robustness and resilience in a quickly evolving social context.

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4 Keeping track in robust and resilient dairy farms

Robustness and resilience are complex characteristics that depend on many variables which are interrelated. Therefore, **farmers need simple and understandable indicators which are easy to measure** to describe and monitor them. This is the first step towards supporting operational, tactical and strategic decisions, and for benchmarking.

A large number of indicators exist, particularly for assessing productivity aspects (production, health, societal concerns such as animal welfare, etc.) in dairy cattle at individual and group level. However, most of these indicators have been designed as 'snapshot' indicators for experimental or on-farm welfare assessment use and **require validation for use in the long-term** which is needed to assess robustness and resilience.

There is also a lack of indicators that provide information on the resilience of farms and systems or relate the robustness and resilience of animals to that of the farm, and also a lack of indicators which link a farm to the overall social context. **Different indicators could be combined to create a single, easy to use index**. Developing this index needs further work and was not addressed in the focus group. This index needs to be adapted to regional conditions.

The Focus Group identified different groups of indicators according to the type of challenge: production, environmental, welfare and health and social concerns.

Some key indicators discussed by the group are presented below for the three levels considered: cow, farm and system.

Indicator	Dairy cow level
Breeding index	Including R&R indicators e.g. cow lifespan, litres per day of life, resistance to environmental stress.
Reproduction	Combining ordinary fertility indices like days in milk, open days, services per pregnancy and others. Easy to understand, to compare and to set a goal for farmers and advisers.
Ability to efficiently convert a wide variety of feed into milk	Measured at individual level; it explains the ability to transform a wide variety of feed (energy, protein, dry matter or other) into milk by the cow. Fatty acids in milk might be a good method to measure this.

Indicator	Farm level
Feed self-sufficiency	Including protein, energy or other elements gives at a glance a good figure in terms of creating more resilient dairy farms to either environmental or economic volatility.
Antibiotics	Amount of antibiotics used per unit of milk, life weight; it gives insight in the disturbances in health due to bacterial infections and indicates disease prevalence and animal welfare too.
Lifetime daily yield (LDY)	It means yield per day from birth to culling, and can be used as an overall indicator of technical performance at the farm, as it averages out total milk production over every day a cow has been alive. It is a very good indicator of performance and puts the cow's health and fertility in the center. It embeds age at first calving, longevity and milk yield.

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Indicator/Index	Social level
Edible food in feed	Ability of dairy cows to transform non-human-edible feed in food is considered an advantage in terms of ethical demands of society.
Antibiotics	Indicator of animal welfare and good use of resources, low use of antibiotics means more healthy cows, better management of herd and more socially responsive farmers.
Water	Scarcity of water is a social concern. Water consumption should be measured according to Life Cycle Analysis (i.e. considering irrigation of forages and crops, etc.)

The second meeting also included field visits to two Scottish dairy farms. Parkend Farm, Brian Weatherup and Partners, a dairy farm with Holsteins which had installed 2 milking robots. The 2nd farm was A&S Lawrie Cuthill Towers, an Ayeshire dairy farm. These visits helped the experts to keep a practical implementation perspective in mind while formulating their recommendations.

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5 Success and fail factors

At the second Focus Group meeting in Edinburgh, the experts discussed directions towards robust and resilient dairy production through the main question 'How to facilitate adoption'. Success and fail factors were identified using the following 4 specific topics which were formulated and selected by the experts:

Precision Livestock Farming	Integration and interpretation of data collected from different devices at farm level to produce alerts and decision support at farm level, and data for benchmarking at system level
Farming Systems	Put in place a programme for dairy farmers to review/reflect/validate their system of production to achieve 'best practices' for R&R dairy production systems
Indicators	Integration of a selection of indicators in an index that provides R&R scores at individual, group and system level
Farmer Skills	Define skills and knowledge for robust and resilient dairy farms and include these in the curricula for different types of farmer training, which are adapted to farmers` needs

Precision Livestock Farming can contribute to robust and resilient dairy farming if the data can be collected without additional costs and workload for the farmer. The information derived from the data should help the farmer in his/her decision making at operational, tactical and strategic level. In other words, data collection should benefit the farmer. Using the information for benchmarking at individual animal/group or system level will contribute to the use of data. A good and independent advisory system with sufficient skills to support the farmer in using the data is needed.

