EIP-AGRI Focus Group
Permanent Grassland

Differentiation of grass based products for higher market value: linking quality traits and management practices related to the ecosystem services

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Main question

How it is possible to provide a sound link between premium, grassland-based products and their quality in order to achieve/ensure a high market value for them?

Relevance of the topic in the context of the overall question of the Focus Group

In the last decades, consumers have increased their demand for food products with a perceived positive image concerning food safety, nutrition value, healthiness, production practices and the environment in which the production takes place. Grassland-based animal products, especially if pasture-based and of regional origin, are currently positively perceived by the consumers. They carry therefore a potential added value, which should be exploited in form of premium products. This can in turn contribute to sustain the income of farmers and/or counterbalance higher production costs due to management practices aiming to guarantee the sustainability of the production or being due to constraints (i.e. climatic or topographic) in less favoured areas.

In order to successfully establish premium products on the market, several elements should be given.

Product quality can be assessed from different point of views (a quality trait may belong to more than one category):

1. Nutritional composition: Depending on management and diet of the animals, the content of substances known to be relevant to human health is increased. Example: protein, fat (unsaturated, omega 3, …), soluble carbohydrate, vitamin, minerals, antioxidants (polyphenols, carotenoids, vitamin A and E...).

2. Hygiene and food safety: Absence of chemical product residues, of pathogen germs, of dangerous prions, of all substances that have a negative effect on human health.

3. Technological characteristics: These traits relate to the aspect of hygiene and chemical composition, which have direct implication on transformation process of animal products, ripening or on the shelf life of the product (Examples: casein content and composition in milk, *Listeria* and *Clostridium* in cheese, antioxidants content, fat composition)

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4. Sensory characteristics (Example: flavour, odour, taste, texture, juiciness, tenderness, colour, fat colour or proportion in meat, SEUROP classification of meat carcass.) which are a pivotal issue for the gastronomic valorisation of the products.

5. Ethical dimension: This kind of quality is only indirectly carried by the product. By buying the product, the consumer supports specific values: i.e. biodiversity, animal welfare, improvement of the agricultural landscape or of the image of cattle farming (i.e. by grazing animals), traditional management (maintenance of the cultural landscape). Products responding to principles of responsible consumption can be promoted by means of labels:

- 'green': biodiversity, environment (i.e. zero kilometre), animal welfare;

- 'social': fair remuneration of (South) producers;

- 'origin': support to regional economy, specifications including permanent grassland-based feeding.

Besides the knowledge of how quality can be obtained through suitable management practices, authentication and traceability of the products must be ensured, in order to guarantee the product's image. Authentication and traceability may also prevent false advertising resulting in unfair market advantages made by producers not complying with the quality standards or the production practices.

Product authentication is the process by which a food product is verified as complying with its label description[1] (i.e. verifying that the product really possesses certain characteristics ensuring its authenticity). Product traceability is defined as the ability to follow the movement of a food product from site of production, via processing to distribution to the consumer[2]. This is particularly important if the quality of the product cannot be directly or easily assessed on the product itself (i.e. biodiversity of the grassland may not be reflected by i.e. nutritional composition or sensory traits). Analytical systems do not always perfectly discriminate the products ("grey zones"). Thus, decisions should be made in order to either include all products complying with the specification commitments or to exclude all products not complying with them. Both authentication and traceability require affordable monitoring tools in order to be implemented in practice.

For large-scale enterprises, the biggest challenge faced by farmers is to ensure uniform product quality over time (i.e. producing milk with uniform quality over the whole year using a grassland-based diet). However, especially in small-scale enterprises, the lack of a reproducible standard in seasonal productions could be considered a positive characteristic of uniqueness.

Further, the total offer of products with additional values has to be kept balanced with the market demand for these products at a regional scale; it should be possible to deliver as much products as the market demands in the same quality and the same area. For this reason, there is a need of further developing specific markets for these products. In the end, consumer's willingness-to-pay the products is necessary to ensure an adequate remuneration to the farmers.

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State of the art

An analysis of the state of the art concerning the assessment of the quality traits and the authentication methods of the products is pivotal to the identification of the constraints preventing a successful establishment of the products on the market. The following tables aim at summarising the current knowledge.

The assessment of the quality traits are given in Table 1: an overview of the recent literature reporting any difference in the quality traits according to different management practices together with the challenges to the farmers to ensure a constant product quality is presented. The authentication methods are given in Table 2: an overview of the recent literature reporting the use of quality traits or of other methods to distinguish, discriminate or authenticate milk, cheese or meat according to the management practice is presented. Some of the quality traits reported in Table 1 are still not tested for their authentication potential, thus they are missed in Table 2. Superscript numbers refers to literature providing the respective information.

Abbreviations used in Table 1 and Table 2

CLA	Conjugated linoleic acid
DHSME	Dynamic head-space micro-extraction
FA	Fatty acids
GC	Gas chromatography
HPLC	High-performance liquid chromatography
IR	Infrared spectroscopy
MS	Mass-spectrometer
PUFA	Polyunsaturated fatty acids
SPME	Solid-phase micro-extraction
UPLC	Ultra- performance liquid chromatography
VOC	Volatile organic compounds

Table 1. Effect of some management practices on different quality traits, challenges to the farmers to ensure a constant product quality and methods to assess the quality trait. Only quality traits being significantly affected by the described management practices according to recent scientific literature have been taken into account.

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Pasture-based diet (grazing, fresh forage) instead of diet based on preserved forage and/or concentrates	Oleic acids, PUFA, CLA, Omega-3 PUFA, odd and branched chain FA, vaccenic acid	Nutritional/ technological	Milk, cheese, butter and all fat-containing dairy products	Increase [4, 5, 6, 7, 8, 9]	Need to switch to a diet based on conserved forage or even on concentrates in winter, pasture shortage during summer, changes in the botanical composition (i.e. plant families) of pastures due to site conditions, grazing management, seasonal changes (phenology) during the growing season and fluctuations between years, parasitism affecting growing rate and therefore age at slaughter	GC Prediction model of some FA on milk and cheese by IR	Expensive Cheap but reliable only for some FA at the moment
	Omega-6/omega-3 PUFA ratio	Nutritional		Decrease [4, 5, 7, 8]			
	Oleic/palmitic fatty acid ratio (spreadability index)	Sensory/ technological		Increase [10,11, 12, 13]			
	Vitamin A and E	Nutritional/ technological		Increase [14, 15, 16, 17, 18, 19, 21], Increase of shelf life		HPLC/UPLC	Expensive
	Carotenoids	Sensory/ nutritional/ technological		Increase [14, 20, 15, 17, 18, 21], Increase of shelf life			
	Texture	Sensory	Butter and cheese	Increased softness and spreadability [22, 23, 12, 13]		Sensory panel or dynamometers	Expensive
	Colour	Sensory	Milk, cheese and butter	More yellow [14, 23, 12, 13,		IR or visible reflectance spectrum Sensory panel	Cheap Expensive
	Flavour/Odour/Taste	Sensory	Milk, cheese and butter	More grassy and flowery aroma, more intense notes [14, 23, 13]		Sensory panel	Expensive
	Volatiles compounds	Sensory	Milk and cheese	Increase in odour active compounds [3, 24, 25, 26, 27, 28]		VOCs extraction (steam distillation, SPME, DHSME, Purge and trap, etc.) coupled with GC-MS	Expensive

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Pasture-based diet (grazing, fresh forage) instead of diet based on preserved forage and/or concentrates	Omega-3 PUFA, CLA	Nutritional/ technological	Meat	Increase [3, 29]	Need to switch to a diet based on conserved forage or even on concentrates in winter, pasture shortage during summer, changes in the botanical composition (i.e. plant families) of pastures due to site conditions, grazing management, seasonal changes (phenology) during the growing season and fluctuations between years, parasitism affecting growing rate and therefore age at slaughter	GC	Expensive
	Carotenoids	Sensory/ nutritional/ technological		Increase [14, 20, 30, 31, 32, 33], increase of shelf life		HPLC/UPLC Reflectance spectrum of adipose tissue	Expensive Cheap
	Indoles, skatoles	Sensory		Increase [20, 34, 35, 36, 33]		VOCs coupled with GC-MS HPLC	Expensive Expensive
	Flavour/Odour/Taste	Sensory		More animal, more grassy, more intense [20, 35, 36]		Sensory panel	Expensive
	High standard of animal welfare*	Ethical	All				

*The achievement of a high standard of animal welfare requires an optimal pasture management and adequate animal nutrition. Animal welfare may be sometimes higher in the consumer perception than it really is.