The use of Precision Livestock Farming, and more specific data collection, can be hampered by many factors. There is concern regarding misuse or biased use of data, related to the question of who owns the data[12]. The integration of data from different sources is complex. Often there is no compatibility of data. This is addressed by the **Focus Group on Benchmarking**. Many farmers are not used to working with this kind of information and lack time. The cost of the systems that collect data can be too expensive.

Training of farmers and advisers is a key element. There is also a need for simplification and unification of data collection to facilitate data integration. Common data protocols and platforms are needed. The issue on data ownership should be clarified. Cost/benefit analysis can support adoption of precision livestock farming tools.

It was discussed by the experts that a programme for dairy farmers to review/reflect/validate their system of production to achieve 'best practices' for R&R dairy production systems would support the adoption of such systems. Robust and resilient is not recognised as such by the farmer. Conditions for dairy farmers have changed a lot, stability in output and input prices was usually a given. New parameters of stability and volatility must be tackled in future. We must not only take into account volatility in economics; environmental and societal volatility must be considered too. These unknown aspects and lack of encouragement are considered by experts as fail factors to improving systems and skills.

Incentives are needed for farmers to plan ahead towards robustness and resilience. Benchmarks could be used by the market as an incentive: positive resulting in a higher price or negative a lower price. In the end, a robust and resilient dairy farm results in less workload and a higher quality of life and more welfare for the farmer.

Most people are somewhat reluctant to change; there is apprehension for the unknown. The concept of robustness and resilience is complex for many farmers and they lack knowledge and time to adapt. Tools and support, including coaching, for strategic planning are missing. The concept of robust and resilient dairy farming is missing a set of standard common indicators.
Financial incentives for implementing robustness and resilience are lacking. The current milk price volatility suppresses the willingness to change.

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A framework programme could support the adoption by promoting data integration leading to easily readable and understandable information. These should include positive indicators which are used in a monetary incentive scheme. Farmers should be encouraged to exchange their experiences and cooperate with advisory services and research to develop and share 'best practices'.

Indicators are often mentioned as an important factor in creating the necessary conditions for robust and resilient dairy systems. Many indicators are available for a wide variety of topics and at different levels. The experts considered an R&R index that combines the ratings for different indicators at an individual, group and system level. This index should contain different types of indicators: technical including environmental, financial and social. The index should be reliable and made up of indicators that all stakeholders agree on, easy to use and to understand by both consumers and farmers. There should be visible benefit for the farmer in using the index, and it should support him or her in taking decisions at farm level. The index has to be accessible and useful for all stakeholders.

There are many factors that are blocking the development of this index, most of them have already been mentioned. Aside from the cost, conflict of data ownership and the number of indicators, there is also the diversity in background of farmers but also of other stakeholders. Also, the way that data are synthesised may influence the stakeholders' confidence in the results.

Farmers are at the core of the system. There is a lack of incentives to change farming systems
But education is a key word in creating good conditions for robust and resilient dairy farming systems. The (young) farmer's education should address not just technical skills but go beyond that. It is important to teach the different options for robust and resilient farming and show that it can be dynamic. According to the Focus Group experts, there is a lack of (young) farmer exchange programmes.

It is difficult to reach the big majority of active dairy farmers. To connect to farmers the timing of meetings and training courses needs to be adapted to the farmers` timetable, e-learning systems are a great opportunity which can support this. Smartphone technology brings new possibilities. A group approach (group learning) is a well-known way of exchanging (not only between farmers) knowledge, good practices and skills. Peer groups (including international peer groups) and apprenticeships should not be forgotten. For international peer groups, language can be a barrier.

6 Ideas for research & Operational Groups

6.1 Research Needs

Topic	Research need
Indicators	**Validation of R&R indicators** Analysis of existing indicators regarding different needs depending on adaptability of these indicators to farm conditions, system, region or others
Indices	**Integration of indicators to indices** Indices = indicators classified into groups. These indices benchmark farms' performance to increase their robustness and resilience, indices should be reliable, easy to understand by farmers and some of them by society too
Dynamic indices	**Indices into context** Relating the indices to the farming environmental context by adjusting the weight of different indicators forming every index. Benefit/cost balance must be considered too
Agronomic strategies	**Crop and forage production** Search for best practices and strategies to improve R&R at individual animal or farm level. Improve forage digestibility, protein and energy self-sufficiency at farm level. Farm strategy in terms of crops. Forage alternatives in case of severe drought or other problems
Animal strategies	**Develop locally adapted animals** New parameters for breeding indices should be considered: easy management, food conversion efficiency, health…
Best practices	**Identification of best practices in different systems** Once indices are validated in terms of R&R, best practices that are optimal for each system must be identified
Efficient utilisation of resources	**Life Cycle Analyses; CO_2, N, P efficiency** Coordinate and make reliable methods to measure parameters related to good utilisation of resources at farm level. More efficient farms are more environmentally friendly
Social strategies	**Social demands from dairy industry** Need to know the real opinion of consumers about dairy farming. Surveys about social demands; farmer attitudes to fulfil these demands
Genetics	**R&R breeding** What is the connection between genetics and R&R? To achieve genetic progress for resilience and efficiency it is necessary to have a balanced breeding goal. A balanced breeding goal will ensure progress for productivity as well and cost-reducing traits

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6.2 Ideas for Operational Groups

Topic	Operational Groups
PLF	**Adoption of Precision Livestock Farming** Discussion groups to use PLF and sensors in dairy, how to reach farmers not using these technology or data. Demonstration fields of PLF systems available
KPI	**Key Performance Indicators** Identify indicators to asses if a dairy production system is more robust and resilient. Farmers face to face meeting with advisers, researchers and teachers of agricultural colleges/universities
Labour shortage	**Scarcity of labour force for dairy farms** Identify causes of shortage of labour force at dairy farms. Test new ways for farmers to make effective and efficient teams at farm level. Identify best practices to make jobs at dairy farms more attractive Identify and test potential new solutions, possibly including educational policies to train farm workers
Skills	**Skills needed by farmers and advisers** Test new ways to develop independent advisory services that can enhance the robustness and resilience of dairy farms. What advisory areas are needed to increase R&R of dairy farms? Dairy farmers need to improve their knowledge and have a wider perspective over their farms. Independency of advisers from commercial brands
Social	**Policy of communication** Identify and test new ways to improve communication between farmers and consumers. Cooperation between dairy industry stakeholders: farmers, industry, retailers and consumers. Identify shared interests for these actors
Labels	**Translate indicators into labels** Find and test new easy, visual and reliable ways to address consumer demands: farm or retail dairy product labels should identify and answer societal concerns.v Bonus/penalty system for milk payments including these new parameters
Data	**Efficiency in use of data at farm level** Find new ways to address data ownership in a way that allows farmers to share data and be committed with own farm data

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7 Conclusions/Recommendations

There is no single dairy production system, instead there are many production systems, each with their respective advantages and disadvantages. The system for a specific country, region or farm must be robust, resilient and provide a good income and return on investment for the farmer while maximising animal welfare, health, and social and environmental sustainability.

Precision Dairy Farming and new breeding strategies and instruments offer a high potential to reconcile productivity gains and health and welfare conditions for dairy cows, while also improving the social and environmental performance of dairy farms.

New requirements for education both for farmers and advisers are needed to achieve more R&R dairy farms. What is needed are instruments for the farmers and advisers to manage robustness and reliance. In other words, the right indicators for their individual situation and the knowledge and skills to use these indicators to enhance the robustness and reliance of their farms. The technology is there already, we need to learn how to use it. Most of the instruments are already available and developments will continue, both in the way existing instruments can be used, and in creating new instruments.

Lack of knowledge is a real problem for farmers and advisers, and both groups would benefit from learning more about R&R dairy systems. Farmers and advisers able to plan how to respond to new requirements, how to deal with volatility and societal demands using new technologies are a guarantee of success for R&R dairy systems. "Skill before scale" summarises part of the philosophy of this final report.

The integration of different indicators to create a new index to benchmark farm robustness and resilience is needed. Further research is also needed to give some of these indicators greater consistency, life cycle analysis is an example of this. A reliable index, easily understood by consumers and farmers will contribute to increasing robustness and resilience. A positive communication policy towards consumers, with cooperation of dairy industry and retailers, is needed to explain how the dairy industry contributes to fulfil many social demands in terms of animal welfare, sustainability of systems or rural development.

Indicators for R&R for milk payment might be an effective way to encourage farmers to produce milk under R&R conditions. To create appropriate conditions enabling farmers to work towards more R&R is key, e.g. encouraging protein self-sufficiency. This is not only the farmers' and the dairy industry's responsibility, but there is a role for all stakeholders, including consumers, retailers and policy makers.