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Increase of conserved grass proportion in the diet, reduction or renunciation to feeding maize silage and concentrate, including winter periods of pasture-based systems	PUFA, CLA, Omega-3 PUFA, odd and branched chain FA, vaccenic acid	Nutritional/ technological	Milk, cheese, butter and all fat-containing dairy products	Increase [4, 5, 7, 8, 37, 38, 39]	Changes in the botanical composition (i.e. plant families) of grassland due to site conditions, seasonal changes (phenology) during the growing season and fluctuations between years	GC	Expensive
	Omega-6 PUFA, Omega-6/omega-3 PUFA ratio	Nutritional		Decrease [4, 5, 7, 8, 37, 39]		Prediction model of some FA on milk and cheese by IR	Cheap but reliable only for some FA at the moment
	C18:1t10/C18:1t11	Nutritional/ animal welfare		Decrease [37, 40]			
	Oleic/palmitic fatty acid ratio (spreadability index)	Sensory/ technological		Increase [37, 39]			
	Vitamin A and E	Nutritional/ technological		Increase [17, 18, 19, 21], increase of shelf life		HPLC/UPLC	Expensive
	Carotenoids	Sensory/ nutritional/ technological		Increase [17, 18, 19, 21], increase of shelf life		HPLC/UPLC Reflectance spectrum of adipose tissue	Expensive Cheap
	Texture	Sensory	Butter and cheese	Less firm [14, 23]		Sensory panel or dynamometers	Expensive
	Volatiles compounds (including terpenes)	Sensory/none	Milk and cheese	Higher terpene content [3, 27, 41]		VOCs extraction coupled with GC-MS	Expensive

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Feeding only hay, renunciation to the use of silage in systems based on conserved forage or in pasture-based systems during winter period	Oleic acids, PUFA, CLA, Omega-3 PUFA, Odd and Branched chain FA, vaccenic acid	Nutritional/ technological	Milk, cheese, butter and all fat-containing dairy products	Increase [4, 5, 7, 8, 37, 38, 39]	Changes in the botanical composition (i.e. plant families) of grassland due to site conditions, grazing management, seasonal changes (phenology) during the growing season and fluctuations between years	GC	Expensive
	Omega-6/omega-3 PUFA ratio	Nutritional		Decrease [4, 5, 7, 8, 37, 39]		Prediction model of some FA on milk and cheese by IR [64, 65, 66]	Cheap but reliable only for some FA at the moment
	Oleic/palmitic fatty acid ratio (spreadability index)	Sensory/ technological		Increase [37, 39]			
	Vitamin A and E	Nutritional/ technological		Decrease [15, 17, 42, 18, 43, 19, 21], decrease of shelf life		HPLC-UPLC	Expensive
	Carotenoids	Sensory/ Nutritional/ technological		Decrease [15, 17, 42, 18, 43, 21], decrease of shelf life			
	Texture	Sensory	Butter and cheese	More elastic [44, 14, 23, 45]		Sensory panel or dynamometers	Expensive
	Colour	Sensory	Milk, cheese and butter	Less yellow [44, 14, 23, 43]		Sensory panel	Expensive
						IR or visible reflectance spectrum	Cheap
	Flavour/Odour/Taste	Sensory	Milk, cheese and butter	Less intense, acid, bitter, pungent, persistent, yogurt, fermented cream [44, 14, 23, 45]		Sensory panel	Expensive
	Volatiles compounds (including terpenes)	Sensory/ none	Milk and cheese	Increase [43]		VOCs extraction (steam distillation, SPME, DHSME, Purge and trap, etc.) coupled with GC-MS	Expensive
	Listeria and *Clostridium*	Technological	Milk and cheese	Decrease of late swelling of ripened cheese (increase of safety) in comparison to diets including silage not correctly conserved or consumed		PCR and DNA microbial analyses	Expensive (in some cases not available)

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Occurrence in a certain amount of Plant Secondary Metabolites (PSM)-rich plant species in the forage (chemical fingerprint of animal diet)	Omega-3 PUFA	Nutritional	Milk and cheese	Increase [7, 8, 46]	Changes in share of PSM-rich plants over time (within and between seasons)	GC Prediction model of some FA on milk and cheese by IR	Expensive Cheap but reliable only for some FA at the moment
	Flavour/Odour/Taste	Sensory	Milk, cheese and butter	More intense and increase of stronger notes [23, 13]		Sensory panel	Expensive
	Volatiles compounds (including terpenes)	Sensory/ none	Milk and cheese	Increase [3, 24, 25, 26, 27, 28, 47, 20, 41, 43]		VOCs extraction (steam distillation, SPME, DHSME, Purge and trap, etc.) coupled with GC-MS	Expensive

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Use of local breeds	Texture, taste	Sensory	Meat, cheese	Specific sensory attributes of local breeds products [48, 49, 50]	Maintain high performance or balancing production costs with the lower performances of local breeds	Sensory panel	Expensive
	Milk fat content	Technological	Milk, cheese	Low milk fat content [49, 50]		IR	Cheap
	Fatty acid composition	Nutritional/ sensory	Milk and cheese	Specific fatty acids composition of local breeds [19, 21, 51]		GC	Expensive
	Casein composition	Nutritional/technological	Milk and cheese	Increased casein, different casein profile [39]		IR for total caseins HPLC for casein profile description	Cheap Expensive
	Animal biodiversity	Ethical	All				

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Low management intensity of grassland, low stocking rate, use of suitable breeds flock type, see also PSM-rich grassland*	Biodiversity	Ethical	All		Define minimum management intensity to conciliate production and conservation aims	Presence/absence of bioindicators	Costs depend on the implementation and on logistic aspects, as expert persons and *in situ* assessments are required

* please notice that PSM-rich may occur in high amount also in intensively managed or sown temporary grasslands

Management practice	*Quality trait*	*Quality aspects involved*	*Product the trait is relevant to*	*Effect on product*	*Main challenges for the farmers to keep a constant product quality*	*Available methods of analysis*	*Costs of analysis methods*
Local origin of products	Geographical origin (incl. zero kilometre-origin, mountain origin), preservation of local agriculture and thus of the cultural landscape	Ethical	All				

Table 2. Currently available authentication methods to distinguish, discriminate or authenticate milk, cheese or meat according to the management practice and constraints to their implementation in routine authentication.

Management practice	*Quality trait*	*Product the trait is relevant to*	*Available authentication methods*	*Available methods of analysis*	*Costs of authentication methods*	*Tested in controlled conditions or validated on farm*	*Limits of the methods*
Pasture-based diet (grazing, fresh forage) instead of diet based on preserved forage and concentrates	Fatty acid composition	Milk, cheese, butter and all fat-containing dairy products	Discrimination model on milk fatty acid profile [15, 53, 52, 10], Prediction model of proportions of various feeds based on fatty acid profile [54]	GC	Expensive	On farm	Mixed diets Precision of the models
	Vitamin A and E	Milk	Discrimination model on vitamins content [15, 52]	HPLC/ UPLC	Expensive	On farm (small area and numbers)	Vitamin supplements in the diet
	Carotenoids	Milk	Discrimination model on carotenoids content [15, 52]				Mixed diets. Light exposure
	Phenolic compounds	Milk	Discrimination model on phenolic compound content [55]				Mixed diets
	Colour	Milk, cheese, butter, meat	Discrimination model based on sensory attributes [52, 12, 13] Index based on reflectance spectrum of milk, cheese and meat [15, 52, 17, 31, 32]	Sensory panel Visible or IR spectrum	Expensive Cheap	On farm (small area and numbers)	Mixed diets Mixed diets.
	Flavour/Odour/ Taste/ Texture	Milk, cheese and butter	Discrimination model based on sensory attributes [23, 13]	Sensory Panel	Expensive	On farm (small area and numbers)	Mixed diets Results depends on cheese type + ripening time
	Stable isotopes (δC, δN, δS, δO)	Milk, cheese, butter, meat	Discrimination model based on stable isotopes ratios [52, 56, 57]	MS coupled to a CNSO analyser	Expensive	On farm (small area and numbers)	Mixed diets, for meat: change in feeding regimes, differences between individuals
	Volatiles compounds (including terpenes)	Milk and cheese	Discrimination model based on VOC composition [28, 52, 33]	VOCs coupled with GC-MS	Expensive	Controlled conditions Terpenes on farm	Mixed diets, low analytical repeatability, for meat: change in feeding regimes, differences between individuals
	Infrared Spectroscopy	Milk and cheese	Discrimination models based on IR spectra [58, 61, 9, 30, 59]	IR	Cheap	On farm	Mixed diets, for meat: change in feeding regimes