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8 References

1. Ranking is done based on the DNA information rather than on the pedigree information of each animal.

2. For a more detailed analysis of precision farming technologies please refer to **Final Report of EIP-AGRI Focus Group on Precision Farming**

3. See i.e. Veissier and Miele 2014, Mendl et al. 2010, Desire et al., 2002; Wemelsfelder et al., 2007

4. Many trials show that it is possible to reach 7000 kg of milk per lactation with Holstein type cows, on a grass based system with spring calvings and with less than 500 kg of concentrates.

5. Fagon, Callaud, Seegers et Dockes, 2017, Les éleveurs bovin lait face aux crises et aux aléas

6. FADN, 2013

7. European dairy farms are becoming more dependent on off-farm and human-edible feedstuff, often imported from other continents (i.e. soybean from South America). According to FADN data, purchase of off-farm feed represented 88% of feed cost increase in the period 2007-2014.

8. On 27 September 1999, the Council of Ministers for Agriculture showed clearly that agriculture in the EU was filled with more aspects than just producing sufficient and cheap food for EU citizens. The multifunctional model of EU agriculture has an important role in the economy and society as a whole.

9. For instance the recent case of Salmonella in baby milk boxes

10. Issues of debate challenging livestock dairy farming (Delanoue et al., 2014)
    Controverses sur l´élevage bovin en France. Séminaire GIS Elevage Demain, 11 juin 2014)

11. Some life cycle analyses (LCA) highlight that there is a lower C02 emission per kg of milk produced in intensive dairy farming systems, compared extensive ones. This may be due to life cycle calculation systems, which may not take into account the carbon stock in the soil from permanent grassland and the losses in carbon stock in the soil by land use for concentrate production in the long term (among other aspects related to boundary setting in LCA methods used). At same time ruminants can valorise proteins which are not usable in human nutrition (the ones from grasslands or by-products), without competition on land-use with other food.

12. See final report of **EIP-AGRI Workshop on Data Sharing**

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List of members of the Focus Group

Name of the expert	Profession	Country
Bodas Raul	Scientist	Spain
Brady Michael	Farm adviser	Ireland
Brocard Valérie	Expert from agricultural organisation, industry or manufacturing; Scientist	France
Coppa Mauro	Farm adviser; Scientist	Italy
Haskell Marie	Scientist	United Kingdom
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Lassen Jan	Scientist	Denmark
Liimatainen Anna	Expert from agricultural organisation, industry or manufacturing; Farm adviser	Finland
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Lund Lecornu Katrine	Farmer	France
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McCormack Pat	Farmer	Ireland
Mirbach Dieter	Expert from agricultural organisation, industry or manufacturing	Germany
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You can contact Focus Group members through the online EIP-AGRI Network.
Only registered users can access this area. If you already have an account, you can log in here
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Annex: Mini papers

Mini-papers produced by the participants in the EIP-AGRI Focus Group

No.	Title	Authors
MP1	Sustainable (robust and resilient) systems of milk production for dairy cows	Michael Brady, Cynthia Verwer, Katrine Lund Lecornu, Kirsten Wosnitza
MP2	The implication of precision livestock farming (PLF) on dairy farms robustness	Jan Lassen, Joanna Marchewka, Gundula Hoffmann, Marisanna Speroni, Raul Bodas, Lazlo Lukacs
MP3	Skills for the future robust and resilient dairy farming - curriculum for farmers and farm advisers	Michael Brady, Isabelle Vuylsteke, Kristen Wosnitza, Leena Suojala
MP4	Farm Management Strategies to increase Robustness and Resilience of Farming systems	Valerie Brocard, Raul Bodas, Dieter Mirbach, Cynthia Verwer, Mauro Coppa, Anna Liimatainen
MP5	A genetically robust and resilient dairy cow for the future	Jan Lassen, Pol Lonch, Leena Suojala, Marie Haskell
MP6	a strong relationship between consumers and producer to make dairy farms robust and resilient: a societal and economical challenge. Looking for synergies for a sustainable livestock production	Kirsten Wosnitza, Katrine Lund Lecornu, Anna Liimatainen, Valerie Brocard, Leena Suojala, Dieter Mirbach, Mauro Coppa, Laslo Lukacs
MP7	Indicators of robust and resilient dairy systems	Raul Bodas, Pol Lonch, Gundula Hoffmann, Jose Pires, Dieter Mirbach, Cynthia Verwer, Marie Haskell

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AGRICULTURE & INNOVATION

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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