Management practice	*Quality trait*	*Product the trait is relevant to*	*Available authentication methods*	*Available methods of analysis*	*Costs of authentication methods*	*Tested in controlled conditions or validated on farm*	*Limits of the methods*
Pasture-based diet (grazing, fresh forage) instead of diet based on preserved forage and concentrates	Omega-3 PUFA	Meat	Discrimination model of muscle fatty acid profile [3, 29], Functional genomics? [3]	GC	Expensive		
	CLA	Meat	Discrimination model of muscle fatty acid profile [3, 29], Functional genomics? [3]	GC	Expensive		
	Carotenoids	Meat	Index based on reflectance spectrum of adipose tissue [14, 20, 60, 31, 32]	HPLC/UPLC	Expensive	Controlled conditions	Mixed diets
				Spectrocolorimetry	Cheap	On farm + on-line in the abattoir	Change in feeding regimes; differences between breeds and individuals

Management practice	*Quality trait*	*Product the trait is relevant to*	*Available authentication methods*	*Available methods of analysis*	*Costs of authentication methods*	*Tested in controlled conditions or validated on farm*	*Limits of the methods*
Increase of conserved grass proportion in the diet, reduction or renunciation to feeding maize silage and concentrate, including winter periods of pasture-based systems	Fatty acid composition	Milk, cheese, butter and all fat-containing dairy products	Discrimination model on milk fatty acid profile [15, 53, 52, 10], Prediction model of proportions of various feeds based on fatty acid profile [54]	GC	Expensive	On farm	Mixed diets; precision of the models
	Vitamin A and E	Milk	Discrimination model on carotenoids contents and vitamins content [52]	HPLC/UPLC	Expensive	On farm (small area and numbers)	Vitamin supplements in the diet
	Carotenoids	Milk	Index based on reflectance spectrum of milk or cheese [52]	HPLC/UPLC	Cheap	On farm (small area and numbers)	Mixed diets. Light exposure
	Colour	Milk, cheese and butter	Index based on reflectance spectrum of milk or cheese [52]	Visible or IR spectrum	Cheap	On farm (small area and numbers)	Mixed diets.
	Volatiles compounds (including terpenes)	Milk and cheese	Discrimination model based on Terpene composition [52]	VOCs coupled with GC-MS	Expensive	Terpenes on farm (small area and numbers)	Mixed diets, Low analytical repeatability
	Stable isotopes (δC, δN, δS, δO)	Milk, cheese and butter	Discrimination model based on stable isotopes ratios [52, 56]	MS coupled to a CNSO analyser	Expensive	Controlled conditions	Mixed diets
	Infrared Spectroscopy	Milk and cheese	Discrimination models based on IR spectra [58, 61, 9]	IR	Cheap	On farm	Mixed diets

Management practice	*Quality trait*	*Product the trait is relevant to*	*Available authentication methods*	*Available methods of analysis*	*Costs of authentication methods*	*Tested in controlled conditions or validated on farm*	*Limits of the methods*
Feeding only hay, renunciation to the use of silage in systems based on conserved forage or in pasture-based systems during winter period	Fatty acid composition	Milk, cheese, butter and all fat-containing dairy products	Discrimination model on milk fatty acid profile [15, 53, 52, 10], Prediction model of proportions of various feeds based on fatty acid profile [54]	GC	Expensive	On farm	Mixed diets Precision of the models
	Vitamin A and E	Milk	Discrimination model on carotenoids contents and vitamins content [15]	HPLC/ UPLC	Expensive	On farm (small area and numbers)	Vitamin supplements in the diet
	Carotenoids	Milk	Index based on reflectance spectrum of milk or cheese [15]	HPLC/ UPLC	Cheap	On farm (small area and numbers)	Mixed diets. Light exposure
	Colour	Milk, cheese and butter	Index based on reflectance spectrum of milk or cheese [15]	Visible or IR spectrum	Cheap	On farm (small area and numbers)	Mixed diets.
	Stable isotopes (δC, δN, δS, δO)	Milk, cheese and butter	Discrimination model based on stable isotopes ratios [56]	MS coupled to a CNSO analyser	Expensive	Controlled conditions	Mixed diets
	Infrared Spectroscopy	Milk and cheese	Discrimination models based on IR spectra [58, 61, 9]	IR	Cheap	On farm	Mixed diets

Management practice	*Quality trait*	*Product the trait is relevant to*	*Available authentication methods*	*Available methods of analysis*	*Costs of authentication methods*	*Tested in controlled conditions or validated on farm*	*Limits of the methods*
Occurrence in a certain amount of Plant Secondary Metabolites (PSM)-rich plant species in the forage (chemical fingerprint of animal diet)	Volatiles compounds (including terpenes)	milk	Discrimination model based on VOCS composition [28]	VOCs coupled with GC-MS	Expensive	Controlled conditions	Mixed diets, Low analytical repeatability

Management practice	*Quality trait*	*Product the trait is relevant to*	*Available authentication methods*	*Available methods of analysis*	*Costs of authentication methods*	*Tested in controlled conditions or validated on farm*	*Limits of the methods*
Local origin of the product	Stable isotopes (δC, δN, δS, δO)	Milk	Discrimination model based on stable isotopes ratios [62, 56, 67, 63]	MS coupled to a CNSO analyser	Expensive	On farm (small area and numbers)	Close regions, interaction with diet effects

Research projects and innovative projects relevant to the topic

Research Projects

Eating Biodiversity: An Investigation of the Links between Quality Food Production and Biodiversity Protection (http://www.esrc.ac.uk/my-esrc/grants/RES-224-25-0041/read). Modern food production systems have long been thought of as essentially detrimental to biodiversity. Although the last twenty or so years have seen an increasing number of policy measures and instruments to reduce biodiversity loss in agricultural areas biodiversity is largely conceived as an 'externality' to the process of food production, albeit a positive externality, which responds to societal demands. Increasingly, where food comes from is becoming important as a means of regaining consumer trust. Food that comes from identifiable natural areas is often perceived to be more trustworthy and of better quality than anonymous industrialised produce. In countries such as France and Italy, the specific natural qualities of individual 'terroirs' define not only the agronomic conditions of production but also, and crucially, the distinctive taste and consumption experience associated with the product. By examining selected examples of specific food production chains that fully integrate biodiversity as an explicit means of generating distinctiveness and adding value, this research offers an inter-disciplinary perspective by positioning biodiversity and environmental quality as an integral 'input' to, and component of, food quality. The research is investigating through the combining of social and natural science, the extent to which environmental distinctiveness and quality (specifically the biodiversity of grasslands) in UK food production sites can be actively 'valorised' through the food product chain to ensure the protection, maintenance and enhancement of that natural distinctiveness and quality but also to achieve similarly distinctive quality food products and the socio-economic benefits for producers and rural communities that might accrue from their production.

OriginAlp: quality and origin control of regional alpine food products (http://originalp.eu/en.html). OriginAlp is an Interreg IV project (2011-2014) involving a cross-border cooperation between Austria (North and East Tyrol) and Italy (South Tyrol) and aiming at establishing efficient and fast analytical methods for quality and origin control of regional alpine food products. Regional food samples (milk, meat, apples) are analysed by means of near infrared (NIR) analyses of the. NIR spectroscopy. Reference values necessary for calibrating the NIR method are obtained by high-performance liquid chromatography (HPLC) and gas chromatography (GC) coupled with mass spectrometry (MS) measurements. Isotopic fingerprints of the samples for origin determination are supplied as well.

TRUEFOOD – Traditional United Europe Food (Contract number: FOOD -CT-2006-016264) (http://www.truefood.eu/) – is an Integrated Project (IP) financed by the European Commission under the 6th Framework Programme for RTD. The project started in 2006 and lasted 4 years. The overall aim of TRUEFOOD was to introduce suitable innovations into traditional food industry to maintain and increase the competitiveness of the industry in an increasingly global European market place. For milk and dairy products, Truefood showed it is possible to improve the nutritional quality of traditional products in line with consumer demand, using in particular pasture and fat-rich seeds in the diet of animals.

LowInputBreeds (http://www.lowinputbreeds.org/): Development of integrated livestock breeding and management strategies to improve animal health, product quality and performance in European organic and 'low input' milk, meat and egg production. Work programme topics addressed: KBBE-2007-1-3-07 : Improving animal health, product quality and performance of organic and 'low input' livestock systems through integration of breeding and innovative management techniques.

MultiSward (**www.multisward.eu**).

Implementation examples

Project	*Region, Land*	*Quality aspects the project is related to*	*Quality traits the project is related to*	*Product*	*Obligatory practices for farms taking part in the project*	*Quality traits of the product expected because of production practices*	*Is the product quality being monitored?*	*If yes, by which method?*	*Is there a traceability system?*	*Is the production system certified?*	*Is the product protected by a registered trademark?*
Arctic lamb meat (Arktisk lammekjøtt)[a]	Norway	Sensory, nutritional	Consumer health, local origin of products	Meat	Pasture-fed or concentrate-fed lambs; lowland, mountain, concentrate	Concentrate higher Omega-6	no		no	no	no
PDO cheeses of Massif Central[b]	Massif Central, France	Sensory, nutritional, ethic	Consumer health, organoleptic qualities, local origin of products	Milk, cheese	The combination of obligatory practices depends on the cheese to be produced: pasture-feeding within fixed dates for Salers, requirements of pasture and hay by renunciation to the use of silage for Saint nectaire and Laguiole, requirements of pasture and limitation of the proportion of maize silage during winter for Cantal and Fourme d'ambert (max. 30% resp. max. 50%)	Healthier FA profile, higher sensory quality (but this is not communicated to the consumer)	yes	Sensory panel	yes	yes	yes (but not only based on the grass diet)

AOC Prés-Salés du Mont Saint-Michel[c]	France	Sensory, nutritional, ethic	Consumer health, organoleptic qualities	Meat	Pasture-fed lambs, not to finish the lambs indoors for longer than one month	Higher sensory quality, green product image	yes	Sensory panel	yes	yes	yes
Burgundy pasture beef[d]	Texas, USA	Nutritional	Consumer health	Beef	No hormones; exclusively pasture-raised beef.		no				
Omega Beef Direct[e]	Knockmeal down Mountains, South Tipperary, Ireland, UK	Sensory, nutritional, ethic	Consumer health, organoleptic qualities, traditional management	Beef	Grass-fed and grass-finished breed-specific (Galloway) beef applying transhumance methods to enable year-round grazing, including overwintering on preserved in situ grassland; organic farming.	Higher Omega-3 and Omega-6 fatty acids, distinctive taste	yes	Sensory panel	yes	yes	yes
Pastureland[f]	Minnesota, USA	Sensory	Organoleptic qualities	Butter, cheese	Pasture-fed cows; organic farming.	Improved taste	no				
ARGE Heumilch[g]	Vorarlberg/ Tirol/Salzburg/Oberösterreich/ Steiermark, Austria	Nutritional, sensory	Consumer health	Milk, cheese, yoghurt, butter of cows, sheep and goats	No silage making on farm meadows; renunciation to feeding silage over the whole year; no additives and preservatives	Improved FA profile	no		yes	yes	yes

Biobeef[h]	South Tyrol, Italy	Sensory, nutritional, ethic	Consumer health, organoleptic qualities, animal welfare	Beef	Animals are exclusively feeding on pastures during the summer, on on-farm produced hay during the winter, no silage, no concentrates with the exception ; suckler cow husbandry: calves stay together with their mothers the whole time; organic farming.	Improved FA profile, improved taste, odour and juiciness	no		yes	yes	yes
Kovieh[i]	South Tyrol, Italy	Ethic	Local origin of products, animal welfare	Beef					yes	yes	
Gourmet pasture beef[j]	Tennessee, USA	Nutritional	Consumer health	Beef	No hormones, no antibiotics; exclusively pasture-raised beef.	Lower fat; higher Omega-3 fatty acids, CLA and Vitamin E	no				
QRCheese[k]	Piedmont, Italy	Nutritional/ ethics	Consumer health, local origin of products, biodiversity	Milk, cheese	Correct pasture management, correct use of home-grown and purchased conserved forages. Max 20% of concentrates daily.	Healtier FA profile, improved sensory traits	yes	GC analyses of FA	yes: QR code on cheese giving a link to a report of FA composition and the description of the production chain	no	no

Laugenrind[l]	South Tyrol, Italy	Ethic	Local origin of products, animal welfare	Beef	Grazing in upland pastures is obligatory during summer, prohibition of milk replacers (German: MIlchaustauscher)	Improved healthiness in general,	only SEUROP classification of meat carcass		yes	yes	no
Green Grass Dairy[m]	Veneto, Italy	Ethic, Sensory, Nutritional	Maintenance of cultural landscape, consume health, organoleptic qualities	Cheese	Use of pasture grazing for dairy cows during the summer with limited energy supplements		only within the project framework	NIRS calibration for chemical, rheological and sensory traits	yes	no	yes
Weidemelk[n]	The Netherlands	Ethic	Animal welfare, landscape quality	Dairy products	Grazing of dairy cows for a period which is chosen by the farmer itself (a 5 cent-increase of the milk price is applied in this period)	Improvement of biodiversity and landscape quality, green image of dairy farming	no	no	yes (separate streams of milk collection)	yes (?)	no (?)
Slowfood[o]	Mainly Italy, but few productrs form several countries all around the world	Ethic	Historical heritage	Dairy and meat products, vegetables and fruits, etc. Potentially all local, traditional products	none	none	no		no	no	yes

Homepages of the mentioned projects:
[a]http://www.bioforsk.no/ikbViewer/page/prosjekt/hovedtema?p_dimension_id=19681&p_menu_id=19690&p_sub_id=19682&p_dim2=19683, [b]http://www.prairies-aoc.net/, [c]http://www.aop-pressales-

montsaintmichel.fr/qualite_viande.php, [d]http://www.burgundypasturebeef.com/, [e]http://www.omegabeefdirect.ie/, [f]http://www.minnesotagrown.com/wholesaler/pastureland-cooperative/, [g]http://www.heumilch.at/, [h]http://www.biobeef.it/, [i]http://www.kovieh.com/de/, [j]http://www.gourmetpasturebeef.com/ [k]http://www.formaggio-rivetdor.it/, [l]http://www.laugenrind.com/cms/de/laugenrind.html, [m]http://www.grunalpepennar.it/, [n]http://www.weidemelk.nl/, [o]http://www.slowfood.com/

Research needs from practice

Develop affordable and rapid analytical methods for routine authentication and traceability, including a validation on a large scale in order to take the between-animal variability (genetic component) into account.

Optimise a set of markers able to ensure a good discrimination of the products based on management practices and/or origin (i.e. multiple markers or in more than in one tissue).

Validation on a large scale (large number of commercial farms representative of European farming system and practices) of authentication methods developed at a local scale under controlled conditions or on-farm.

Optimise authentication and traceability protocols minimising the bureaucratic effort of farmers; exploit the potential of ICT-based tools.

Refine the understanding of the effect of botanically diverse composition of pastures and forage on the product quality.

Define management practice ensuring a constant quality over time.

Define management practice enabling to take advantage of the occurrence of legumes in the pastures without sensory defects in the lamb meat (too strong flavour arising from skatole and indole production in the rumen).

Appraisement of the relevance of ecosystem services for product improvement (i.e. improvement of biodiversity of pollinators and plants in order to improve honey yield and honey quality). Study and model the trade-offs between product quality traits and other ecosystem services.

For grazing animals, synchronisation of feed demand and grass on offer on pastures (see the mini paper "Help farmers to manage grassland production versus animal needs").

System and participatory approaches with multiple stakeholder types.

Ideas for innovative actions

The EIP program should support innovative operational groups in the European Community on the purpose to link together:

Permanent grasslands - products - territories

• Ensure the sustainability of farming, agro-processing firms and territories providing professionals with a set of tools that enable them to develop and promote quality products based on enhancement of grassland-based production systems, especially in mountain areas and with associated woody vegetation. These areas have indeed natural, historical and social characteristics that specifically needs to be transformed into assets, enabling the outstanding intrinsic (nutritional and sensory values) and extrinsic (ecosystem services) qualities of their products to be recognized by consumers.

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• Support projects and works carried out in this field throughout the territories with the aim to establish recognized operational groups and to participate actively in regional development.

• Define marketing arguments ensuring valorisation of permanent grass-based products to consumers.

• Create a European network (movement) of producers sharing the same management strategies for producing grassland-based products. Define quality standards for them.

The expected socio-economic impacts are primarily aimed to

• create wealth on the entire sector, sustaining the continuation of farmers in mountainous area and the development of local processing of milk and meat,

• create differentiated offerings, develop new products and services and increase the value of products in sectors recognized by the market,

• enable economic diversification territories (e.g. the development of "baskets of goods", associating food and activities related to agro-tourism and eco-tourism) and development planning (landscapes, local breeds, natural and cultural heritage),

• improvement of public health, reduce environmental impact.

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